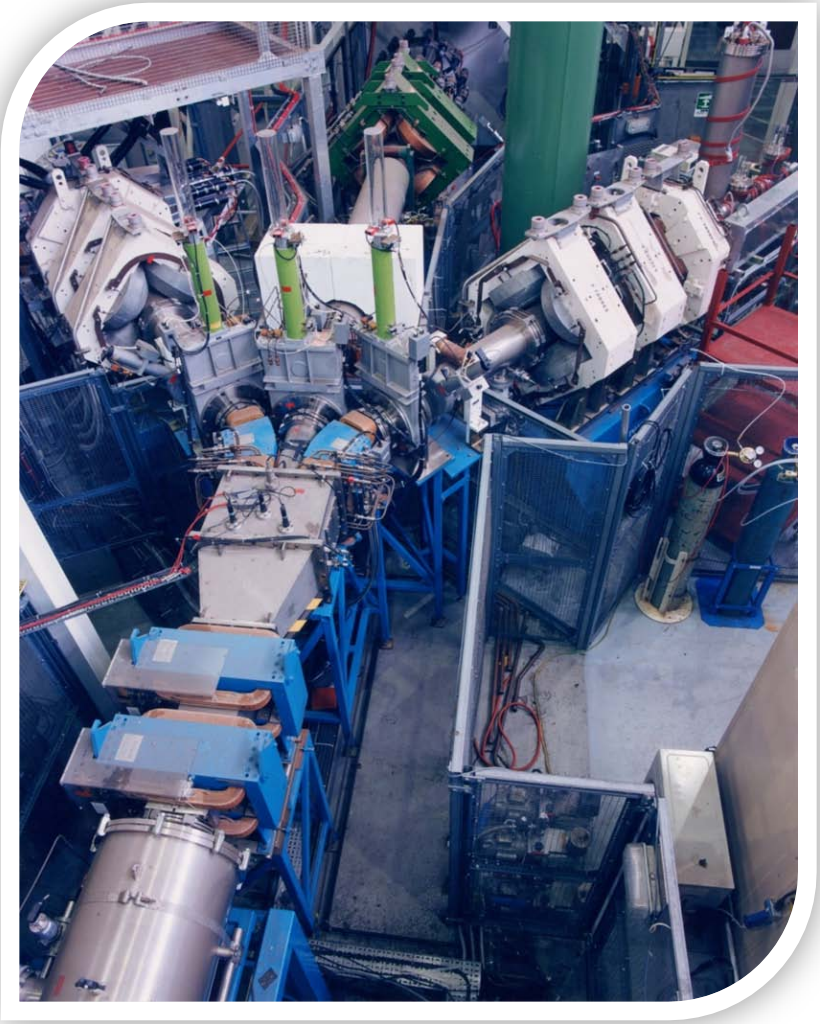
ISIS Muon Training School 24-28 May 2010

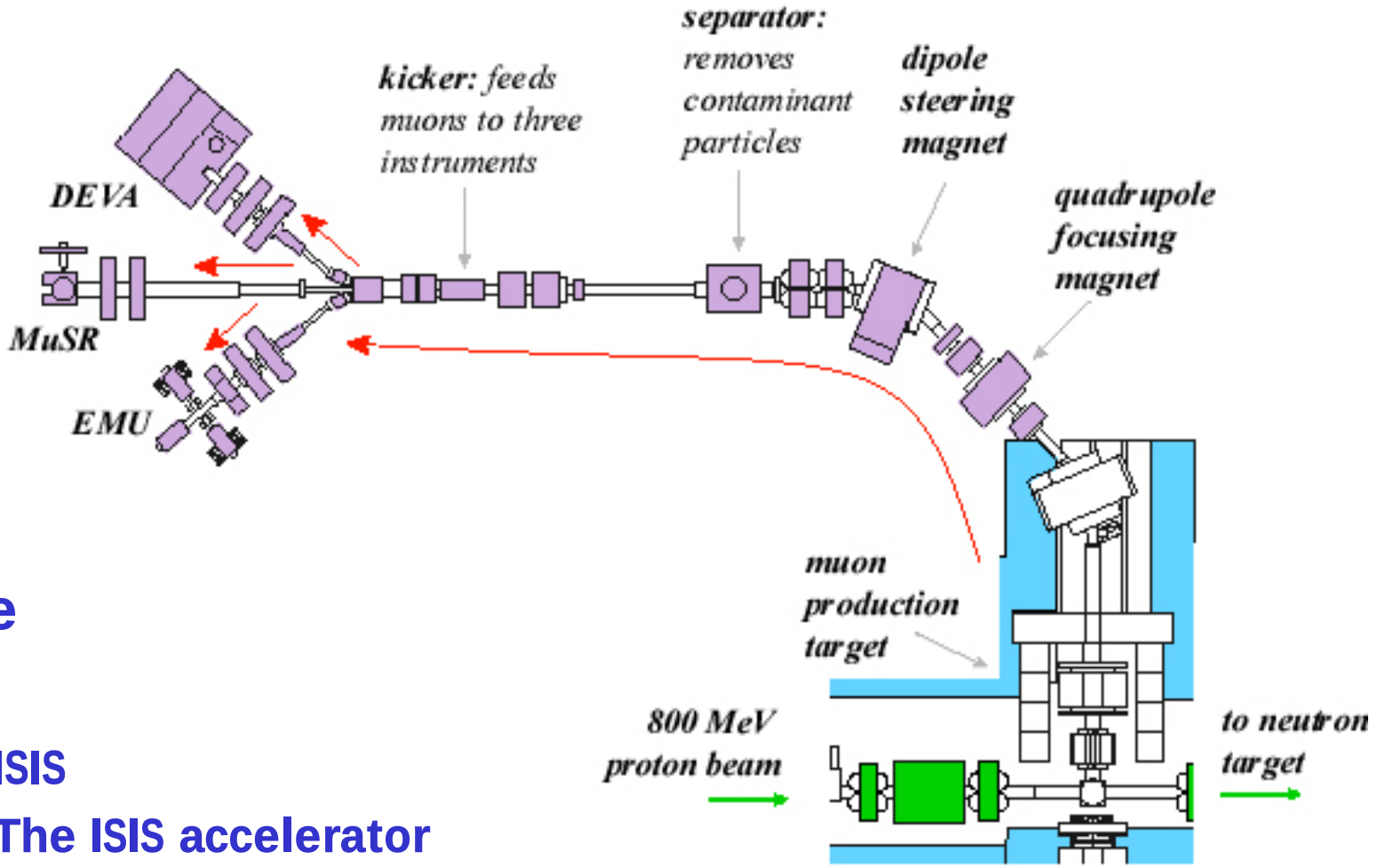


ISIS and its Muon Facility

Philip King

ISIS Muons

Science & Technology Facilities Council
ISIS



Outline

- ISIS
- The ISIS accelerator
- The ISIS Muon Facility

Introduction to ISIS

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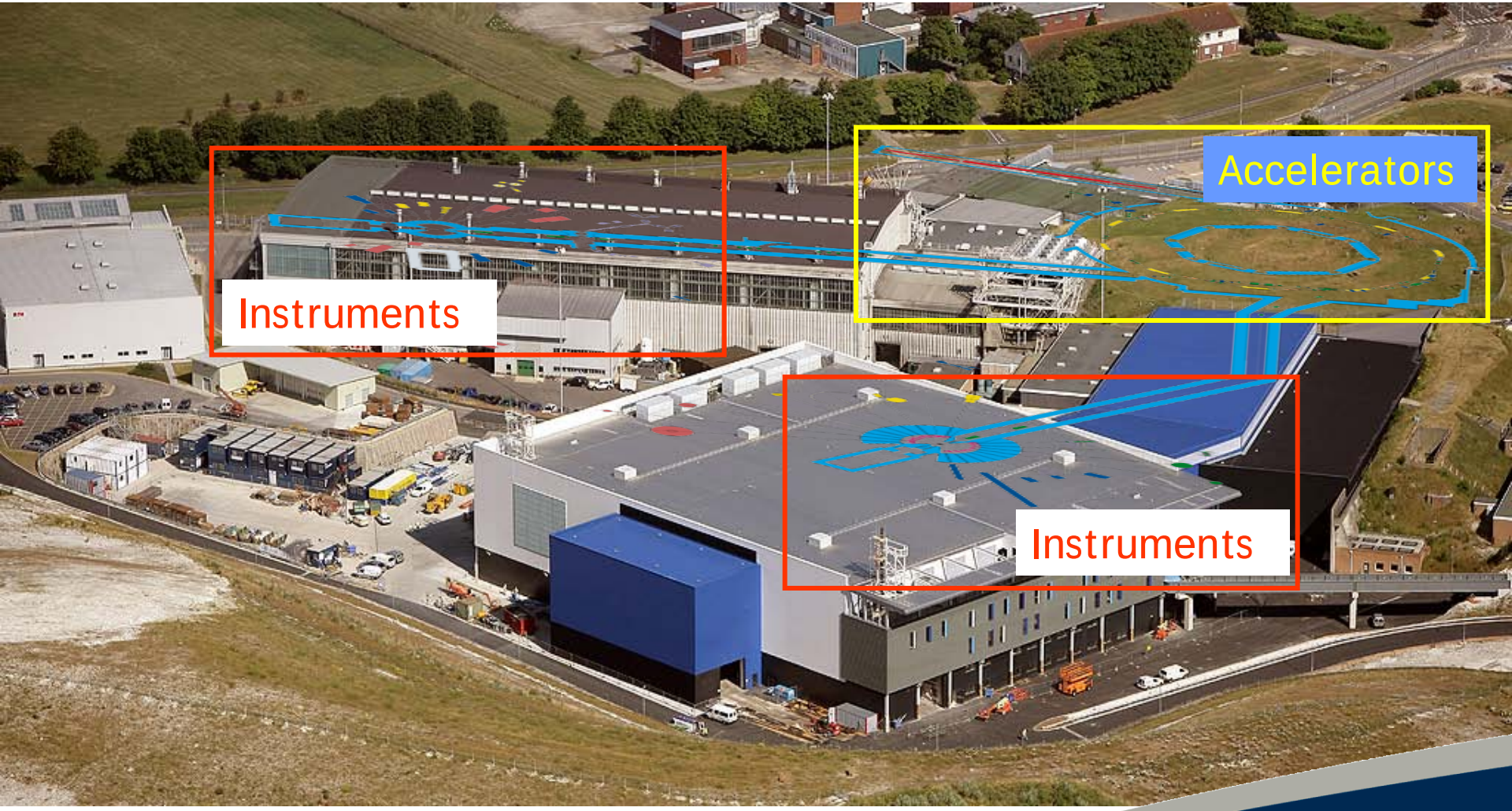
ISIS

- Broad academic base
- 32 Instruments
- 700 Experiments per year
- 3000 Instrument-days per year
- 500 Publications per year
- 2000-strong user base

‘World-class’

