

**The international
Muon Ionisation Cooling Experiment**

**Muon Technical Advisory Committee
7th April 2009**

Mar08



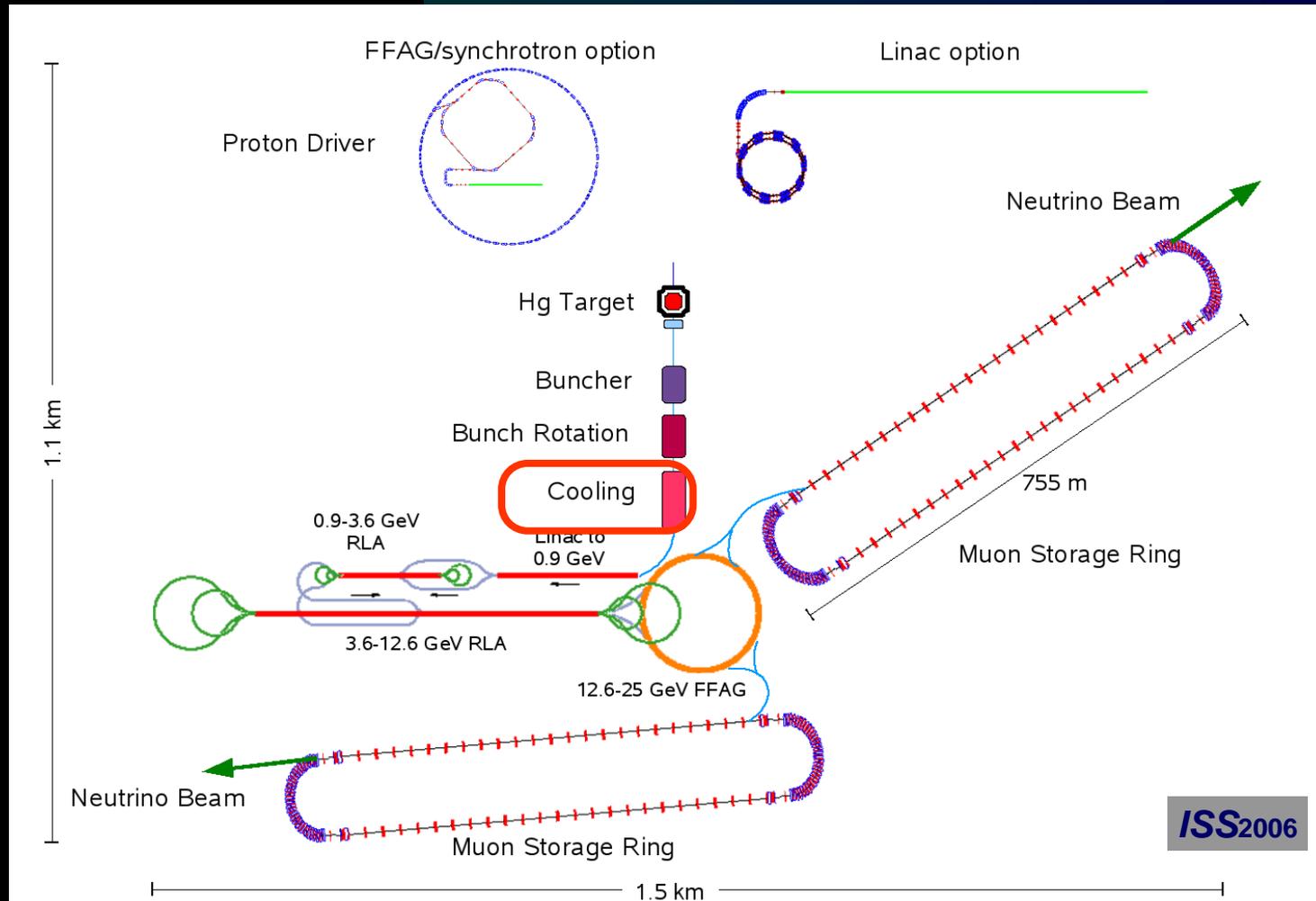
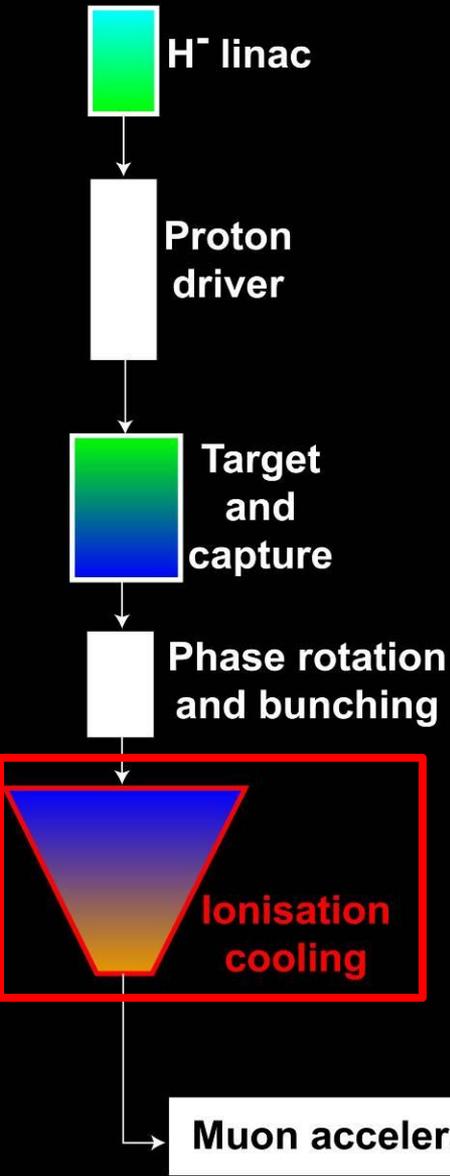
Mar09



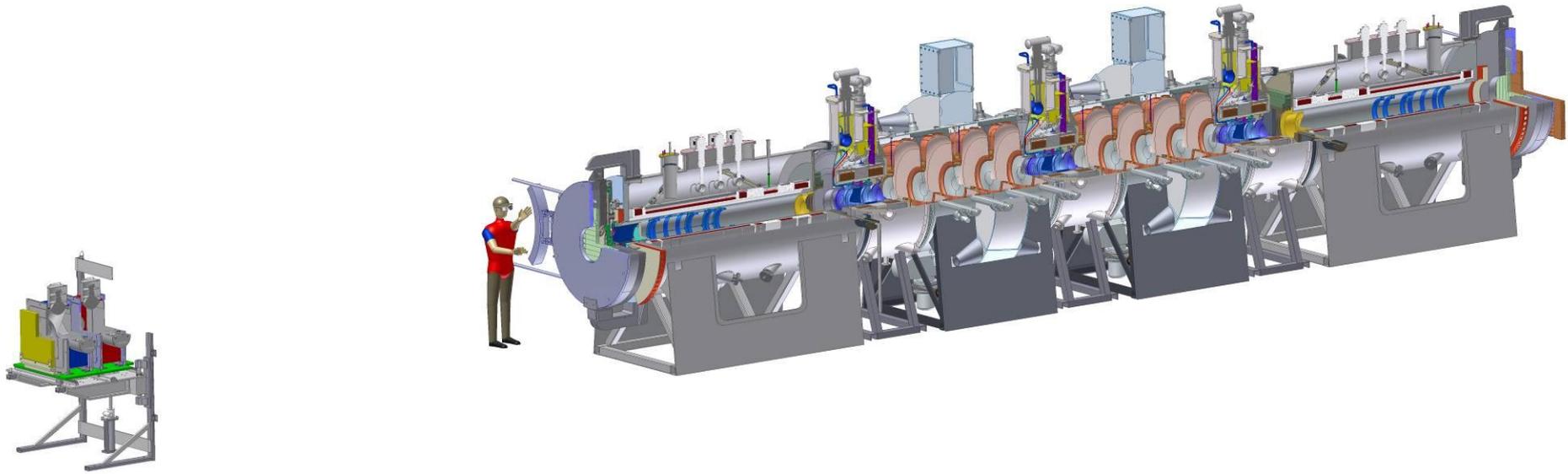
Contents:

- Muon ionisation cooling; motivation
- MICE status
- Issues and schedule
- Conclusions

IDS-NF baseline: accelerator



Muon ionisation cooling experiment



■ MICE:

- Design, build, commission and operate a realistic section of cooling channel
- Measure its performance in a variety of modes of operation and beam conditions ...

