Upgrades to ISIS for the New Second Target Station

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ISIS, Rutherford Appleton Laboratory, STFC

TS-2 First Announcement

•April 2003: £140M Funding from UK Government

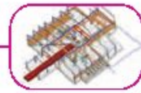
Science & Technology Facilities Council
ISIS

TS2 ISIS
second target station project


First Science and Technical Advisory Committee **July 2002**


Detailed planning approval **March 2003**


Approve initial instrument suite **June 2003**


Approve target station design concept **July 2003**


First Project Board **October 2003**


Complete earth moving and landscaping **November 2003**


Complete access Road 10 **October 2004**


Complete R78 technical support building **November 2004**


Begin R80 experimental hall construction **January 2005**


Compete R80 structural frame **May 2005**


Complete target monolith foundation **September 2005**


R80 weather-tight **November 2005**


Complete R80 construction **March 2006**


Complete target services area structure **January 2007**


Begin Extracted Proton Beam installation in synchrotron **February 2007**


Complete target services area equipment **August 2007**


Complete extracted proton beam **September 2007**

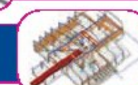

Complete target station **September 2007**


First Proton Beam to Target **October 2007**


First Operation of Instruments **November 2007**

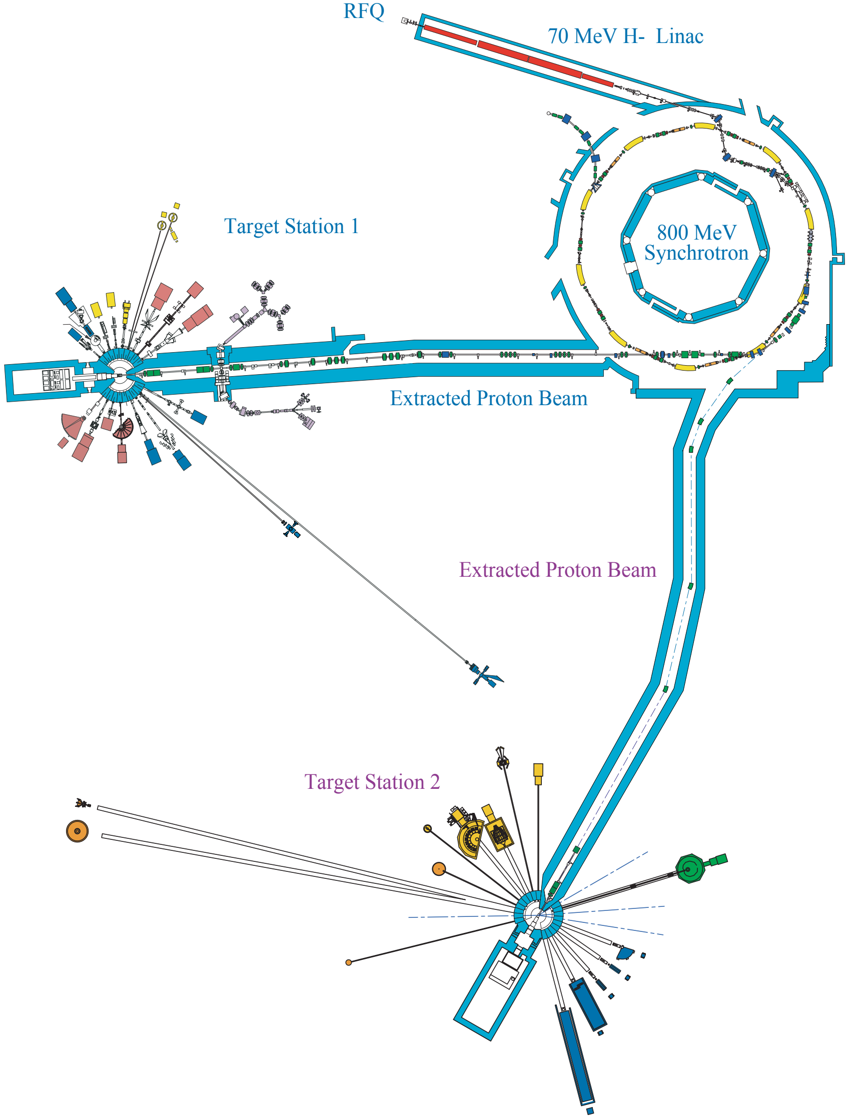

Complete instrument neutron guides **January 2008**


Complete first phase instrument detectors **March 2008**

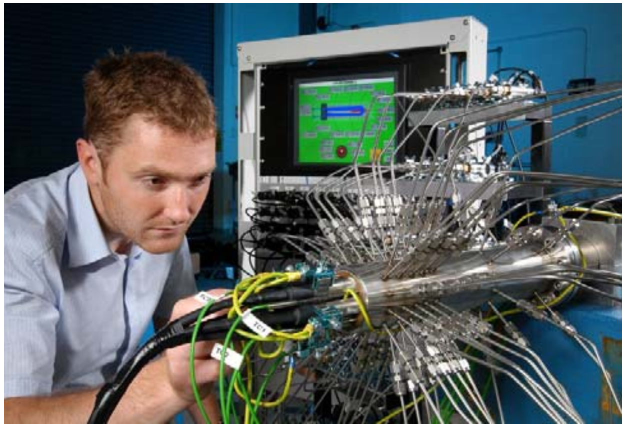

Complete instrument installation **June 2008**


Start of experimental programme **October 2008**

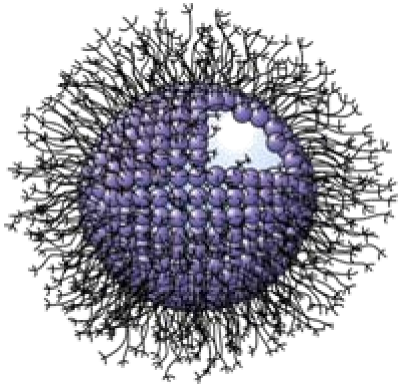
Second Target Station



Second Target Station



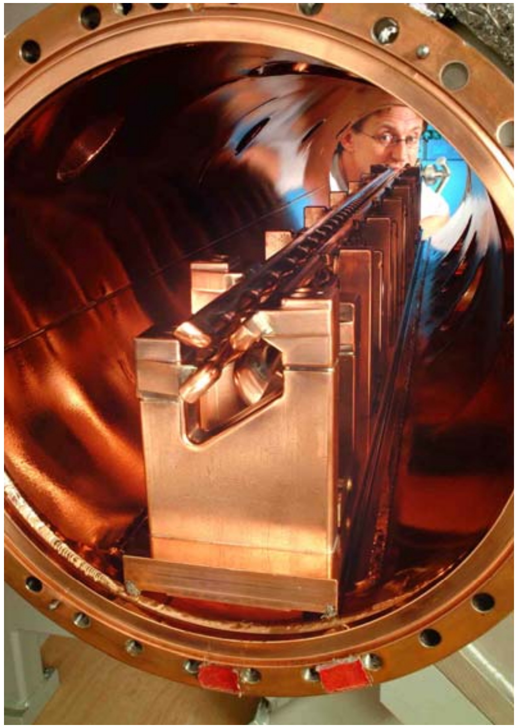
- 10 Hz target optimised for cold neutrons
- 1 out of 5 proton pulses diverted to TS-2
- Phase 1: seven instruments for surface science, disordered materials, magnetic diffraction, small-angle neutron scattering and slow dynamics
- First experiments October 2008

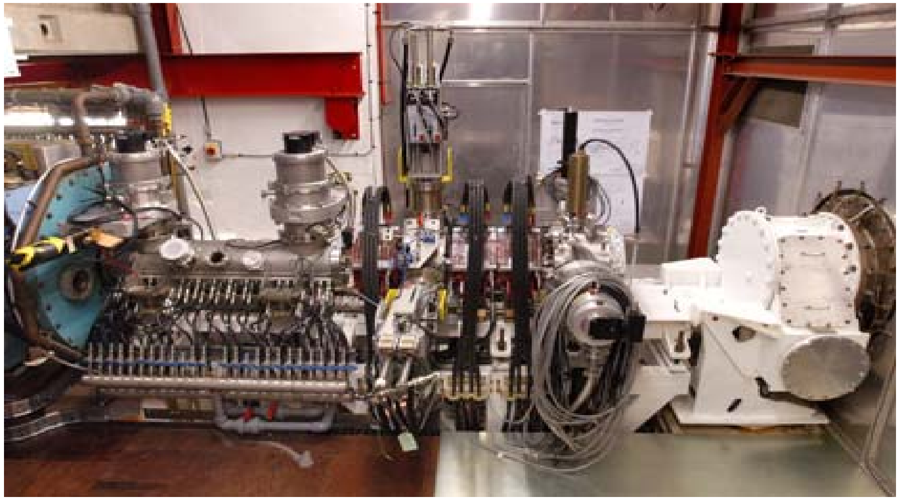


Science & Technology Facilities Council ISIS

Increased Beam Intensity

The RFQ Accelerator





- 4-rod 202.5 MHz RFQ accelerates 35 keV H^- beam from ISIS ion source to 665 keV
- Focuses and bunches with ~ 95% transmission efficiency (compared with ~ 60% for the old pre-injector)

