The Armagh Observatory Business Plan 2012/2013

Business Plan for Period 2012 April 1 to 2013 March 31

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0 Executive Summary

This Business Plan shows how astronomers at the Armagh Observatory will deliver on the Observatory's key business areas in support of the Northern Ireland Executive's Programme for Government, the cross-cutting STEM Strategy and key actions and objectives of its sponsor government department, the Northern Ireland Department of Culture, Arts and Leisure (DCAL). First, we provide an introduction to the organization and the principal research themes in astronomy and related sciences addressed by staff in the Observatory and their international partners. The Observatory has a high-quality computing infrastructure, and a library, archives and astronomical museum collection that is one of the premier specialist collections of its kind in the UK and Ireland.

The Observatory's principal function is to carry out international-quality research in astronomy and related sciences in order to expand our understanding of the Universe and of humanity's place in it. Staff at the Observatory also have secondary, but no less important, responsibilities to (1) promote, preserve and widen access to the heritage of astronomy at Armagh (the Observatory is the oldest scientific institution in Northern Ireland with a heritage spanning the development of modern astronomy over more than 200 years); (2) maintain the continuity and precision of the daily weather readings at Armagh (the Observatory contains the longest daily climate series from a single site in the UK and Ireland, stretching back nearly 220 years); and (3) pursue a vibrant programme of Science in the Community in support of the Northern Ireland Executive's STEM Strategy and the strategic goals of the DCAL's Learning Strategy. Taken together, these activities feed into many areas of government policy, particularly those directed towards improving the economy, education and lifelong learning and the attractiveness of Northern Ireland to national and international visitors.

Section 2 of the Business Plan presents relevant trends from the Observatory's key historic performance indicators as well as other results from the Observatory's 2011 and 2011/2012 financial year outturn. These provide the basis for a set of key performance indicators and SMART targets for 2012/2013, aligned with the Observatory's primary functions and with the policies of the Northern Ireland Executive and the DCAL.

Key Observatory objectives during 2012/2013 are to (1) obtain external grants and funding to support new research projects; (2) strengthen the Observatory's research capacity in astronomy and related sciences by recruiting 2–3 PhD students and providing a high-quality research environment to facilitate their advanced training and that of other Observatory staff; and (3) build on the Observatory's involvement in the DCAL Learning Strategy by developing new initiatives in education and public outreach associated with the Observatory's programme of Science in the Community.

As well as these objectives, the Observatory intends to progress plans for the design of a new Library, Archives and Historic Scientific Instruments building, a project that plays a central role in the Observatory's forward look. The Observatory has an important function to promote, preserve and widen access to the Observatory Grounds and to the library, archives and museum collection at Armagh, which together represent a very significant component of Northern Ireland's scientific heritage. During 2012/2013 it is intended to continue, as resources allow, a programme to improve the documentation, digitization and storage conditions of the historic library, archives and astronomical museum collection.

The resources to carry out these activities are identified in Section 3 of the Business Plan. Appendix A provides more details on how these Observatory-driven objectives align with those of the DCAL's Museums Policy and the Northern Ireland Executive's Programme for Government, while Appendix B provides further information on the interpretation of the Observatory's key performance indicators.

1 Organization and Funding

The Armagh Observatory is the oldest scientific institution in Northern Ireland, the longest continuously operating astronomical research institute in the UK and Ireland. There is a fluctuating population of approximately 30 academic staff, which at the end of 2011 comprised 6 Research Astronomers and 24 other academic staff (including the director, several PDRAs and around a dozen PhD students) as well as several academic visitors, 2 core research and 4.5 core grounds and administrative support staff. The Observatory has an active visitors programme, each year hosting between 10 and 20 temporary academic visitors from abroad, people who visit Armagh for periods of typically a day or two ranging up to several weeks at a time, as well as PhD students that are co-supervised by Observatory staff but based elsewhere.

The group operates on the international stage and is underpinned by core funding from DCAL and the receipt of external grants from the UK Science and Technology Facilities Council (STFC) and other grant-awarding bodies. The total expenditure of the Observatory is in excess of £1M per year, of which approximately three-quarters is directed towards research. In 2010/2011, for example, £122.4k was spent on administration and corporate governance (cf. £107.5k in 2009/2010); £179.3k on buildings and grounds (cf. £145.3k in 2009/2010); and £1266.7k on research and related education and public outreach projects (cf. £1093.8k in 2009/2010).

Core DCAL funding for 2011/2012 was £1030k, with additional non-cash resource funding to allow for depreciation (£119k + £15k) and pension costs (£81k) totalling £215k. The Observatory is also able to bid for additional in-year funds to support various research, education and public outreach, technical equipment and infrastructure projects that cannot be progressed using core funding alone. In 2011/2012 such bids provided a further very significant contribution of additional DCAL funding (Resource plus Capital) amounting to £104.5k. The balance of income in recent years, largely made up by external grants, has averaged around £250k per year, but in the last several years has provided rather more additional income than this (approximately £300k per year). This success in attracting external grant income is unlikely to be matched in the short term, as external grants are increasingly hard to obtain owing to reductions in the budget of the Science and Technology Facilities Council and increased competition from UK university groups for the numerically fewer available grants. It is noteworthy that the use by Armagh Observatory staff of UK facilities located abroad or in space corresponds to a further very significant element of external income, averaging of the order of £0.5M per year over the past decade. This 'in kind' contribution to the Observatory's research arises through collaboration between Armagh Observatory staff and other research groups, and central UK government subscriptions to facilities such as the European Southern Observatory or the European Space Agency. Thus, the Armagh Observatory provides a very high rate of return on Northern Ireland government investment in astronomy at Armagh.

1.1 Research Environment

Year	Research Astronomers	Other Academic Research Staff	Core Research Support	Core Grounds and Admin.	External/Visitors and Others	Total
2001	6	14	3	4	4	31
2002	5	14	3	5	3	30
2003	5	14	3	5	3	30
2004	5	18	3	5	4	35
2005	3	16	3	5	3	30
2006	3	16	3	5	4	31
2007	6	18	3	5	5	37
2008	6	20	3	5	6	40
2009	6	21	3	5	6	41
2010	6	21	3	5	7	42
2011	6	24	2	5	6	43

Table 1: The head-count of Armagh Observatory staff in various categories at the end of each calendar year, over the last ten years. Table last updated 2012 April 14.

1.1.1 Principal Research Themes

The Observatory carries out front-line astronomical research in three key areas of astrophysics, namely: Solar-System Science, Solar Physics, and Stellar and Galactic Astrophysics. Solar-System research encompasses the dynamical structure, evolution and origin of objects in the inner and outer solar system and comparative planetology and meteor physics. Solar research uses data from spacecraft such as SoHO (Solar and Heliospheric Observatory), Hinode, Stereo and SDO (Solar Dynamics Observatory), and from ground-based facilities such as the Dunn Solar Telescope at Sacramento Peak Observatory and the New Solar Telescope at Big Bear Solar Observatory, to study fundamental questions such as how the Sun's outer atmosphere is heated, what drives the solar wind and the Sun's variable magnetic activity and its resulting effect on the Earth's climate. Stellar and Galactic research includes a wide range of investigations into the formation and evolution of stars, taking into account factors such as mass loss through stellar winds, studying stellar oscillations, stellar magnetic fields, extreme chemical abundances, understanding the details of accretion physics and conducting wide-field surveys to discover a diverse range of astrophysically important short-period variable stars. These research themes illustrate the Observatory's primary long-term research function. The projects are often funded by external (i.e. non-DCAL) funding agencies with lead times of typically a year or two; they are normally led by an individual Research Astronomer and often require up to 3–5 years for completion.

1.1.2 Computer Facilities

Computer facilities are used primarily for numerical analysis, computer modelling and data reduction; the computers and peripherals are largely funded by the DCAL, but occasionally by external research grants, for example those funded by the STFC, The Leverhulme Trust and various EU grants. Staff have access to a number of powerful iMac and Linux workstations, as well as the Stokes supercomputer at the Irish Centre for High-End Computing (ICHEC) and, through ICHEC, to occasional advanced computer training programmes. In addition, the Observatory has two high-performance computer systems: one ('Polar') with 4 × 64-bit AMD Opteron processors each having 16 cores giving a total of 64 processing units; the other ('Eddington') with 2 × 64-bit Intel Xeon processors each having 8 cores giving a total of 16 processing units. These computing resources are used mainly for computationally intensive research projects in observational and theoretical astrophysics (including data reduction and modelling) in areas such as solar physics, stellar atmospheres, stellar winds, radiation hydrodynamics, numerical magneto-hydrodynamics, and solar system dynamics. In addition, the Observatory has over 100 TB of on-line storage capacity. The internal network is a 1 Gbps backbone ethernet linked with switched hubs and the external network is connected to the Joint Academic Network (JANET) through a 100 Mbps link provided through the Observatory's participation in the Northern Ireland Regional Area Network (NIRAN).