... i.e. results will allow NuFact complex to be optimised

THE MICE COLLABORATION -130 collaborators-

Universite Catholique de Louvain, Belgium

University of Sofia, Bulgaria

The Harbin Institute for Super Conducting Technologies PR China

INFN Milano, INFN Napoli, INFN Pavia, INFN Roma III, INFN Trieste, Italy

KEK, Kyoto University, Osaka University, Japan

NIKHEF, The Netherlands

New collaborators
this year: Pavia, Warwick

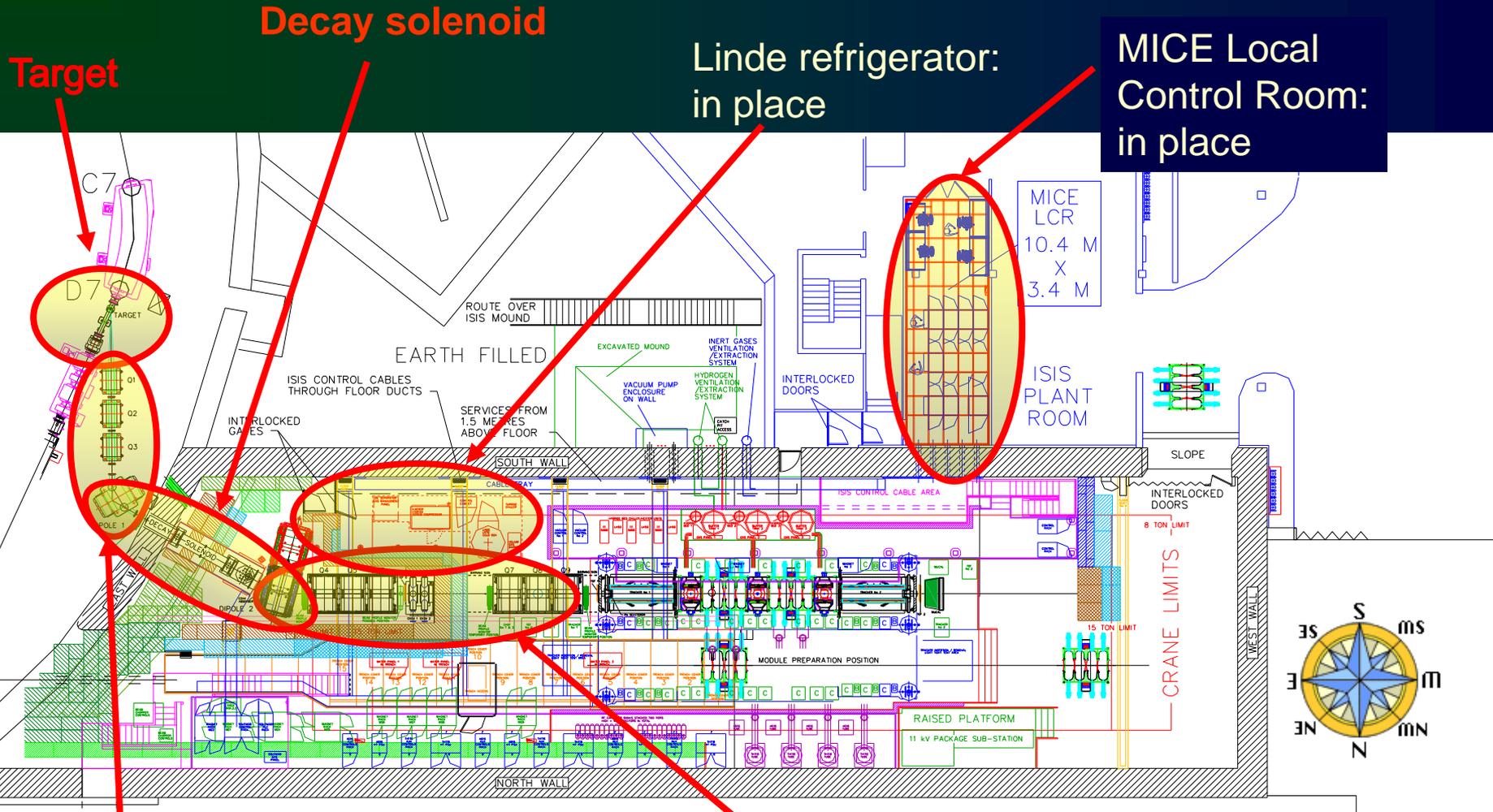
CERN

Geneva University, Paul Scherrer Institut Switzerland

Brunel, Cockcroft/Lancaster, Glasgow, Liverpool, ICL London, Oxford, Darsbury, RAL, Sheffield UK

Argonne National Laboratory, Brookhaven National Laboratory, Fairfield University,
University of Chicago, Enrico Fermi Institute, Fermilab, Illinois Institute of Technology,
Jefferson Lab, Lawrence Berkeley National Laboratory, UCLA, Northern Illinois University,
University of Iowa, University of Mississippi, UC Riverside,
University of Illinois at Urbana-Champaign, Muons Inc. USA

Status of MICE:



Decay solenoid

Target

Linde refrigerator:
in place

MICE Local
Control Room:
in place

Upstream
Beamline:
in place

Downstream beamline: in place

Instrumentation in place:
Beam monitors
Trigger/rate scintillators
CKov, TOF0&1, KL

Infrastructure:

- The bulk of the heavy civil engineering has gone very well:
 - Civil engineering now almost complete

