

Introduction to the Cockcroft Institute and Welcome!!!

*Roger M. Jones (Cockcroft Inst. and Univ. Manchester)
for Swapan Chattopadhyay (Director Cockcroft Inst.)*

December 1, 2008



44th ICFA Workshop under the sponsorship of the ICFA BD Panel, Cockcroft Inst., 1-4 Dec 2008



Sir John Cockcroft FRS

b. Todmorden (Lancashire *and* Yorkshire!)

ed. Manchester University: Maths

Manchester College of Technology (UMIST): Elec. Eng.

Metropolitan-Vickers, Manchester

PhD then post-doc, Cambridge Univ.

Nobel Laureate, Physics, 1951



44th ICFA Workshop under the sponsorship of the ICFA BD Panel, Cockcroft Inst., 1-4 Dec 2008

Cockcroft Institute Mission: Deliverables

- **Generic research and development at the frontier of Accelerator Science and Technology;**
- **Project-specific research and development in Accelerator Science and Technology;**
- **Leadership and management of national deliverables to international facilities (projects);**
- **Competence in crucial and specific technologies;**
- **Support in design, construction and operation of national and international facilities;**
- **Technology transfer to (and Knowledge Exchange with) industry nationally and globally;**
- **Staff complement of internationally acknowledged expertise;**
- **Seamless involvement of the Universities and Research Councils ;**
- **Education and training to ensure a flourishing next generation of scientists and engineers.**

Foundation and Inauguration

- Founding Director, Prof. John Dainton
- Succeeded by Prof. Swapan Chattopadhyay



The Opening of the Cockcroft Institute by the Minister of Science,
Lord Sainsbury, in 2006

*“When we talk about world-class science we need look no further than
the North West and the Cockcroft Institute”*

- Prime Minister, Tony Blair (2006)

Foundational Constitution and Operational Basis

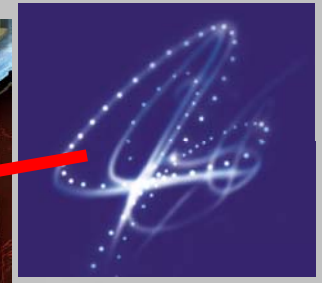
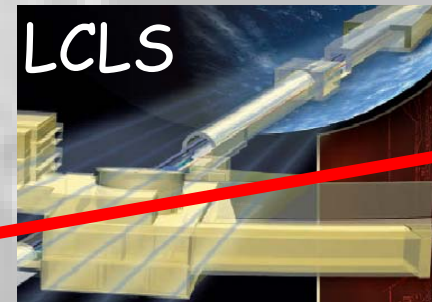
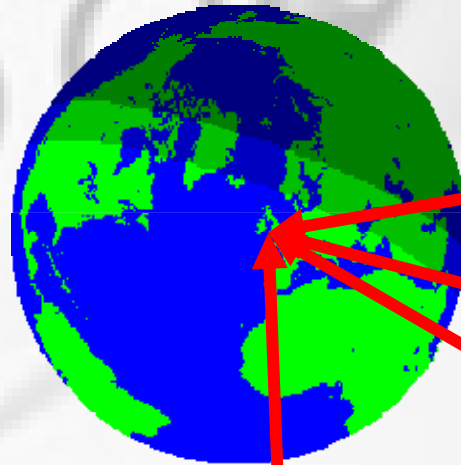
- **The Cockcroft Institute was founded Autumn 2004 and officially inaugurated by Minister of Science Lord Sainsbury in 2006;**
- **Joint partnership and commitments from University of Liverpool, University of Manchester, Lancaster University, Science and Technology Facilities Council (STFC, then PPARC and CCLRC separately before the merger) and the North West Development Agency (NWDA);**
- **A number of new faculty members in accelerator physics and engineering appointed in each of the three universities, according to a master plan till 2017;**
- **An additional limited number of faculty staff members in the universities funded and jointly appointed by Universities and STFC, aligned with the STFC mission and programme;**
- **Incorporation of professional accelerator physicists and engineers (about 60 FTEs) from STFC/ASTeC;**
- **An amount of core funding from STFC sustaining post-doctoral staff in balance with the faculty members (at least one per faculty member), some number of Ph.D. students and additional costs of education, training, experimental equipment, visitor programme and promotional events to run the institute;**
- **Direct “Quota” studentship from STFC;**
- **A purpose-built building for the Cockcroft Institute housing staff from the universities and STFC/ASTeC and funded by the NWDA.**