1.1.3 Library and Archives

The Observatory's suite of technical equipment is complemented by a Library and Archives that is one of the premier specialist collections of its kind in the UK and Ireland. The library, archives and museum collection together comprise a unique and growing collection of historic books and manuscripts, as well as images, photographic plates, scientific instruments, clocks and other artefacts concerning the development of astronomy in the UK and Ireland over more than two hundred years. These rank amongst the leading collections of their kind in the UK and Ireland. In recent years more than 25,000 records have been added to the on-line, publicly accessible archives and library database, with many linking to associated images or digitised documents. The library catalogue with over 3,000 entries is also on-line.

In recent years the Observatory has implemented a rolling programme of improvements to the main Grade A Listed building, historic telescopes and telescope domes, supported by funding from the DCAL and other bodies (e.g. the Heritage Lottery Fund) totalling c.£700k since 2001. An important Capital project is construction of a new Library, Archives and Historic Scientific Instruments building. This must provide an addition to the Observatory complex that will complement and enhance the existing Grade A Listed building, and its later developments, and fit sensitively into the historic building complex in a way that reflects the Observatory's research function and its more than 200-year historical development. The new building must also provide additional space for academic staff; adequate space properly to house the collection and provide for its future needs in an appropriately controlled environment; and rooms to conserve and display on a rotating basis the Observatory's fascinating and unique historic material. During 2009 a grounds survey was completed and a draft outline specification for the new building was passed to CPD architects. Efforts will be made during 2012/2013 to build momentum for this key Observatory project.

The meteorological archive contains what is believed to be the longest continuous daily climate series from a single site in the UK and Ireland and one of the longest in the world. The climate station has been continuously maintained since 1795, with readings currently taken every day at 09:00 (GMT). Calibration of these data has enabled researchers and government agencies to use the Armagh series for reports and research into global warming. This is a subject of strategic importance for Northern Ireland as we move into an era of rapid climate change. The Armagh Observatory's climate record provides a long historical baseline against which to judge how Northern Ireland's climate is responding to climate change world-wide.

Heritage Policy The Observatory's heritage policy is to progressively restore the historic buildings and scientific instruments in its possession, placing the restored material where possible close to its original location in the main Grade A listed building. The objective is to maintain the integrity of the Library and Archives as a coherent collection for future generations in the City of Armagh and to preserve this historic material and improve the environment in which it is held. The Observatory also seeks to widen access to this material so that researchers or visitors to the Observatory's web-sites, and others who may use the Observatory's facilities, will be able to use the material for individual research projects and appreciate more clearly the context in which the historic material was first used. As part of widening access we have commissioned eleven 'Virtual Visits' (http://star.arm.ac.uk/virtualvisit/), which are available to everyone through the Internet. The Observatory's Library and Archives is a rich scientific, educational and cultural resource, reflecting the Observatory's position as Northern Ireland's oldest scientific institution.

1.1.4 International Standing

Armagh Observatory staff also have access to world-class international facilities provided through STFC and UK Government subscriptions or bilateral agreements and collaborations involving individual Armagh Observatory research staff. Observatory staff regularly obtain telescope time on national and international facilities such as the ESO Very Large Telescope (http://www.eso.org/outreach/ut1fl/) and various spacecraft missions (such as SoHO, SDO, Hinode, Stereo, Swift, XMM-Newton, and the Hubble Space Telescope). They obtain research grants from a wide range of grant awarding bodies (e.g. the STFC, the Royal Society, the Leverhulme Trust, British Council etc.), and through the Observatory's membership of the UK SALT Consortium (UKSC) have access to the 11-metre diameter Southern African Large Telescope (SALT; see http://star.arm.ac.uk/SALT/), located at the Sutherland Observatory, South Africa. Complementing these international facilities, restoration of the Observatory's historic telescopes has brought opportunities to reintroduce some visual observing from Armagh, while new computer and camera technology has enabled a variety of new automatic observational programmes to be introduced from Armagh, recording data autonomously whenever the sky is clear.

1.2 Science in the Community

1.2.1 Key Audiences and Outputs

The Observatory's principal research findings are published in the international scientific literature in the form of refereed journal publications, books, articles in conference proceedings (refereed and unrefereed), and in a variety of other media (e.g. web-sites, astronomical telegrams etc.). The number of refereed journal publications over the years is illustrated in Figures 1 and 2.

The initial beneficiaries or **audiences** of this work are members of the international astronomical community, for example our work developing new software for modelling stellar evolution and measuring stellar magnetic fields, and new theories and population codes for modelling stellar remnants and identifying new stellar tracers of Galactic structure. Similarly, in space astronomy our survey work will impact on space missions such as Kepler, LISA and PLATO; our work with the Atomic Data and Analysis Structure (ADAS) software on the Solar Dynamics Observatory (SDO) filter sets impacts on groups world-wide in their analyses of SDO data; and our work on the irregular satellites of the major planets will probe giant planet formation and the origin of the Solar System.

Other beneficiaries or audiences of our work are teachers and researchers in astronomy and cognate disciplines, as well as those working in fields far removed from research astronomy, for example in art, literature, science journalism, film and television. The Observatory's research frequently attracts media interest, and through this the work of the Observatory helps to facilitate a growing appreciation and public understanding of science throughout the community, so contributing to the Northern Ireland Executive's STEM (Science, Technology, Engineering and Mathematics) strategy.

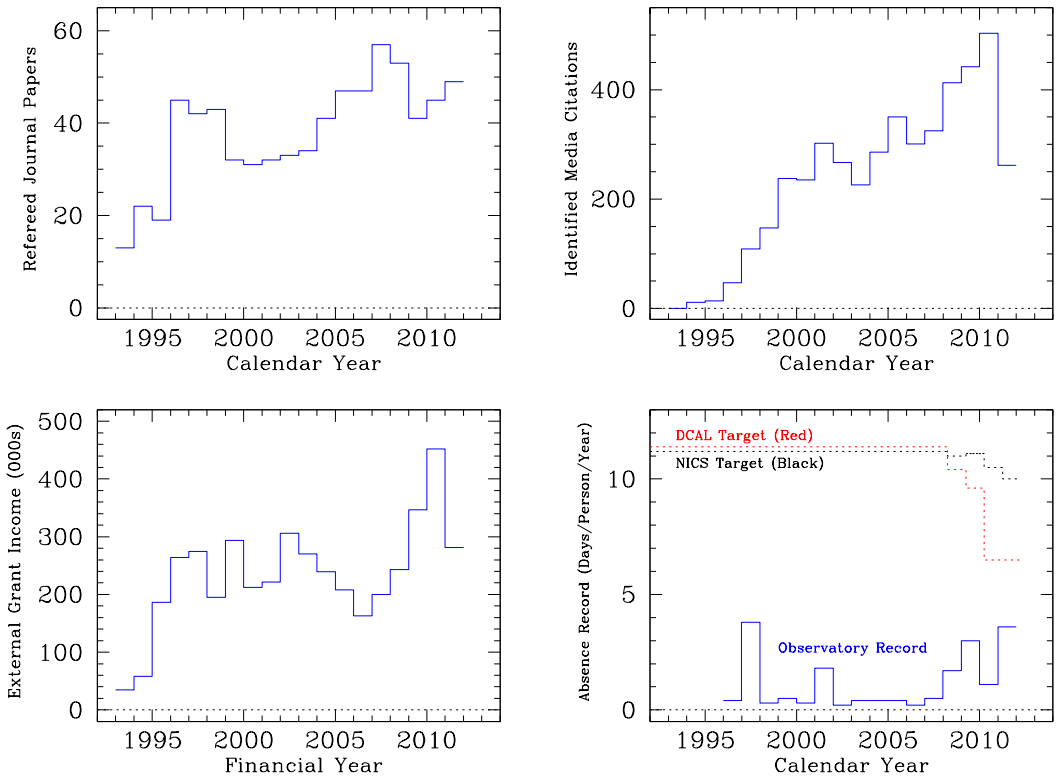

Figure 1: Histograms showing the annual trends of various performance indicators for the Armagh Observatory since during the past twenty years. The different panels show the number of refereed journal publications per calendar year; the amount of external (i.e. non-DCAL) grant income (£000s) received or receivable in cash terms per financial year; the number of identified mass-media citations to the Observatory, its staff and their work per calendar year (in recent years the target has been 250); and the rate of staff absence per calendar year (days per person per year), compared with the varying DCAL target for the same quantity. **Figure last updated 2012 April 12**. Financials for 2011/2012 are based on unaudited figures and therefore subject to review.