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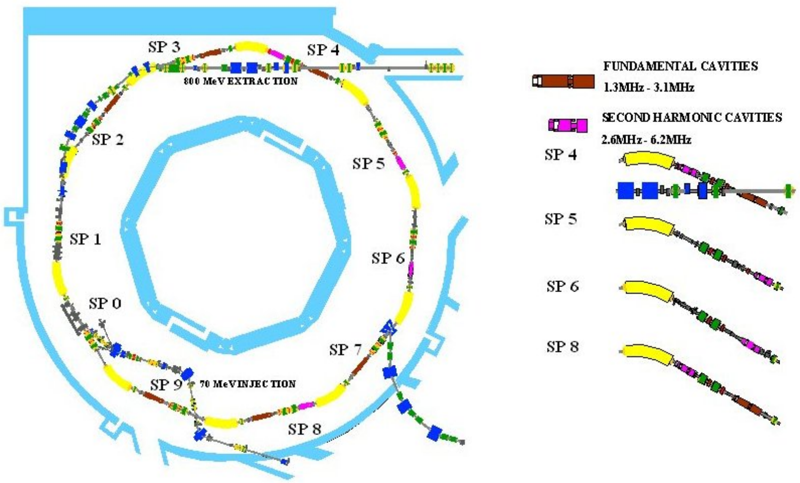
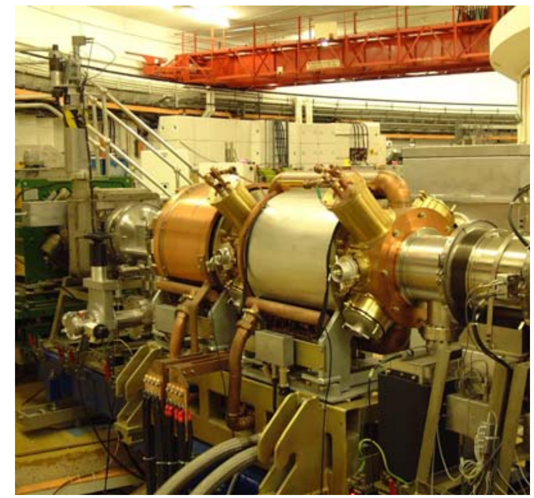
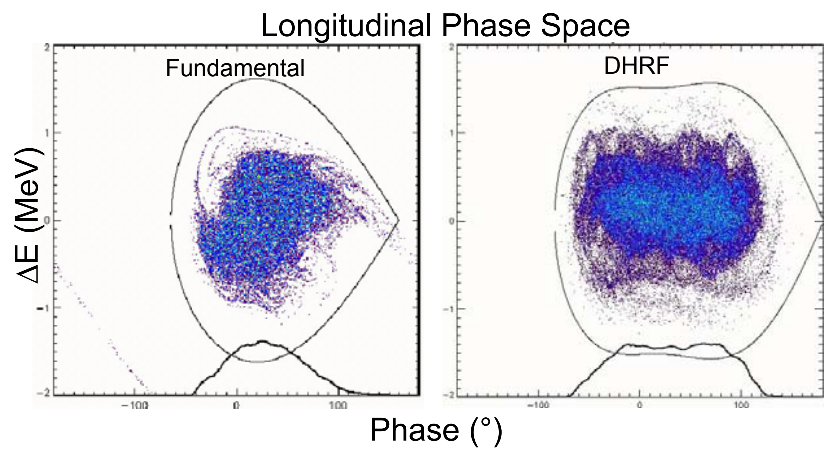
Increased Beam Intensity

The Dual Harmonic RF System



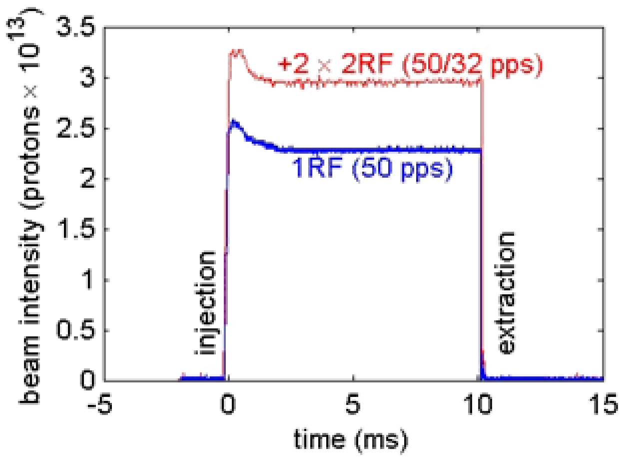


- Fundamental RF system of six cavities (1.3 – 3.1 MHz) gives up to 140 kV/turn
- Four additonal RF cavities (2.6 – 6.2 MHz) give up to 80 kV/turn
- Increased phase stable regions, enhanced bunching factors and smaller beam loss