Science "Driver"

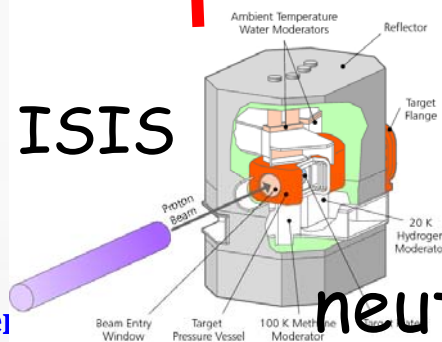
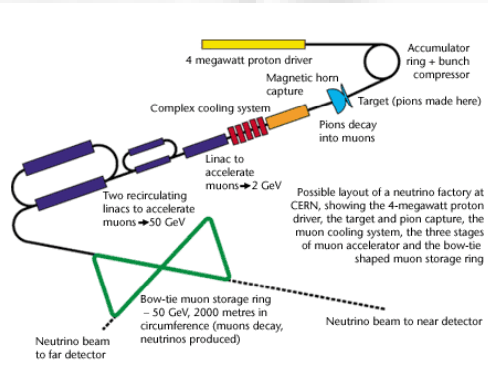
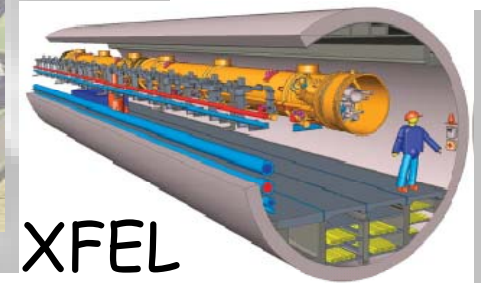
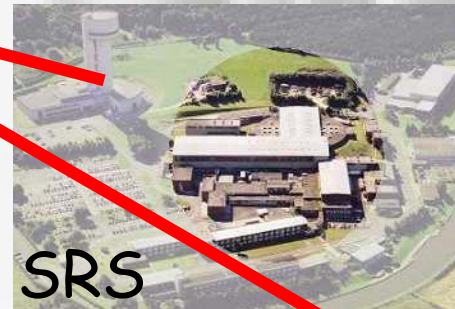
High Energy
Physics

- global
- UK membership

"light fantastic"



NLS



ν -Factory

neutrons

R&D Challenge ...

High Energy
Physics

- global
- universal

"light fantastic"



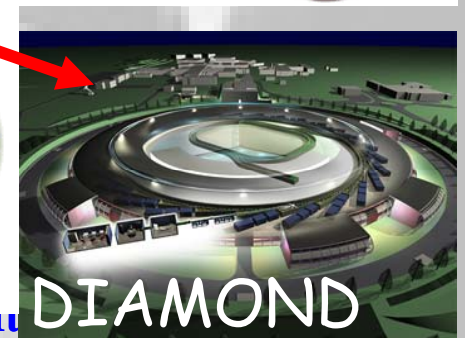
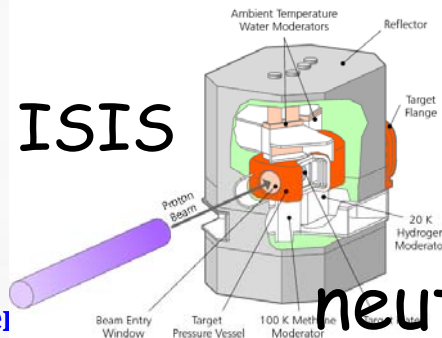
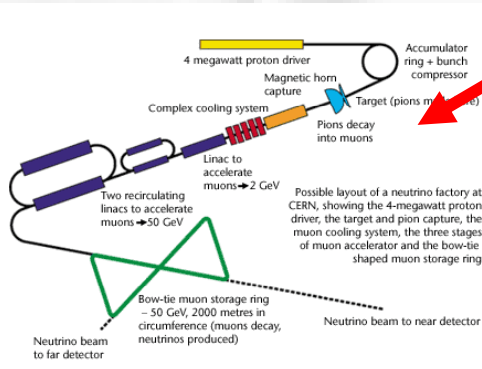
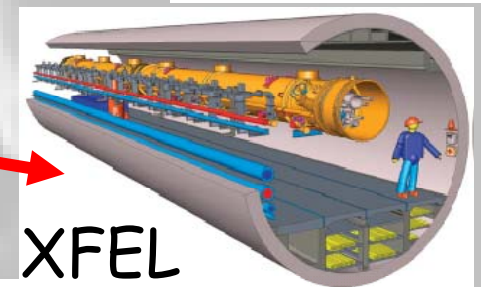
- MV/m
- intensity
- nm delivery