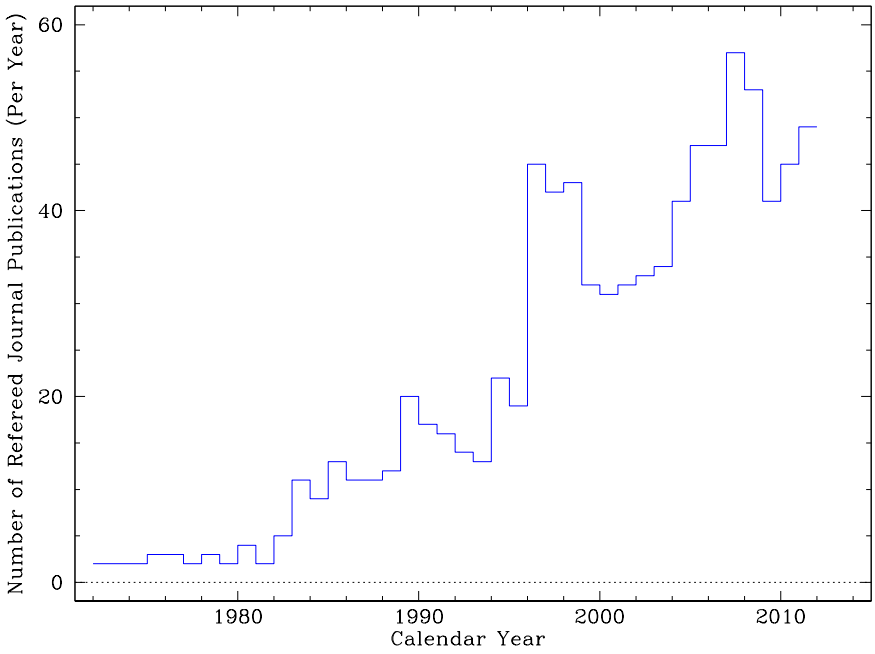

Figure 2: The number of refereed journal papers published per year by Armagh Observatory staff over the past thirty-five years for comparison with Key PI 'Refereed Publications' illustrated in Figure 1 and Tables 2 and 3. **Figure last updated 2012 March 13.**

Academic beneficiaries also include students of all ages, many of whom enter the world of work beyond academia. Those at postgraduate level benefit through seminars and advanced training courses, and by experiencing research at the forefront of world-leading projects. Others benefit through the Observatory's programme of **Science in the Community**, which includes public lectures, schools lectures, teacher training and work-experience projects. In this way, the Observatory's primary astronomical research programmes contribute directly to the Government's primary economic goals to improve scientific literacy throughout the community, to increase the number of people studying STEM subjects at school and university, and to support young people into employment by providing skills and training, so benefiting all.

1.2.2 Learning and Education

In addition to its core function to carry out an international level programme of scientific research in astronomy and related sciences, and to develop the heritage of astronomy at Armagh, the Armagh Observatory also carries out a vibrant and multifaceted programme of Science in the Community aligned with the DCAL Learning Strategy and aimed at widening public understanding of science — and of astronomy in particular — for all. There are many strands to this programme, which includes education and learning as well as public lectures and guided tours of the Observatory and the Grounds, Astropark and Human Orrery. In addition, there are formal education programmes associated with the Observatory's programmes of work experience, student and teacher training, and engagement with the local community, all of which draw on the professional knowledge and expertise of research astronomers at Armagh.

In the past, projects have included construction of the Human Orrery (the first such exhibit in the world to be laid out with precision) and the creation of the first International Phenology Garden in Northern Ireland (see http://star.arm.ac.uk/phenology/), which is closely linked to European and Cross-Border phenology projects and to the Observatory's own unique climate record (http://star.arm.ac.uk/). The Observatory also presents a biennial public 'Robinson Lecture' in honour of Archbishop Robinson, the Observatory's founder, and in alternate years has worked with the Centre for Cross Border Studies to arrange a biennial Cross-Border Schools Science Conference, held using the facilities of the Observatory together with those of the Royal School Armagh and the Armagh Planetarium. The last such conference

took place on 2011 May 5–6, and the next Robinson lecture will take place on 2012 November 22.

A highlight of the Observatory's outreach activities during 2011 has been the work of its UK European Universe Awareness (EU-UNAWE) Project Manager, Libby McKearney. Since her appointment in 2011 September, she has developed an innovative programme of primary-sector teacher training courses which in the autumn of 2011 reached 67 primary-sector teachers who in turn would reach nearly 1500 primary schoolchildren every year, and indirectly — through colleagues and related dissemination of course materials — approximately 6800 children per year. The courses have attracted very positive comments and it is intended that this programme of primary-sector teacher training will continue during the coming years 2012 et seq.

The various strands of the Observatory's programme of Science in the Community highlight the contribution of the Observatory's astronomical heritage to Northern Ireland and to the City of Armagh. They help to explain to a wide audience the results of modern astronomy and the benefits of carrying out international-level astronomy, particularly for education, learning and training in the so-called 'STEM' subjects (Science, Technology, Engineering and Mathematics) of such importance for our knowledge-led economy. The Observatory also makes a major contribution to the international profile of Northern Ireland; helps to develop science and science-based skills in the community; and provides an active programme of public lectures, guided tours, and work-experience activities which together contribute to wider UK and Northern Ireland Government initiatives aimed at deepening scientific knowledge and improving scientific literacy across the whole community.

In short, the Observatory's vibrant programmes of science in the community highlight the strength of international astronomical expertise in Armagh and help to explain to a wider audience the very active research programmes in astronomy and related sciences that are and have been undertaken in Armagh. The Observatory is an international research institute that makes a major contribution to promoting the City of Armagh and Northern Ireland on the world stage. It attracts a high level of media interest (hundreds of identified mass-media citations to its work per year); its web-sites attract nearly a million distinct e-visitors (DEVs) annually from around the world; and approximately 50,000 people visit the landscaped Grounds and Astropark every year, a unique inner-city parkland designed to enrich the lives of residents and visitors to Armagh alike. The trends of some of the Observatory's key performance indicators are shown in Table 2 (p.8) and Table 3 (p.9).

2 Performance

The generally positive trends of the Observatory's key performance indicators over the past decade and more are shown in Table 2 and Figure 1. These results demonstrate a very high level of scientific and other outputs, an achievement that makes a significant contribution to the Observatory's high profile on the national and international stage.

Over the past number of years (see http://star.arm.ac.uk/annrep/), the Observatory has made significant contributions to Solar-System Science, Solar Physics, and Stellar and Galactic Astrophysics, as well as to other areas such as the history of science and meteorology. It is developing new research programmes in each of these principal areas, as well as other projects, many of which are expected to be completed and to lead to new understanding over the next 3–6 years.

2.1 Business Plan Outturn for 2011/2012

The principal Business Plan objectives for 2011/2012 were to:

- obtain external grants and funding to support new research projects — done;
- strengthen the Observatory's research capacity and capability in Solar-System Science, Solar Physics, and Stellar and Galactic Astrophysics, by recruiting 3–4 PhD students and providing a high-quality research environment to facilitate their advanced training as well as that of the postdoctoral staff at the Observatory at the beginning of their astronomical careers — done;
- build on the Observatory's involvement in the DCAL Learning Strategy by developing new initiatives in education and public outreach associated with the Observatory's programme of Science in the Community — done; and
- progress plans for the design of a new Library, Archives and Historic Scientific Instruments building, a project that plays a central role in the Observatory's forward look — begun.

In addition to these programmes of frontline scientific research and public understanding of science, the Observatory has an important function to promote, preserve and widen access to the Observatory Grounds and the historic library, archives and museum collection at Armagh, which together represent a very significant component of Northern Ireland's scientific heritage. During 2011/2012 it was intended to continue, as resources allow, a programme to improve the documentation and storage conditions of the library, archives and astronomical museum collection, and this was successfully carried out with the support of the DCAL and funding from the Pilgrim Trust in collaboration with Armagh Public Library.