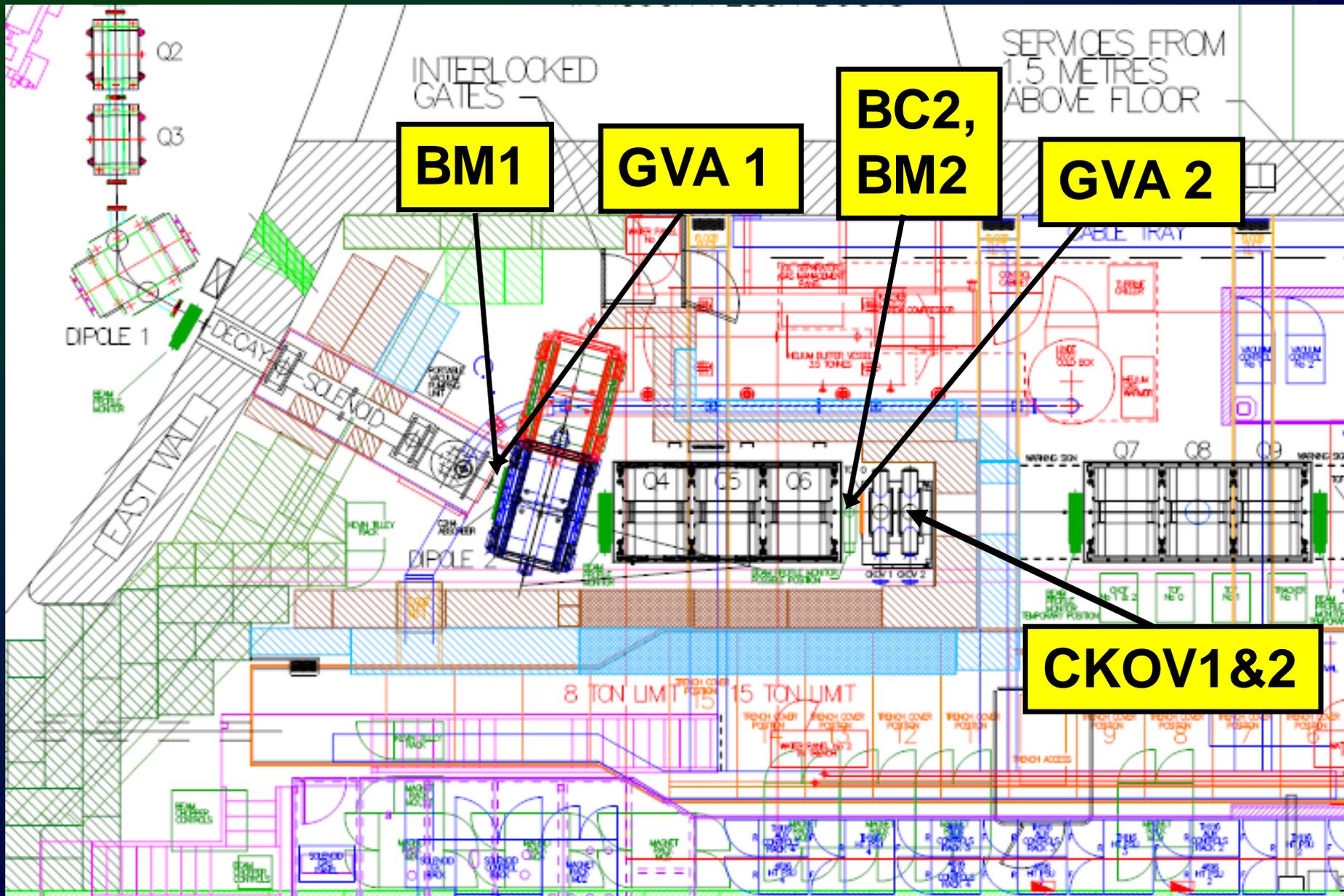


Air-con

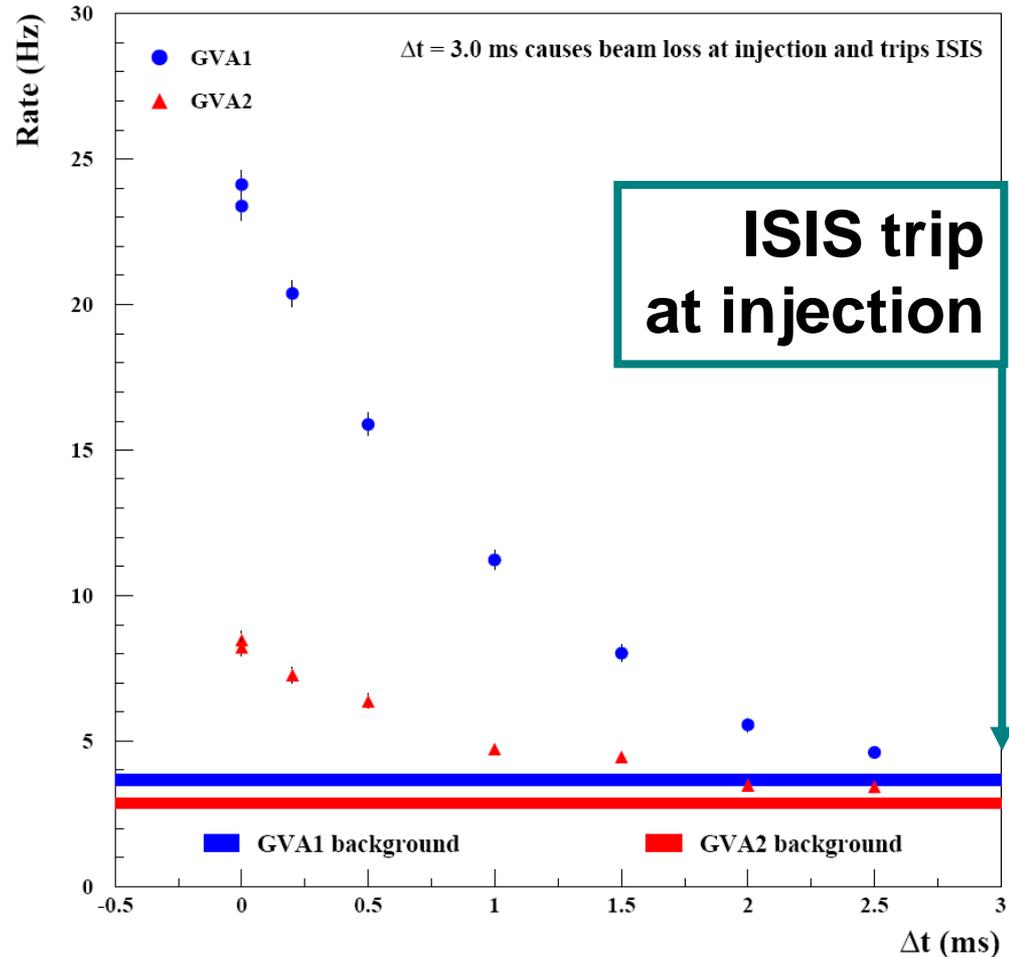
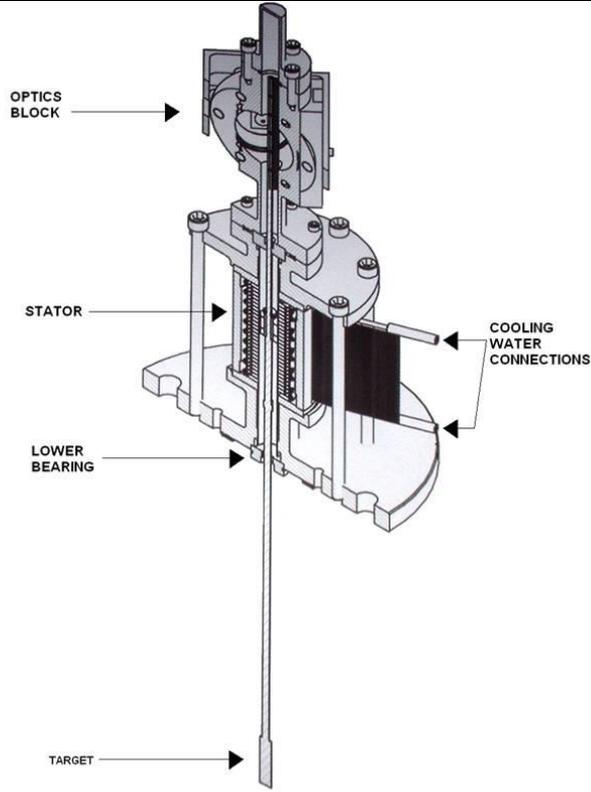


**Compressed
air plant**

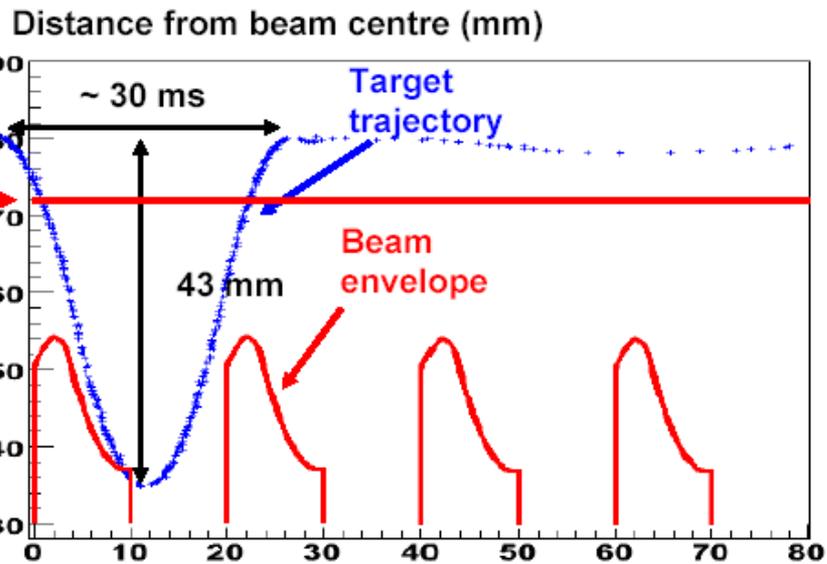
Beam studies, a selection:



Parasitic running:



ISIS trip at injection



3 ms 'operational range'

Extracted Proton Beam 1

**Beam-loss monitors
in each sector:**

- **Ionisation chambers**
- **Beam loss reported
in 'Volts'**

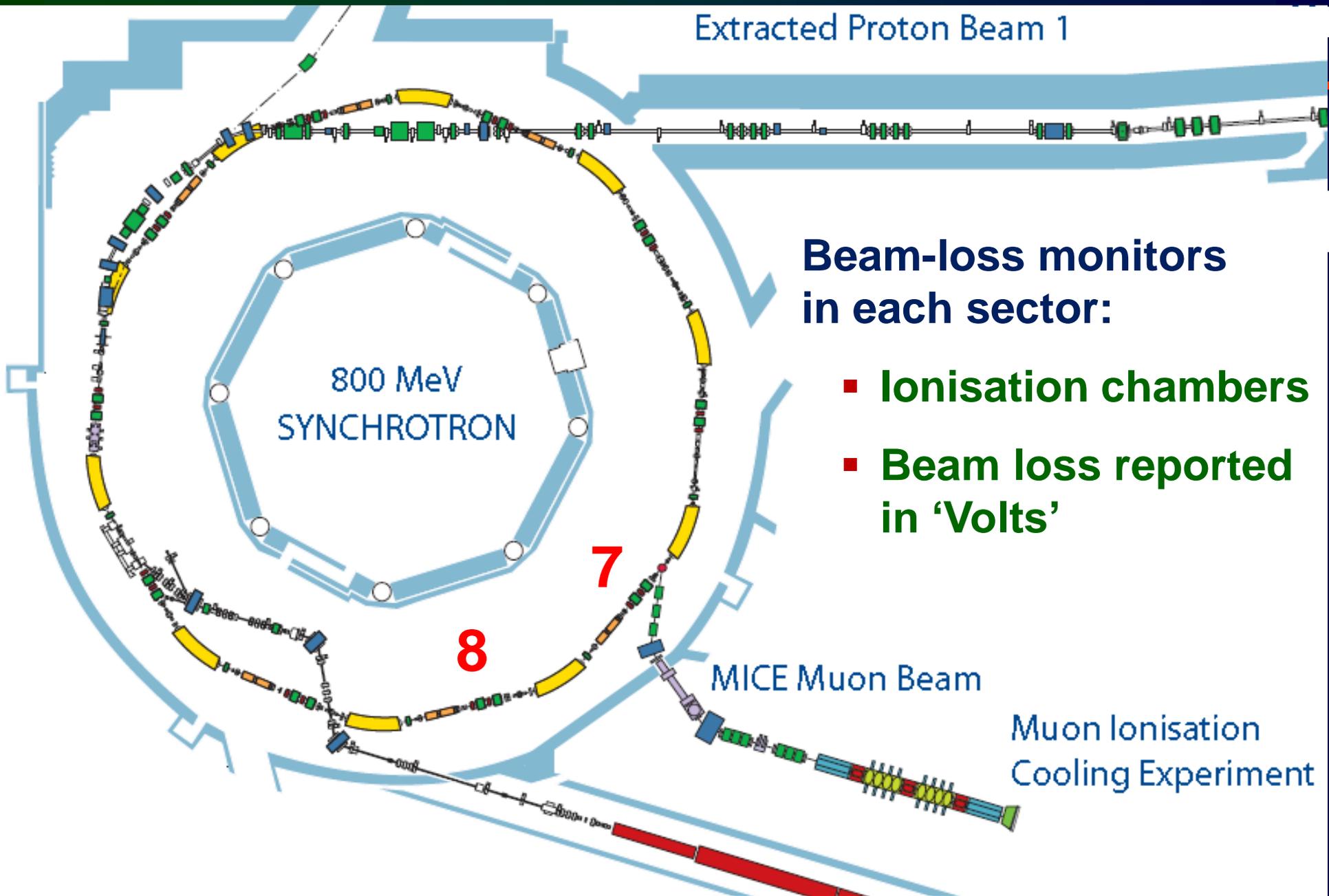
800 MeV
SYNCHROTRON

7

8

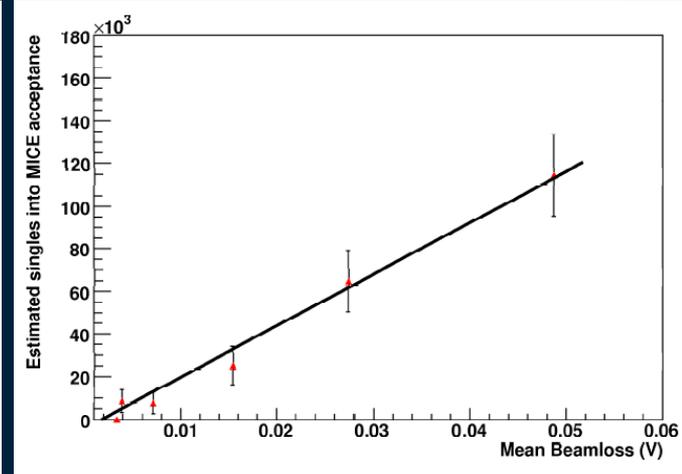
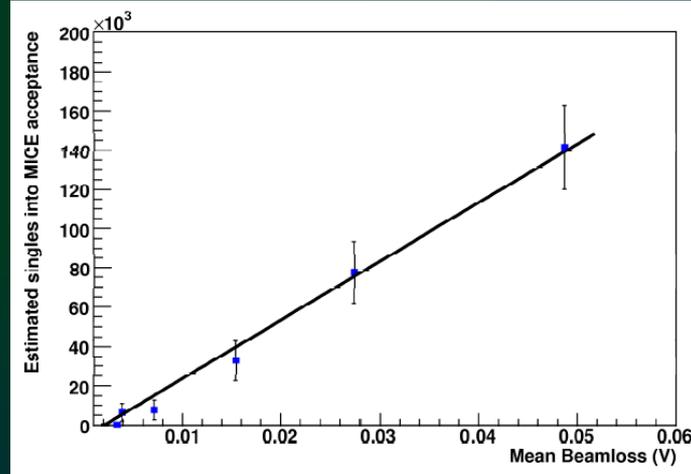
MICE Muon Beam