ALICE



Cockcroft
Institute
+UK plc



ν -Factory

neutrons



The pieces

- "blue sky" and project R&D
- delivery + operation
- international collaboration



physicist(s?)

core funding



physicists



building



physicists engineers



physicists engineers

Cockcroft Institute



+UKplc



- why here ?
 - Daresbury ↔ accelerator-lead research univs
lab Lancaster Liverpool Manchester
R&D + delivery + operation
Nuclear Physics (since Rutherford !)
High Energy Physics (since Chadwick !)
Synchrotron Radiation science (since SRF 1970s)
 - all required new accelerator systems for progress
synergetic challenges
- Cockcroft/Walton experience 70 years on ?

"... they were fortunate to have the support of
Metropolitan Vickers: ... the Manchester company."

B Cathcart in "The Fly in the Cathedral"

The first Accelerator

- matter @ MeV scale: the discovery of the "point-like" atomic nucleus
- Disproves "plum-pudding" model
- Rutherford Appointed Professor at Univ. Manchester 1907
- Exp. Marsden, Geiger and Rutherford, Manchester 1909

rare



Alpha particles: probe

MeV from an atomic nucleus

$\sim 10^{14}$ MV/m !



Ultra thin Gold foil: target

- large energy transfer Q
- large scattering angle

$$\sigma \sim 1/Q^4$$

Cambridge: "splitting the atom"

- splitting the atom 14th April 1932
the birth of the energy frontier
 - 800 KeV $p + \text{Li} \rightarrow \text{He} + \text{He}$ fundamental



John Cockcroft

b. Todmorden (Lancs and Yorks!)

ed. Manchester Univ (Maths)

Manchester College of Technology (Elec. Eng.)

Metropolitan-Vickers, Manchester

PhD then post-doc Cambridge Univ.

Li



Ernest Walton

ed. TC Dublin, MSc hydrodynamics

PhD student, Cambridge Univ.

... with NW England's industry

"The facts are that we looked first for gamma rays and not alpha particles, since at that time we had a fixed idea that gamma rays would be the most likely disintegration products."