The trends of the key performance indicators which together span the Observatory's principal strategic objectives are summarized in Figure 1 (p. 4). Further relevant material is presented in Tables 2, 3 and 4 (see pp. 8, 9 and 9 respectively). Taken as a whole, these Tables and Figures demonstrate that the Armagh Observatory has achieved considerable recent success and is well-placed to build on these activities and to make further very significant contributions to Northern Ireland's Cultural Capital.

2.2 Performance Monitoring

Results for various performance indicators are summarized in Tables 2, 3 and 4 (see pp. 8, 9 and 9). Note that in this report all items with the exception of financial matters refer to calendar year. In order to avoid any confusion, we also note that total external grant income received in cash terms per financial year (Table 2) is not the same as the total external grant income per financial year shown in the accounts or total external income as defined implicitly in key PI 'A' Rate of Return (Table 3). The latter is calculated on an accruals basis following Resource Accounting rules.

Calendar or Financial Year	DCAL Grant-in-Aid (£000s)				External Grant Income (£000s)		Refereed Scientific Journal Publications		Distinct e-Visitors (000s)		Identified Media Citations		RAE Grade	Days Absence Per Person Per Year	
	Core Revenue	Core Capital	Additional Funding	Total	Actual	Target	Actual	Target	Actual	Target	Actual	Target	Actual	Actual	DCAL Target
2001	466.0	7.5	240.0	713.5	221.3	200	32	30	318	200	302	100	4	1.8	
2002	616.0	7.5	110.0	733.5	305.7	230	33	32	354	350	267	200		0.2	
2003	660.0	6.5	115.0	781.5	270.4	250	34	32	470	370	226	200		0.4	
2004	660.0	6.0	218.0	884.0	239.4	250	41	32	576	500	284	200		0.4	
2005	660.0	6.5	125.0	791.5	207.9	200	47	35	1012	400	349	200		0.4	11.4
2006	660.0	6.5	144.5	811.0	163.1	200	47	40	1539	1200	301	200		0.2	11.4
2007	660.0	6.5	202.5	869.0	200.0	300	57	45	1585	1800	325	250		0.5	11.4
2008	817.0	25.0	113.9	955.9	242.8	300	53	50	997	1800	413	250	5 30 50 15	1.7	10.4
2009	922.0	25.0	78.3	1025.3	346.7	300	41	50	910	1800	442	250		3.0	9.6
2010	1027.0	25.0	207.4	1259.4	452.3	300	45	50	981	900	503	250		1.1	6.5
2011	1030.0	0.0	104.5	1134.5	281.4	300	49	50	823	900	262	250		3.6	6.5
2012	1043.0	49.0	0.0	1092.0		250		45		800		250			6.5
2013	**1043.0**	**25.0**	**0.0**	**1068.0**		**250**		**45**		**800**		**250**			**6.5**
2014	**1043.0**	**15.0**	**0.0**	**1058.0**		**250**		**45**		**800**		**250**			**6.5**

Notes to Table of Historic Key Performance Indicators:

1. Financial figures refer to the corresponding financial year, so that Core Revenue funding for 2011 refers to the core revenue funding received in cash terms during 2011/2012 and so on. All other figures are per calendar year.
2. Total DCAL grant-in-aid received in cash terms during each financial year is broken down into Core Revenue (i.e. Announced Cash Funding), Core Capital (i.e. Announced Capital Funding) and Additional Funding received in-year (Resource and Capital). The latter represents funding provided by the DCAL in response to competitive bids from the Observatory to support specific in-year projects and other activities, whether Resource or Capital. The 2011/2012 figure includes an additional £37.0k for research, outreach and maintenance costs awarded in the 2011 September monitoring round and additional Capital funding totalling £67.5k. The corresponding projected Revenue figures for 2012/2013 et seq. are based on the provisionally announced joint cash plus non-cash budget for the Armagh Observatory and Planetarium (£1828.0k for 2011/2012 plus £30k non-cash from the 2011 June monitoring round) less non-cash costs such as depreciation which are currently estimated as £119k for the Observatory and £231k for the Planetarium, i.e. a total of £350k, leaving a cash budget of £1508k to be split between the two institutions. In addition, under the Annually Managed Expenditure (AME) budget (not shown here), there is a further allowance of £125k (£81k for the Observatory and £44k for the Planetarium) for AME Pension Costs.
3. Figures for External Grant Income refer to external grant income received or receivable in cash terms during each financial year.
4. The 2008 RAE Result is a grade profile indicating the percentage of the Observatory's overall activity that is world-leading (5%), internationally excellent (30%), recognized internationally (50%), and recognized UK-nationally (15%), with none at less than UK-national quality. These figures indicate that 85% of the Observatory's overall activity is of international quality. This periodic assessment of the Observatory's research in comparison with UK university research groups will be repeated in 2014 under the new Research Excellence Framework (REF2014) exercise.
5. The number of days absence per person is defined as the ratio D/N, where D is the total number of days lost due to staff absence per calendar year and N is the number of staff in post at the end of the corresponding calendar year. The Observatory's absence results are very good. For comparison, the respective NICS targets for financial years 2012/2013, 2013/2014 and 2014/2015 are 9.5, 9.0 and 8.5 days per person per year (PfG Commitment #75).
6. Targets and/or requirements for calendar year 2012 and financial year 2012/2013 and beyond are expressed in round figures.

Table 2: Trends of Armagh Observatory performance indicators (PIs) versus calendar year. Table last updated 2012 May 28.

Calendar or Financial Year	Rate of Return Key PI 'A'		Admin. Efficiency Key PI 'B'		Staff Absence Key PI 'C'		Refereed Publications Key PI 'D'	
	Actual (%)	Target (%)	Actual (%)	Target (%)	Actual (d/p/yr)	Target (d/p/yr)	Actual (per year)	Target (per year)
2004 or 2004/2005	19.9	–	6.5	–	0.4	–	41	32
2005 or 2005/2006	18.1	–	7.2	–	0.4	–	47	35
2006 or 2006/2007	19.0	20.0	9.8	10.0	0.2	12.0	47	40
2007 or 2007/2008	20.7	20.0	7.4	8.8	0.5	11.0	57	45
2008 or 2008/2009	20.2	21.5	8.2	8.2	1.7	10.4	53	50
2009 or 2009/2010	24.2	21.5	8.0	8.2	3.0	9.6	41	50
2010 or 2010/2011	19.4	21.5	7.8	8.2	1.1	6.5	45	50
2011 or 2011/2012	24.0	21.5	8.2	8.2	3.6	6.5	49	50
2012 or 2012/2013		**21.5**		**10.0**		**6.5**		**45**
2013 or 2013/2014		**21.5**		**10.0**		**6.5**		**45**
2014 or 2014/2015		**21.5**		**10.0**		**6.5**		**45**

Table 3: The trend of annual results for key performance indicators agreed with the DCAL during 2006. The first column denotes the calendar or financial year. The percentage Rate of Return (Key PI 'A') corresponds to the ratio of total external income to total income per financial year; Admin. Efficiency (Key PI 'B') represents the ratio of the total expenditure of the Observatory on governance and administration to total expenditure, again per financial year; Staff Absence (Key PI 'C') denotes the average number of days absence per person per calendar year (d/p/yr); and Refereed Publications (Key PI 'D') denotes the number of refereed journal papers produced by Observatory staff in each calendar year. Table last updated 2012 May 28.

Performance Indicator	Prior Year (2011 or 2011/2012)	Current In-Year Result (2012 or 2012/2013)	Current-Year Target (2012 or 2012/2013)
A: 'Rate of Return'	24.0%	14.6 (2 months)	21.5%
B: 'Admin. Efficiency'	8.2%	7.6 (2 months)	10.0%
C: 'Staff Absence' (days/person/year)	3.6	3.4 (3 months)	6.5
D: 'Refereed Journal Publications'	49	30 (5 months)	45
External Grant Income Received In-Year (£000s)	281.4	0.2 (2 months)	250.0
Other External Income Received In-Year (£000s)	10.0	2.0 (2 months)	10.0
Distinct e-Visitors (millions)	0.82	0.22 (3 months)	0.80
Web-Site 'Hits' (millions)	16.41	4.79 (3 months)	16.5
Data Exported (TB)	7.57	1.81 (3 months)	8.00
Identified Media Citations	262	112 (3 months)	250
Astropark Visitor Numbers	41935	18216 (3 months)	45000

Table 4: In-year results for Armagh Observatory Performance Indicators. Table last updated 2012 June 4.