Institute of Physics International Review of UK Physics 2005

The ISIS Pulsed Neutron and Muon Source



A World Centre for Condensed Matter
Science with Neutrons and Muons

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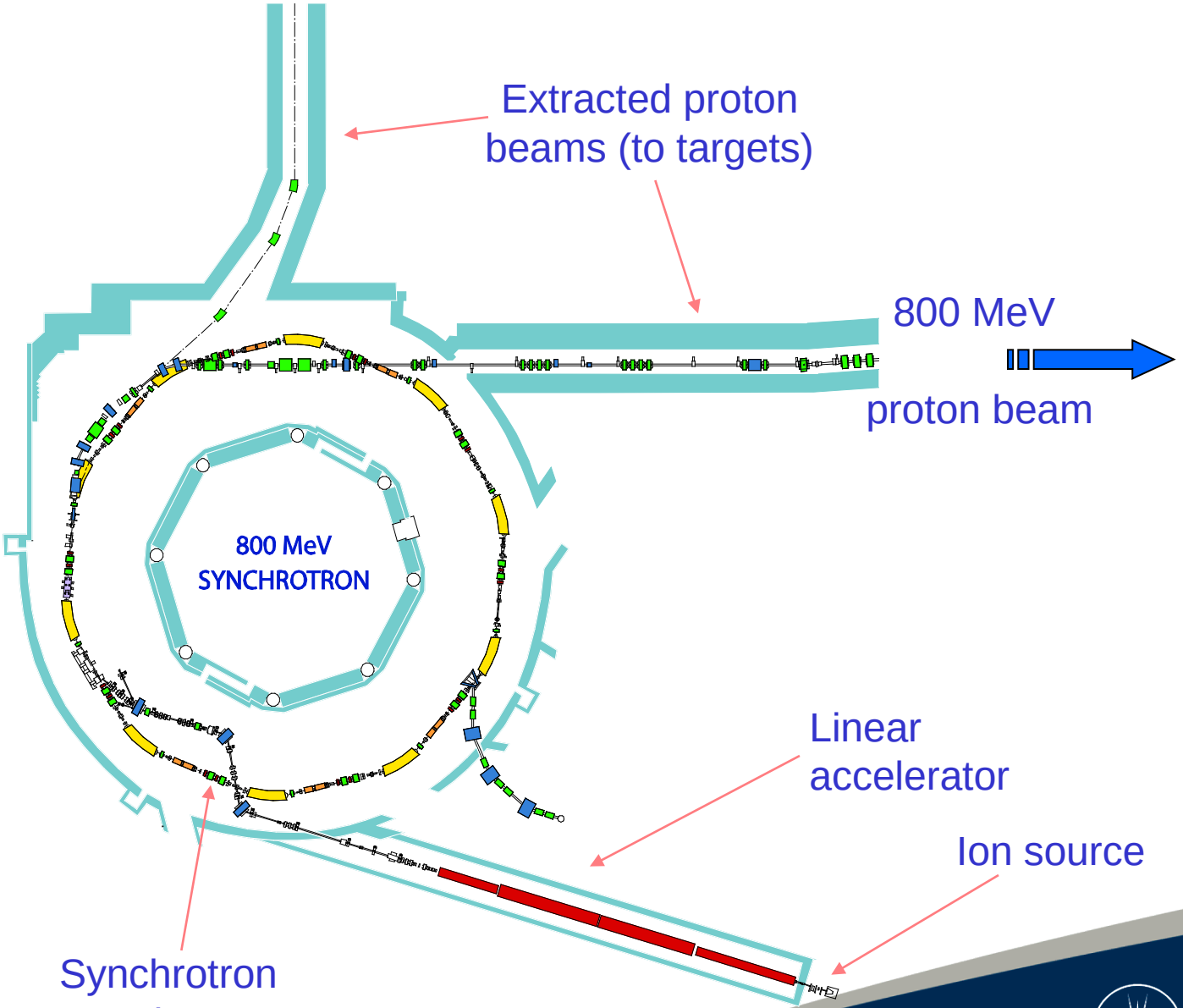
The ISIS Accelerators



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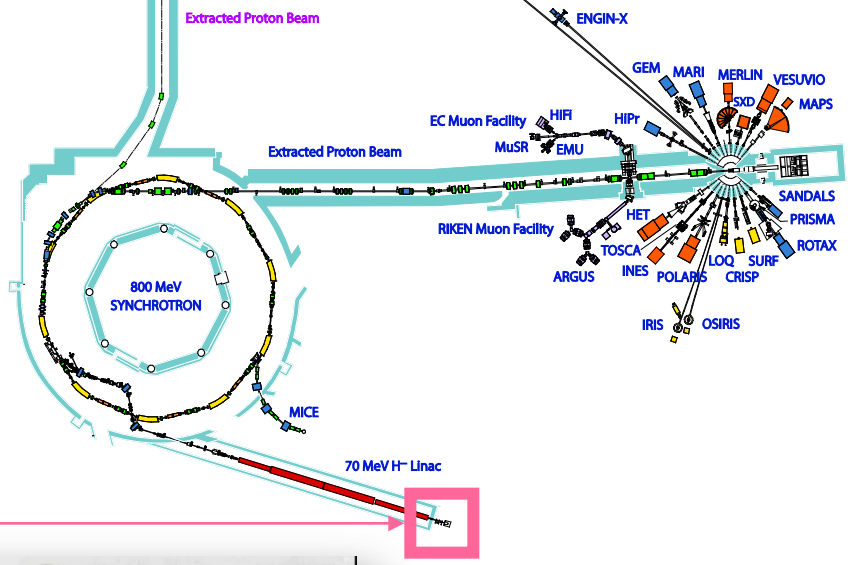
The ISIS Accelerators

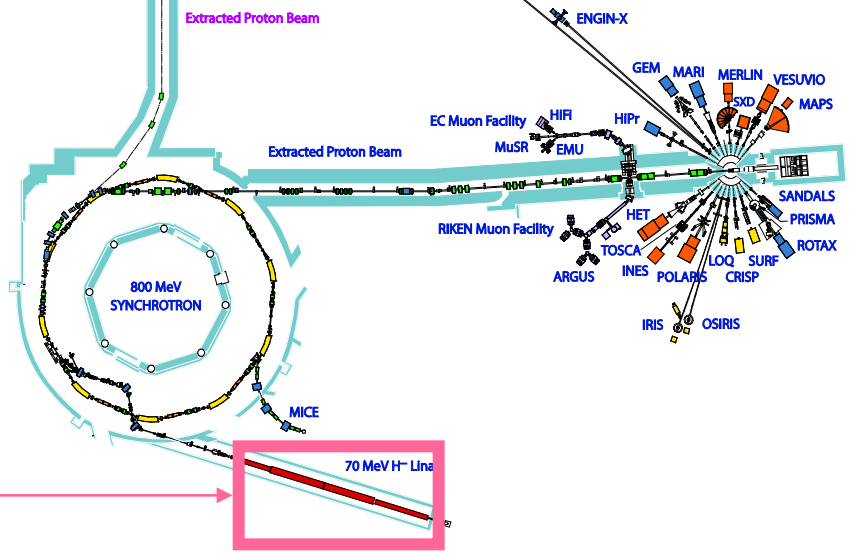


The beginning - the *Ion Source*

Produces H^- ions and accelerates them to 665 keV.

The ISIS Accelerators

The middle - the *Linear Accelerator*



Accelerates the H^- ions to 70 MeV.

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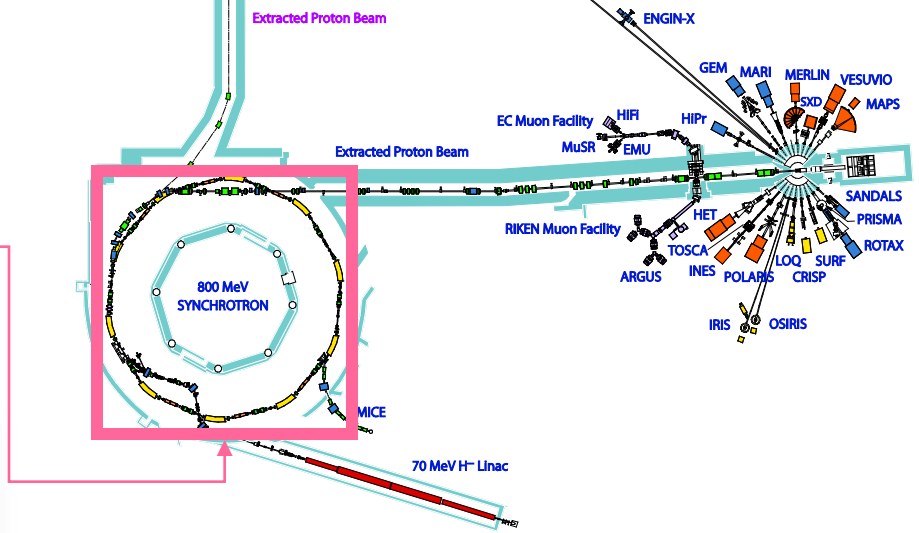
The ISIS Accelerators

The final stage - the *Synchrotron Accelerator*



- H^- ions stripped to protons
- Protons travel ~10,000 times round
- Accelerated to 800 MeV (84% light speed)