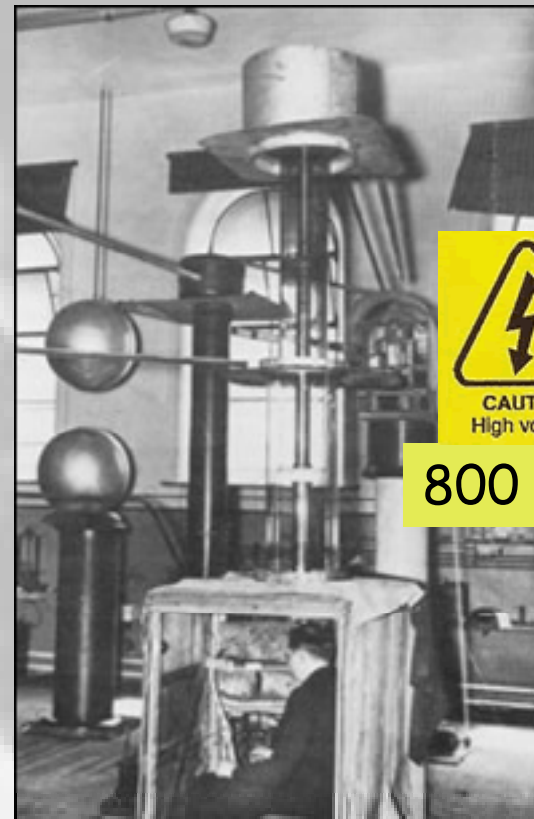
Sir John Cockcroft FRS 1938

"... a singularly modest and self-effacing life."

C P Snow on John Cockcroft in "Physicists"

"... they were fortunate to have the support of Metropolitan Vickers: ... the Manchester company."

B Cathcart in "The Fly in the Cathedral"



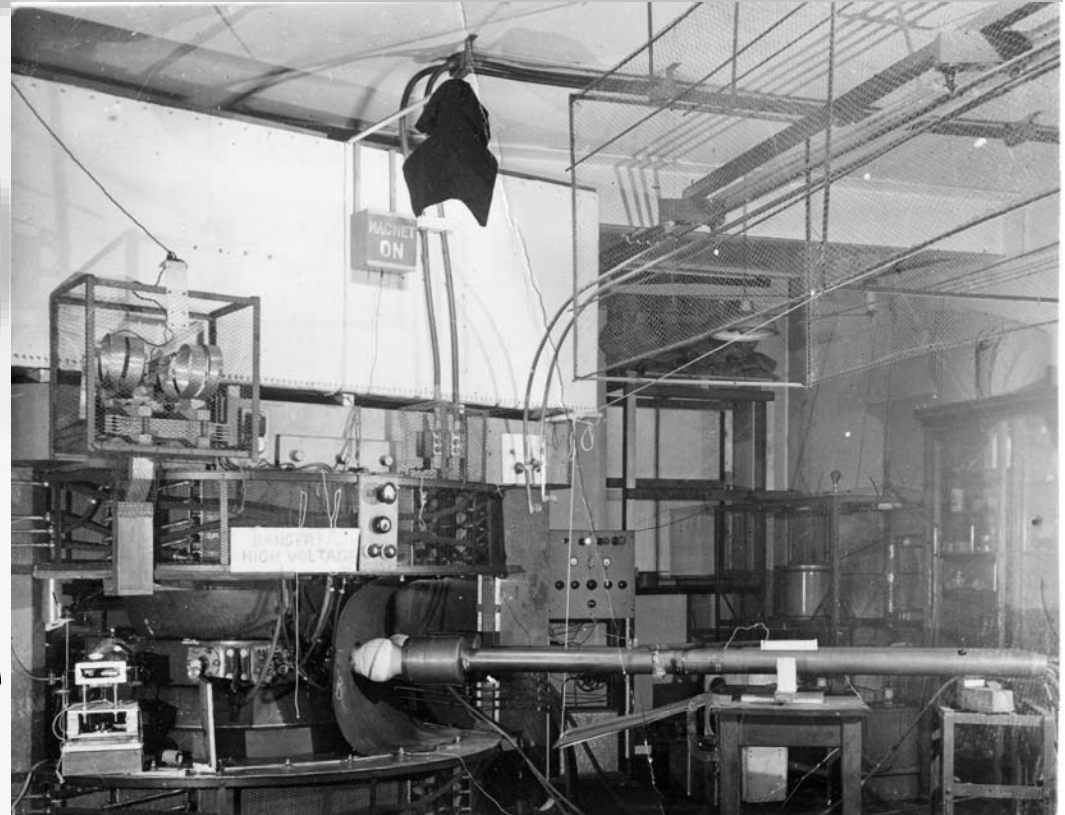
800 kV



The Cockcroft Institute
of Accelerator Science and Technology

Synchronous Acceleration

- NW England (again)
James Chadwick
- Liverpool cyclotron
 - first outside US?
 - cross sections for Manhattan
 - Liverpool Physics in Downing Street !