Muon Ionisation
Cooling Experiment

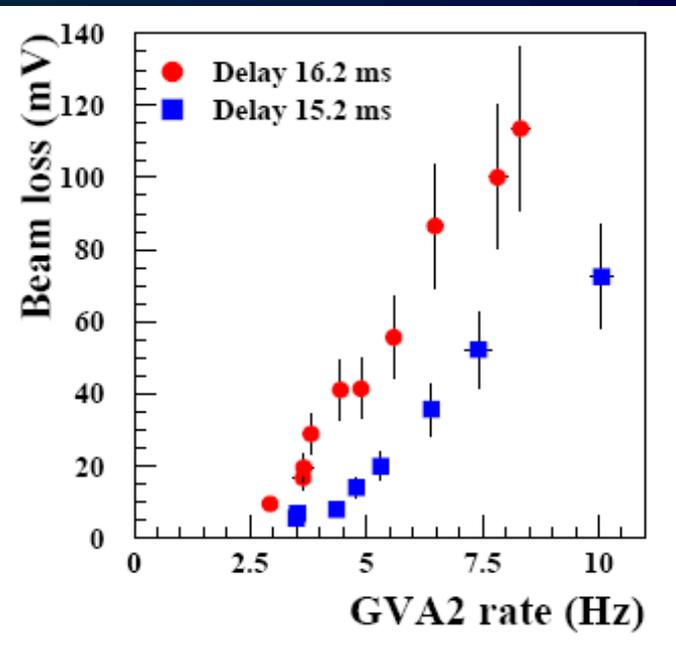
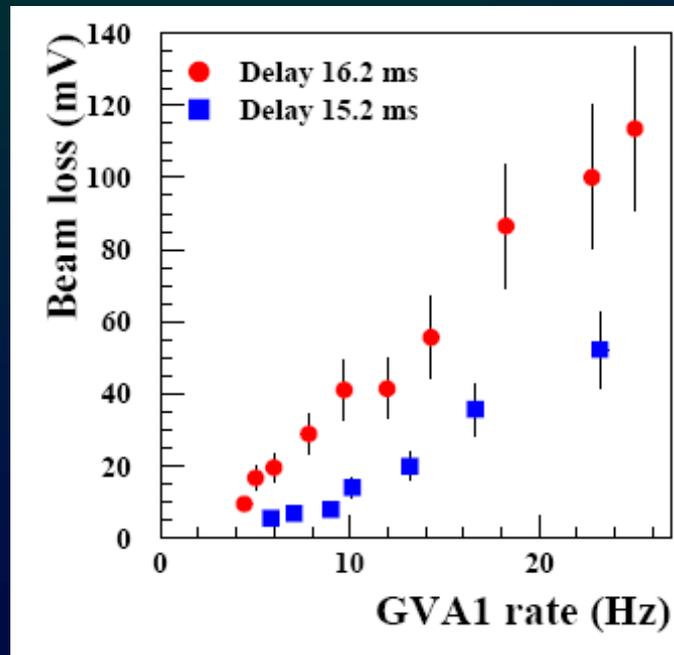


Particle rate and beam loss

■ Target test 2006



■ Summer 2008



Correlation remains pretty much linear to beam loss $\sim 1V$

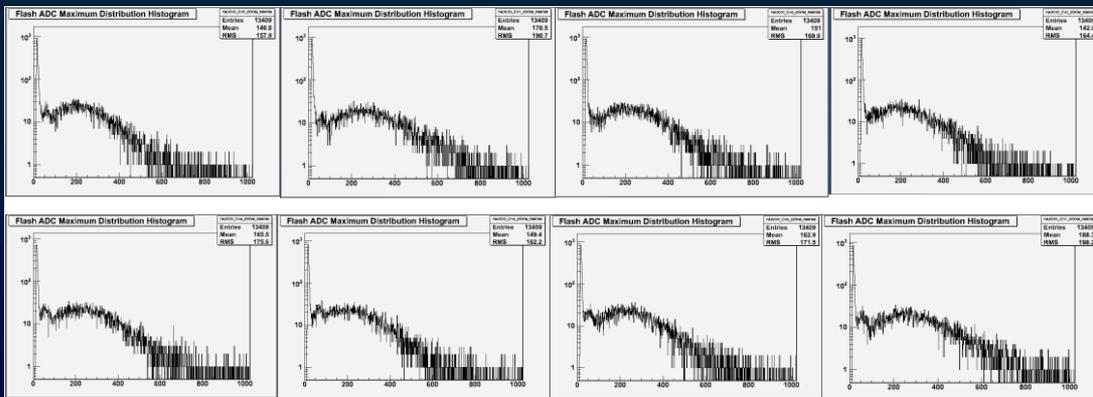
Target: particle rate and beam loss:

- Compared to March 2008 required:
 - 500 fold increase in projected muon rate
 - Equivalent to a BLM signal in sector 7 of ~10—25 V
- Progress to December 2008:
 - Beam losses up to 1V had been produced for short periods
 - Schedule high beam loss investigation to 2—5V for weekend when target failed
 - Other than increased beam loss, no adverse effects for example on extraction observed
 - Activation studies:
 - 12—16 hour runs at fixed beam loss:
 - Runs performed at 50mV, 200mV and 500mV
 - No increase in activation of machine observed
 - 16 hour run at ~1—2 V scheduled for weekend when target failed
- Optimistic that required muon rate can be achieved

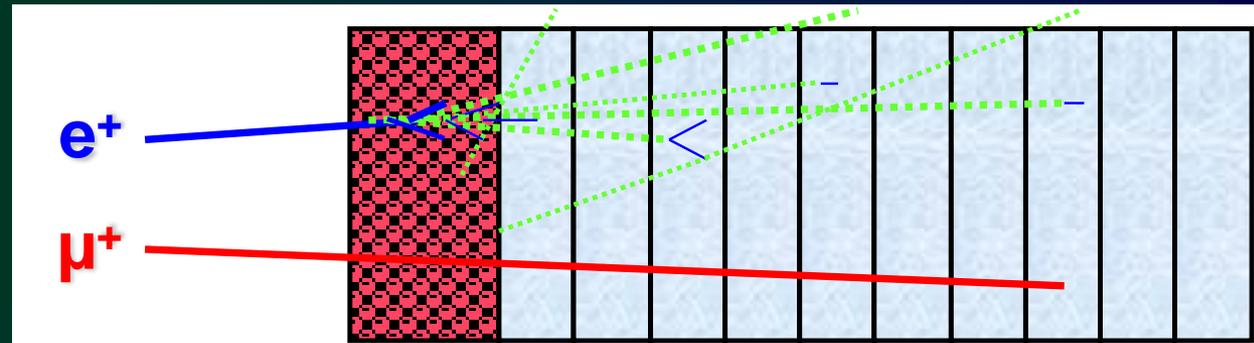
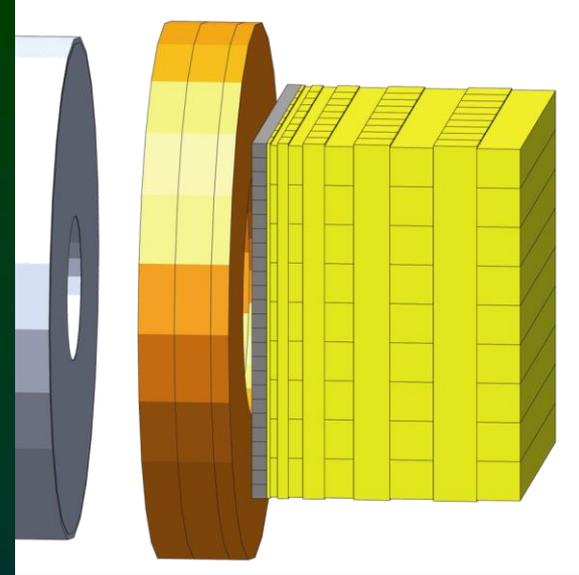
Particle identification:

KL/TOF1
installation

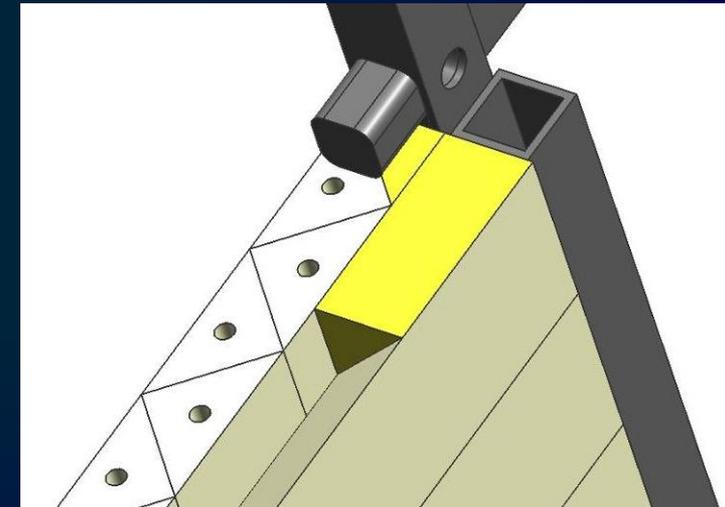
- Time-of-flight system:
 - TOF0 & TOF1 installed and commissioned
 - TOF2 expected Jun09
- CKOVa&b:
 - Installed and commissioned
 - Data; see D.Kaplan's talk
 - Example: 100 MeV positrons



Electron Muon Ranger:



