

John Dainton  
Daily Telegraph  
@ Liverpool Univ  
August 15 2007



THE COCKCROFT INSTITUTE of  
ACCELERATOR SCIENCE and TECHNOLOGY

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

# Welcome to the Cockcroft Institute

John Dainton

Founding Director, Cockcroft Institute for  
Accelerator Science and Technology, and  
Sir James Chadwick Professor of Physics  
The University of Liverpool, GB



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## 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

LANCASTER  
UNIVERSITY

*Celebrating 60 Years of Excellence*



UNIVERSITY OF  
LIVERPOOL

The University  
of Manchester

MANCHESTER  
1824



Northwest  
REGIONAL DEVELOPMENT AGENCY



Science & Technology  
Facilities Council

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# Science "Driver"

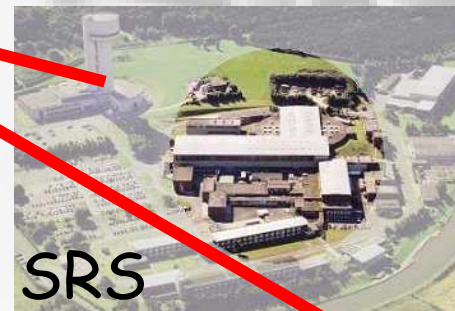
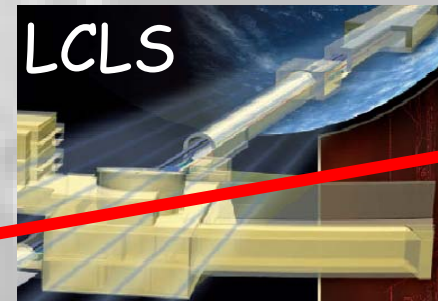
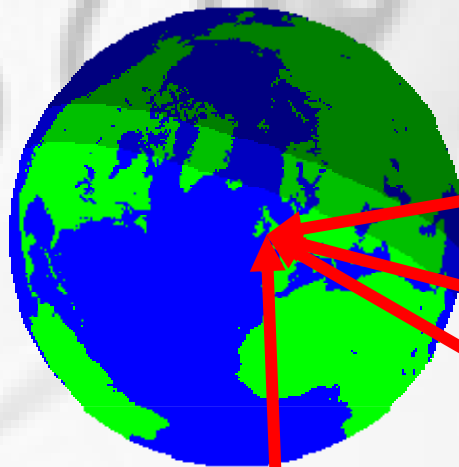


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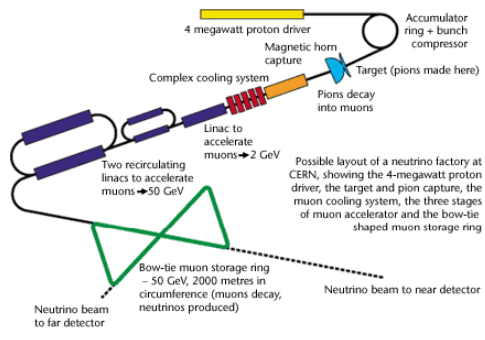
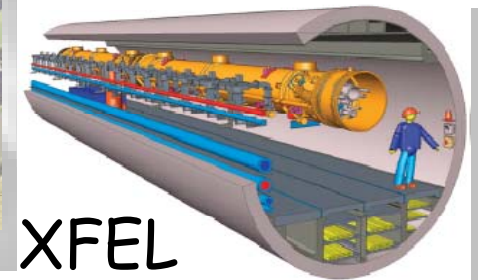
High Energy  
Physics

- global
- UK membership

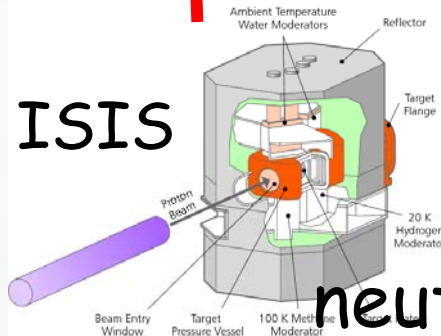
"light fantastic"



NLS



$\nu$ -Factory

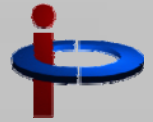


neutrons



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# R&D Challenge ...



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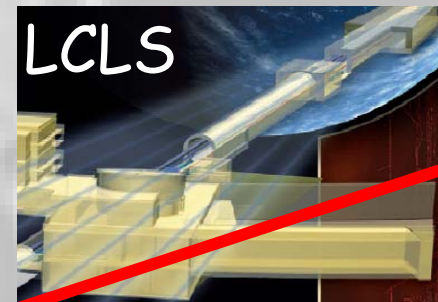
## High Energy Physics

- global
- universal

"light fantastic"