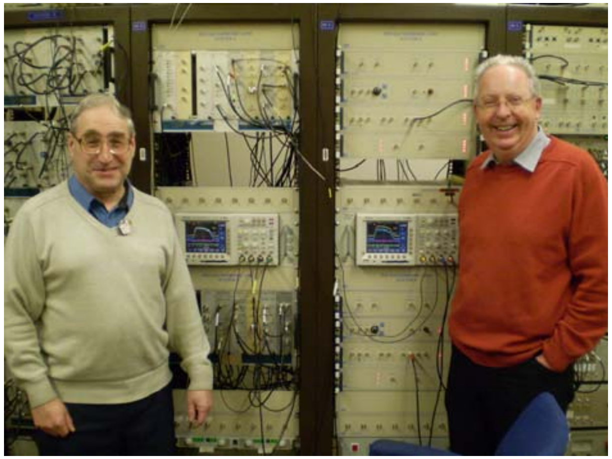
Increased Beam Intensity

The Dual Harmonic RF System



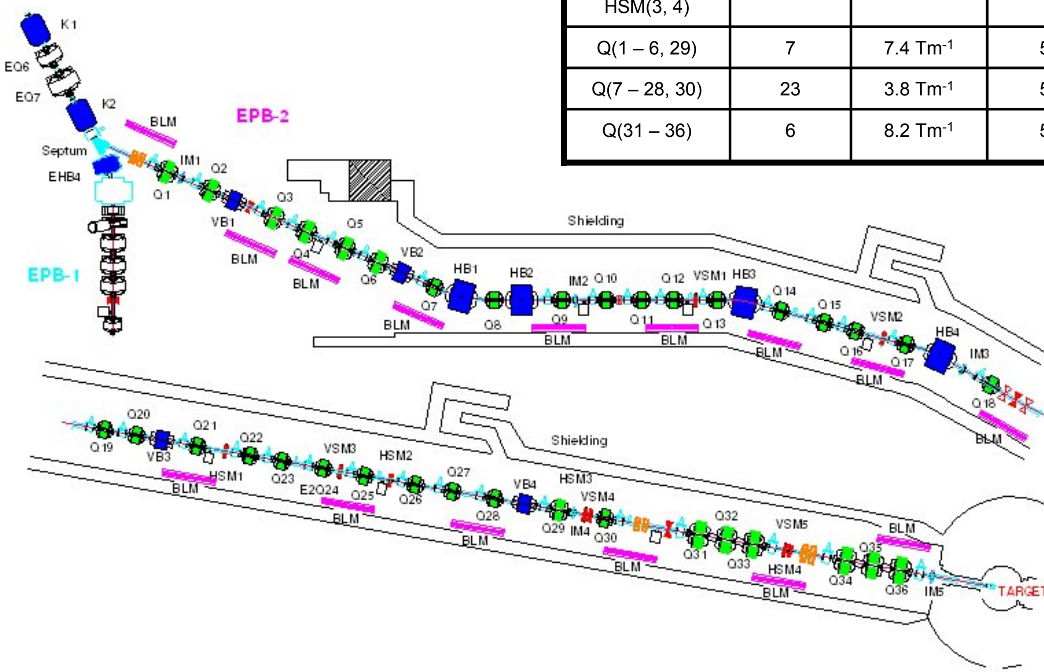
Operating Regime	Trapped beam intensity (protons)	Total beam loss (protons)	Equivalent current to TS-1 (μA)	
			50 pps	40 pps
1RF (50 pps)	2.30×10^{13}	2.76×10^{12}	184	148
+2 × 2RF (50 pps)	2.65×10^{13}	1.60×10^{12}	212	170
+2 × 2RF (50/32 pps)	2.93×10^{13}	2.70×10^{12}	234	187

(MOPC121)