3 Operational Plan

3.1 2012/2013 Business-Plan Objectives

The Armagh Observatory is a vibrant international research institute that plays a full role in international astronomy whilst developing and promoting the rich heritage of Northern Ireland astronomy and presenting an attractive and positive image of Northern Ireland on the international stage. The principal Business Plan objectives for 2012/2013 are to:

- obtain external grants and funding to support new research projects;
- strengthen the Observatory's research capacity in Solar-System Science, Solar Physics, and Stellar and Galactic Astrophysics, by recruiting 2–3 PhD students and providing a high-quality research environment to facilitate their advanced training and that of other Observatory staff;
- build on the Observatory's involvement in the DCAL Learning Strategy by developing new initiatives in education and public outreach associated with the Observatory's programme of Science in the Community; and
- progress plans for the design of a new Library, Archives and Historic Scientific Instruments building, a project that plays a central role in the Observatory's forward look.

In addition to these programmes of frontline scientific research and public understanding of science, the Observatory has an important function to promote, preserve and widen access to the Observatory Grounds and to the library, archives and museum collection at Armagh, which together represent a very significant component of Northern Ireland's scientific heritage. During 2012/2013 it is intended to continue, as resources allow, a programme to improve the documentation, digitization and storage conditions of the historic library, archives and astronomical museum collection.

3.2 Key Performance Indicators and SMART Targets for 2012/2013

Table 5 (p. 11) provides a summary of seven key performance indicators and targets which together span the Observatory's principal functions and activities. Full details of the trends of many of these key performance indicators have been provided above. Although these keyPIs and associated targets are designed to be SMART (i.e. Specific, Measurable, Attainable, Relevant and Time-bounded), it has to be recognized that they will inevitably be affected by in-year fluctuations, and in some cases, particularly in the recording of website 'hits' and Astropark visitor numbers, are subject to external factors beyond the Observatory's control. Nevertheless, as shown in Section 2, the trends of these PIs versus time can provide a valuable proxy to assess the Observatory's long-term performance. Further remarks on the Observatory's basket of Key Performance Indicators are noted in Section B (p. 18).

3.3 Required Resources and Budget

Tables 6 and 7, showing projected income and expenditure for 2012/2013, provide a detailed summary of the Observatory's balanced projected 2012/2013 Business-Plan Budget (Red) together with a comparison with the budget outturn for 2011/2012 (Green). Blue and Black columns represent opening values and are subject to in-year variations depending on possibly changing circumstances (e.g. additional funding provided by DCAL in-year and/or additional funding obtained in-year for new projects from external funding agencies).

In comparing the 2012/2013 Business-Plan budget with that of the previous year (2011/2012) it is important to note the significant additional income obtained from several monitoring rounds during 2011/2012 (cf. Table 2, p. 8). Nevertheless, along with other DCAL Arms-Length Bodies, the Observatory has had to make a number of difficult choices and decisions in order to achieve a balanced opening budget for the year.

These decisions have been made following a strategy to focus on the Observatory's core research function and to ensure that, wherever possible, any reductions in activity do not irreversibly affect the Observatory's ability to maintain a leading frontline role in research, education and advanced training. The savings that have been introduced in 2012/2013 have been made with the aim of minimising any adverse impact on the Observatory's primary research mission, and with the objective of ensuring that in the long term its ability to sustain the full breadth of its key research programmes and contributions to education and learning across the community is not permanently impaired.

1. Research: Number of Refereed Scientific Journal Publications		
Period	In-Year Result	Target
2012 Jan 1 to 2012 May 31	30 (5 months)	45
2. Rate of Return: Total External Income / Total Income (per Financial Year, accrued)		
Period	In-Year Result	Target
2012 Apr 1 to 2012 May 31	14.6 (2 months)	21.5
3.1. Outreach: Number of Recorded Website 'Hits'		
Period	In-Year Result	Target
2012 Jan 1 to 2012 Mar 31	4.8 million (3 months)	16.5 million
3.2. Outreach: Number of Recorded Astropark Visitors		
Period	In-Year Result	Target
2012 Jan 1 to 2012 Mar 31	18,000 (3 months)	45,000
3.3. Outreach: Number of Recorded Media Mentions		
Period	In-Year Result	Target
2012 Jan 1 to 2012 Mar 31	112 (3 months)	250
4.1. Administration: Recorded Staff Absence (days per person per year)		
Period	In-Year Result	Target
2012 Jan 1 to 2012 Mar 31	3.6 (3 months)	6.5
4.2. Administration: Percentage of Invoices Paid Within Mandatory 10 Days		
Period	In-Year Result	Target
2012 Apr 1 to 2012 May 31	100% (2 months)	90%

Table 5: Key Performance Indicators and SMART Targets for 2012/2013. These Key PIs span the Observatory's principal Research, Education and Learning programmes as well as mandatory Management targets introduced by the Northern Ireland Executive. Outreach figures are approximate, with targets expressed in round figures. Table last updated 2012 June 4.

Last Up-date 2012 June 4	2012/2013	2012/2013	2012/2013	2011/2012
INCOME: CASH	**Projection**	**TO DATE**	**Business Plan**	**Actual**
	(2012 May 31)	**(2012 May 31)**	**(2012 May 31)**	**£k**
DCAL recurrent grant paid				
DCAL recurrent grant paid - deferred + released	1043.0	228.0	1043.0	1030.0
Re-allocation of DCAL recurrent grant from Planetarium	0.0	0.0	0.0	0.0
Re-allocation of cash to non-cash to cover any non-cash projected shortfall	0.0	0.0	0.0	0.0
Additional in-year recurrent grant	0.0	0.0	0.0	37.0
Total DCAL recurrent grant paid	1043.0	228.0	1043.0	1067.0
DCAL capital grant				
Capital grant paid	49.0	0.0	49.0	0.0
Capital grant deferred/released	0.0	0.0	0.0	0.0
Additional in-year capital funds paid	0.0	0.0	0.0	67.5
Total DCAL capital grant paid	49.0	0.0	49.0	67.5
External Grants and Other Restricted Funds				
New Library, Archives and Historic Scientific Instruments Building	0.0	0.0	0.0	0.0
Grants and other restricted funds received/receivable	328.4	0.2	328.4	281.4
Grants and other restricted funds deferred	-188.1	0.0	-188.1	-34.5
Grants and other restricted funds released	182.6	36.9	182.6	100.7
Total	322.9	37.0	322.9	347.6
Miscellaneous income				
Interest	0.2	0.0	0.2	0.3
Rents	5.6	1.7	5.6	6.8
Miscellaneous	2.4	0.3	2.4	2.9
Total	8.2	2.0	8.2	10.0
Total Income (Cash)	1423.1	267.1	1423.1	1492.1

Last Up-date 2012 June 4	2012/2013	2012/2013	2012/2013	2011/2012
	Projection	**TO DATE**	**Business Plan**	**Actual**
SUMMARY OF DCAL OBSERVATORY INCOME AND EXPENDITURE: NON-CASH	**(2012 May 31)**	**(2012 May 31)**	**(2012 May 31)**	**£k**
Non-Cash Budget Income				
Opening non-cash DEL budget	120.0	0.0	120.0	119.0
Additional in-year non-cash DEL grant paid	0.0	0.0	0.0	15.0
AME Pension Costs to cover any projected pension cost shortfall	81.0	0.0	81.0	81.0
Total available non-cash	201.0	0.0	201.0	215.0
Non-Cash Budget Expenditure (Depreciation)				
DEL Depreciation Announced	102.0	0.0	102.0	119.0
In-Year Adjustment for Revaluation of Assets (Land and Buildings): 2011/2012	0.0	0.0	0.0	-901.8
DEL Depreciation In-Year Adjustment	0.0	0.0	0.0	-20.4
Total Observatory expenditure on Depreciation	102.0	0.0	102.0	-803.2
Non-Cash Budget Expenditure (AME Pension Costs)				
Service Cost	137.0	0.0	137.0	144.0
Interest on obligation	181.0	0.0	181.0	198.0
Expected return on pension-fund assets (counts as negative expenditure)	182.0	0.0	182.0	222.0
Employer's pension contributions (funded by DCAL Cash Resource; counts as negative expenditure)	119.0	0.0	119.0	117.1
Total non-cash expenditure (AME Pension Costs)	17.0	0.0	17.0	2.9
Projected Net AME Pension Surplus	64.0	0.0	64.0	78.1

