

Accelerators at Huddersfield

Roger Barlow

8th April 2016



Founded 5 years ago

- 5 Professors
- 3 Research Fellows/postdocs
- 16 PhD students and 2 MSc students

“To teach, research and lead developments in innovative accelerator technology and particle-target interactions, with applications for society in medicine, energy, industry and science”

Fundamentals:

University has tradition of strong links with industry

Not competing in areas where established groups are already strong

No undergraduate teaching - pure research institute

MSc course

(Advertisement)

A unique 1 year course in accelerator science - featuring real accelerator codes (MAD, COMSOL, Geant4, LabVlew, etc)

Please take a poster back with you and stick it up where potential students will see it - and recommend it in appropriate cases.

Note: no grants, but students can now get postgraduate loans - and fees are only £4,950

MSc in Accelerator Science at the University of Huddersfield

This 1 year post-graduate Master's programme covers the physics and engineering of particle accelerators, from the lowest to the highest energies.

A mixture of taught modules and a research dissertation, this new course is unique in the world, with all material specifically designed for it.

This course would suit students who have, or expect to obtain, an honours degree (generally 2:1 or above), but others will be considered in special circumstances in physics, engineering, mathematics or computing, and who want a specialist higher level qualification.

There are more than 30,000 particle accelerators in use worldwide, in fields from archaeology to zoology, as well as in hospitals and industrial plants, all needing experts to operate and exploit them. So graduates of this course will be well placed for employment - or perhaps to continue research with a PhD.

Huddersfield is a vibrant university with strong links to industry, with particular emphasis on student satisfaction.

The International Institute for Accelerator Applications (IIAA) is designed as a centre of excellence for research into accelerators and their applications. MSc students work on our own small accelerators, and their dissertations may involve them on larger machines, in the UK and abroad, such as the SS at Lund and the IFAE at Geneva, using our own high performance computer server.

Our international students are an important part of our community, and with 85 nationalities represented, we are confident that whenever you come from, you'll quickly feel at home.

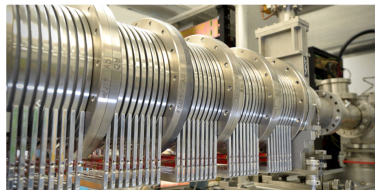
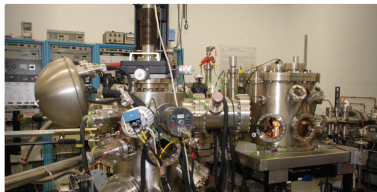
Course fees for UK and EU students are currently only £4,950 annually. And starting this year - students on MSc courses are eligible for a £10,000 student loan.

To apply, or just for more information, go to hull.ac.uk/iaaa

MEIS

Medium Energy Ion Scattering: Jaap van den Berg and Andrew Rossall

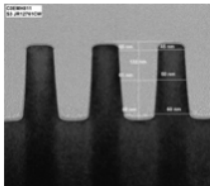
200 keV ion source, formerly at Daresbury. Moved across the Pennines and rebuilt+recommissioned



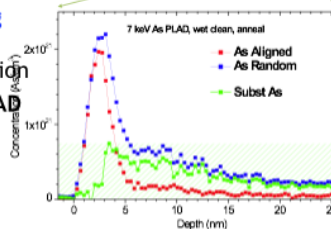
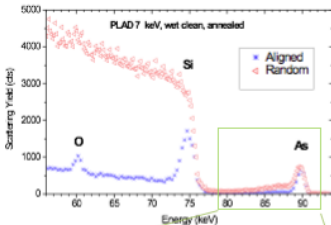
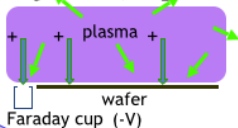
High-rate detector+readout electronics measures energy and angle of scattered ions, yielding information on target nuclei - and their disposition in the sample

Plasma doping in Si: substitutional As fraction

22 nm node transistors
Fin FET transistors



Conformal plasma doping
(PLAD) of fins is required
As deposition & Implantation
AsH₃ (5-10%) / H₂ / Xe PLAD



MEIS spectra using
100 keV He⁺ ions

Random & Aligned
[-1-11] in, [112] out

Substitutional As is
shadowed in an Aligned
spectrum but is “seen”
by the ion beam in a
Random spectrum

Converted depth
profiles

As doses:

Random: $1.4 \text{ e}^{15} / \text{cm}^2$

Aligned: $6.7 \text{ e}^{15} / \text{cm}^2$

Active As: $7.3 \text{ e}^{15} / \text{cm}^2$

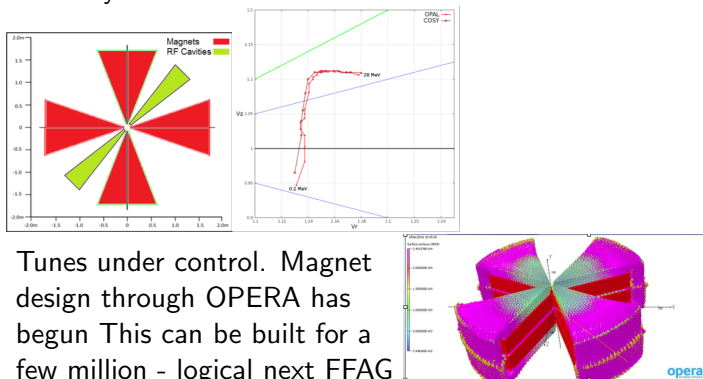
Segregated As

$4 \text{ e}^{15} / \text{cm}^2$

nsFFAG designs (1) PIP

David Bruton, Rob Edgecock, Carol Johnstone

The Proton Isotope Production accelerator A low energy nsFFAG with an internal target - like ERIT, using peaks in cross section to improve efficiency.



