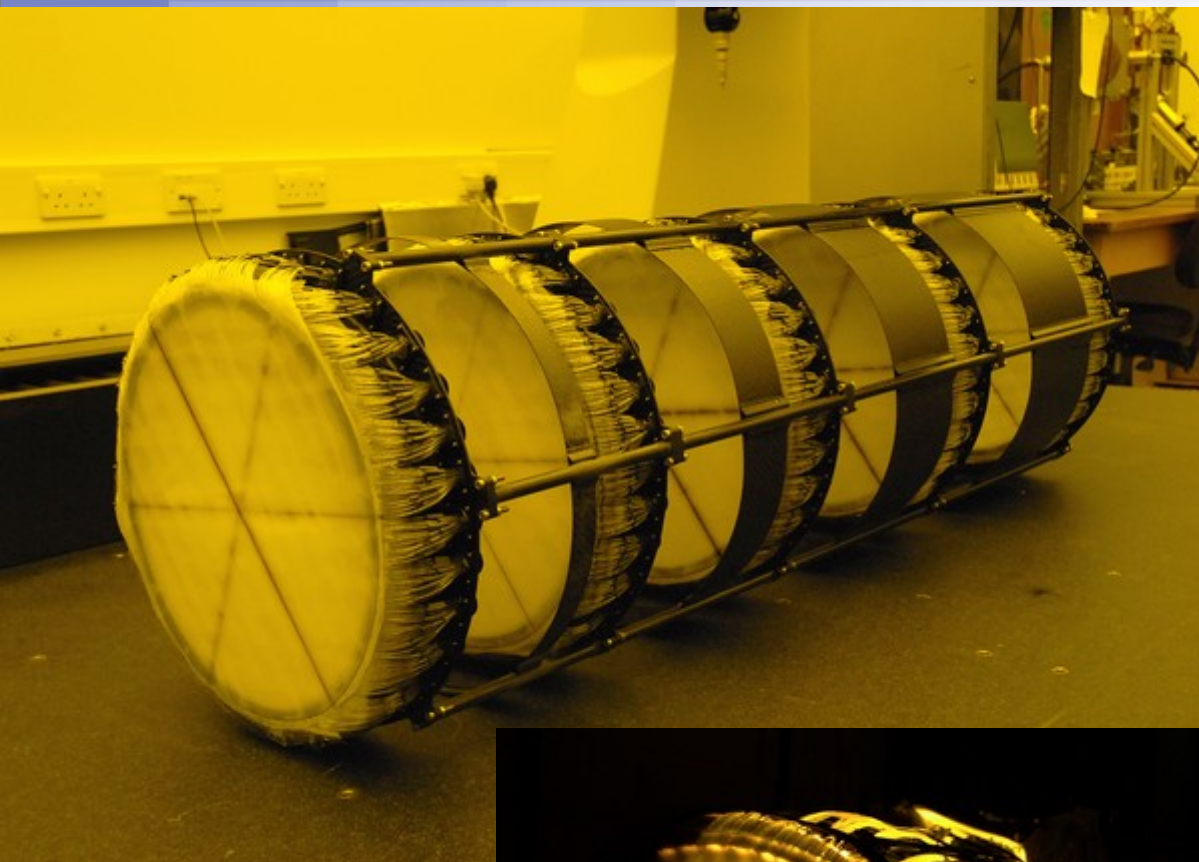
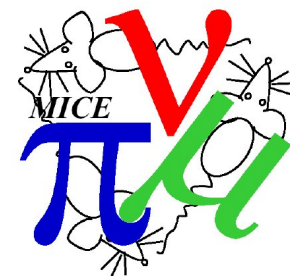


The Tracker

Melissa Uchida

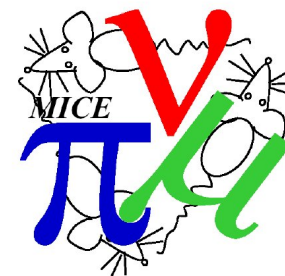
10/7/14

The Trackers

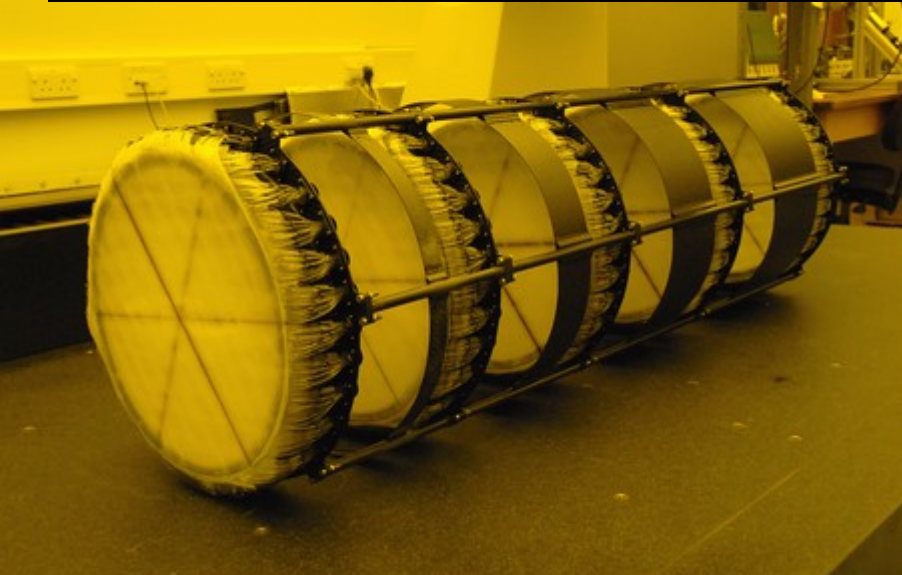


- Two scintillating fibre trackers, one upstream, one downstream of the cooling channel.
- Each within a 4T spectrometer solenoid.
- Each tracker is 110 cm in length and 30 cm in diameter.
- 5 stations per tracker at varying separations in z between 20 and 35 cm.
- LED calibration system.