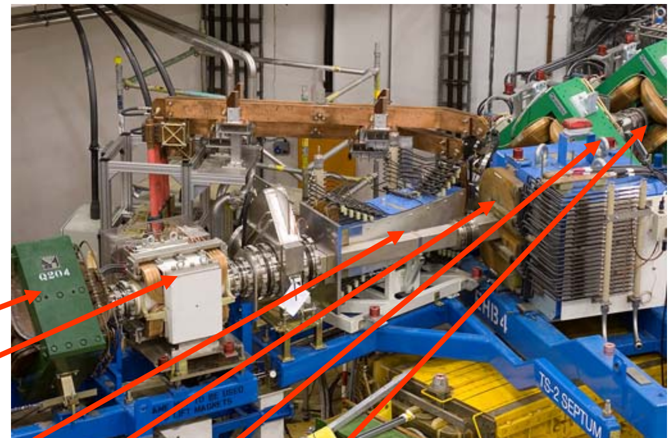
EPB-2

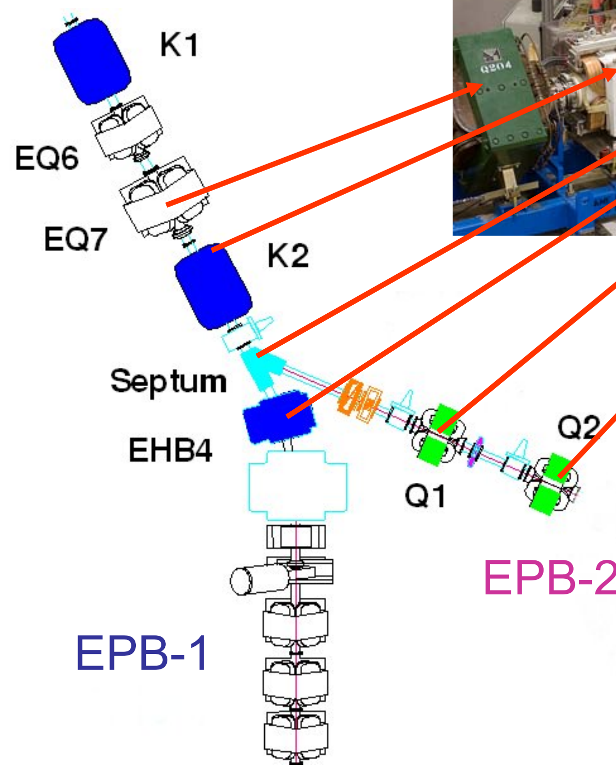
Magnet type	Number	Maximum B or G (T / Tm^{-1})	Magnetic length (mm)	Deflection angle (°)	Half aperture (mm)	Field homogeneity (± %)
K1	1	0.15 T	500	0.69	100	0.25
K2	1	0.95 T	500	5.16	100	0.25
Septum	1	1.05 T	1458	17.62	73	0.25
VB(1, 2)	2	0.76 T	800	7.16	100	0.25
VB(3, 4)	2	0.13 T	800	1.24	100	0.25
HB(1 – 4)	4	1.05 T	1250	15.00	100	0.25
EHB4	1	1.58 T	1038	18.44	78	0.25
VSM(1 – 3) HSM(1, 2)	5	0.061 T	200	± 0.13	100	1
VSM(4, 5) HSM(3, 4)	4	0.061 T	300	± 0.20	155	2.5
Q(1 – 6, 29)	7	7.4 Tm^{-1}	500	-	100	0.5
Q(7 – 28, 30)	23	3.8 Tm^{-1}	500	-	100	0.5
Q(31 – 36)	6	8.2 Tm^{-1}	500	-	155	0.5



EPB-2

Extraction





- K1 and K2 operate at 10 Hz, 12 ms rise time for 600 μs
- Septum runs at 9000 A DC to deflect the beam by 17.62°
- Redesigned EPB-1 magnet (EHB4) reduces displacement required at septum exit

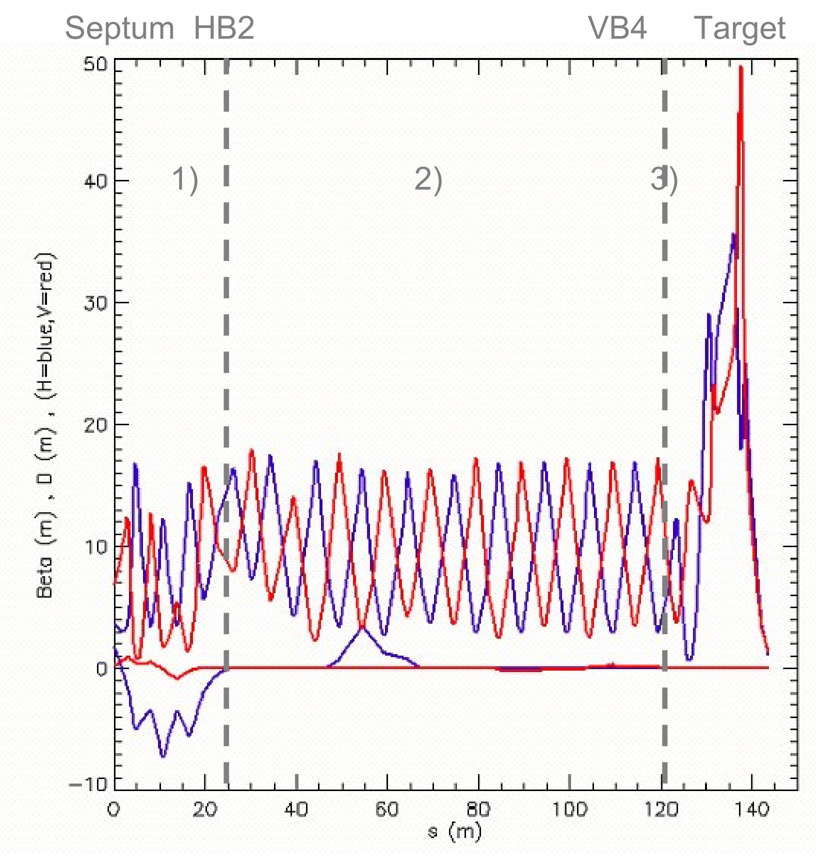
EPB-2

Extraction

(TUPD004)