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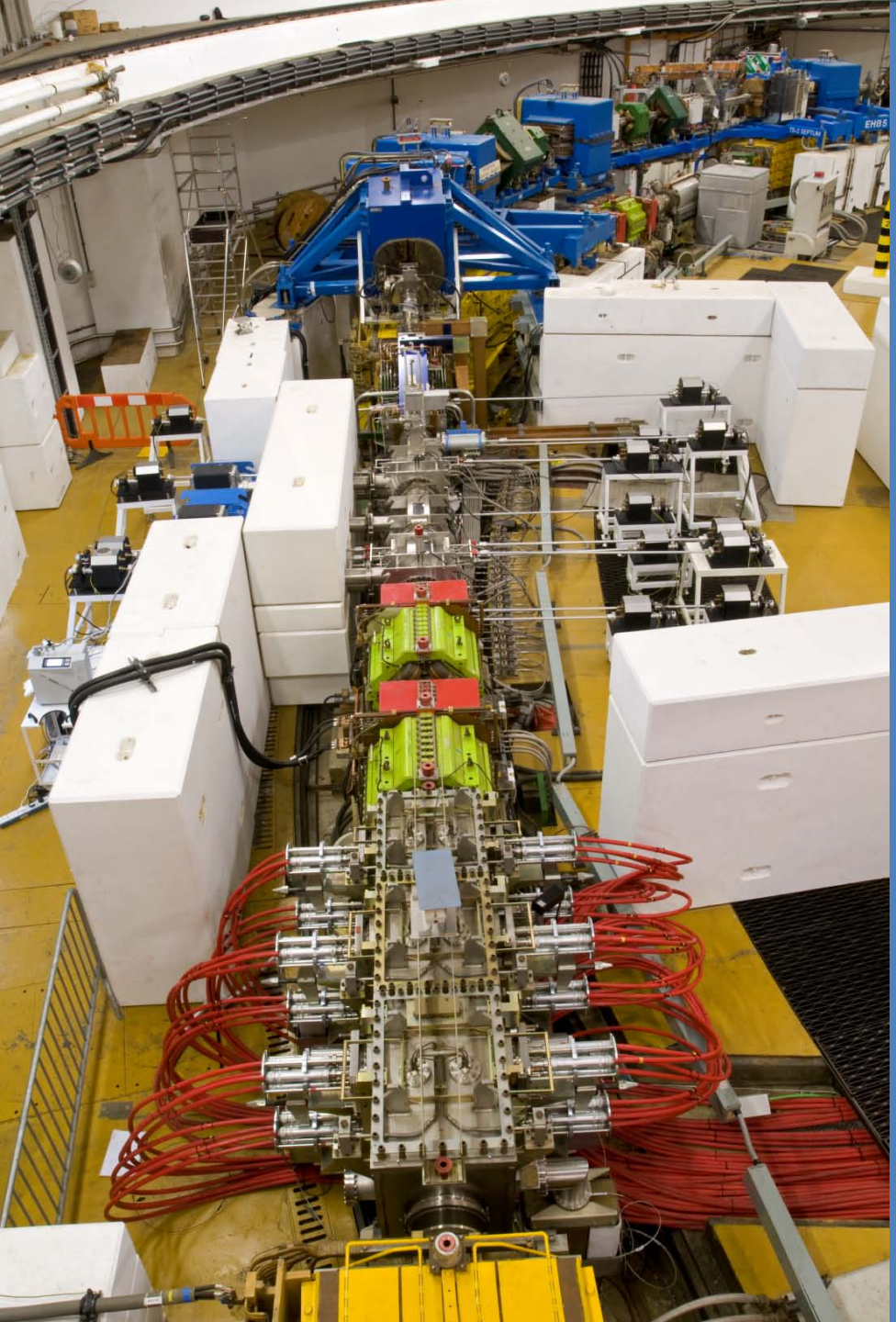
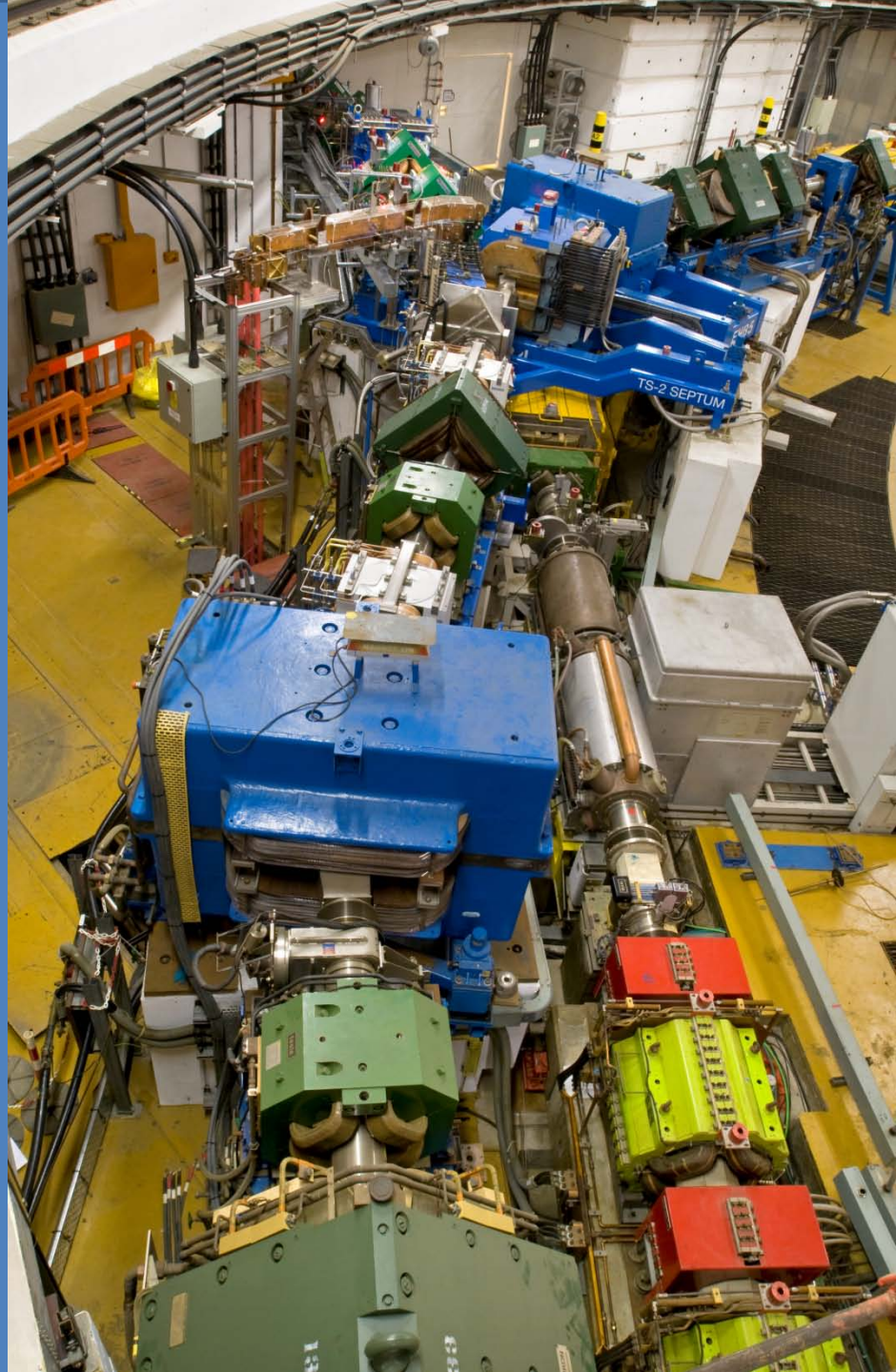
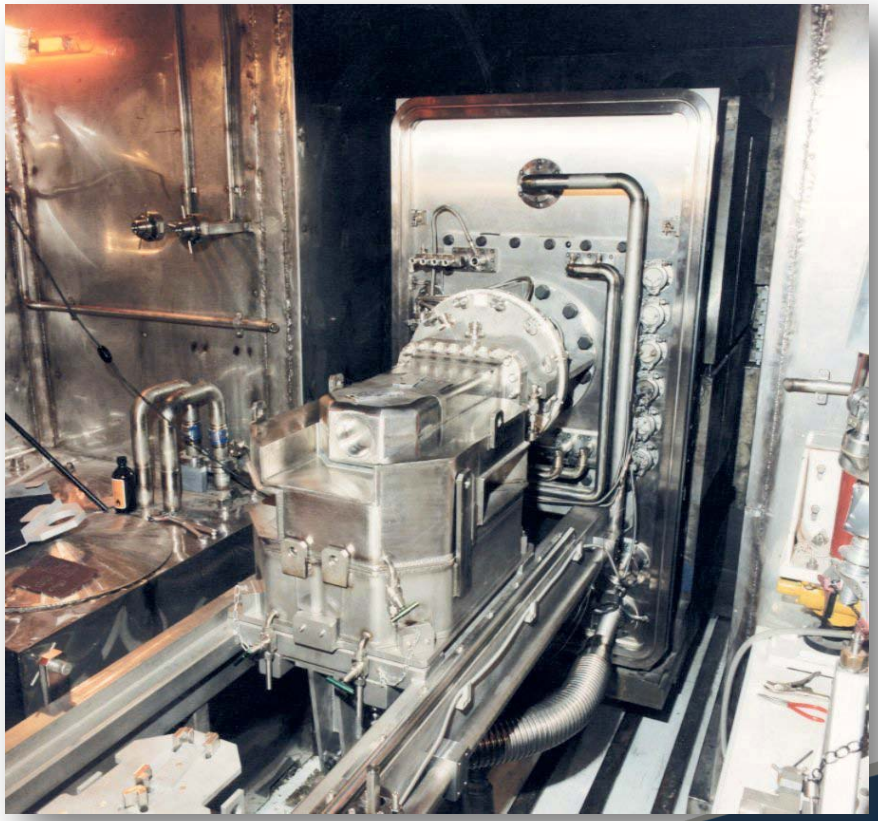

TS-2 SEPTUM
EH85

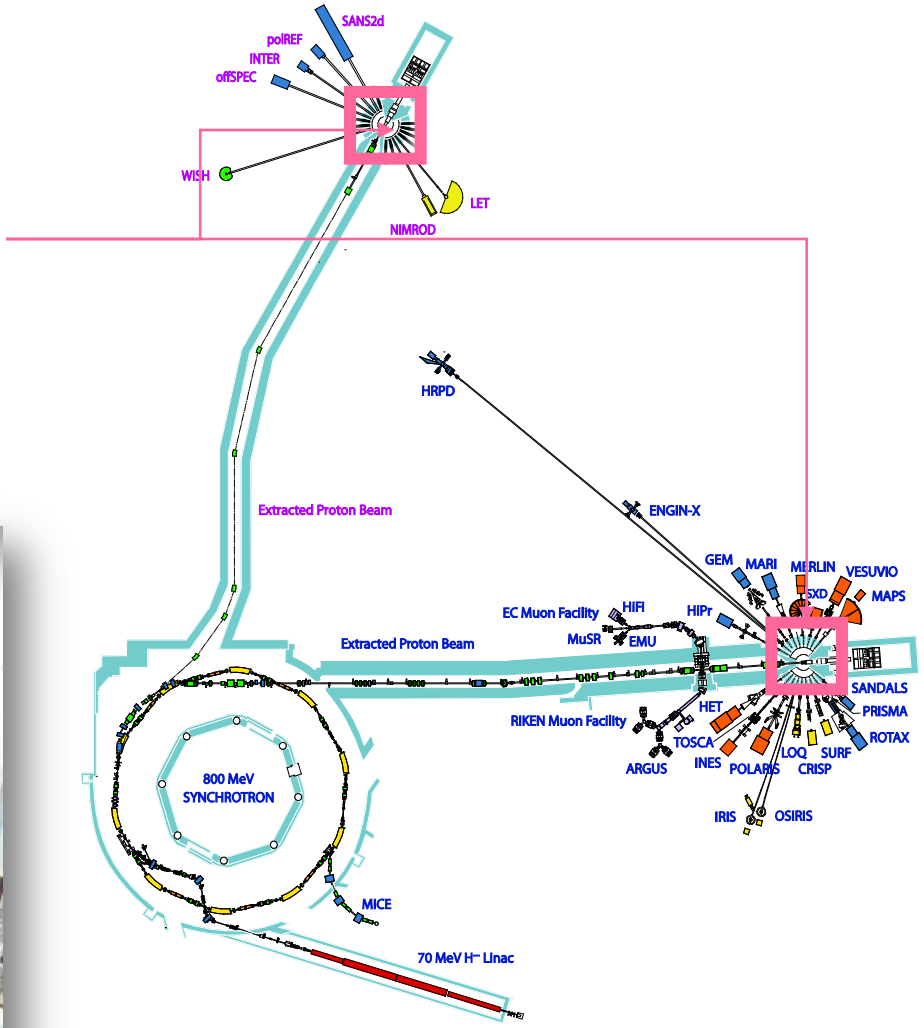

TS-2 SEPTUM

The ISIS Targets

- Tantalum targets
- Neutrons produced by ‘spallation’
- Heat dissipation is 160 kW

The *Neutron Targets*





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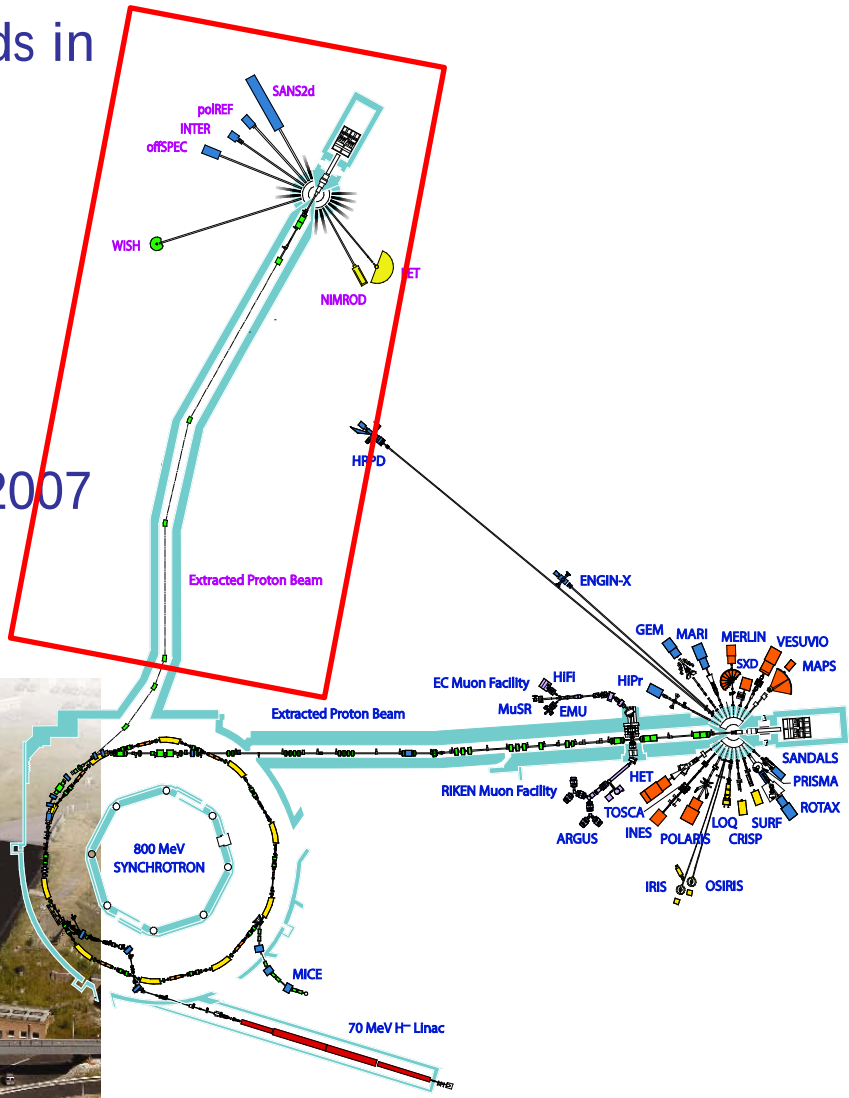
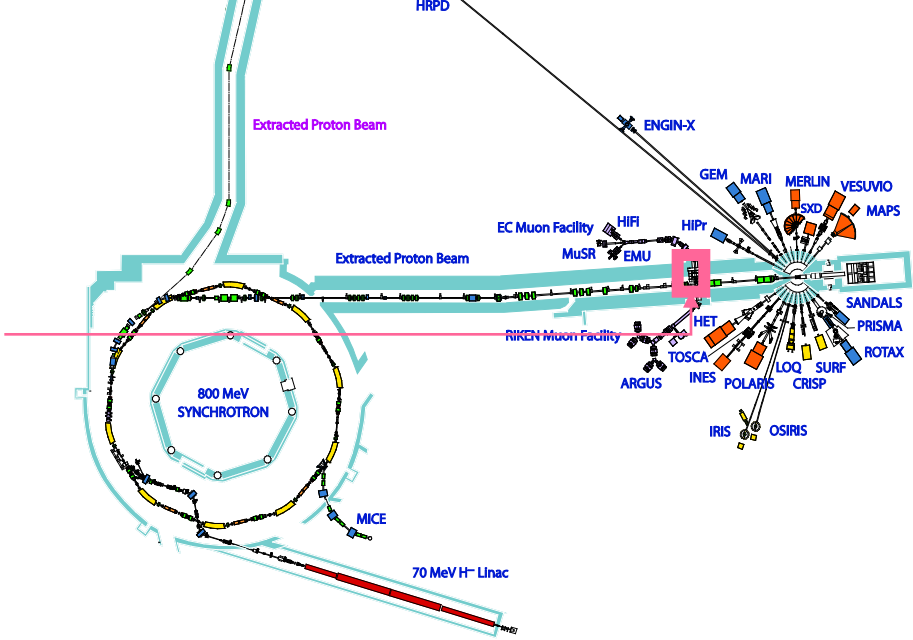
The Second Target Station Project