- Group formed to provide EMR:
 - Como, FNAL, Geneva, Milano, Trieste
- Status:
 - Design complete:
 - Prototyped tested in CERN test beam in 2006
 - Scintillator (Minerva-style extrusions) provided by FNAL now at Geneva for production
 - Electronics/readout specified

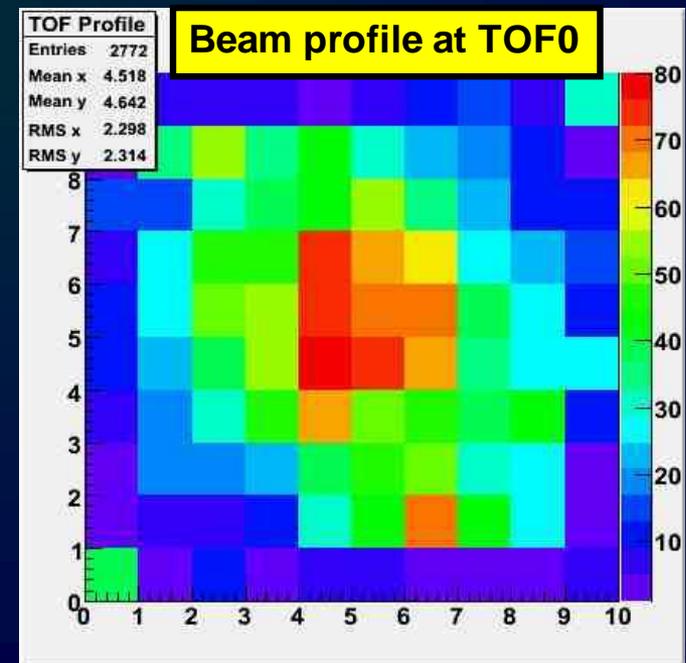
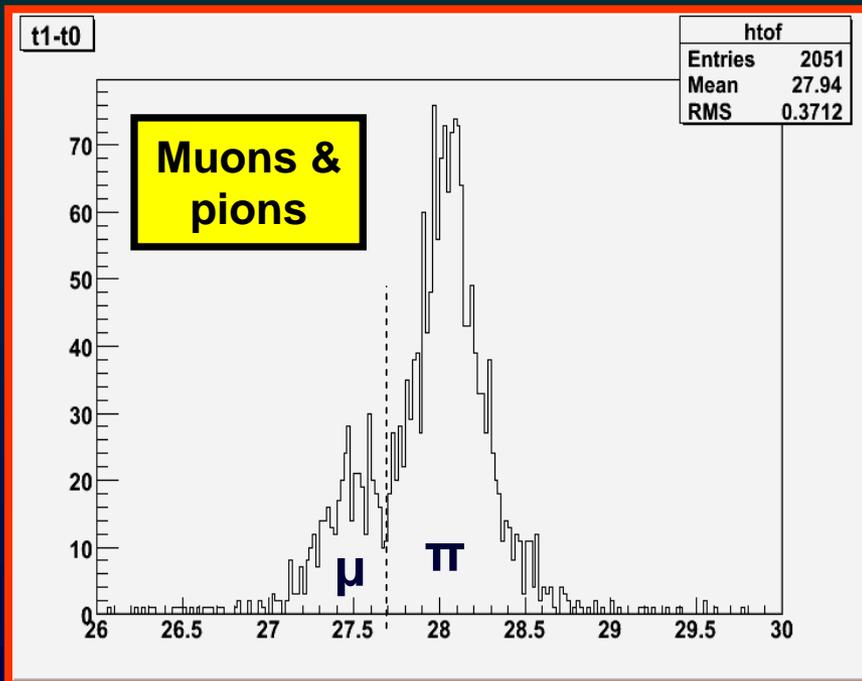
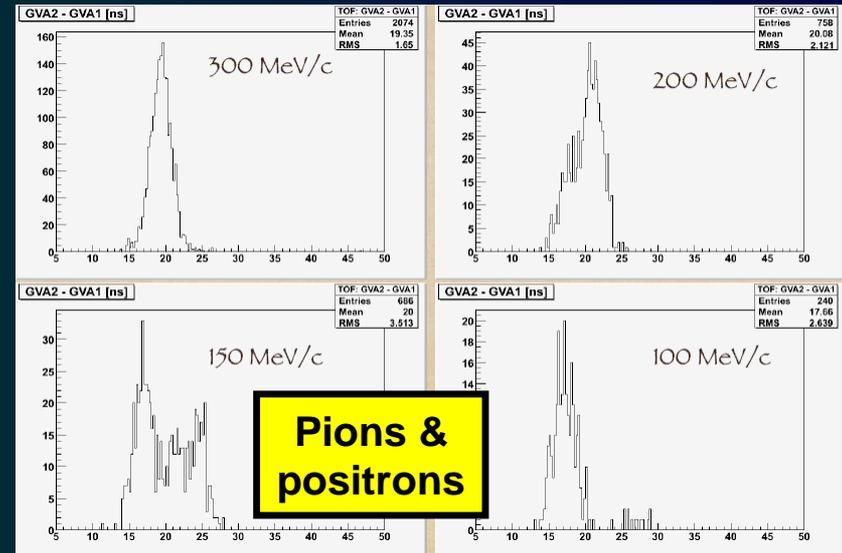
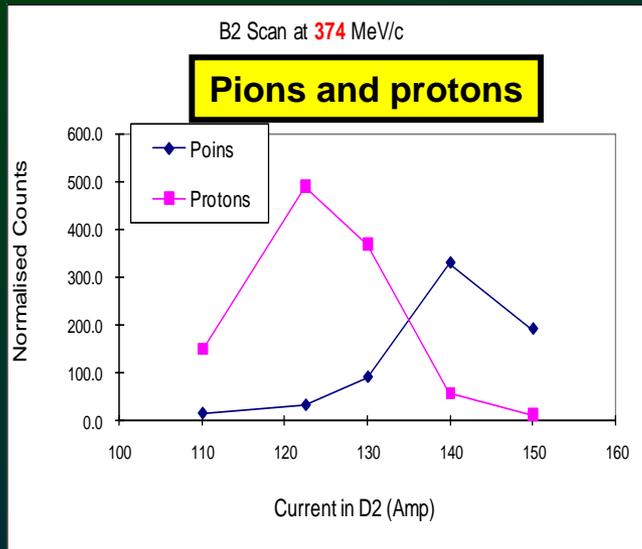


Total: 2360 channels

One M64 Pmt per layer for the first 32 layers (59 channels per Pmt)

Two M256 Pmts for the last 8 layers (236 channels per Pmt)

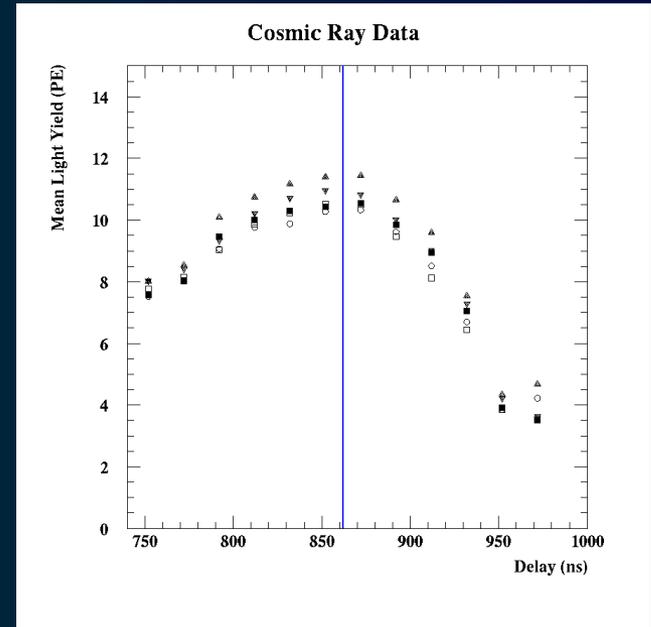
Commissioning: sample data:



Spectrometers:

Tracker:

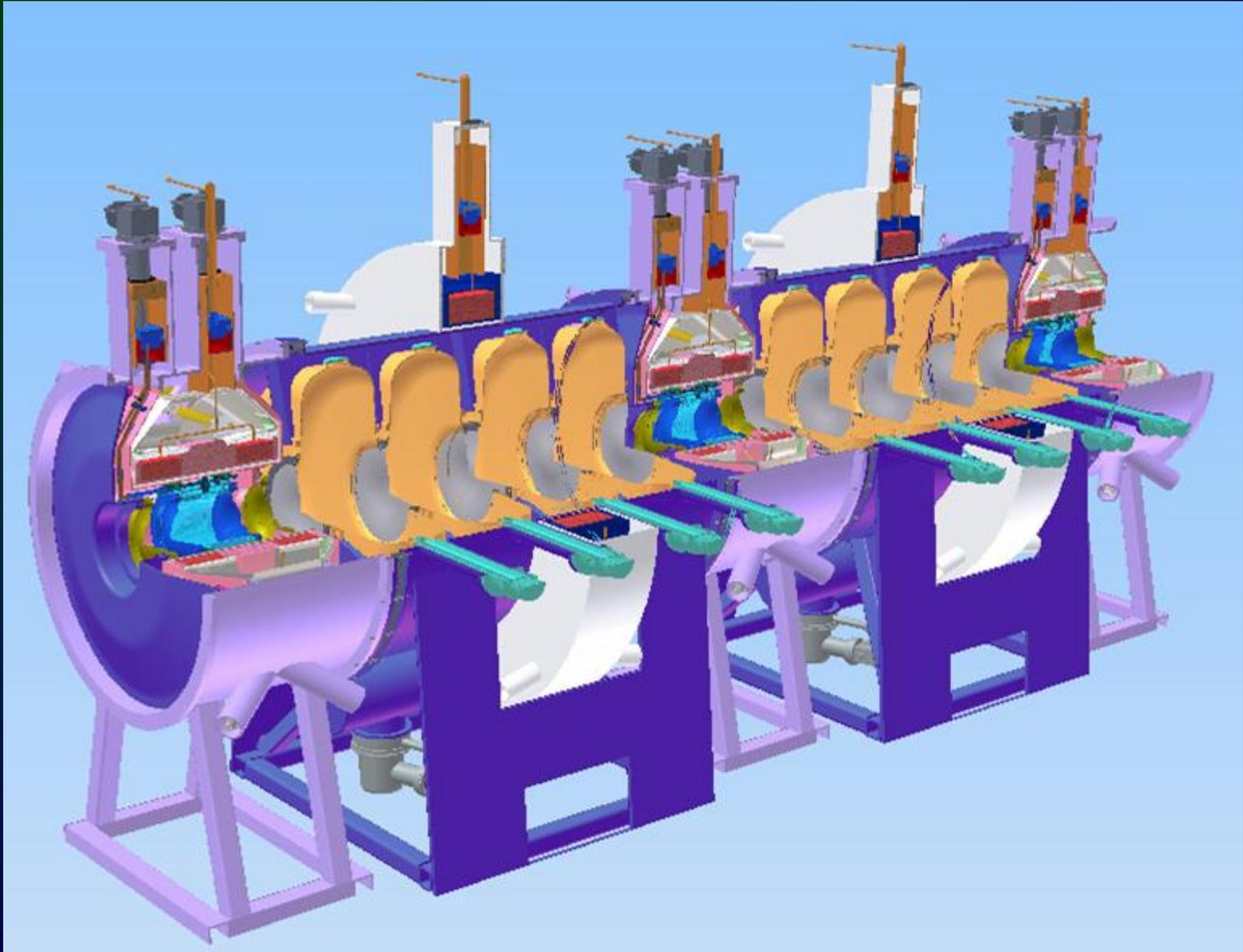
- Extended cosmic test of tracker #1
- Set up for extended cosmic test of trackers #1 and #2