EPB-2

Beam Line

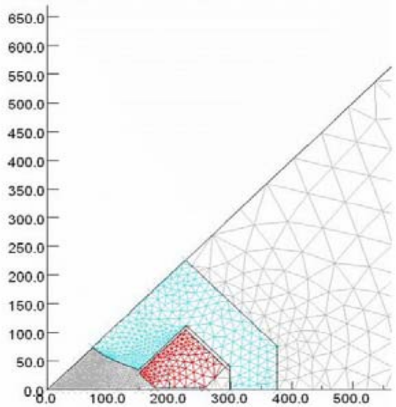


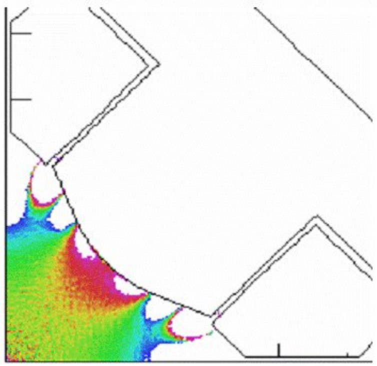
1) Dropped by 1.526 m and turned left through 30°, dispersion closed at exit face of HB2
2) Raised by 0.87 m and turned right through 30°, 10 m FODO structure with 90° phase advance per plane
3) Triplet sturcture to supply a beam waist at target in both planes

EPB-2

Magnets

- Based on EPB-1 magnets and other designs worldwide
- Electromagnetic FEA using 2D and 3D modelling techniques
- Choice of steel, configuration of coils, heat issues





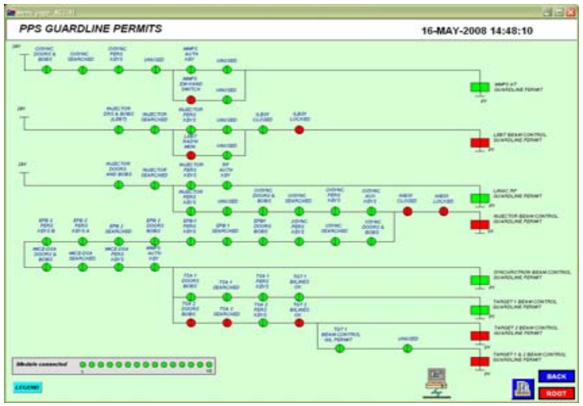
EPB-2

And Not Forgetting...

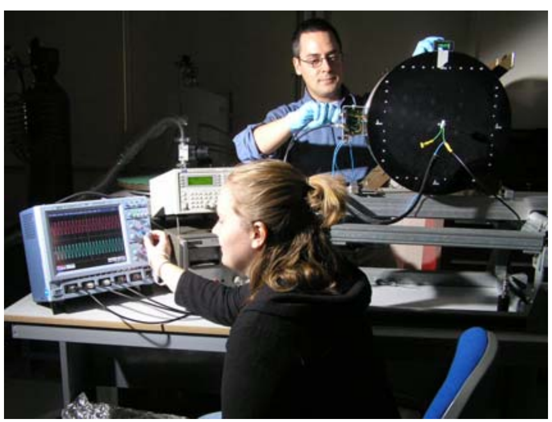
- Civil Engneering
- Building
- Shielding
- Cabling
- Plant

EPB-2

And Not Forgetting...