↳ Liverpool synchrocyclotron "Metro Vick"
- first ever extracted beam Crewe and Gregory

↳ NIMROD (p) and NINA (e) synchrotrons
CERN (p e) PS SPS SpS LEP LHC

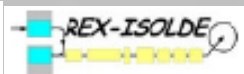
Mission

The Institute's "mission" is summarised in the following "deliverables":

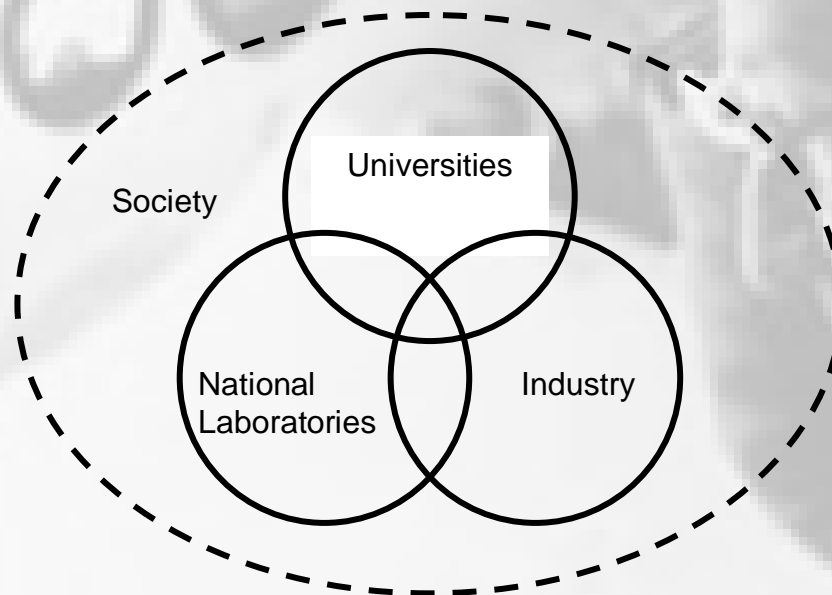
- generic R&D in Accelerator Science and Technology (AST);
- project specific R&D in AST
(e.g. a linear collider and a Neutrino Factory);
- leadership and management of national deliverables to international facilities (which may be UK-situated);
- competence in crucial and specific technologies;
- technology transfer to industry;
- staff complement of internationally acknowledged expertise;
- seamless involvement of the HEI and STFC sectors;
- education and training to ensure a flourishing staff supply side.

R&D Investment

- RF: supply (incl CLIC+IFMIF) Lanc+ASTeC
 cavity (incl MICE+UKNF) Lanc(+IC)
 novel cavity surface R&D Lanc
 scRF Lanc+Manch+ASTeC
- theory (incl CLIC/CTF3) Lanc+Liv
- ILC: e^+ source+spin tran^t Liv+Durham+ASTeC
 damping rings Liv+ASTeC
 linac wakefields Man
 BDS layout+lattice design ASTeC+univs
 BDS collimⁿ ASTeC+Lanc+Man(+Brum)
 crab cavity Lanc+ASTeC
- newly developing projects:
 EMMA: e non-scaling FFAG ASTeC+Man
 laser-plasma (ALPHA-X) Lanc+ASTeC
 FP420 at LHC + LHC comm^a Man



The Cockcroft Model





The Cockcroft Institute Board

(meets quarterly)

CHAIR

Dr. Mike Dexter FRS, *Ex- CEO of Wellcome Trust, corporate Board Chair and President*

ACADEMIC

Prof. Sir Howard Newby, Vice-Chancellor, Univ. of Liverpool (replacing Prof. Sir Drummond Bone, last VC)
Prof. Alan Gilbert, President and Vice Chancellor, Univ. of Manchester
Prof. Paul Wellings, Vice-Chancellor, Lancaster University

