UK INDIA
BUSINESS COUNCIL

SATELLITE PROGRAMMES AND EARTH DATA APPLICATIONS
INDIA – UK ASTROSAT COLLABORATION

HELD ON THE 27TH NOVEMBER 2015 IN INDIA AND IN THE UK AT:

UK INDIA BUSINESS COUNCIL,
MILLBANK TOWER,
LONDON SW1P 4QP
UK

UK INDIA BUSINESS COUNCIL,
TOWER 3, 2ND FLOOR,
EQUINOX BUSINESS PARK (PENINSULA TECHNO PARK),
OFF BANDRA KURLA COMPLEX, L.B.S. MARG
MUMBAI
INDIA

The Roundtable was developed to highlight India's success in the Asian space race and the recent launch of the first of India's space observation Astrosat satellites. On board was a Soft X-ray camera built by the University of Leicester. The session had two overall themes:

- India's advance in space and the recent successful launch of the Astrosat satellite
- The potential uses and benefits of geospatial analysis of earth observation data

Through a VC link at the UK India Business Council's (UKIBC) Mumbai office, lead scientist, Prof. K.P. Singh talked about this UK-India collaboration as part of the Soft X-ray telescope and electronics built by him with his team at the Tata Institute of Fundamental Research's (TIFR) for the Astrosat programme,. Increasing space collaboration between India and the UK could lead to many future opportunities in both countries for the use of earth information from satellites for meteorology, agriculture, disaster relief, water and air pollution control.

The session was attended by:

UK ATTENDEES

NAME	COMPANY	DESIGNATION
Sabe Tibbitts	UK India Business Council	Sector Manager – Digital Innovation
Matthew Maher	Inmarsat	Director, Market Development, Global Government Business Unit
Akther Javid	Inmarsat	Director, Enterprise Growth Sectors

Professor Mark Sims	University of Leicester	Professor of Astrobiology and Space Instrumentation
Andy Powell	Knowledge Transfer Network	Transfer Manager - Space
Tony Hart	Accelerator India	Mediatech Practice Lead

INDIA ATTENDEES

NAME	COMPANY	DESIGNATION
Prof. K.P. Singh	Tata Institute of Fundamental Research, Department of Astronomy & Astrophysics	Senior Professor and Lead Scientist

TATA INSTITUTE OF FUNDAMENTAL RESEARCH (TIFR)

The TIFR is a National Centre of the Government of India, under the umbrella of the Department of Atomic Energy, and a respected university awarding masters and doctoral degrees. TIFR carries out basic research in physics, chemistry, biology, mathematics, computer science as well as its role in science education. The TIFR is made up of a network of research facilities. The main campus is in Mumbai with other campuses in Pune, Bangalore and Hyderabad. The Department of Astronomy and Astrophysics is part of the TIFR's School of Natural Sciences. The department carries out cutting edge research in theoretical and observational astrophysics with an active interest in instrumentation.

Tata links with the TIFR are historic rather than current. Tata assisted in the establishment of the Institute in 1945 by providing some funds and land. Tata has no direct involvement currently, apart from Ratan Tata's chairmanship of the Tata Institute's Council.

The TIFR has been doing space related astronomy since 1960 (radio astronomy is a small part of its work). There was previous collaboration with Nagoya University of Japan on X-ray, Gamma-ray and infrared research (for astronomers UV and X-ray wavelengths are the principal signals such as from black holes, hot white dwarfs, neutron stars and quasars). Japan's development in this field has been exponential and this collaboration has now ceased.

The Indian Space Research Organisation's (ISRO) satellites are "like a bus on which the other institutes are passengers. "The TIFR's role is to "look up not down" and so TIFR loads its small instruments for space observation on to ISRO's satellites.

ASTROSAT PROGRAMME OF SPACE OBSERVATION

Launched on 28th September, 2015, by the ISRO from Sriharikota, Astrosat is purely for astrophysics research. The first ever Indian satellite dedicated to astronomical observations, Astrosat weighs around 1.5 tonnes (Hubble weighs 11.1 tonnes) and was carried into a 650 km orbit on a PSLV (Polar Satellite Launch Vehicle) rocket. Astrosat has unprecedented capability to simultaneously observe cosmic objects in visible light, the ultraviolet waveband and the entire X-ray waveband from very low energy to very high energy X-rays. This unique ability to observe the universe in multi-wavelengths, simultaneously, is aimed at performing cutting-edge research in astrophysics (this can only be done currently by coordinating ground and space telescopes and lining them up for simultaneous observations).