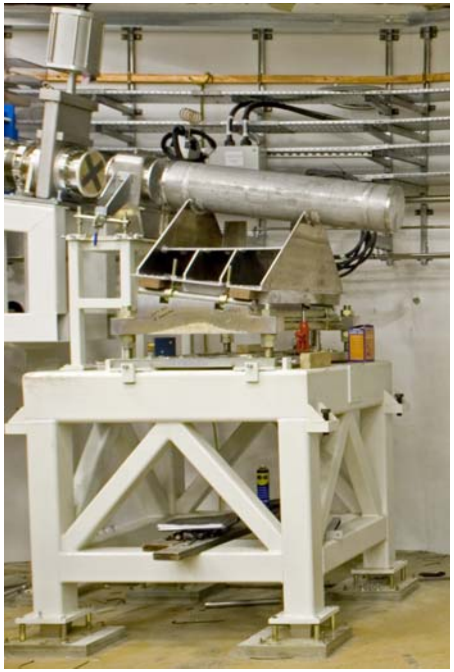


- Vacuum technology
- Beam diagnostics
- Controls
- Interlocks

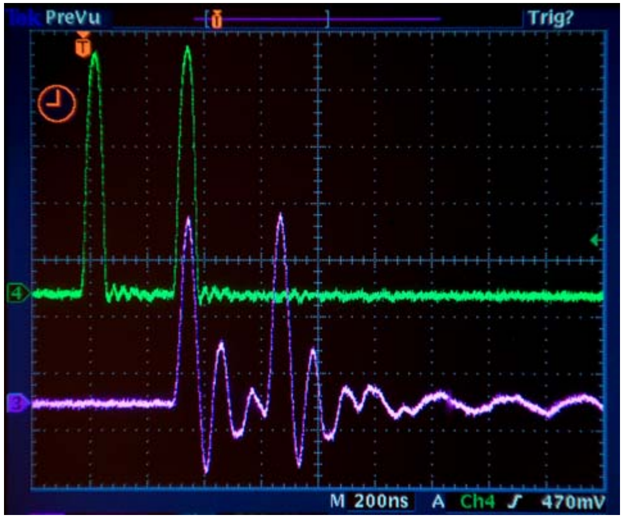


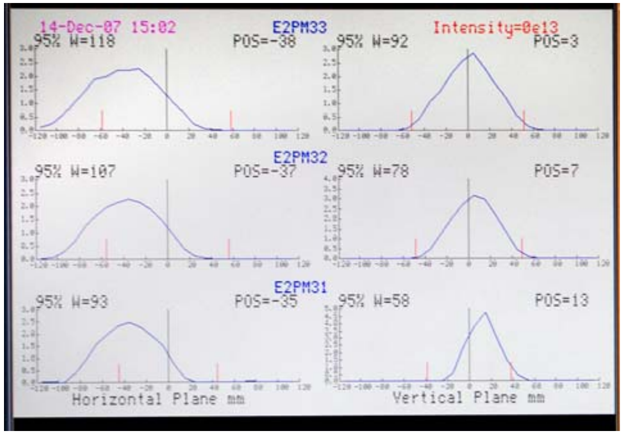
First Beam Tests

- First EPB-2 commissioning tests on 14th December 2007



- Graphite block as temporary beam dump
- Beam to target essentially at first attempt
- Only about 50 pulses required to demonstrate and measure satisfactory beam transport to TS-2
- Further tests when actual TS-2 target is installed





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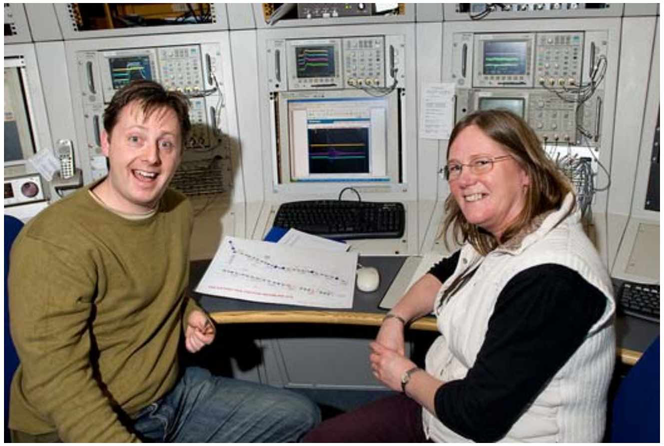
First Beam Tests



Other Upgrades

New anode power supplies for the 202.5 MHz Linac should improve stability and performance

Three 300 kVA UPSs and ten separate chokes will replace the AC part of the main magnet power supply

(THPP136)

New drivers for the fast extraction kickers provide 48 kV (maximum 60 kV) compared with the old 40 kV system, reducing beam loss as the beam enters the extraction septum

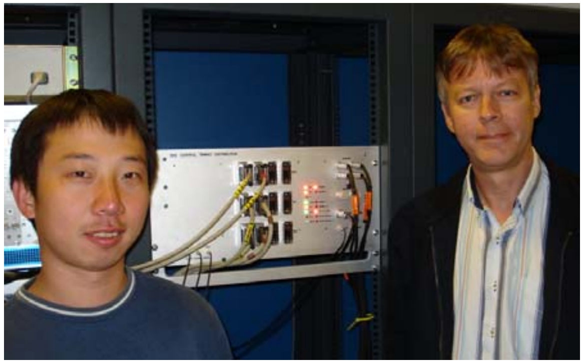
(TUPD009)

Other Upgrades

New beam loss display and trip systems use a modern FPGA design with faster trip reaction time and greater flexibility

The entire ISIS accelerator interlock system has been replaced and upgraded to includes TS-2 and bring it up to modern standards (IEC 61508 compliant)

A new Central Timing Distributor has been installed to allow running to either TS-1 alone or to TS-1 and TS-2 simultaneously at all required repetition rates



Accelerator Upgrade Team

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Clive Appelbee
Mark Arnold
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Derek Bayley
Stuart Birch
Richard Brodie
Paul Drumm
John Ellis
Dan Faircloth
David Findlay
Matt Fletcher
Ian Gardner
Peter Gear
Mike Glover
John Govans