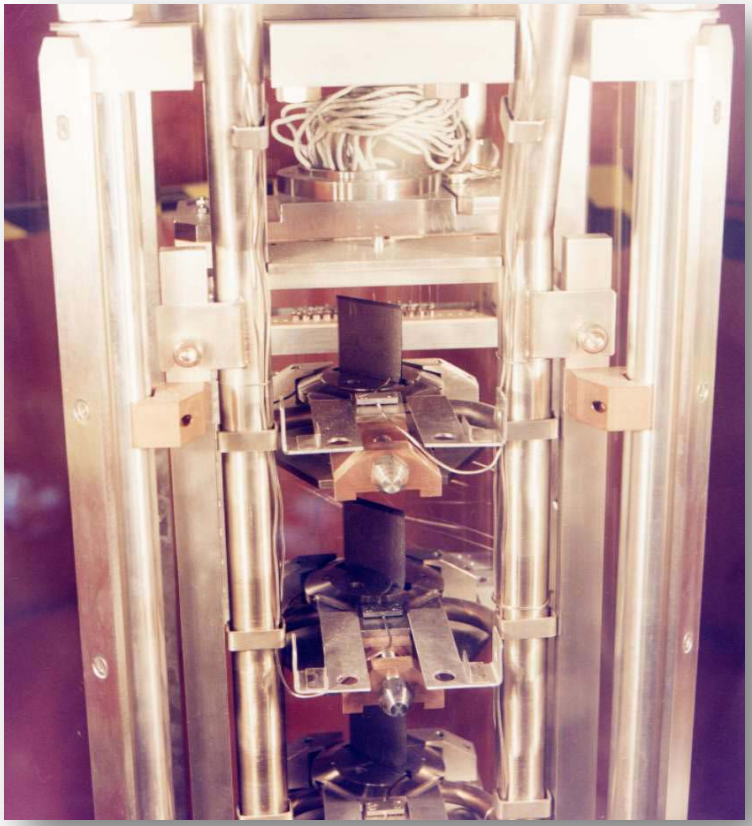
- £150M project
- Designed to meet future scientific needs in the key areas of:
  - Soft Matter
  - Advanced Materials
  - Bio-molecular Science
  - **Nanoscience**
- First proton beam to target area: Dec 2007
- First measured neutrons: August 2008
- First user experiment: May 2009



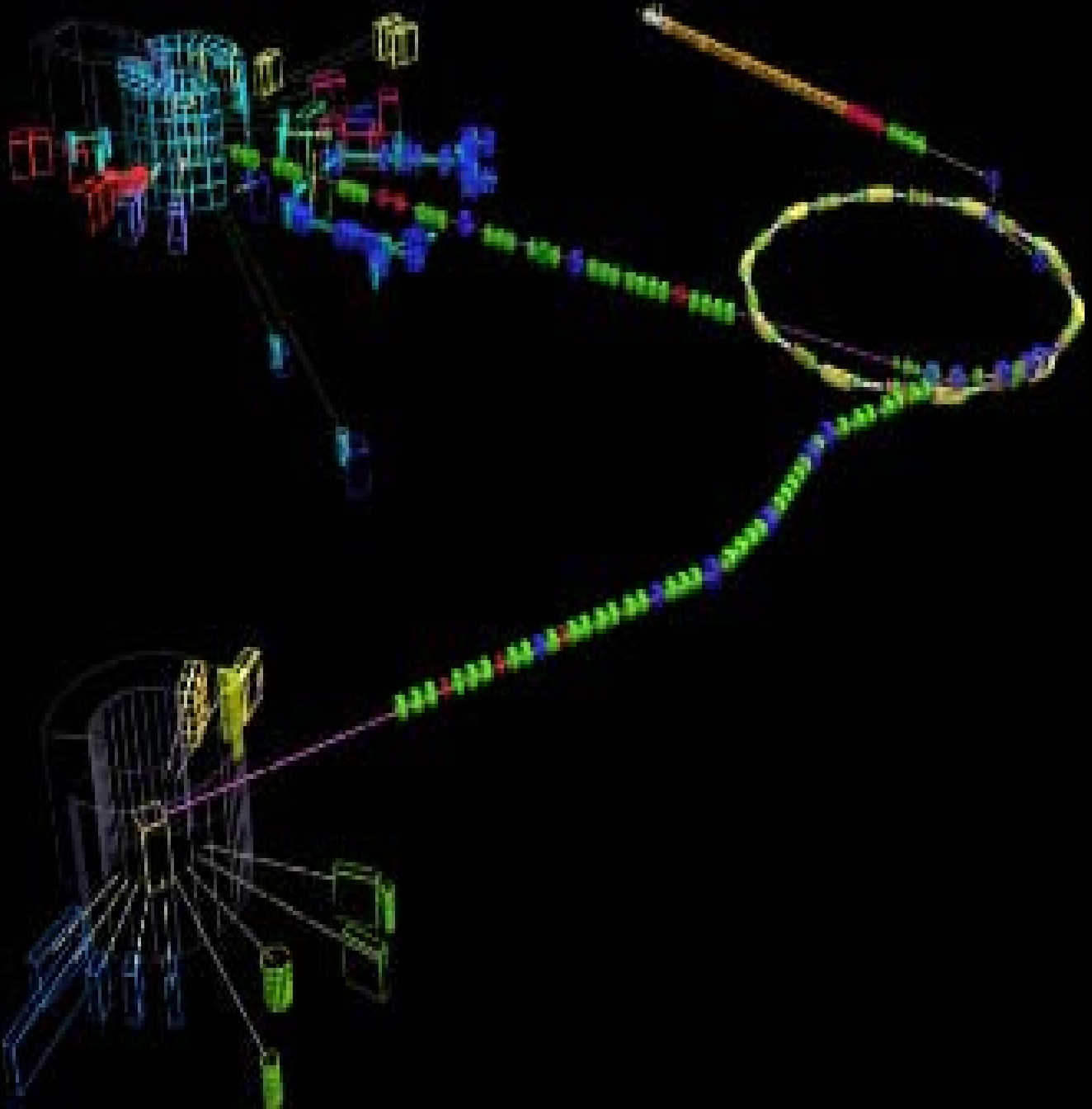
The ISIS Targets

The *Muon Target*





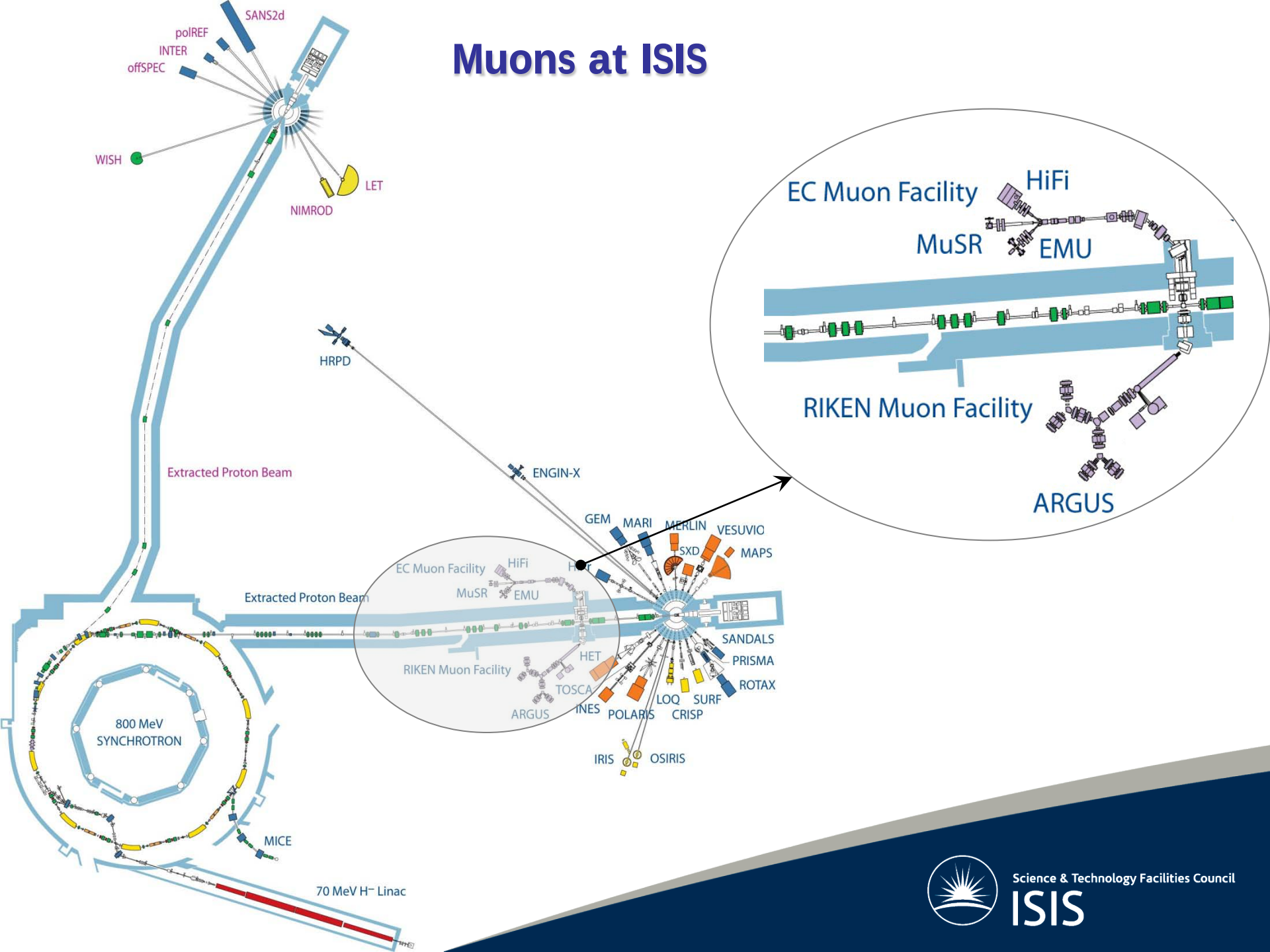
Carbon target, 10 mm thick
Takes ~5% of the proton beam



The ISIS Pulsed Neutron and Muon Source

- ISIS runs ~180 days per year
- It runs in ‘cycles’ of 30-40 days each
- ISIS is controlled from the Main Control Room – which is always staffed