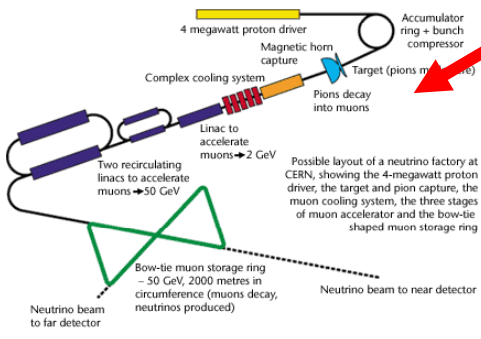
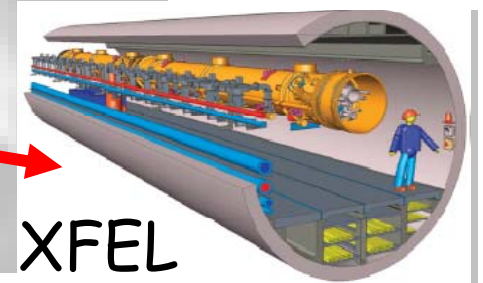


- MV/m  
- intensity  
- nm delivery

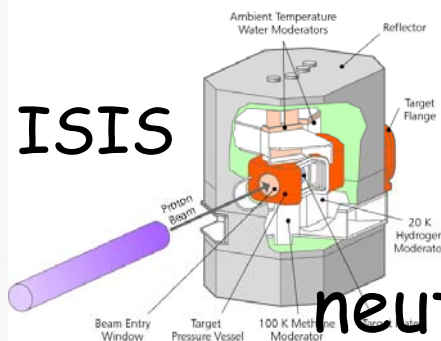


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Institute  
+UK plc

ERLP



$\nu$ -Factory



neutrons



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# The pieces

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



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physicist(s?)



physicists



physicists  
engineers



Cockcroft  
Institute

+UKplc



core  
funding



building



physicists  
engineers

# The Cockcroft Institute @ DSIC



- 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  
Marsden and Rutherford, Manchester 1909

rare



Alpha particles: probe

MeV from an atomic nucleus

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

- large energy transfer  $Q$
- large scattering angle



Ultra thin Gold foil: target

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

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# Cambridge: "splitting the atom" .....



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- splitting the atom 14<sup>th</sup> 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.



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## ... with NW England's industry



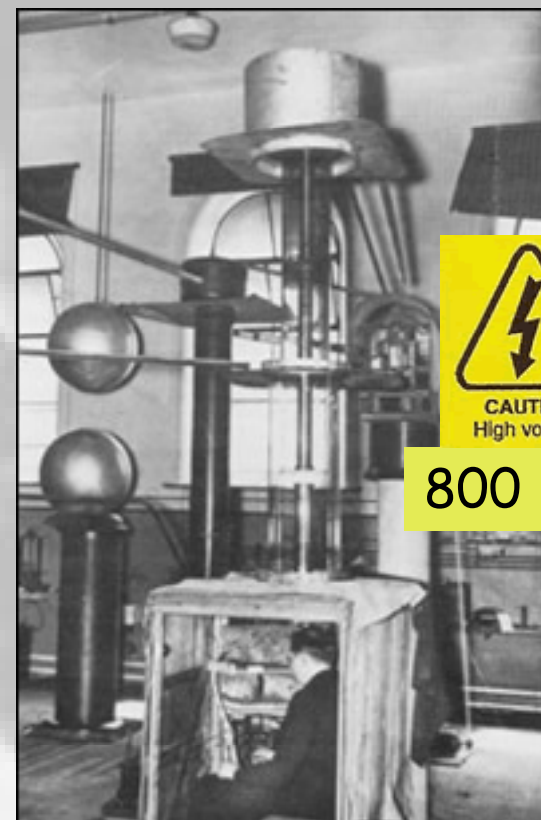
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"The facts are that we looked first for gamma rays and not alpha particles, since at that time we had a fixed idea that gamma rays would be the most likely disintegration products."

Sir John Cockcroft FRS 1938

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

C P Snow on John Cockcroft in "Physicists"