RESEARCH COUNCIL

Dr. Keith Mason, CEO, STFC (RCUK) (represented by Dr. John Womersley, Director of Science Programs)
Dr. Colin Whitehouse, Dep. CEO, STFC for *Campus Development*

LOCAL ECONOMY/INDUSTRY

Dr. George Baxter, Chief Scientific Officer, NWDA

INSTITUTE

Prof. Swapan Chattopadhyay, Director, CI
Prof. John Dainton FRS , Chief Scientist and Founding Director

Often in attendance are: Prof. John Saunders, Deputy VC or Prof. Steve Holloway, Pro-VC and Dean representing Liverpool; Prof. Jon Perkins, Dean of Science and Engineering or Prof. Helen Gleeson, Head of School of Physics and Astronomy, representing Manchester; Prof. Trevor McMillan, Pro-VC, representing Lancaster.

The Cockcroft Institute international Scientific Advisory Committee (SAC)

(meets annually)

***Dr. Ferdinand Willeke (BNL, USA), Chair, 2006-2008: General Accelerator Physics, Colliders, Light Sources**

Prof. Tor Raubenheimer (SLAC/Stanford Univ., USA), 2008-2010: General Accelerator Physics, Linear Colliders

Prof. Georg Hofstaedter (Cornell, USA), 2007-2009: General Accelerator Physics, Colliders, Energy Recovery

Dr. Hans Weise (DESY, Germany), 2007-2009: Superconducting RF (SRF), Free Electron Lasers (FELs)

Prof. Kwang-Je Kim (ANL/U. Chicago, USA), 2007-2009: General Accelerator Physics, FELs, Linear Colliders

***Dr. Junji Urakawa (KEK, Japan), 2006-2008: Linear Colliders, Test Facilities**

***Prof. Ilan Ben-zvi (BNL, USA), 2006-2008: Superconducting RF, ERLs, General Accelerator Physics**

Dr. Lia Merminga (TRIUMF, Canada), 2007-2009: General Accelerator Physics, Energy Recovery, SRF

***Dr. Roland Garoby (CERN, Switzerland), 2006-2008: Radio Frequency for Rings and Linear Accelerators**

(* Completed a full 3-year term. Replacement membership being sought)

Selected Conferences/Workshops/Schools Organized/Sponsored

- Energy Recovery Linac, ERL, 2007, UK (Cockcroft Institute)
- Particle Accelerator Conference, 2007, USA (Albuquerque)
- European High Energy Physics Conference, 2007, UK (Manchester)
- CERN/CI Accelerator School, UK (Cockcroft Institute)
- Polarized Antiprotons, 2007, UK (Cockcroft Institute)
- European FEL Conference, 2007, Italy (Frascati)
- Institute of Physics Workshop on medical Accelerators, 2007, UK (Oxford/Cambridge Gray Institute)
- Three ADSR Workshops at CI and Univ. Of Manchester in 2007/2008 (R. Barlow)
- ICFA X-Band Workshop planned in December 2008 (R. Jones) at Cockcroft Institute)
- Vacuum Workshop in 2008 (O. Malayashev) at Cockcroft Institute)
- European Synchrotron Radiation Facilities workshop in November 2008 (Hywel Owen/Jim Clark) at Cockcroft Institute
- DIS Conference sponsored in 2008, UCL, in London
- LINAC 2008, EPAC 2008 and PAC 2009 Sponsorships
- High Power RF Symposium, February 2009, London, RF Faraday Partnership/IET

Collaborations

- **CERN/CI: a new model of European collaboration in accelerators. Comprehensive MoU for collaboration on High Energy Particle Colliders, Low Energy Accelerators for Nuclear and Atomic Physics and New Frontiers (CERN Courier , November 2008, faces and Places);**