Last Up-date 2012 June 4				
SUMMARY OF TOTAL DCAL OBSERVATORY PLUS PLANETARIUM INCOME (CASH+NON-CASH)				
Observatory Total DCAL Income				
DEL Cash (Resource + Capital)	1092.0	228.0	1092.0	1134.5
DEL Depreciation	102.0	0.0	102.0	-803.2
AME Pension Costs	87.6	0.0	87.6	81.0
Total Observatory DCAL Income	1281.6	228.0	1281.6	412.3
Planetarium Total DCAL Income				
DEL Cash (Resource + Capital)	533.0	0.0	533.0	534.0
DEL Depreciation	176.0	0.0	176.0	-568.2
AME Pension Costs	16.0	0.0	16.0	-1.0
Total Planetarium DCAL Income	725.0	0.0	725.0	-35.2
Total DCAL Income for Observatory and Planetarium (Cash + Non-Cash (DEL+AME) + Capital)	2006.6	228.0	2006.6	377.1

Table 6: Projected income following the Business Plan 2012/2013 and corresponding income received to date. Shaded rows indicate largely non-DCAL income. Non-Cash Budgets and outturns are particularly volatile owing to variable depreciation and AME Pension Costs. Table last updated 2012 June 4.

Last Up-date 2012 June 4	2012/2013	2012/2013	2012/2013	2011/2012
EXPENDITURE	**Projection**	**TO DATE**	**Business Plan**	**Actual**
	(2012 May 31)	**(2012 May 31)**	**(2012 May 31)**	**£k**
Research and Research Support Costs				
Capital equipment from announced DCAL capital grant	49.0	0.0	49.0	0.0
Capital equipment from current year DCAL recurrent grant or prior year DCAL capital grant	0.0	0.0	0.0	0.0
Additional capital equipment from in-year DCAL capital grants	0.0	0.0	0.0	67.5
Capital equipment funded by external grants and other income	0.0	0.0	0.0	0.0
New Library, Archives and Historic Scientific Instruments Building Development Costs	0.0	0.0	0.0	0.0
Salary of Archivist/PRO/Outreach Officer	0.0	0.0	0.0	0.0
UKSC Subscription and SALT operating costs	16.0	0.2	16.0	17.0
Other UKSC/SALT expenses	1.0	0.0	1.0	1.8
ARTI project	0.0	0.0	0.0	0.0
Hosting Conferences, Workshops and Misc. Research Infrastructure	0.0	0.0	0.0	0.0
Salaries of permanent research and research support staff	586.5	90.7	586.5	598.7
Salaries of fixed-term research and research support staff	115.8	19.4	115.8	137.3
Former Director's pension supplement	2.4	2.2	2.4	2.2
Student maintenance grants	96.6	18.2	96.6	141.6
Student maintenance funded by external grants	41.4	11.3	41.4	42.8
Student fees	25.0	2.8	25.0	10.7
Student fees funded by external grants	13.5	1.4	13.5	12.4
Core travel and subsistence from DCAL funds	33.0	5.9	33.0	41.5
Travel and subsistence from external grants and other income	37.7	3.9	37.7	24.1
Visitors programme	4.0	0.1	4.0	2.2
Visitors programme funded by external grants and other income	0.0	0.0	0.0	0.0
Conferences (principally biennial Robinson Lecture)	1.5	0.0	1.5	0.9
Hosting meetings and lectures	2.0	-0.3	2.0	4.4
JANET access costs	19.0	3.3	19.0	19.6
Core computer consumables from DCAL funds	18.0	1.0	18.0	18.5
Computer consumables funded by external grants and other income	9.4	0.1	9.4	9.4
ADAS: The Atomic Data and Analysis Structure database (Solar Physics)	0.0	0.6	0.0	1.3
Library costs: book purchase, subscriptions and journals, binding etc.	38.5	7.5	38.5	35.8
Armagh Public Library/Observatory joint projects plus in-year conservation and scanning work	7.0	1.1	7.0	30.0
Historic books/instruments: museum, library, archives collection purchases	0.3	0.0	0.3	0.0
Publications	1.5	0.4	1.5	0.1
Public Understanding of Science (including misc. externally funded outreach projects)	2.0	0.0	2.0	0.2
Cross-Border Schools Science Conferences (SSC2011, 2009, 2007); Lindsay Mtg 2007	0.0	0.0	0.0	0.0
15th ADAS Workshop (2010 Oct); IMC2010 (2010 Sep)	0.0	0.0	0.0	0.0
Externally funded conferences, meetings and lectures	13.5	0.0	13.5	0.0
Advertising and promotions	0.0	0.0	0.0	0.0
UK entertaining	0.1	0.0	0.1	0.1
External grants: miscellaneous expenditure	41.9	0.0	41.9	14.1
DCAL Additional Restricted Funds: Creativity Industries Fund Expenditure	0.0	0.0	0.0	9.9
Agency staff costs (telescope/archives/meteorological records)	0.0	0.0	0.0	0.0
Pension deficit (Note: not shown as deficit not yet announced)	0.0	0.0	0.0	0.0
Losses and Special Payments	0.0	0.0	0.0	0.0
Total research and research support costs	1176.6	169.9	1176.6	1244.2
Buildings, Buildings Refurbishment and Grounds Costs				
Externally funded buildings/conservation/repair projects (e.g. DCAL and EHS buildings, domes, telescopes)	0.0	0.0	0.0	0.0
DDA and other legally or goverment-required maintenance/capital costs	0.0	0.0	0.0	0.0
New Library, Archives and Historic Scientific Instruments Building Estates Costs	0.0	0.0	0.0	0.0
Salaries of grounds and meteorological records support staff	47.2	7.6	47.2	47.1
Agency Cleaning Costs	12.6	1.6	12.6	7.7
Cleaning consumables	1.1	0.0	1.1	1.2
Service contracts and professional fees	6.0	0.9	6.0	4.5
Central procurement costs	1.0	0.7	1.0	-0.2
Property repairs, grounds, furnishings, office and minor equipment	20.0	-1.2	20.0	26.8
Heat, light, power	35.0	0.6	35.0	26.8
Insurance	10.6	1.8	10.6	10.6
Rates	0.0	0.0	0.0	0.0
Total Buildings, Buildings Refurbishments and Grounds Costs	133.5	12.1	133.5	124.5
Administration and Corporate Governance Costs				
Salaries of administrative and administrative support staff	81.3	13.3	81.3	88.6
Management Committee/Board of Governors	2.7	0.2	2.7	2.9
Internal audit	4.0	0.7	4.0	3.6
External audit	6.0	0.8	6.0	5.0
Legal fees	0.0	0.0	0.0	0.0
Staff training	2.0	0.0	2.0	1.6
Recruitment	2.0	0.2	2.0	0.1
Stationery	3.0	0.0	3.0	1.6
Post and telephone	4.5	0.4	4.5	4.8
Printing	1.0	0.1	1.0	1.5
General expenses	4.0	0.9	4.0	8.6
Other professional fees (Actuary, SELB, VLA, EEF)	2.5	-1.6	2.5	4.7
Currency fluctuations	0.0	0.0	0.0	0.0
Bank interest and other charges	0.0	0.0	0.0	0.0
Total Administration and Corporate Governance Costs	113.0	15.0	113.0	123.0
Total Expenditure	1423.1	197.0	1423.1	1491.6
Surplus/-Deficit (Before Pension Costs)	**0.0**	**70.1**	**0.0**	**0.5**

Table 7: Projected expenditure following the Business Plan 2012/2013 and corresponding expenditure to date. Shaded rows indicate cost centres that have significant contributions from external income. Table last updated 2012 June 4.