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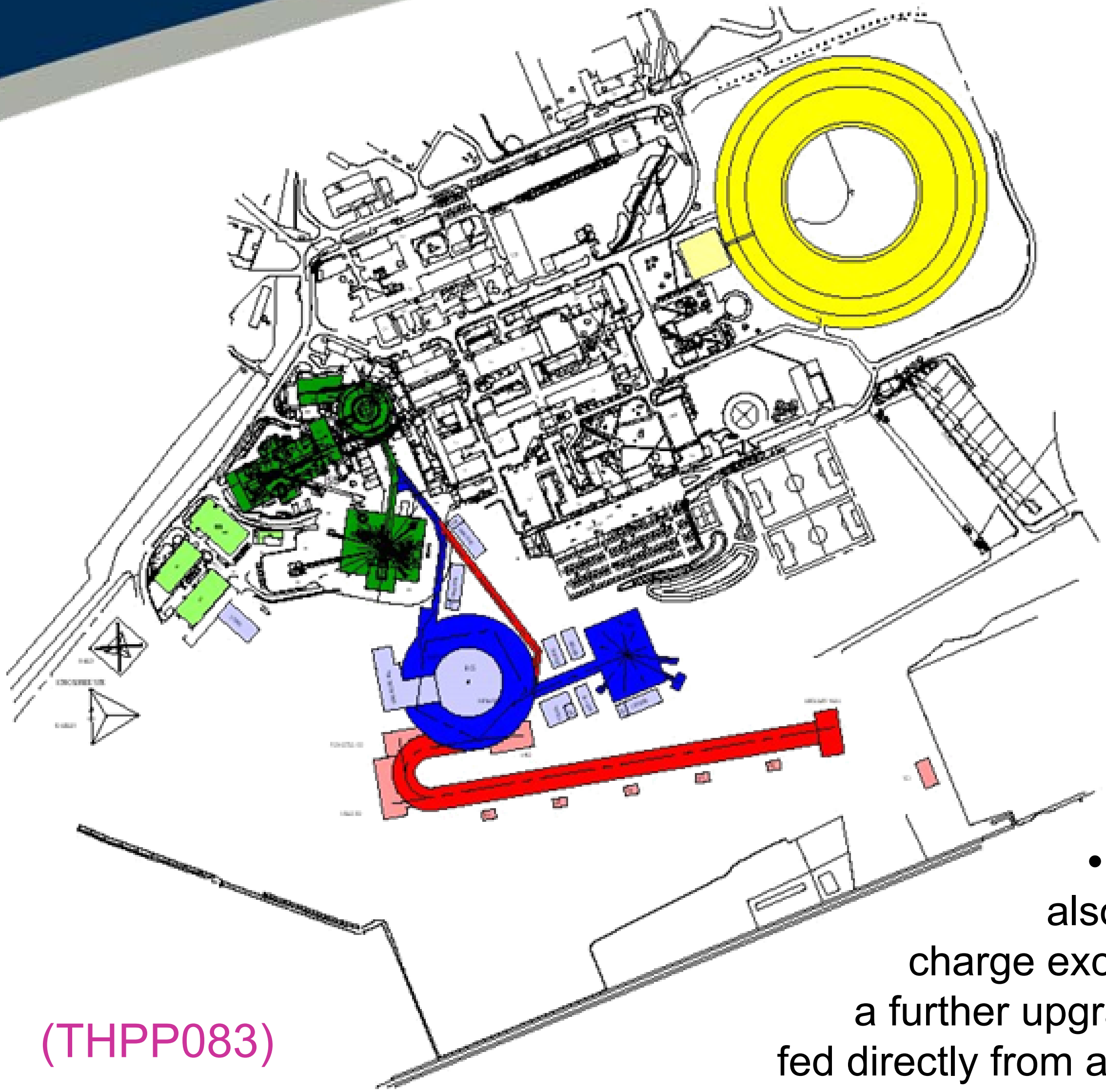
Harry Jones
Mark Keelan
Tony Kershaw
Andy Kimber
Mike Krendler
Clive Lambourne
Alan Letchford
Jim Loughrey
Eddie McCarron
Adrian McFarland
Bob Mannix

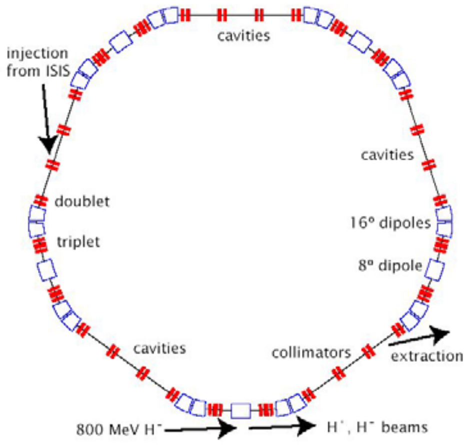
and many others

Adrian Morris
Steve Payne
Mike Perkins
Chris Prior
Eamonn Quinn
Steve Ruddle
Ian Scaife
Andy Seville
Alan Stevens
Steve Stoneham
Jane Vickers
Steve Warner
Chris Warsop
Steve West
Di Wright
Paul Wright

Megawatt Upgrades



- Based on a ~ 3 GeV RCS fed by bucket-to-bucket transfer from ISIS 800 MeV synchrotron (1MW)



- 5 superperiod RCS design also accommodates multi-turn charge exchange injection to facilitate a further upgrade path where the RCS is fed directly from a 800 MeV linac (2 – 5 MW)

(THPP083)