Muons at ISIS



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RIKEN-RAL Muon Facility

Largest UK-Japan science collaboration

First muons 1994

4 experimental areas
- condensed matter
- other ‘exotic’ uses of muons

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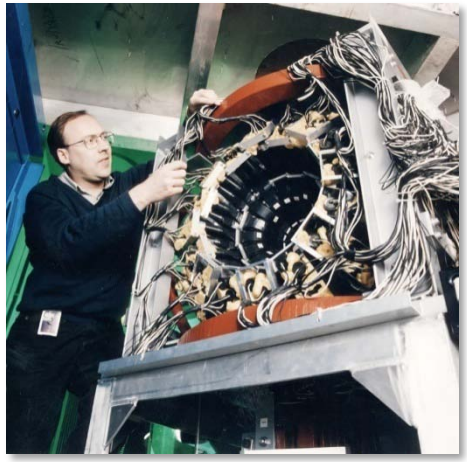
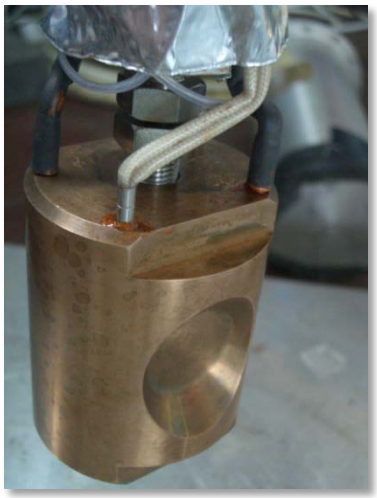
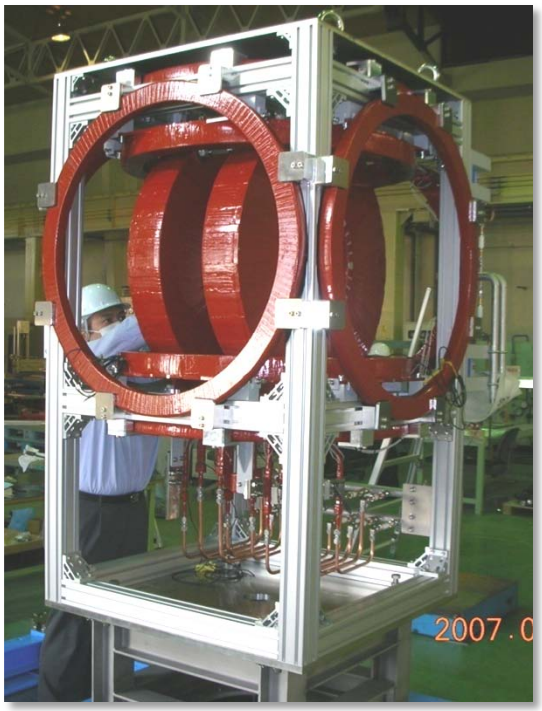
RIKEN-RAL Muon Facility

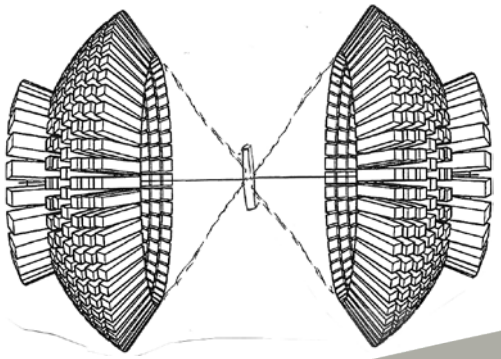
ARGUS (Port 2)





New spectrometer (Port 4)





The European Muon Facility

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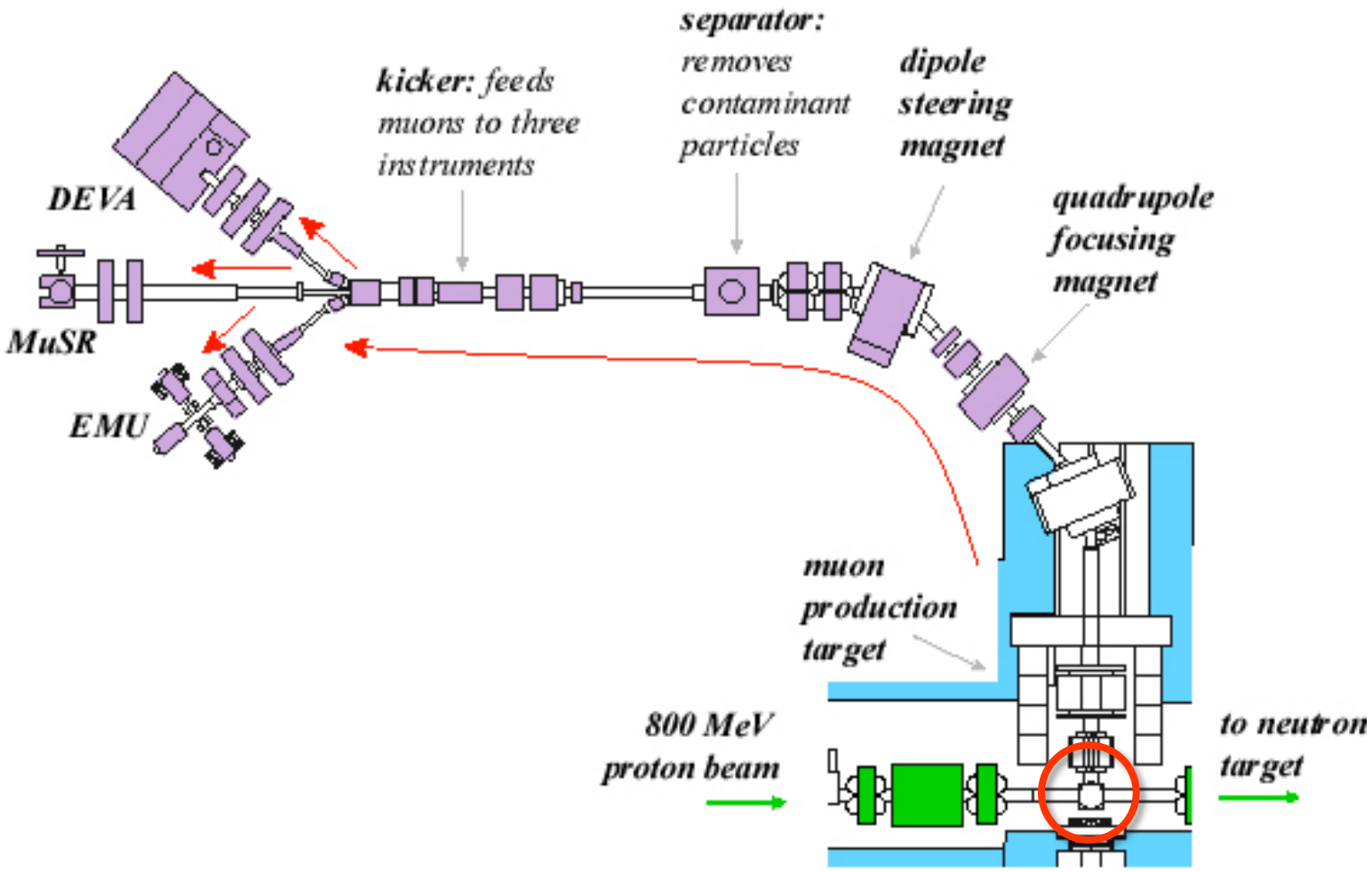
The EC Muon Facility



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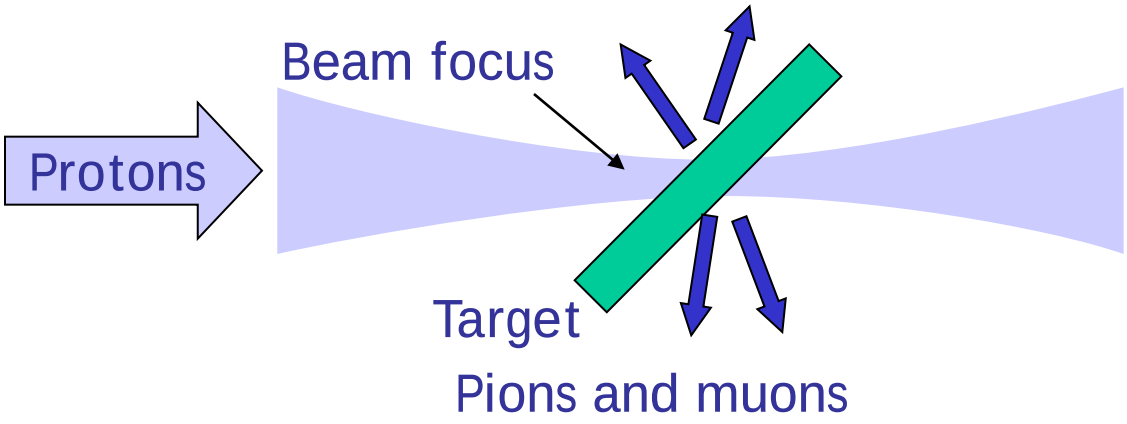
Muon Production Target

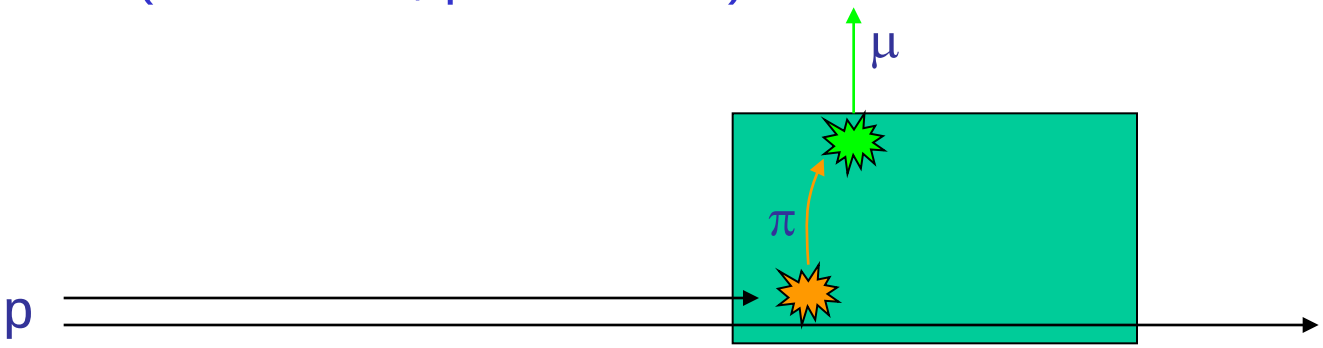
- Made of graphite
- Low-Z – less proton scatter
- Gets to perhaps 900K
- Takes ~5% of the proton beam



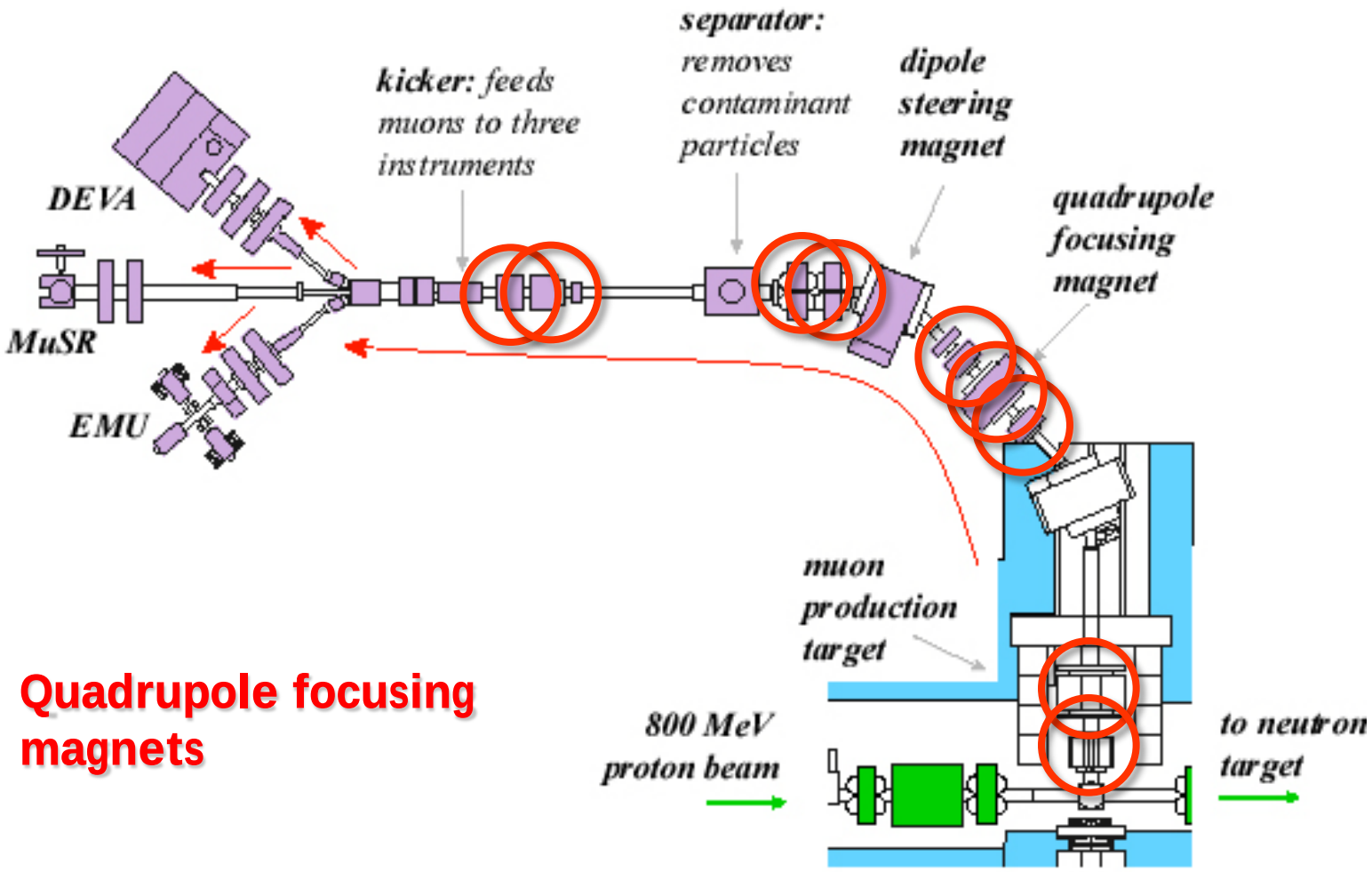
‘Surface’ muons

- Proton collisions produce ***pions***, e.g.