A Alignment of Armagh Observatory and NI Government Objectives

A.1 Astronomy in Society

The Vision of the Armagh Observatory is:

> *"To build on its position as a thriving astronomical research institute, and to continue to expand our understanding of the Universe and of humanity's place in it."*

The Mission is:

> *"To advance the knowledge and understanding of astronomy and related sciences through the execution, promotion and dissemination of astronomical research nationally and internationally in order to enrich the intellectual, economic, social and cultural life of the community."*

These goals align closely with the corresponding aims and objectives of the Observatory's sponsor government department, namely the Department of Culture, Arts and Leisure (DCAL). The DCAL's Vision is of a "**confident, creative, informed and vibrant community**," and its Mission is "**to protect, nurture and grow Northern Ireland's cultural capital by providing strategic leadership and resources for the promotion and sustainable development of the culture, arts and leisure sectors**". The Department's goals are to (1) enable as many people as possible to experience and appreciate the excellence of our cultural assets; (2) promote creativity and innovation and lifelong learning; (3) encourage respect for and celebration of diversity; (4) ensure the sustainable management of our cultural infrastructure; (5) develop and deliver quality cultural products and services; and (6) reform and modernise our service delivery.

The Armagh Observatory's primary function to carry out international-quality astronomical research is an imagination driver and a creator of Cultural Capital. The Observatory's research outputs as well as its secondary function to disseminate astronomical research nationally and internationally to widen knowledge of science and of the heritage of astronomy at Armagh are highly ranked on the international stage. The Observatory also attracts significant external (i.e. non-DCAL) grant income from UK and other funding bodies every year, and substantially greater amounts of external support in kind, for example through the Observatory's use of ground and space-based telescope facilities abroad and through international collaboration. Thus, Northern Ireland gets an extremely high return on its investment in frontline astronomical research at the Armagh Observatory.

Astronomy stirs people's minds and has the capacity to stimulate a more scientific way of thinking. This contributes to the development of a more scientifically interested and literate population, and to greater numbers of young people attracted towards science at school and university and into the important science, technology, engineering and mathematical (STEM) subjects that lie at the heart of a modern, technological high value-added economy. The low take-up of STEM subjects at schools and universities is of growing government concern, and the presence of a vibrant astronomical research base helps to motivate young people towards science and provides an important stimulus to generate a more creative, vibrant and internationally competitive economy.

In short, whereas many of the Observatory's day-to-day scientific activities reflect its primary, highly skilled professional research function, the work of the astronomers based in Armagh has a rare capacity to reach out to others and motivate them towards an interest in science and a scientific way of thinking. There are many examples where the fruits of astronomical research have an impact right across society, for example opening up possibilities for enquiry, sharing and debating histories, exploring identities and nurturing social cohesion. These facets of astronomy can be truly inspirational, stimulating creativity, invention and innovation. Astronomy not just creates cultural capital, but adds value to the Northern Ireland economy, supporting tourism, the creative industries, the knowledge-based economy and lifelong learning for all. Thus astronomy — the oldest science — not just addresses fundamental questions of existence but has an impact that extends across culture and throughout society.

A.2 Alignment with the NI Museums Policy Goals and Objectives

The Armagh Observatory is the oldest scientific institution in Northern Ireland with a heritage, including a specialist library and archives and museum collection, spanning the development of the whole of modern astronomy over more than 200 years. It has a responsibility to preserve and widen access to this important element of Northern Ireland's scientific heritage, and therefore key Observatory Business Plan actions

should align, at least in part, with the Northern Ireland Museums Policy (see http://www.dcalni.gov.uk/pdf_version_of_final_museums_policy.pdf). Here we briefly illustrate how the Observatory's core functions and activities align with this DCAL policy.

A.2.1 Introduction

The Observatory plays an important role so far as Northern Ireland is concerned as a custodian of Northern Ireland's astronomical heritage. Whilst its primary function is to carry out international-level astronomical research, it also plays a significant role in education and learning through various strands of its programme of Science in the Community, which are closely aligned with elements of the Northern Ireland Executive's Programme for Government (see Section A.3) and the DCAL's Learning Strategy (see http://www.dcalni.gov.uk/quick_links-dcal_learning_strategy). As noted in the former DCAL Minister's introduction to the Museums Policy, museums can provide creative environments and deliver innovative initiatives that enhance education and lifelong learning, as well as contributing to Northern Ireland's tourism offering and catalysing wider economic development through the creative industries. They help us to see the complexities and contradictions of our history and can assist with our understanding of the great events that have shaped our world — as well as dispelling pre-scientific myths and misunderstandings. Astronomers work on a substantially bigger canvas than those of the majority of museums in Northern Ireland, but the argument for the value and impact of museums in Northern Ireland (Section 1 of the Museums Policy) has many parallels with the corresponding argument that might be made for the economic and social value of a national observatory and for maintaining a strong and vibrant astronomical research base in the community.

A.2.2 Strategic Priorities

Developing Audiences (DA) The Observatory attracts many visitors to Northern Ireland: some of a purely academic nature; others who come to Armagh as tourists or with a special interest in astronomy and determined to learn more about astronomy or the history of the Observatory and its contributions to international astronomy. In recent years, the Observatory's programme of Science in the Community has expanded into a multifaceted series of events and activities that attract visitors or all ages and backgrounds into Armagh. As part of this developing programme it seeks to: (1) increase the number and diversity of people visiting Armagh; (2) strengthen its position as a key component of Northern Ireland's and Armagh City's tourism offering; and (3) maximise its role as a cultural ambassador for Northern Ireland abroad. (DA Goals: DA1, DA4, DA5).

Education and Learning (EL) The Observatory is continuously developing its education and learning offering, ranging from the training of PhD students, through summer research projects offered to school and undergraduate students, to work-experience projects offered to school students with ages typically in the range 16–18. In addition, it maintains the Observatory Grounds, Human Orrery and Astropark as an outdoor educational facility for visitors, and provides public lectures, tours, open days and a wide variety of other activities with the objective of promoting wider knowledge and understanding of astronomy and, as part of the DCAL Learning Strategy, contributing to the Executive's STEM Strategy "Success through STEM". (EL Goals: EL1, EL4, EL5, EL7).

Collections Development (CD) and Infrastructure Investment and Resources (IIR) As described in Section 2, the Observatory has an important function to promote, preserve and widen access to the library, archives and astronomical museum collection at Armagh, which together represent a very significant component of Northern Ireland's scientific heritage. It is intended to continue, as resources allow, a programme in partnership with the Armagh Public Library to improve the documentation, digitization and storage conditions of the historic library, archives and astronomical museum collection; and secondly, to progress plans for the design of a new Library, Archives and Historic Scientific Instruments building, a project that plays a central role in the Observatory's forward look. The latter represents a very major infrastructure investment, requiring substantial capital resources. When this is completed, however, the Observatory will have state-of-the-art accommodation for the historic elements of its specialist collection (library, archives, historic scientific instruments, astronomical plates and associated digital storage) as well as office space for research staff and an exhibition area that will enable the story of astronomy and of astronomy at Armagh to be told to the growing number of visitors who come to Armagh attracted by the moniker 'City of Saints and Scholars'. (CD Goals: CD1, CD2, CD5; IIR Goal: IIR2, IIR7).

A.3 Alignment with the NI Programme for Government Goals and Objectives

The Northern Ireland Executive Programme for Government 2011–2015 (see http://www.northernireland.gov.uk/pfg-2011-2015-final-report.pdf) contains 82 commitments or Public Sector Agreements (PSAs) divided into five interrelated priorities, namely: (1) Growing a Sustainable Economy and Investing in the Future; (2) Creating Opportunities, Tackling Disadvantage and Improving Health and Well-Being; (3) Protecting our People, the Environment and Creating Safer Communities; (4) Building a Strong and Shared Community; and (5) Delivering High Quality and Efficient Public Services. Here we provide brief examples to illustrate how the Observatory contributes to these cross-cutting public service agreements.

1. **Growing the economy** by creating a better educated and more highly skilled workforce, for example by:

   (a) Contributing to the DCAL Learning Strategy through the Observatory's programmes of PhD student training, undergraduate work-experience programme, school work-experience programme, talks and tours associated with the programme of Science in the Community etc. (PSAs 10, 12, 61, 64, 66).

   (b) Contributing to improved understanding of mathematics and numeracy through the Executive's STEM Strategy 'Success through STEM', for example by supporting schools lectures, primary-sector teacher training workshops, special events and conferences, such as the 2012 BBC Stargazing LIVE events, the biennial Robinson Lecture and so on. (PSAs 12, 61, 63, 64).

   (c) Contributing to the economic target to increase the drawdown of EU funds by applying, where possible, to appropriate EU Horizon 2020 funding lines to support or extend existing EU-funded research, education and development programmes. (PSA 9).

   (d) Contributing to the economic target to increase visitor numbers and revenue by working in partnership with other bodies in Armagh to improve and enhance the number of special-interest conferences, public lectures and 'tourism' functions held in the City of Armagh, and to improve for visitors the unique educational facility provided by the Observatory Grounds, Human Orrery and Astropark. (PSA 7).