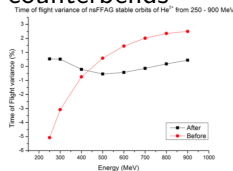
Tunes under control. Magnet design through OPERA has begun This can be built for a few million - logical next FFAG

nsFFAG designs (2) - Helium Ion therapy

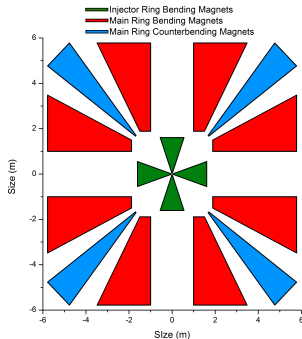
Jordan Taylor, Rob Edgecock, Carol Johnstone

Heavy ions look even more promising than protons - massive $\frac{dE}{dx}$ kills cells through double strand breaks. But very difficult for cyclotron/synchrotron. FFAG looks very promising.

This one has 8 bends, 4 counterbends



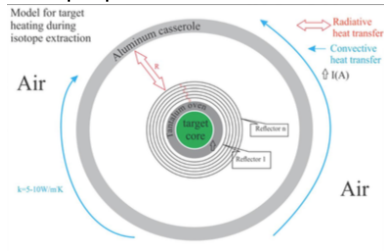
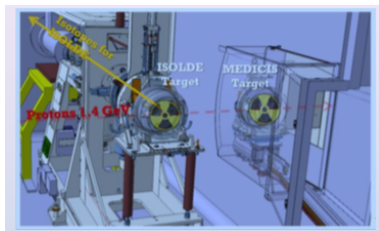
Studies using COSY
Field refined to improve isochronicity
Tunes behave reasonably well
Extraction possible



Isotope production

The MEDICIS project at CERN (Basil Gonsalves)

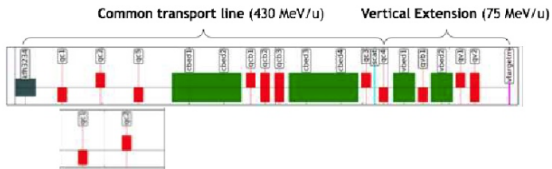
Use the ISOLDE beam for isotope production



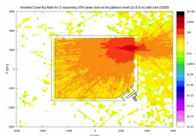
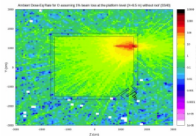
Design oven used to extract useful isotopes from target after irradiation

BioLEIR (Iso known as OpenMED)

(Tanjilul Amin and Roxana Rata)



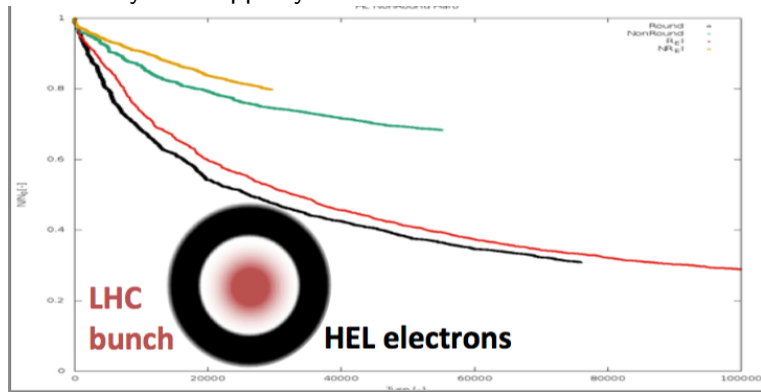
Redesign and optimise
extraction line from
LEIR



Shielding - what is needed? Can the
vertical beam point upwards? Is the
CMS control room safe?