Spectrometer solenoids:

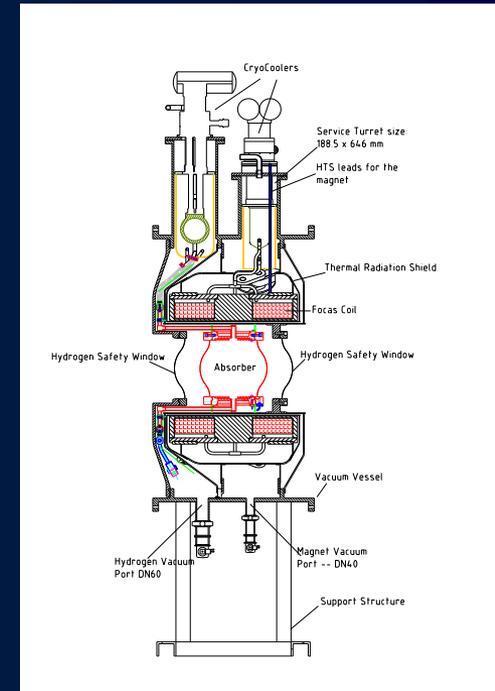
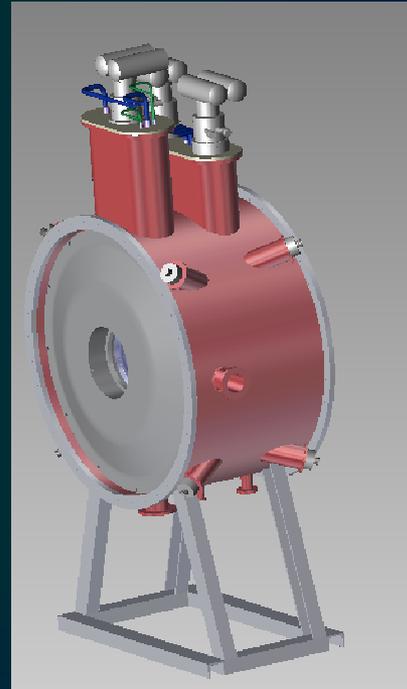
- See M.Zisman's talk

Cooling channel:



Absorber/focus-coil module:

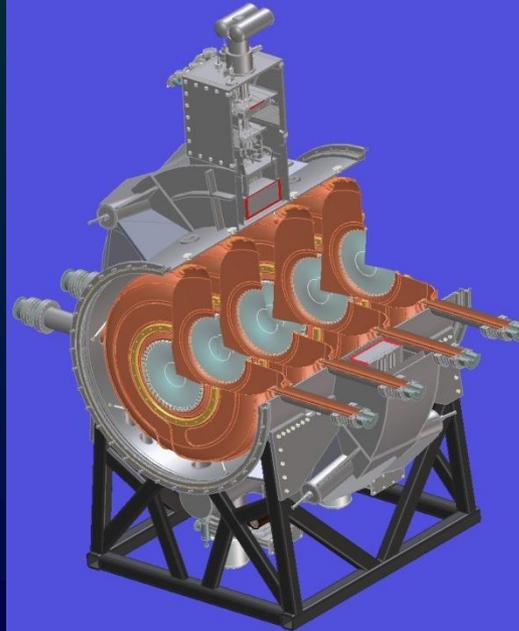
- Focus coil module:
 - Contract awarded to TESLA
 - Presently in 'detailed design' phase:
 - Production Readiness Review passed
 - First payment released to allow procurement
 - First module, Q1 2010
- Absorber:
 - Prototype under test at KEK
 - Production started, delivery will match focus-coil schedule



RF/coupling-coil module:

- Coupling procurement underway:
 - ICST, Harbin in collaboration with LBNL
 - See later contributions
- RF cavity production:
 - Contract let (5 'plus' 5) following successful Production Readiness Review Oct08
 - See later contributions

Winding
test for
CC at Harbin



Design for
RF cavity
module

Issues and schedule:

■ Principal issues:

■ Beam line (and Step I):

■ Target:

- See below ...

■ Decay solenoid (status reported above):

- Diagnosis: heat leak into bore due to lack of MLI on upstream and downstream apertures

- Supported by:

- Quench measurements;
- Enthalpy calculations

- Repair programme presently on schedule

■ Steps II and III:

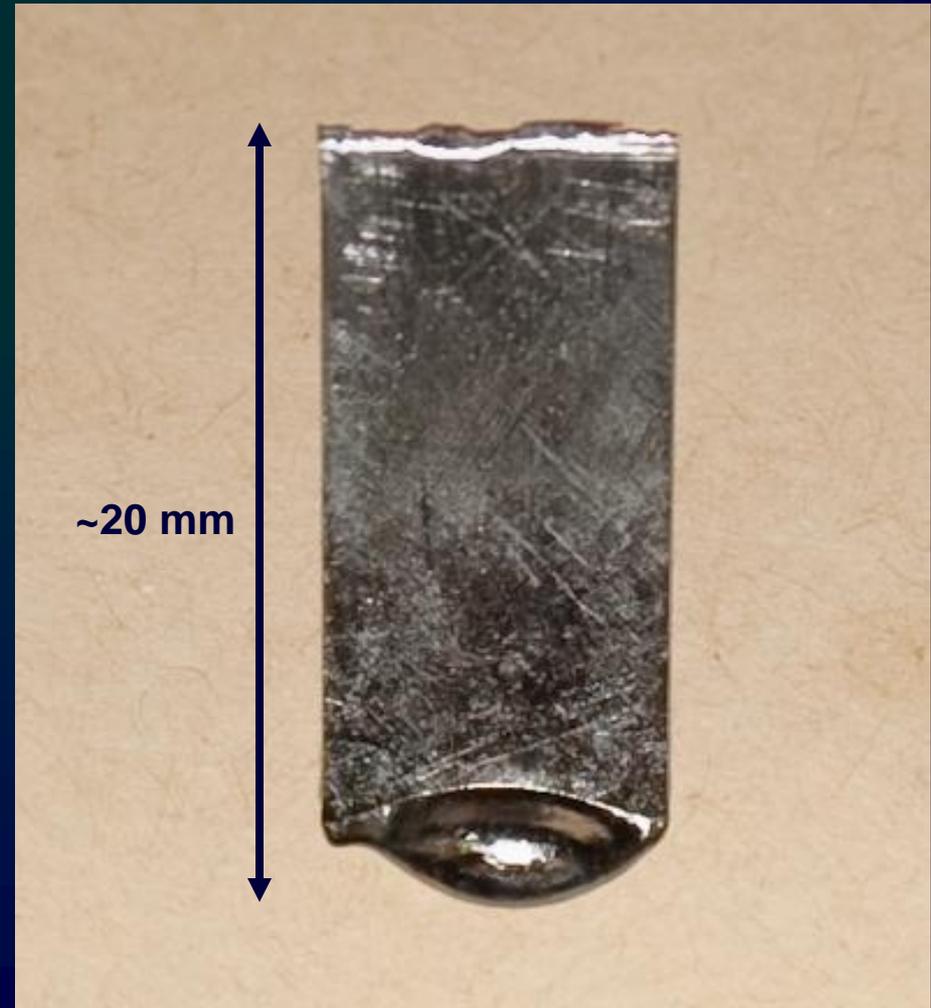
■ Spectrometer solenoid:

- Good progress:

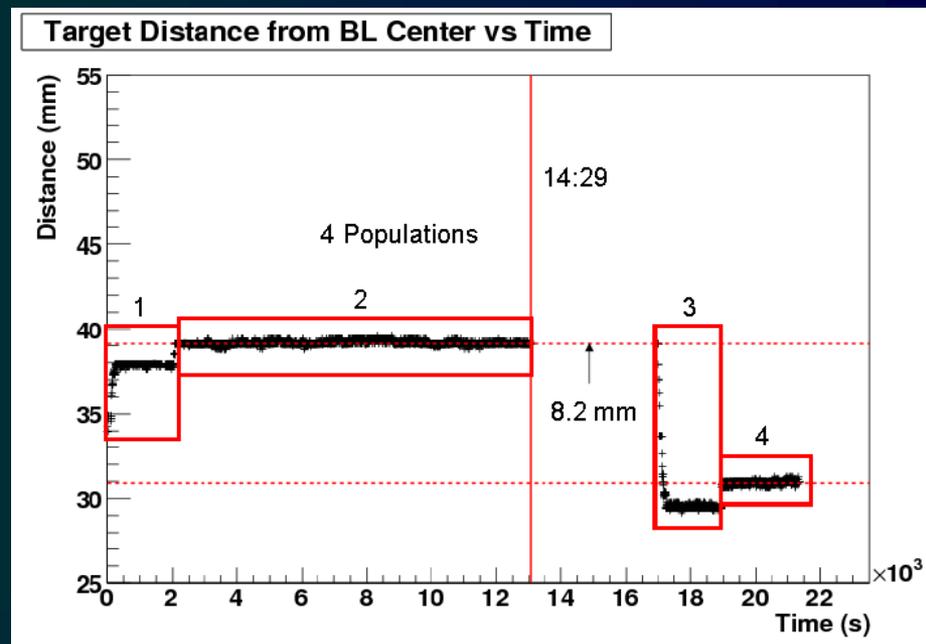
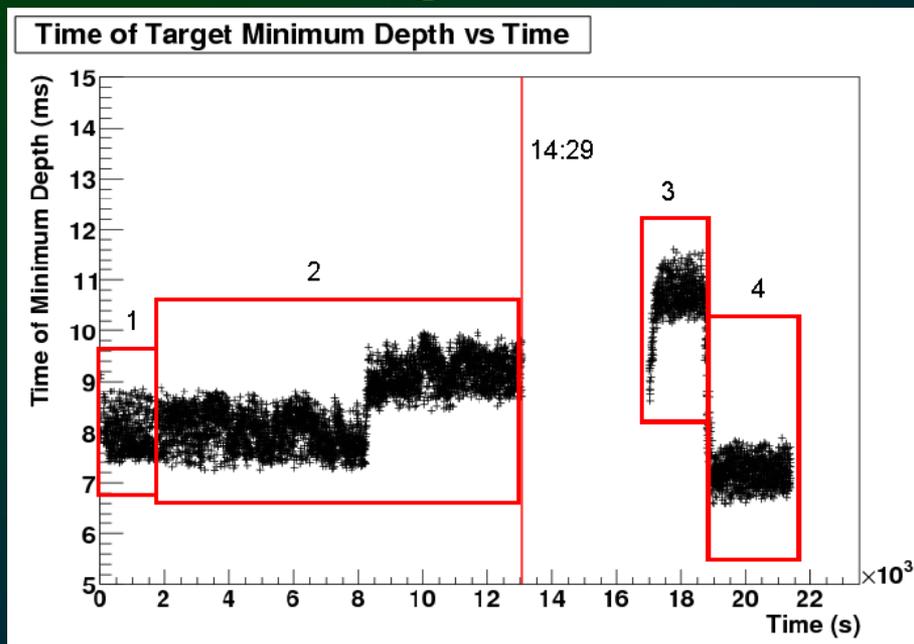
- See D.Kaplan's talk

Target: re-build:

- **Target failures:**
 - Demonstator target in R78 failed at ~340k dips
 - Online target failed (the day before the end of the run!) at ~190k dips
- **Two issues:**
 - Target jammed in bearings
 - Target tip melted



Melting and failures understood:



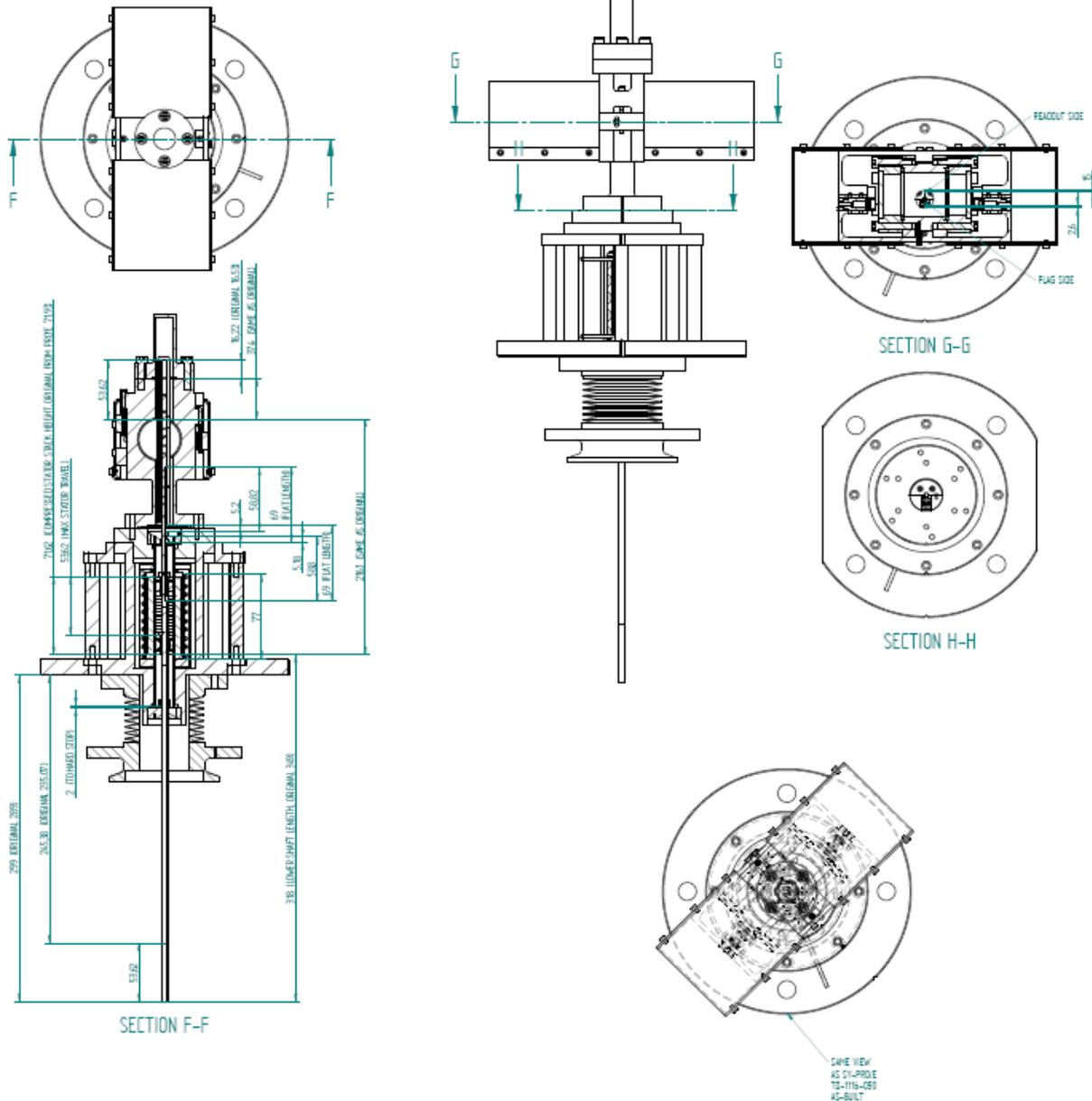
■ Incident on 29Nov08:

- MICE operator error, ISIS operator interlock over-ride, and absence of jacking-frame/'Park' interlock caused target to be placed in beam for more than 12 pulses – caused melting;

■ Failure on 19/20Dec09:

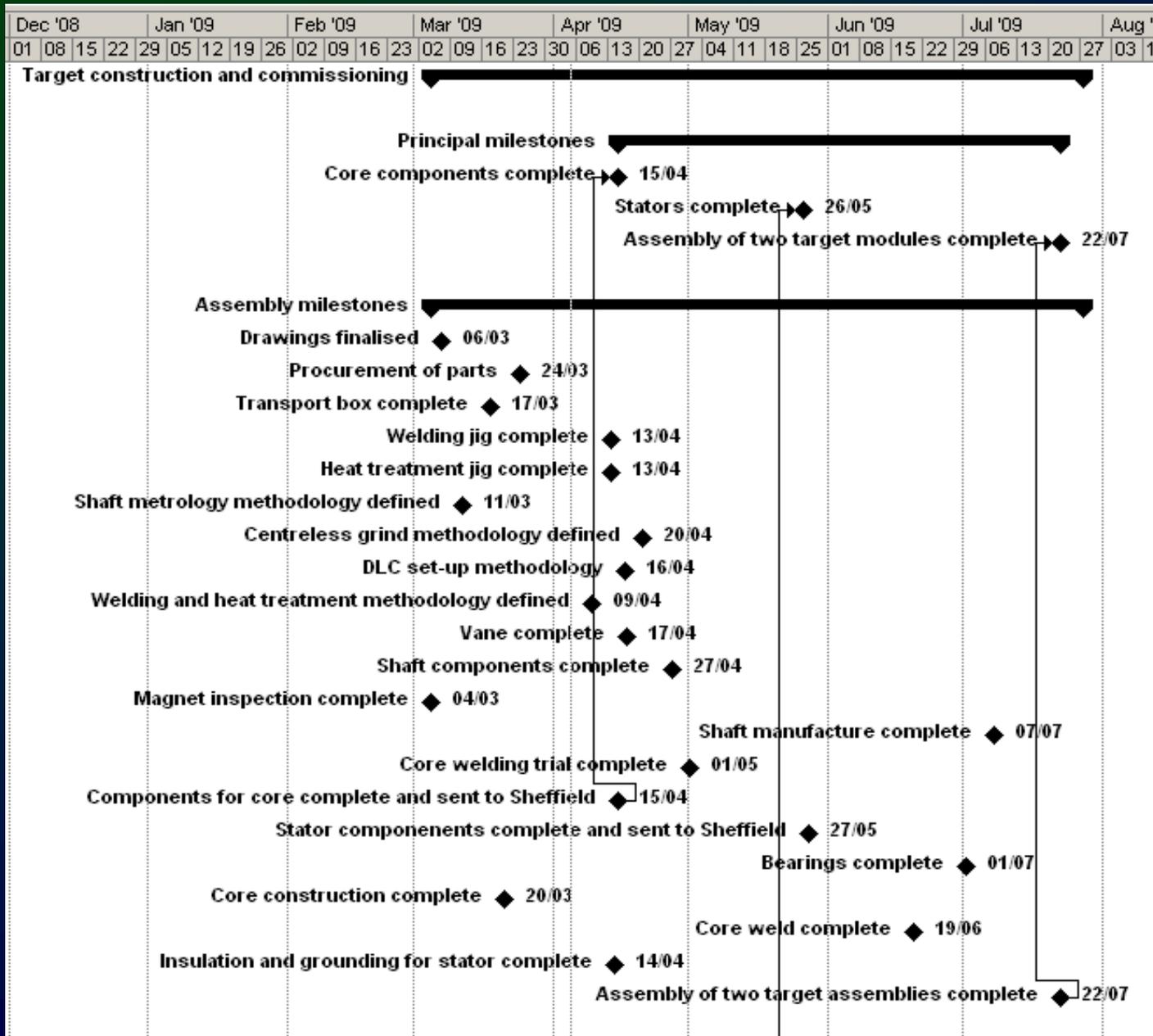
- Permanent-magnet retaining 'spring washer' worked loose causing abrasion and eventual jamming;
 - Calculations in hand to assess likelihood that failure of washer caused by vibration of shaft with asymmetric load due to 'blob'