2. **Creating opportunities and tackling disadvantage** by improving the participation of young people in education, employment and training, for example by:

   (a) Expanding the number of therapeutic work-experience placements under the Observatory's New TSN Policy (PSA 10).

   (b) Supporting the 'shared future' Cohesion, Sharing and Integration strategy using the tool of astronomy and our modern understanding of the Earth's place in space and the wider Universe to highlight the fact that we all live 'under the same sky'. (PSA 41).

   (c) Reducing educational underachievement by 'training the trainers', i.e. by providing primary-sector teachers with knowledge of astronomy and Earth's place in space through the European Universe Awareness (EU-UNAWE) programme and additional DCAL support (e.g. via the Creative Industries Fund). (PSA 64).

3. **Protecting our people, the environment** and creating safer communities, for example by:

   (a) Raising awareness of important strategies to minimise light pollution so as to save energy and reduce greenhouse-gas emissions that contribute to potentially devastating global climate change. (PSA 22).

   (b) Developing the Observatory Grounds and Astropark as an inner-city haven for wildlife and increasing biodiversity. (PSA 24).

   (c) Maintaining the continuity and precision of the daily weather readings at Armagh in order better to assess the risk of global climate change insofar as it affects Northern Ireland (PSAs 22, 24).

4. **Building a strong and shared community**, for example by:

(a) Unlocking the potential of the Culture, Arts and Leisure sectors through the Observatory's programme of Science in the Community and its support for partnership working with other DCAL ALBs as part of the DCAL Learning Strategy. (PSAs 7, 10, 12, 41, 61, 64, 66).

(b) Using astronomy as a tool to help build a united community and improve community relations through the delivery of cross-border and cross-community primary-sector teacher training courses. (PSA 41).

(c) Working with LibrariesNI and special-interest community groups to display the Observatory's From Earth To The Universe (FETTU) posters in libraries and other venues throughout Northern Ireland to help tackle rural poverty and social and educational disadvantage in towns and villages throughout Northern Ireland, and to encourage visitors from such regions into Armagh. (PSAs 7, 41, 78).

5. **Delivering high-quality and efficient** public services, for example by:

(a) Providing more for less by streamlining internal bureaucracy and, where possible, reducing external bureaucracy which diverts Observatory management and other staff away from more important front-line tasks. (PSA 40).

(b) Maintaining the Observatory staff's very good attendance record, ensuring that it remains well below the average target for the NICS as a whole (9.0 days per person per year). (PSA 75).

B Remarks on Performance Indicators

Results for various performance indicators are summarized in Tables 2, 3 and 4; see pp.8, 9 and 9). The new performance indicators introduced by the DCAL during 2006/2007 are defined as follows:

A: **"Rate of Return"**. This is the ratio of total external income as a percentage of total income per financial year following resource accounting rules. In recent years, the result (which takes no account of the value of the Observatory's significant use of external facilities) has averaged around 20%. In general, a high value is better, though it must be remembered that the Observatory is not a commercial organization.

B: **"Administrative Efficiency"**. This is the ratio of total governance and administration costs as a percentage of total expenditure per financial year. This provides a measure of the efficiency or 'value for money' of the Armagh Observatory in delivering a high-quality astronomical service at the lowest reasonable cost. A low percentage administrative cost is better.

C: **"Staff Absence"**. This is the average number of days absence per person per calendar year (days per person per year). A low value is better.

D: **"Refereed Publications"**: the number of scientific papers published per calendar year in refereed scientific journals. In general, a high value is better, though high-quality, influential work is more important and can also appear in other media such as books, conference publications and so on.

It should be noted that in this report all items with the exception of financial matters refer to calendar year. Results for these key PIs for 2006/2007 et seq. as well as for the prior years for which we have data and targets for future years are shown in Table 3. Results for these and other PIs that are routinely collected to assess the Observatory's performance in different areas of activity are also shown in Table 4. We emphasize, in order to avoid any confusion, that total external grant income received or receivable in cash terms per financial year (Table 2) is not the same as the total external grant income per financial year shown in the accounts or total external income as defined implicitly in key PI 'A' Rate of Return (Table 3). The latter is calculated on an accruals basis following Resource Accounting rules. In addition to these specific performance indicators, various other data are routinely recorded for statistical or internal management purposes, many of which are presented in tabular or narrative form in each year's Annual Report. For past reports, see http://star.arm.ac.uk/annrep/.

Interpretation of Armagh Observatory Key PIs The interpretation of some of these proxy performance indicators is straightforward and self-explanatory, but it has to be remembered that others are affected by factors outside the Observatory's control and require greater care in analysis and/or interpretation. A number of such points are indicated below. Thus,

1. External grant income sometimes arrives in advance of expenditure and sometimes in arrears (and the funding agency nearly always retains a proportion of the grant until a satisfactory final report on the work done has been completed). The total amount of external grant income illustrates the high rate of financial return on DCAL investment in front-line astronomical research at Armagh (cf. bottom left-hand panel of Figure 1), but takes no account of the value of the Observatory's 'in kind' use of UK and international facilities both abroad and in space.

2. The pressure on staff to publish a high number of refereed publications has changed in recent years, owing to a decision by the Research Councils to move towards a metric-based measure of the quality of a particular grant application, one that increasingly depends on the quality of the research infrastructure at the applicant's disposal and has an increasing focus on 'popular' or 'influential' publications, defined to be those that are highly cited (and sometimes with significance attached also to the position of an astronomer's name in a multi-author paper). This can skew publication patterns in an unpredictable way.

3. The Observatory's staff-absence statistics are very good, but care must be used in comparing them with those of other institutions, particularly when the majority of Observatory staff (essentially all the research complement) can often work from home, even when unwell (and they often do), and are not required to work a conventional '9-to-5' working day.

4. Web-statistics are notoriously difficult to interpret; for example, neither the 'Distinct e-Visitor' (DEV) nor the 'Hits' metric, although easy to measure, actually measures the number of individual

users accessing the web-site. Full details of the 'health warnings' attached to such measures are provided in the Armagh Observatory Annual Report for 2008 and 2008/2009 (see pp.6–8 of that report), but in general terms the DEV-statistic provides a firm lower limit to the number of individual users accessing the web-site (a lower limit that is decreasing with time), while the number of hits, although always larger than the number of DEVs, depends on the structure of each web-page as well as the same secular downward trend that affects the DEVs. Another measure of Internet traffic is the volume of data exported from the web-site (and we record this too), but this may be increasing only because astronomers are sharing ever larger data files between one another or because people are nowadays tending to put larger files (e.g. images, videos etc.) onto web-sites because they now have the capacity to view such data more easily.

5. Astropark visitor numbers correspond to the number of people recorded passing the counter at the entrance to the Astropark near the start of the Solar System scale model. Some people, for example those accessing and leaving the Astropark using the Observatory's main driveway, are never recorded, while others (those entering and leaving the Astropark beside the Solar System model) will be recorded twice; and repeat visitors are counted repeatedly. The numbers fluctuate significantly, depending (for example) on the time of year, the weather, public holidays, special outreach events and so on. Sometimes data are missing (e.g. when the counter fails or is vandalized), in which case numbers for the missing period are usually estimated simply by interpolation. Values for 2010 appear to have underestimated the actual numbers, perhaps due to a small misalignment of the counter.

Finally, we note that other factors that should be considered when interpreting these results are the number of senior research staff available to obtain external grants and to direct research projects, other pressures on Observatory staff time, and the level of core funding provided by the sponsor government department. For these reasons, it is important not to over-interpret Observatory performance measures, but to recognize that they are proxies for underlying trends, and possibly of value for comparing similar trends seen in the results of other bodies.

In summary, Tables 3 and 4 demonstrate the very high efficiency of the Observatory's corporate governance and administration systems (the latter costing typically rather less than 10% of total income per year), the exceptionally strong commitment of Armagh Observatory staff to their work, illustrated by remarkably low staff-absence figures, and their high research productivity. In particular, there is an increasing trend in the number of high-quality scientific papers published in refereed scientific journals every year (Figure 2, p.5), a growth in the public profile enjoyed by the Observatory (e.g. as evidenced by the growth in the number of mass-media citations to the Observatory or its work), and a very significant number of people visiting both the Observatory's web-sites and the Observatory's Grounds and Astropark every year (Table 4).