Led by the ISRO, Astrosat is a collaboration between four Indian organisations: the TIFR, the Indian Institute of Astrophysics, the Inter-University Centre for Astronomy and Astrophysics and the Raman Research Institute. Researchers from the TIFR have led this multi-institutional effort and have made significant contributions to the design, fabrication and development of three out of five payloads that are on board Astrosat. Two of the payloads are in collaboration with other agencies: with the Canadian Space Agency and the University of Leicester, UK.

In the UK a team from the University of Leicester's Department of Physics and Astronomy, led by Dr Gordon Stewart, assembled a sensitive CCD camera for the Soft X-ray Telescope (SXT) loaded on to Astrosat. Prof. Singh's team at TIFR refined the software to link with the Astrosat optics and provided the data processing electronics for the camera.

PROF. SINGH'S TEAM IN TIFR AND COLLABORATION ON THE SOFT X-RAY TELESCOPE

As a key part of the Astrosat programme Prof. K.P. Singh with his team at the TIFR built the soft X-ray telescope and electronics on board the satellite. Prof. Singh's core team consists of around half a dozen or so people: 3 engineers, 4 laboratory assistants and temporary computer programmers. Staff turnover is a problem.

Prof. Singh's collaboration with Leicester began in 1999 and started in earnest with Martin Turner of the X-ray Astronomy Group at the University of Leicester, who visited the TIFR in 2005. Since his death the work continued through Professor George Fraser (Director of Space Research Centre) and it is now led in Leicester by Dr Gordon Stewart from the Department of Physics and Astronomy at Leicester who has dealt with senior people in ISRO on this. For Prof.Singh the stimulus for links with the University of Leicester was the need for quality, as the required degree of precision was not available in India. Leicester had solid experience to offer having already built 3 cameras for the SWIFT programme.

The soft X-ray camera from Leicester was successfully launched aboard the Astrosat satellite and is now producing data 15 times per day or about every 98 minutes.

ROLE OF THE ISRO

The ISRO 'encourages space sciences' and has a role similar to that of SWIFT in the UK or NASA in the US. In its relationship with other Indian research institutes, the ISRO does not direct research but instead ensures projects will both work and deliver results. ISRO carries out audits and reviews and so-called "pre-mortems" to check project viability from all points of view.

The ISRO has a variety of facilities including a space applications centre in Ahmedabad (large clean rooms and gyro locating centres) and Trivandrum which provides carbon fibre reinforced tubes used in the PSLV. The Indian Space Science Data Centre (ISSDC) is a new facility being established by the ISRO, as the primary data centre for the payload data archives of Indian Space Science Missions. Located at the Indian Deep Space Network (IDSN) campus in Bangalore, it is responsible for the ingestion, archiving, and dissemination of the payload and related ancillary data for India's Space Science missions.

In January the government in Delhi appointed highly accomplished space scientist and engineer AS Kiran Kumar, (formerly Director, Space Applications Centre (SAC), Ahmedabad), as the new Secretary of the Department of Space (DoS) and also as Chairman of the ISRO. In his place at SAC

in February India's eminent scientist Tapan Misra was appointed Director of ISRO's Space Applications Centre (SAC), Ahmedabad.

UK-INDIA SPACE PARTNERSHIP

There are many examples of India's frugal innovation, such as tube well generators used for transport and mobile medical scanners, but a big barrier in space research is that precision quality is needed. India will be held back unless, like Japan, it can produce quality. There are some areas where the UK can learn from India's approach but it's unlikely this will be true in space research - 'jugaad' (Hindi for an innovative fix or simple work-around) is not enough!

Before the establishment of Inmarsat as a United Nations organisation, there was collaboration between the UK's Defence Science & Technology Laboratory (DSTL) and the Defence Research and Development Organisation (DRDO) in India. Collaboration has been sporadic since then and there was general agreement that partnerships need to be set up for the long term. The UK's Space Knowledge Transfer Network (KTN) is hoping that a new focus on this approach will come out of the UK government's latest spending review.