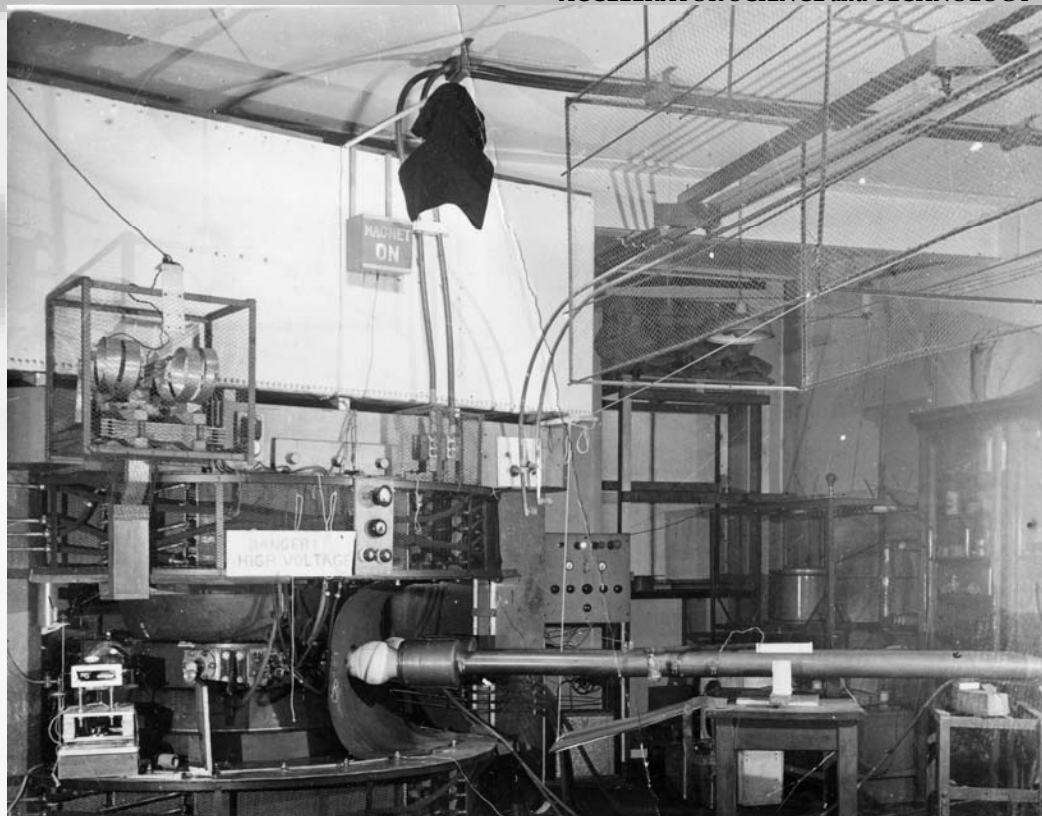
"... they were fortunate to have the support of Metropolitan Vickers: ... the Manchester company."

B Cathcart in "The Fly in the Cathedral"

# 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":

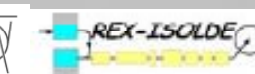
- generic R&D in Accelerator Science and Technology (AST);
- project specific R&D in AST  
(e.g. a linear collider and a Neutrino Factory);
- leadership and management of national deliverables to international facilities (which may be UK-situated);
- competence in crucial and specific technologies;
-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

# R&D Investment



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- 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<sup>t</sup> Liv+Durham+ASTeC  
damping rings Liv+ASTeC  
linac wakefields Man  
BDS layout+lattice design ASTeC+univs  
BDS collim<sup>n</sup> 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<sup>a</sup> Man

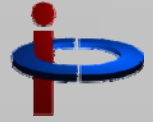


# Summary and Conclusion



- 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 very 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

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# Spares



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UNIVERSITY OF  
LIVERPOOL

The University  
of Manchester

MANCHESTER  
1824

Northwest  
REGIONAL DEVELOPMENT AGENCY

PPARC

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

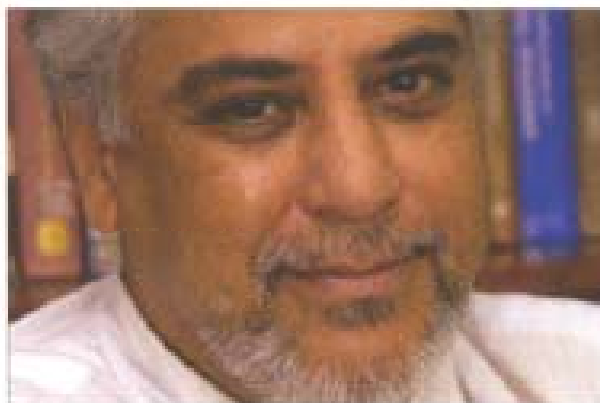


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- there are three C's in CoCkCroft !

## ...while Chattopadhyay moves to Crockcroft

Swapan Chattopadhyay, currently associate director of Jefferson Lab, is to become the inaugural director for the newly created Cockcroft 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)	!	A							EP SRC				
Extremely Large Telescope (ELT) (PPARC)													
European High Performance Computing Service (EPSRC)													
Diamond Phase III (OCLRC)													
Neutrino Factory (PPARC)													
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+
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! 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 20<sup>th</sup> Century
  - from the physics of the 20<sup>th</sup> Century

## General industrial use:

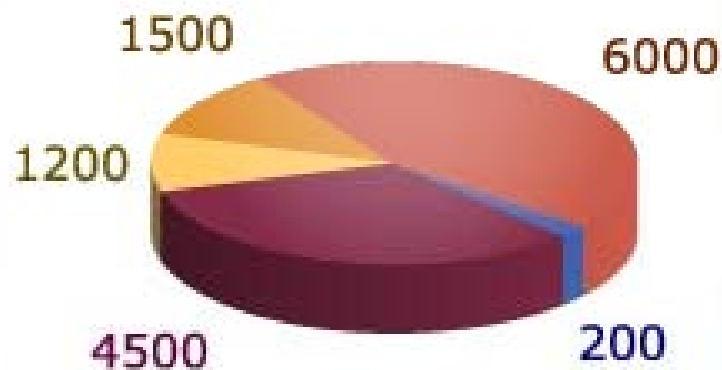
Sterilisation, imaging

## 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

# Accelerators Today



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