Target: rebuild:



- Shaft design simplified:
 - 6 mm OD tube:
 - 0.7 mm wall thickness
- Bearing design simplified:
 - Circular bearing faces
- Complication:
 - Shaft must not rotate:
 - Implies anti-rotation feature
- Schedule:
 - In manufacture
 - Goal:
 - New target for April
 - Electronics/control/DAQ upgrade in parallel

Target rebuild schedule:

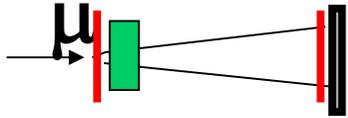


Install in August shutdown ready for September user run

Schedule:

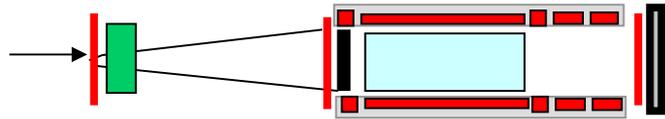
- **Cost and schedule review:**
 - MICE is coming to the end of a detailed cost and schedule review
 - Final result will be presented to the MICE Funding Agency Committee on the 24th April 2009
- **Schedule driven by:**
 - **Step I:**
 - Target rebuild (UK);
 - Assuming decay solenoid repair is satisfactory
 - **Step II:**
 - Delivery of first spectrometer solenoid (US)
 - **Step III:**
 - Delivery of second spectrometer solenoid (US)
 - **Step IV:**
 - Delivery of first focus-coil module (UK)
 - **Step V:**
 - Delivery of first RFCC module (US)
 - **Step VI:**
 - Funding approval for Step VI in the UK

Provisional MICE Schedule as of MUTAC 2009
 (NB cost and schedule under review for F.A.C. on 24 Apr09)



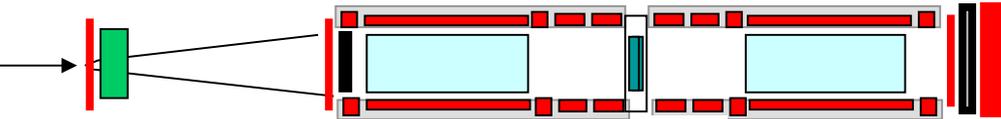
STEP I

fix DS + new target
 Run: Sep09



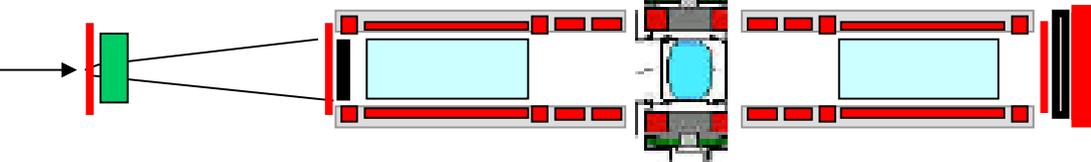
STEP II

Deliv SS-1 Jun09
 Run: Q4 2009



STEP III/III.1

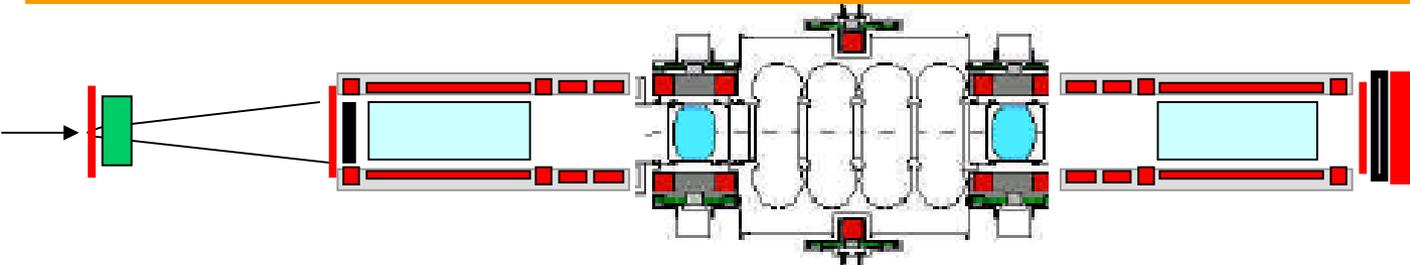
Deliv SS-2 Sep09
 Run: Q1 2010



STEP IV

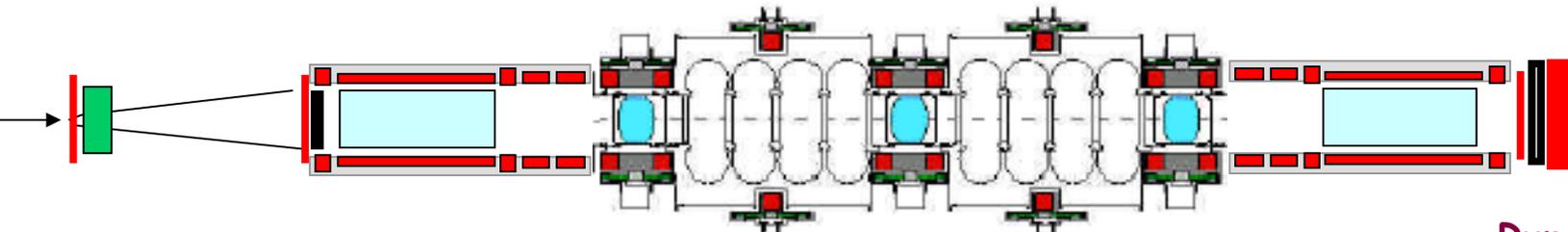
Deliv FC-1 Feb10
 Run: Q2 2010

----- ISIS shut-down (provisional) Aug 2010 - Apr 2011 -----



STEP V

Run: 2011



STEP VI

Run 2011-2012

Professor Alain Blondel
Neutrino Physics Group
Département de Physique
Nucleaire et Corpusculaire
Université de Genève
Quai Ernest-Ansermet 24
CH-1211
Geneve 4
Switzerland& Professor Den Kaplan
Department of Physics
Imperial College London
Prince Consort Road
LONDON SW7 2BZ

Our Ref: JWV/csd/MICE2 2003-10-24

24 October 2003

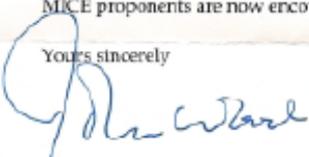
Dear *Alain,*

The last few months have seen the international MICE project proposal peer reviewed at both a national and an international level. The scientific case, technical merits and timeliness of the proposal have been strongly endorsed in each case. CCLRC accepts the strong endorsement of the proposal by the Astbury panel and consequently considers the proposal to have full scientific approval.

Progress of the project is now dependent on satisfactory funding arrangements being in place together with an appropriate project management structure. These arrangements will require scrutiny to ensure "best value" for UK and other investors. Within the UK this will be ensured by an independent review through the "Gateway" process that will be managed by the Joint MICE Project Board.

CCLRC therefore approves the project subject to a satisfactory progress through Gateway. The MICE proponents are now encouraged to actively seek funds to support MICE.

Yours sincerely


Professor J V Wood
Chief ExecutiveCc: Professor Ian Halliday, PPARC
Professor Ken Peach, CCLRC
Dr Andrew Taylor, CCLRC
Professor Richard Wade, PPARC

Step VI:

- Following 'Astbury Panel' report, MICE was awarded 'full scientific approval' by J.Wood on behalf of CCLRC in October 2003
- Resources to provide the UK deliverables for Step VI of MICE rely on the submission of an additional bid
- MICE-UK project milestone for the preparation of this proposal is December 2009

Conclusions:

- **Civil infrastructure for experiment essentially complete**
- **MICE Muon Beam and Step I:**
 - Commissioning of MICE Muon Beam line started in March 2008 and continued through the year
 - Significant improvement in understanding of ISIS/target and particle rate versus beam loss
 - Particle rates measured and Step I instrumentation commissioned
 - Issues (target and decay solenoid) being addressed through energetic programmes
- **MICE Step II-VI:**
 - Detailed plans developed for the installation of the experiment;
 - Component delivery schedules becoming robust and installation team has established track record of timely completion of complicated installation tasks
- **MICE collaboration remains committed to:**
 - Delivering a first measurements with absorber/focus-coil module in 2010;
 - Measurements with MICE Step V in 2011; and
 - Measurements with a full cell of the Study II cooling lattice in 2012
- **An exciting programme!**