The Royal Society has funded exchange visits (e.g. Prof Singh's visit to the UK). Innovative engagement would develop Indian opportunities more but visa restrictions are making it difficult to collaborate.

PRIVATE COMPANIES

There is increasing focus on commercial applications so smaller satellites are progressively likely to be the focus of academic research. There is a cluster of satellite companies in Bangalore but work in this field requires investment and a number of these companies are held back because of low quality. The best known within the Bangalore cluster is Dhruva Space Pvt Ltd which claims to be India's first private space organization and already has links into Harwell and the UK Satellite Applications Catapult.

SUPPORT ROLE OF GOVERNMENT AGENCIES

The United Kingdom Space Agency (UKSA) is an executive agency of the UK government and is responsible for the United Kingdom's civil space programme. However in the UK funding for space research is lower than previously and it is lower than in the US and Germany. The UK's Newton Fund (see Supplementary Information below) is one agency providing support for research, named for India activities as the Newton-Bhabha Fund. Priority areas for India have been identified as:

•Sustainable Cities and Urbanisation

•Public Health and Well Being

•Energy-Water-Food Nexus

The structure of collaborative projects is currently limited as the scheme prohibits collaboration in space hardware (this is covered by other schemes). However the Newton Fund does cover the development of satellite applications so some collaborative research is carried out with its support - for example support of downstream applications in agriculture and air pollution.

DEVELOPING TALENT

The trend in research and development is increasingly towards concentration of resource into key agencies. For example NASA is one of just a few doing big inclusive multi-disciplinary projects in space (environmental studies though still draw in a variety of disciplines including physics and maths. The situation is influenced by two factors: availability of graduate jobs and difficulties with funding. Firstly, because of the limited job opportunities, both in the UK and in India, students prefer to avoid becoming too specialist – they now want to be labelled 'physicists'. Secondly there are more applications for scarce resources for the TIFR's research at the Department of Astronomy than there is funding to support them. Generally in academic institutions there is now more emphasis on having PhD level research leading to table top experiments as opposed to building project platforms. This trend is increasing focus on commercial applications so that it is likely smaller satellites will be progressively the focus of academic research.

Apart from its development work, the TIFR's Department of Astronomy also focusses on training graduate and postdoctoral students in Astrophysics. There is potential for collaborative support in this as the UK India Education and Research Initiative (UKIERI) run by the British Council also focusses on the development of talent (see project below - UCL, in partnership with the Department of Biosciences at the University of Kent and the Indian Institute of Technology IIT Delhi).

SATELLITE COMMUNICATIONS - INMARSAT PLC

The present company originates from the International Maritime Satellite Organization (Inmarsat) - a non-profit intergovernmental organization established in 1979 at the behest of the International Maritime Organization (IMO)—the United Nations' maritime body. The organisation was created to establish and operate a satellite communications network for the maritime community

In the mid-1990s, many member states were unwilling to invest in improvements to Inmarsat's network, especially owing to the competitive nature of the satellite communications industry, while many recognized the need to maintain the organization's older systems and the need for an intergovernmental organization to oversee public safety aspects of satellite communication networks. So an agreement was reached to modify Inmarsat's role as an intergovernmental organization and separate and privatize the organization's operational business, with public safety obligations attached to the sale.

Inmarsat was succeeded by the International Mobile Satellite Organization (IMSO) as an intergovernmental regulatory body for satellite communications, while the operational unit was separated and became the UK-based company Inmarsat Ltd. Inmarsat is now a FTSE 100 company with no government involvement. Inmarsat does not manufacture but does define the specifications for the equipment it uses, in a similar way to ISRO.

Inmarsat users are mainly in shipping, defence and the media. They are on 'L' band 0.5 Mbps small terminals and Ka-band larger very high speed 50 Mbps terminals.

As it does in most countries, Inmarsat works in India through partners. In the future it wants to build innovative engagement with Indian operators on the lines of the earlier collaboration between the UK's Defence Science & Technology Laboratory (DSTL) and the Defence Research and Development Organisation (DRDO) in India. Inmarsat aims to become an innovation partner for the development of downstream applications in India, such as for flood control.