  $p + p \longrightarrow p + n + \pi$
- Some pions ***stop*** in the target
- They decay to muons, which escape if formed near the target surface
- Muons collected into the beam line
- Polarisation 100%
- Intense beam – though low momentum
  (E= 4.1 MeV, p=29 MeV/c)



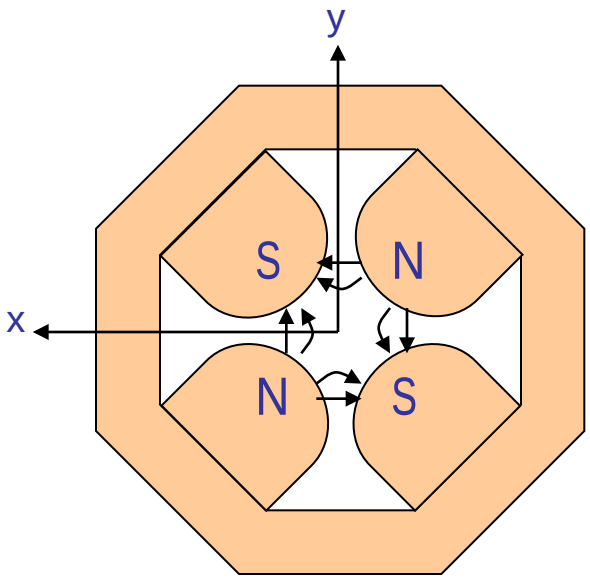
The EC Muon Facility



Quadrupole focusing magnets

Focusing the beam – quadrupole magnets

- Quadrupole magnets focus in one direction, defocus in the other.
- So they appear in our beamline in 2's or 3's
- Allow tuning of the beam by varying the current



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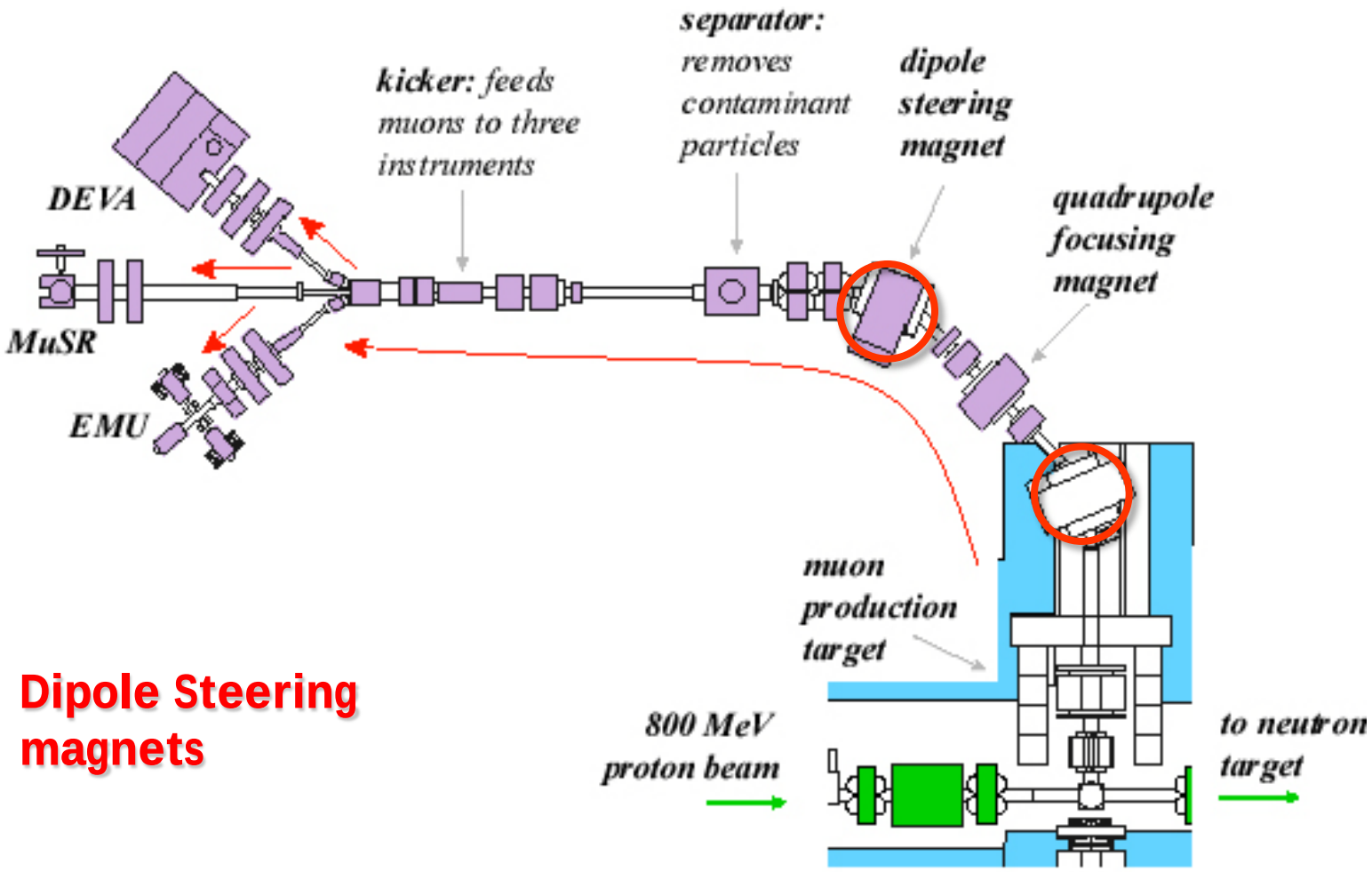
The EC Muon Facility



Dipole Steering magnets

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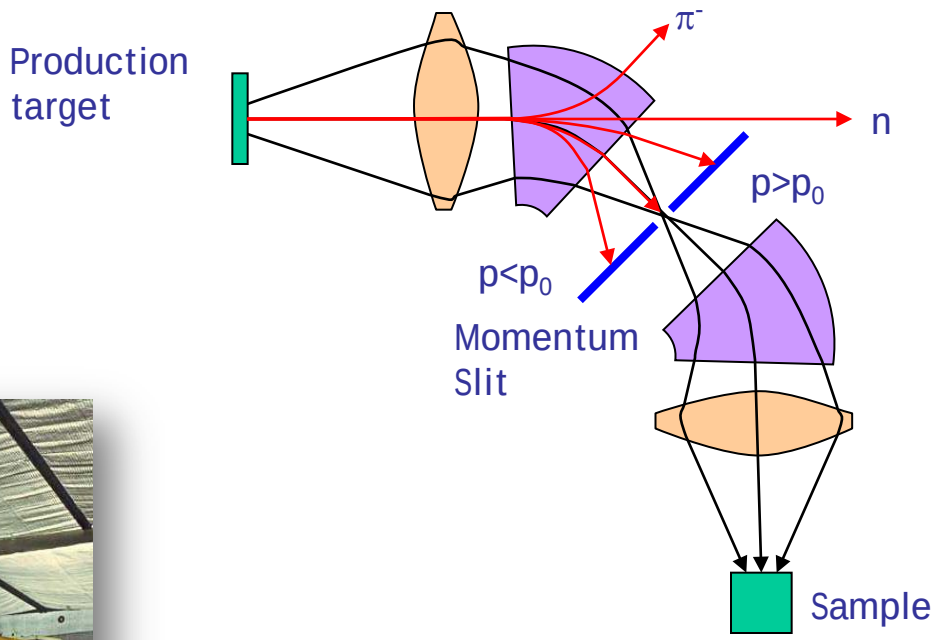
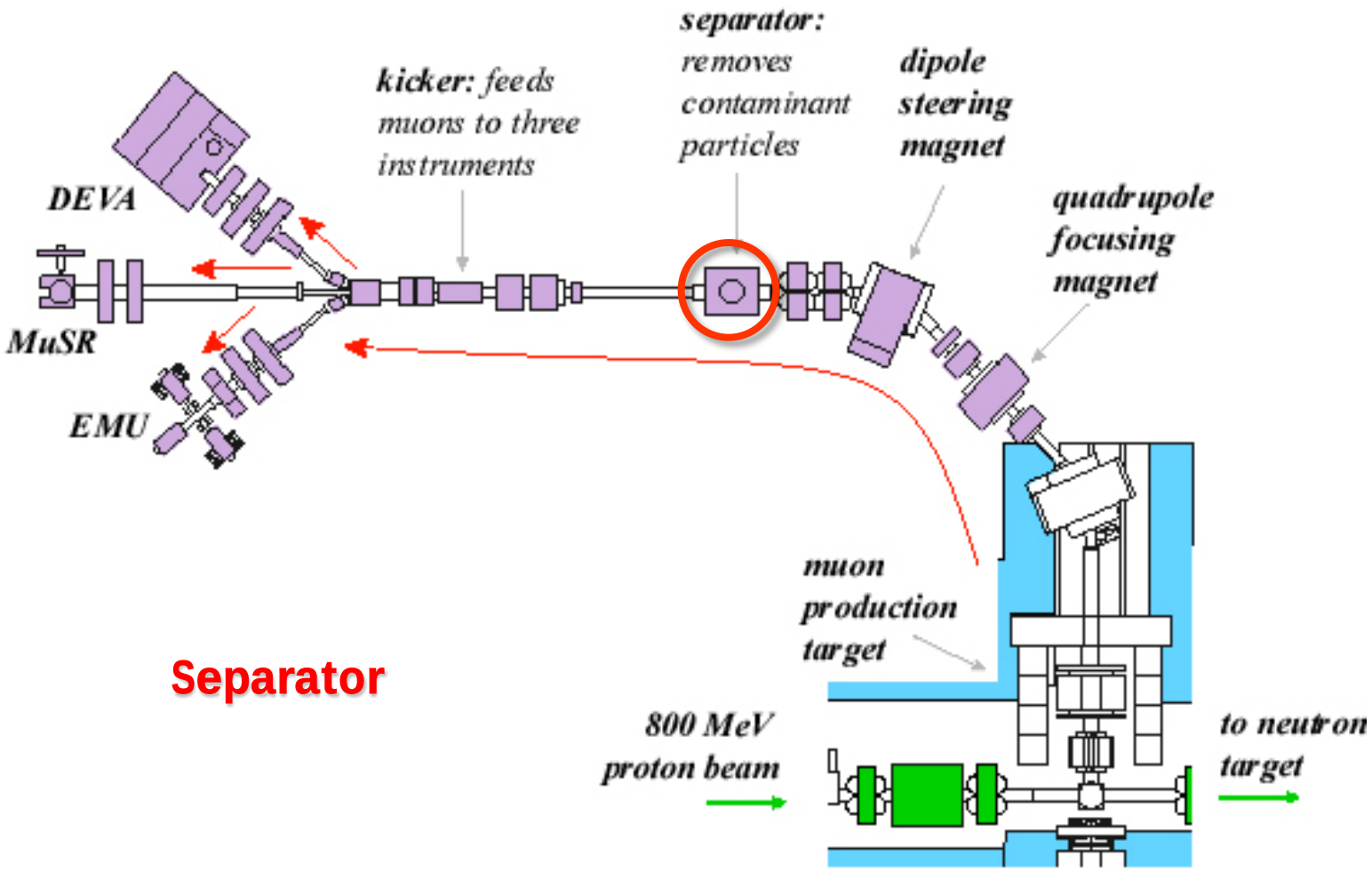
Bending the beam – dipole magnets