- **Imperial College/CI : MoU in progress for collaboration on Accelerators for Neutrino and Muon Physics, on Laser-Plasma Studies, on Hadron therapy, and on ADSR;**
- **Scottish Universities Physics Alliance (SUPA)/CI: MoU in progress for collaboration on Accelerators, Free Electron Lasers and Laser-Plasma Studies for Nuclear Physics and Photon Sciences;**
- **LBNL/CI: MoU for collaboration on light sources, superconducting RF and FELs;**
- **Jefferson Lab/CI: MoU for collaboration on sc cavity development and beam physics.**

MoU with Saha Institute of Nuclear Physics (SINP), India has been in place since 2007. Collaborations with TRIUMF, Cornell, SLAC, University of California at Berkeley, MIT and DESY are being planned. Informal collaborations exist also on multi-beam klystrons with Thales, on innovative magnet design with UCL, etc.

**Education and Training
Contact Lecture Hours
(Talk by Neil Marks and supplemental Appendix: a very
successful program exploited by CERN and sought after
for collaboration by USPAS)**

Category	Academic year			<i>Total</i>
	05/06	06/07	07/08	
Science - basic	24	0	20	44
Science - advanced	10	35	23	68
Technology - basic	8	14	20	42
Technology - advanced	6	31	10	47
<i>Total</i>	48	80	73	201





Staff and Students

Research Staff Scientists, Engineers, Technicians:

Universities + STFC+ Consultants:

60 FTEs

- Post-doctoral Fellows
17

Visiting Professors/Distinguished Affiliates:

8

Ph.D. Students
24
M.Sc. Students
1
Undergraduates
2
International
1

Academic Staff

2008:
Total
26 from Univ. of Liverpool, Manchester and Lancaster and joint w/STFC

2012:
Additional 3 from Universities plus 3 from STFC
Total
32 from Univ. Liverpool, Manchester, Lancaster and STFC-Adjuncts +Durham, Imperial, SUPA.

- Administrative staff
5 FTEs

Academic	26
Research/Technical	60
Post-doctoral	17
Post-graduate students	25
Undergraduates+ International	3
Administrative	5
Visiting Prof./Affiliates	8
Total	143
Nov, 2008	heads = 123 FTEs

Summary and Conclusion

- CI progressing to maturity
 - acknowledged internationally (collaboration)
 - leadership roles
 - hands-on accelerating system(s)
- scientific programme growing (SAC input)
 - strategy responsive to changing world
 - able to focus at right moment
 - niche strengths already appearing (SAC)
 - substantial output
- high quality staff being recruited
 - growing demand for responsive projects
 - crucial to mission: STFC ?

Summary and Conclusion

- industrial KE in early stages
 - excellent individual examples (RF eng)
 - Institute KE unit established with stakeholders: 3 univs + NWDA + STFC
 - coherence of RDA+RC agenda ?
 - how really to engage industry ?
 - how really to enable industry ?
 - european industry coherence ?
- substantial E&T program
 - in-house systems (ERL, large emittance)
- more high quality students should be funded

Acknowledgements

- Liberally used slides from Swapan Chattopadhyay and John Dainton



<http://www.cockcroft.ac.uk/>

Spares



44th ICFA Workshop under the sponsorship of the ICI

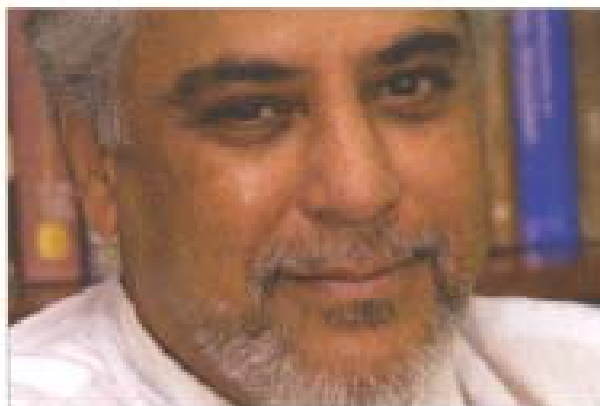
-4 Dec 2008

Getting it right ...
... most of the time!

- there are three C's in CoCkCroft !