Inmarsat has been operating in India for some years but development has been limited because up to now the regulatory environment for satellite phones in India has been challenging. As a result through a regulation waiver system, Inmarsat users have been concentrated in official or government agencies including defence. Up until now Inmarsat has worked servicing this group through only a small group of partners. This is set to change as Inmarsat has recently signed a co-operation agreement with BSNL (itself an India government organisation) as its lead partner in India initially for low data GSPS services to be followed later with GX services. Inmarsat's new Global Xpress (GX) high-speed network will be the first to span the world and give high-speed broadband connectivity on land, sea, and in the air. The agreement with BSNL will allow Inmarsat to engage more widely in the future expanding links beyond its legacy partners.

Longer term Inmarsat wants to be part of the 'eco system' in India to encourage clusters of innovation and develop good ideas on how to use their communications capability. Through Indian start-ups, Inmarsat wants to encourage the development of applications using its communications capacity. Examples of this could be using integrated decision making systems for improved air quality, pollution control, water management, fisheries, agriculture and disaster management. There is potential for such applications to grow through India's mapping and meteorological information. The National Remote Sensing Centre (NRSC) in Hyderabad has been a major force in the adoption and use of geospatial technologies through its aerial and satellite data acquisition, data supply, mapping and nation-wide projects. However data use is, in the main, controlled centrally from Delhi and with defence concerns, there is limited public access to this. This tends to limit Indian innovation in this, both in using earth data commercially and in education (e.g. 'mapping your school' is not possible). Similar to Community for Open Source in Public Academics (COSPA) in the US the UK is taking a different approach and will soon allow full and free access to global data which may by-pass restrictions in India.

FURTHER EVENTS TO HIGHLIGHT UK-INDIA SPACE COLLABORATION

The aim is to follow this initial forum highlighting UK-India collaboration in space with another event covering wider space opportunities for the two countries at a date in May 2016.

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Date: 10th December 2015

SUPPLEMENTARY INFORMATION

NEWTON FUND

The Fund is being delivered by 15 UK delivery partners including Royal Society, British Academy, Royal Academy of Engineering, Academy of Medical Sciences and Innovate UK in collaboration with funders in 15 partnering countries. They develop and run calls, allocate and manage the money they receive as part of the Newton Fund which has two underpinning capabilities:

•High Value Manufacturing

•Big Data

The Newton Fund partnership in India is the Newton-Bhabha Fund and the main Indian funding partners to date are:

- Department of Science & Technology (DST)
- Department of Biotechnology (DBT) within the Ministry of Science and Technology

Sarah Mooney heads the UK Science and Innovation Network in India and is the contact for Newton Fund projects in India.

UK-INDIA EDUCATION AND RESEARCH INITIATIVE (UKIERI) AWARD

A joint initiative between the UK and Indian Governments, UKIERI aims to enhance educational links between the two countries, providing opportunities and funding for UK and Indian universities to collaborate on thematic partnerships and collaborations to enhance the innovation and research capacity of the two countries. Established in 2006, UKIERI has so far committed £25 million in the first phase of the programme, and has recently been extended by a further five years.

In a recent UKIERI award, scientists from the UK's Department of Biochemical Engineering at UCL and India's Department of Space and Climate Physics, in collaboration with other academics in the UK and India, have received funding. Dr Daniel G. Bracewell from UCL and physicist Dhiren Kataria are working on a joint project which aims to develop a strategic research and innovation partnership in the area of space science and instrumentation between teams at the Space Physics Laboratory

(SPL), Vikram Sarabhai Space Centre (VSSC), the Indian Space Research Organisation (ISRO) in India, and the Mullard Space Science Laboratory (MSSL) at UCL.

Dr Bracewell and his team at UCL, in partnership with the Department of Biosciences at the University of Kent and the Indian Institute of Technology (IIT Delhi), will explore imaging technologies in order to understand bio-separations, building on existing work between UCL and IIT Delhi.

“I see the partnership as an exemplar,” commented Dhiren, “with the long term vision of extending such partnerships to other areas of space research between Indian and UK institutions, tapping into India’s already incredibly successful space programme.”