- Get the beam round corners!
- Also exclude neutral particles or those of the wrong charge
- Act as a momentum filter



The EC Muon Facility



Separator

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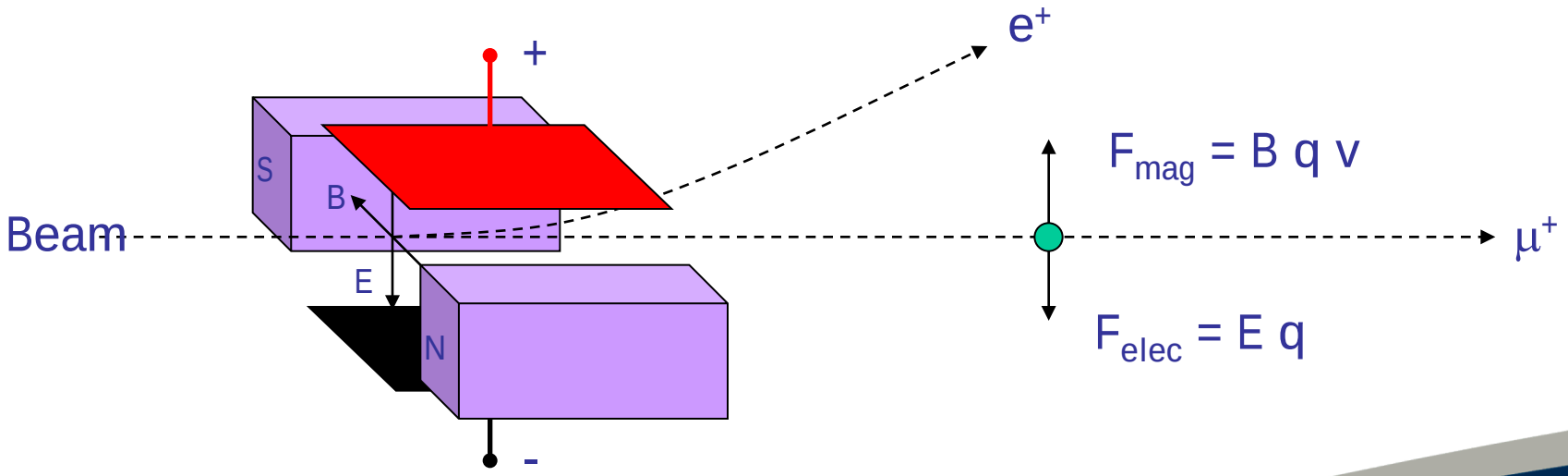
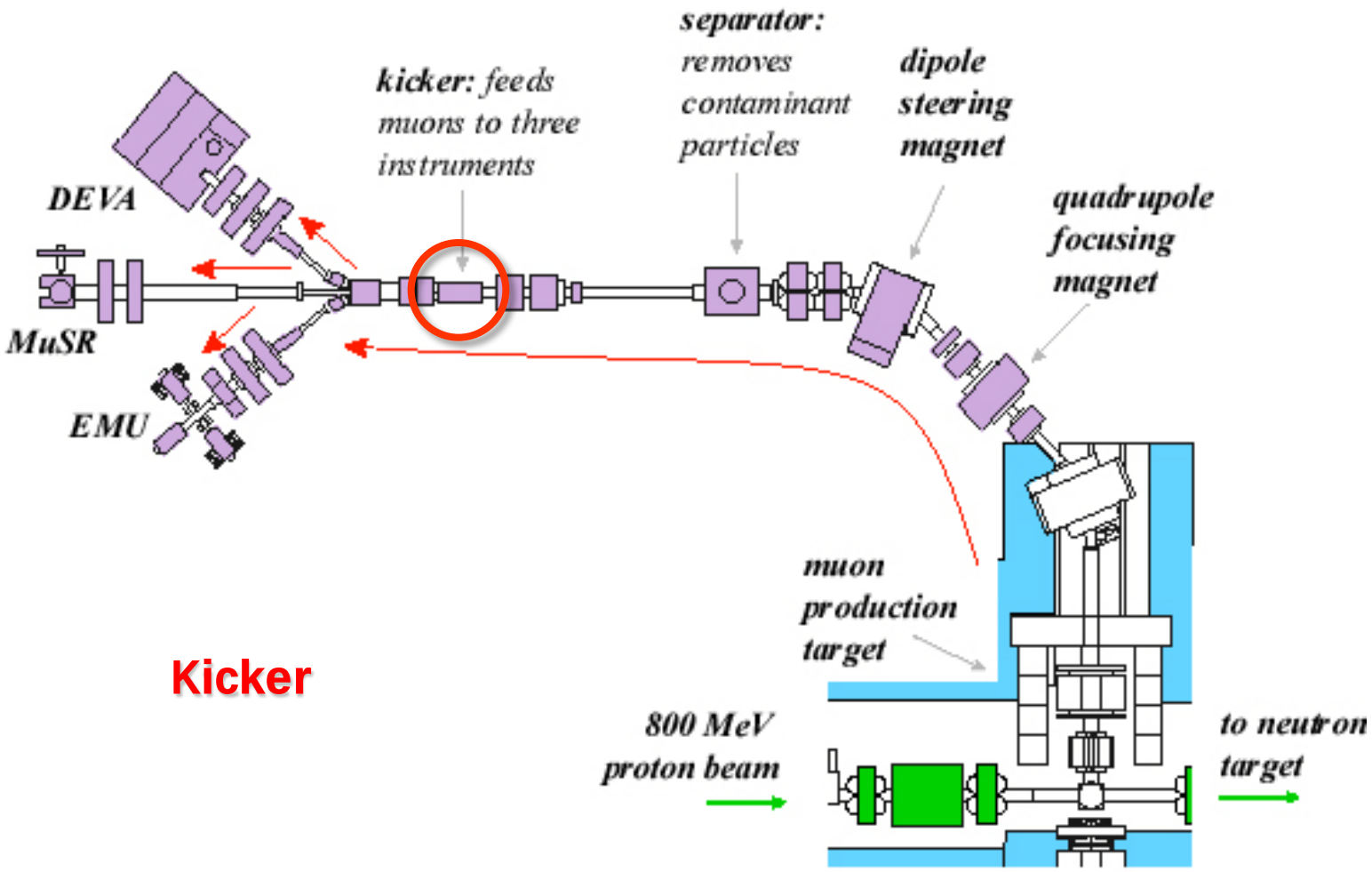
Cleaning the beam – the separator

- E and B fields, mutually perpendicular
- Acts as a velocity filter
- E and B field forces cancel for particles of the correct velocity
- Gives a 6º spin rotation