Collimation in the LHC

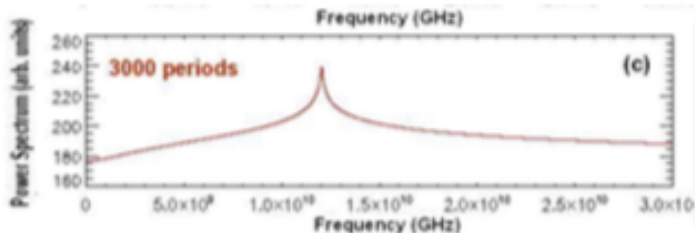
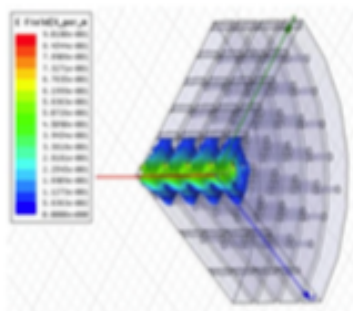
Covered by Rob Appleby's talk



Effect of Hollow Electron Lens collimation (Haroon Rafique)

Novel materials - photonic band gaps

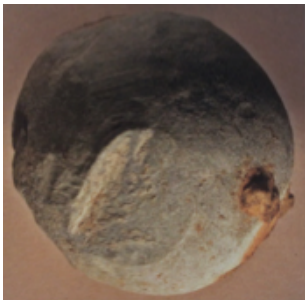
Becky Seviour



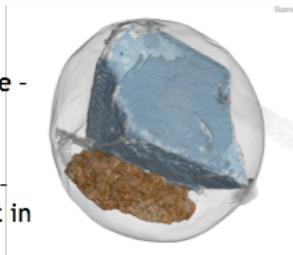
Neutrons as non-destructive probes

Sue Kilcoyne and colleagues

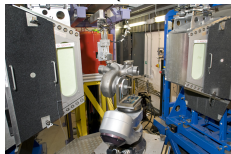
Study cannon shot - Lead is transparent to neutrons
Include chunks of iron. Why???



- Irregular iron cube - roughly chopped from a bar?
- Small stone/flint - intentional or left in mould in error?



This one (from Bosworth Field) has a rock in as well

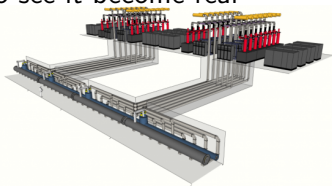


Also use neutrons to
study turbocharger
housings

The ESS

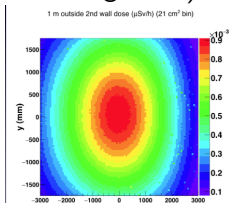
Involved in many ways

Involved from the start (Bob Cywinski) in the campaign to get the ESS built - delighted to see it become real



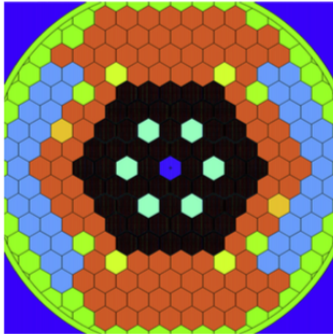
Responsible for RF distributions system - £23M UK in-kind contribution (Rob Edgecock)

Also shielding calculations using Geant4 (Cristian and Adriana Bungau)



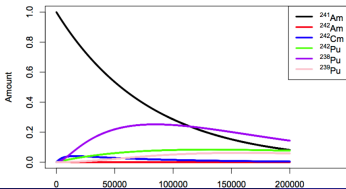
MYRRHA

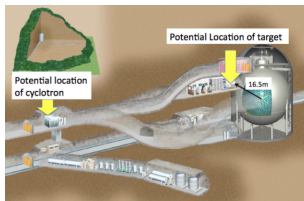
Investigation using thorium fuel



Just published. Studies of MYRRHA core with thorium fuel, as case study

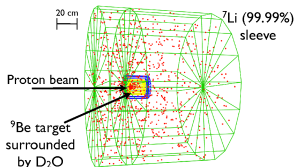
Show use as Minor Actinide burner. Studies done with MCNPX - Geant4 validation to follow



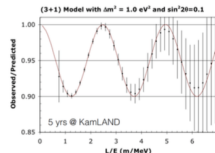


Accelerator and target
down the KAMLAND
mine

Will really sort the sterile neutrino question



Careful design of target
to produce antineutrinos



ADSRs and Thorium Power

Advertisement(2)

Continue to play a major role in ADSR/thorium studies and advocacy

4th International Workshop on ADSRs and thorium fuel

Aug 31-Sep 2 in Huddersfield

Site and bookings about to go live.

Other stuff

Ask for details afterwards

- Production of PET isotopes in proton therapy (Tanjilul Amin)
- Neutron scanning - and its effects (Simon Albright)
- Understanding and parametrisation of spallation neutron spectra (Asiya Rummana)
- Shielding studies from Clatterbridge and Manchester (Roxana Rata)
- Proton Radiography with UPenn (Cezarina Chirvase)
- Proton energy measurements (with UCL)
- Optimising the space-charge dominated PSI injector II
- PASI target studies (Rob Edgecock, Criatian and Adriana Bungau)
- Radiotoxicity - the myth of RBE (Piyanud Thongjerm)
- The RFQ for FETS (Wanisa Promdee)
- Metamaterials (Aimee Hopper)
- Thorium ADSR studies (David Lee)
- Accelerator reliability using Markiv chains (Miha Rescic)
- 3D printing in metal (Innovate UK grant)

No undergraduate teaching - pure research institute **with a radically new MSc course**

University has tradition of strong links with industry **continuing with industrial collaboration and the Buckley Innovation Centre**

Not competing in areas where established groups are already strong **but that still leaves plenty of scope**