...while Chattopadhyay moves to Crockcroft

Swapan Chattopadhyay, currently associate director of Jefferson Lab, is to become the inaugural director for the newly created Crockcroft Institute – one of the UK's two new centres for accelerator science and technology. In addition, the universities of Lancaster, Liverpool and Manchester have made him the first chair of Accelerator Physics in the UK. He will take up his new position in March.



These new appointments reflect Chattopadhyay's contributions to phase space cooling, innovative particle colliders, novel synchrotron-radiation production and ultra-short femtosecond X-ray sources. His achievements also include the development of postgraduate education in accelerator physics and engineering and a number of successful industrial collaborations with hi-tech commercial partners.

... but two R's ? !

CERN Courier
Jan 2007

... for tomorrow's science

- RCUK prioritisation to come (SR07) ?

Large Facility	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Supernemo (PPARC)													
Upgrade the Mega Amp Spherical Tokamak (MAST) at Culham (EPSRC)													
Household Panel Study (ESRC)													
New Scientific Opportunities at the European Synchrotron Radiation Facility (OCLRC)								EP SRC					
4GLS (OCLRC)								EP SRC					
UK Participation in the construction of a facility for antiproton and ion research (EPSRC)								EP SRC					
Oceanographic Research Ship (NERC)													
National Institute for Medical Research (NIMR) (MRC)													
ISIS Second Target Station Instruments (OCLRC)													
The European X-Ray Laser Project (OCLRC)										EP SRC			
Linear Collider (PPARC)										ST FC			
Gravitational Wave Detection Facilities (PPARC)													
A Megawatt Class Spallation Neutron Source for Europe (OCLRC)										EP SRC			
Extremely Large Telescope (ELT) (PPARC)													
European High Performance Computing Service (EPSRC)													
Diamond Phase III (OCLRC)											EP SRC		
Neutrino Factory (PPARC)											ST FC		
HIPER: High Power Experimental Research facility (OCLRC)													
Mini Fabrication facility for Nanotechnology (EPSRC)													
Square Kilometre Array (PPARC)													

Key: £0-10m £10-25m £25-50m £50m+

! SNS (1 MW) from 2007

! JPARC (1 MW) from 2009/10 ?

EP SRC science

ST FC science

A accelerator science and technology



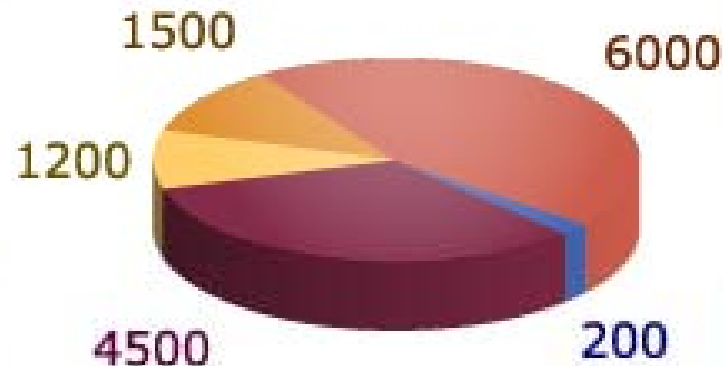
Accelerators Today

- accelerators today drive wealth creation
 - accelerator technology of the 20th Century
 - from the physics of the 20th Century

General industrial use:
Sterilisation, imaging

Research accelerators:
Particles, synchrotron light used in biomedical, physics, chemistry, biology, material research

Radiotherapy:
Cancer treatment with X-rays, protons and other particles



Ion implantation, surface modifications:
Controlled semiconductor doping; Changing properties of surfaces

Radioisotope production:
Cancer treatment; imaging organs for medical use



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Cancer treatment with X-rays,
protons and other particles



Cockcroft
Institute
+UK plc

**Ion implantation,
surface modifications:**
Controlled semiconductor
doping; Changing properties
of surfaces

**Radioisotope
production:**
Cancer treatment; imaging
organs for medical use

- accelerators tomorrow ?
 - accelerator science \leftrightarrow KE \leftrightarrow UK plc