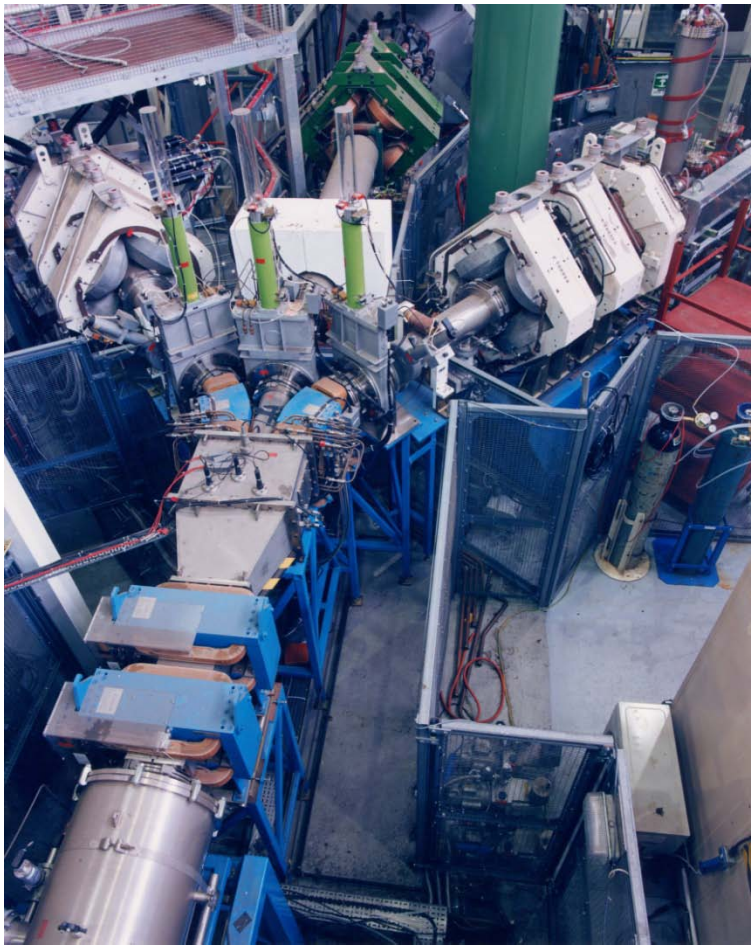


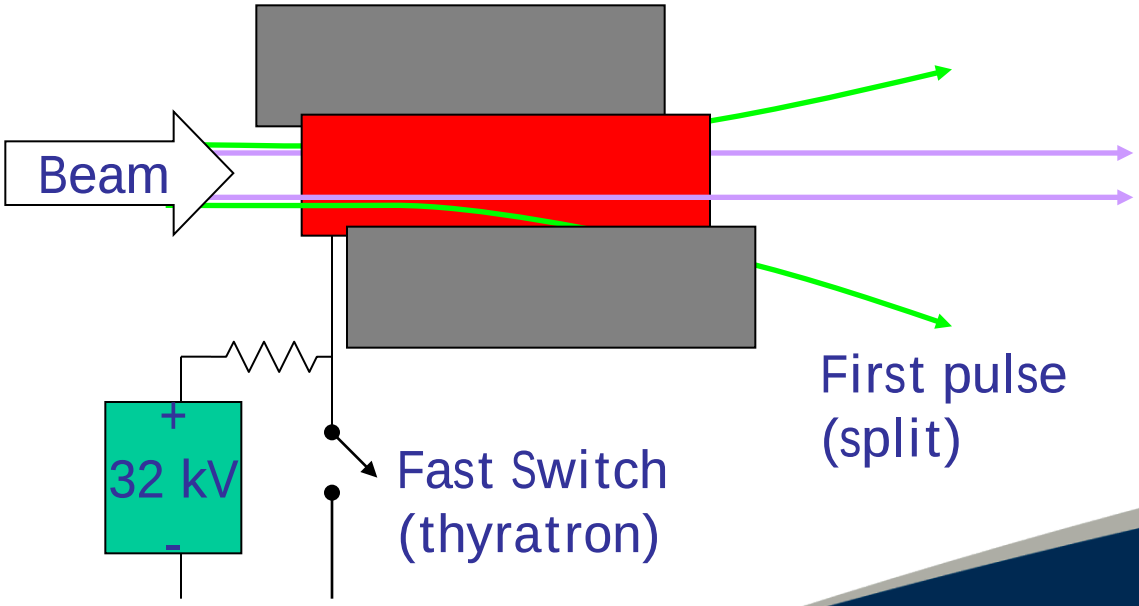
The EC Muon Facility



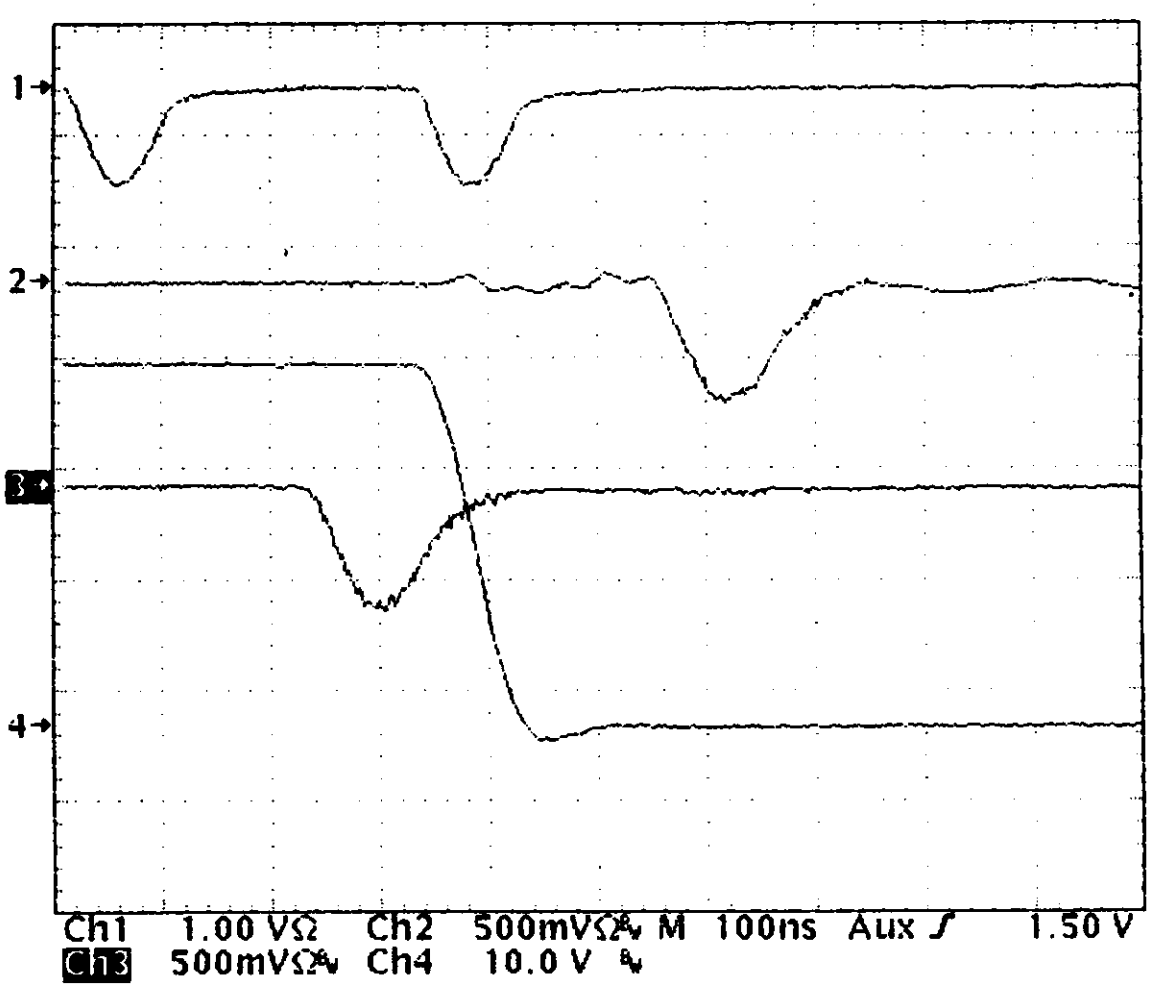
Splitting the beam – the kicker

- Central electrode
- Charged positively for first muon pulse
- Splits the first pulse in two
- No voltage for second muon pulse
- Second pulse goes straight through





Splitting the beam – the kicker



A Brief History of EC ISIS Muons

1985: Construction – EC, UK, Italy, France, Germany, Sweden

1987: First muons – single beamline (MuSR)

1991: Construction of beamline upgrade – EC-funded

1993: 3 beamlines operational (MuSR, EMU, DEVA)

1996 – 2008: €3.9M in EC Access funding

1998-2000: DEVA RF-spectrometer built (EPSRC)

2005-2009: HiFi constructed (£2.1M)

2007: 20th birthday!

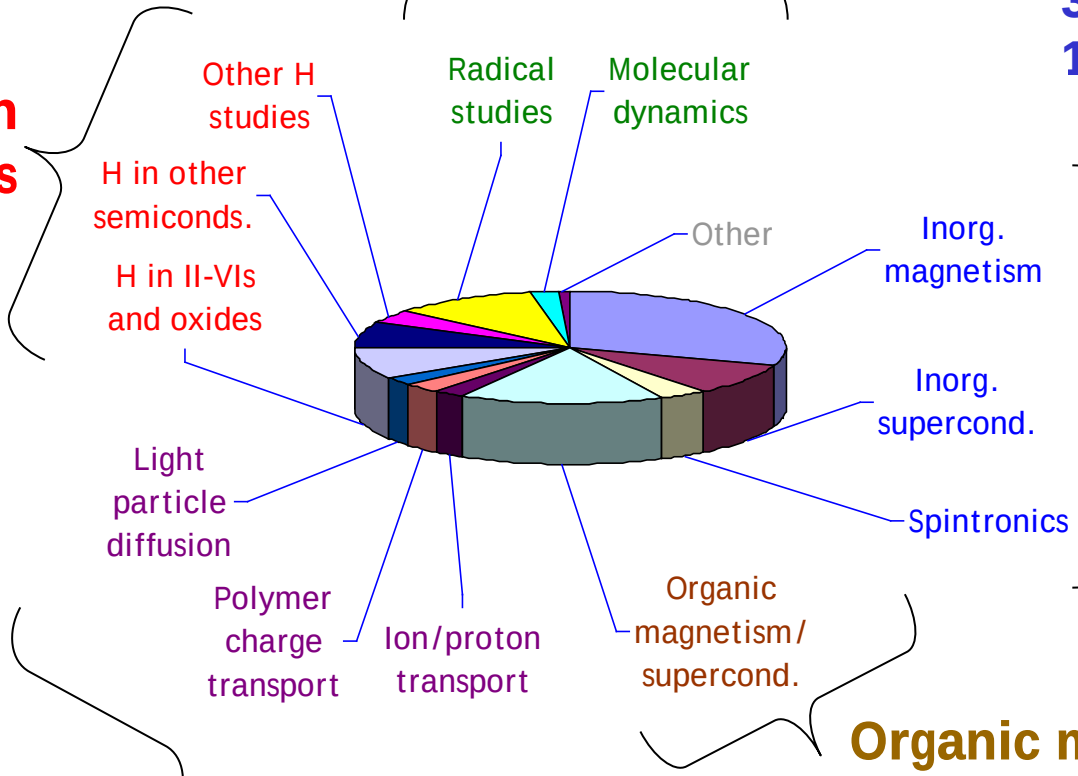
2009: HiFi completed

Usage of EC ISIS Muons

Average of 50 publications per year
Last 18 months:
6 x PRL
3 x Nature
1 x Science

Chemistry and molecular studies

Hydrogen studies



Inorganic magnetism and super-conductivity

Organic magnetism and super-conductivity

Charge transport and diffusion

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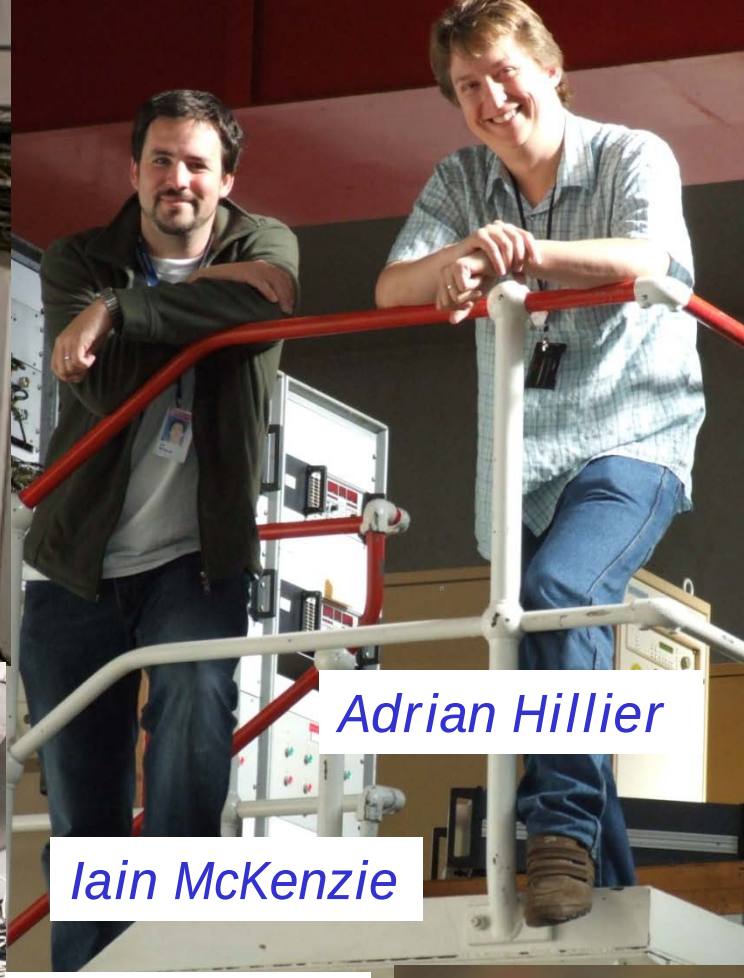
ISIS

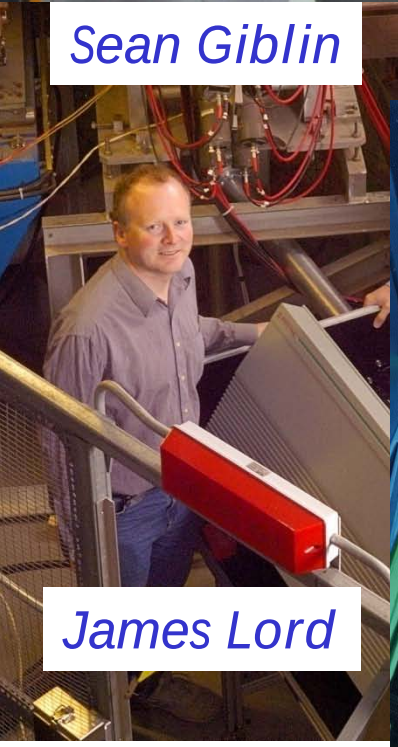
Sean Giblin

Steve Cottrell

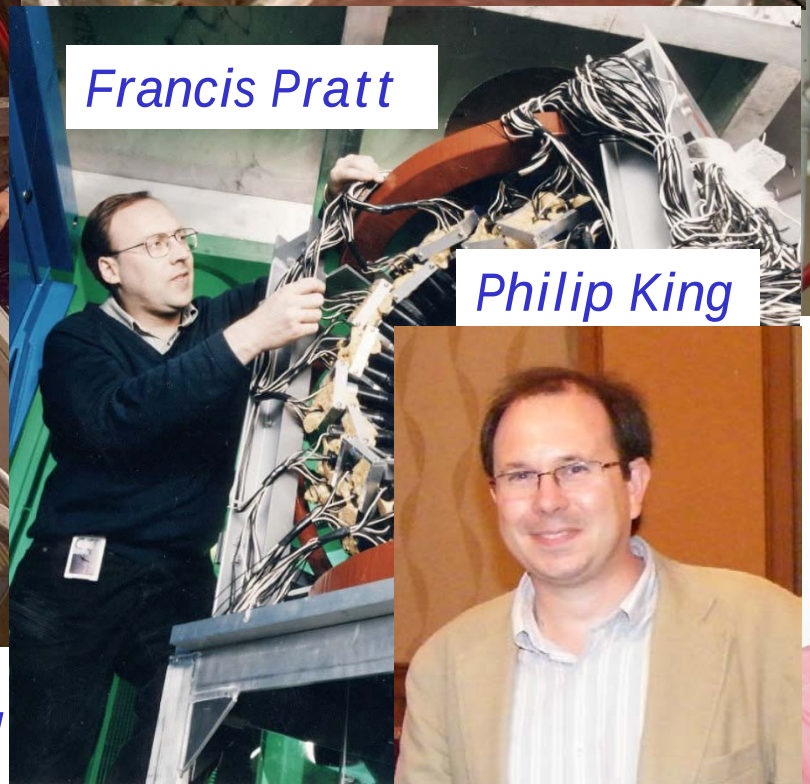


Adrian Hillier

Iain McKenzie



James Lord



Francis Pratt

Philip King

Steve Cox

Peter Baker

Muon People!