The Trackers



- 350 μm scintillating fibres are glued into doublet layers with a thickness of 627 μm .
- 7 fibres are grouped into a single readout channel. (This reduces the number of readout channels, while maintaining position resolution)
- 3 doublet layer fibre planes per station, each offset by 120 deg.
- Position resolution of 470 μm per doublet layer.
- Fibres readout by Visible Light Photon Counters, operating at liquid He temperatures.
- Digitised by FPGA based system from D0.



US Tracker Installation Progress

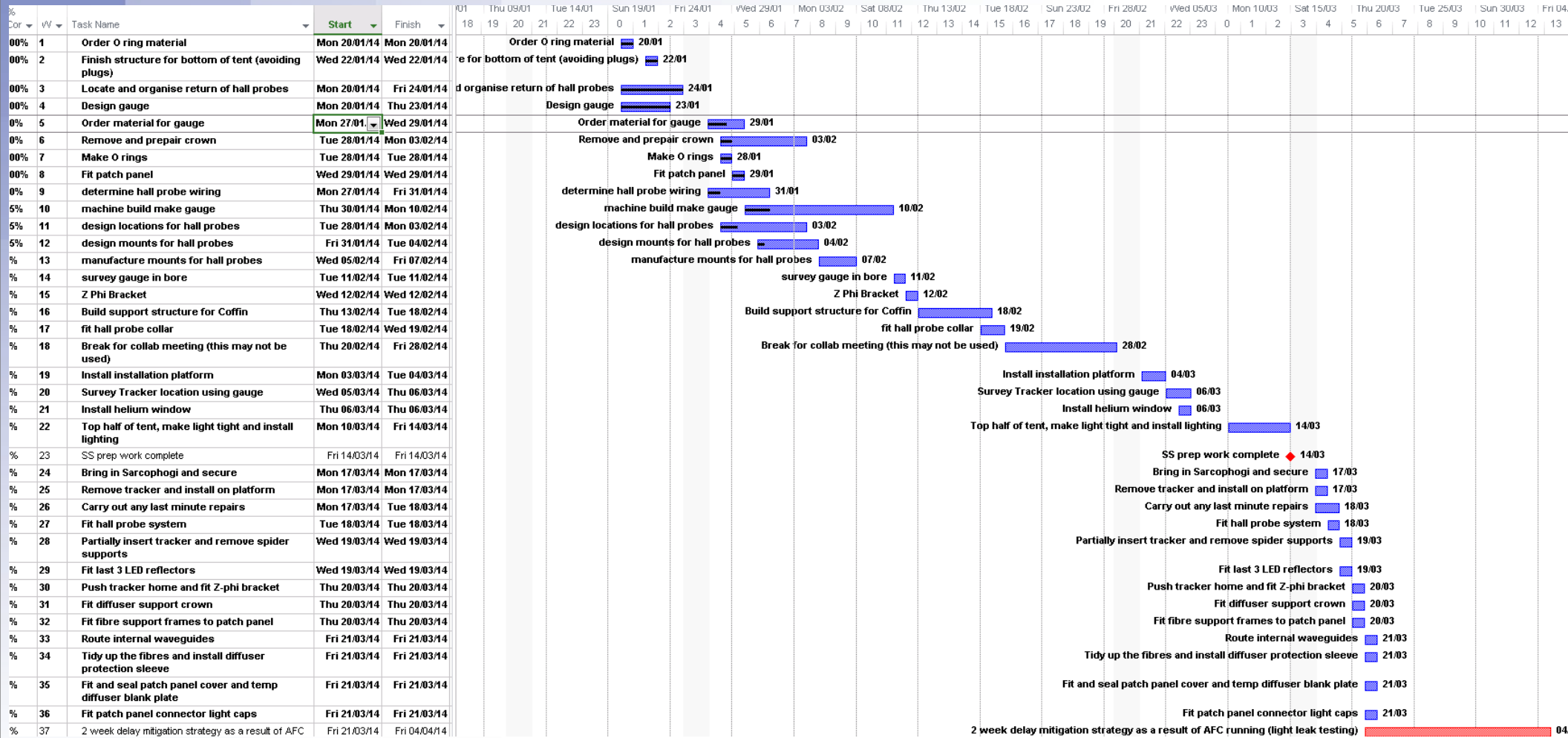
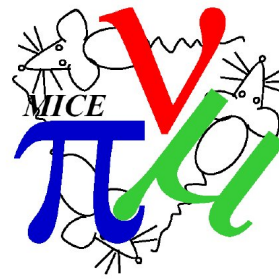


as of CM38

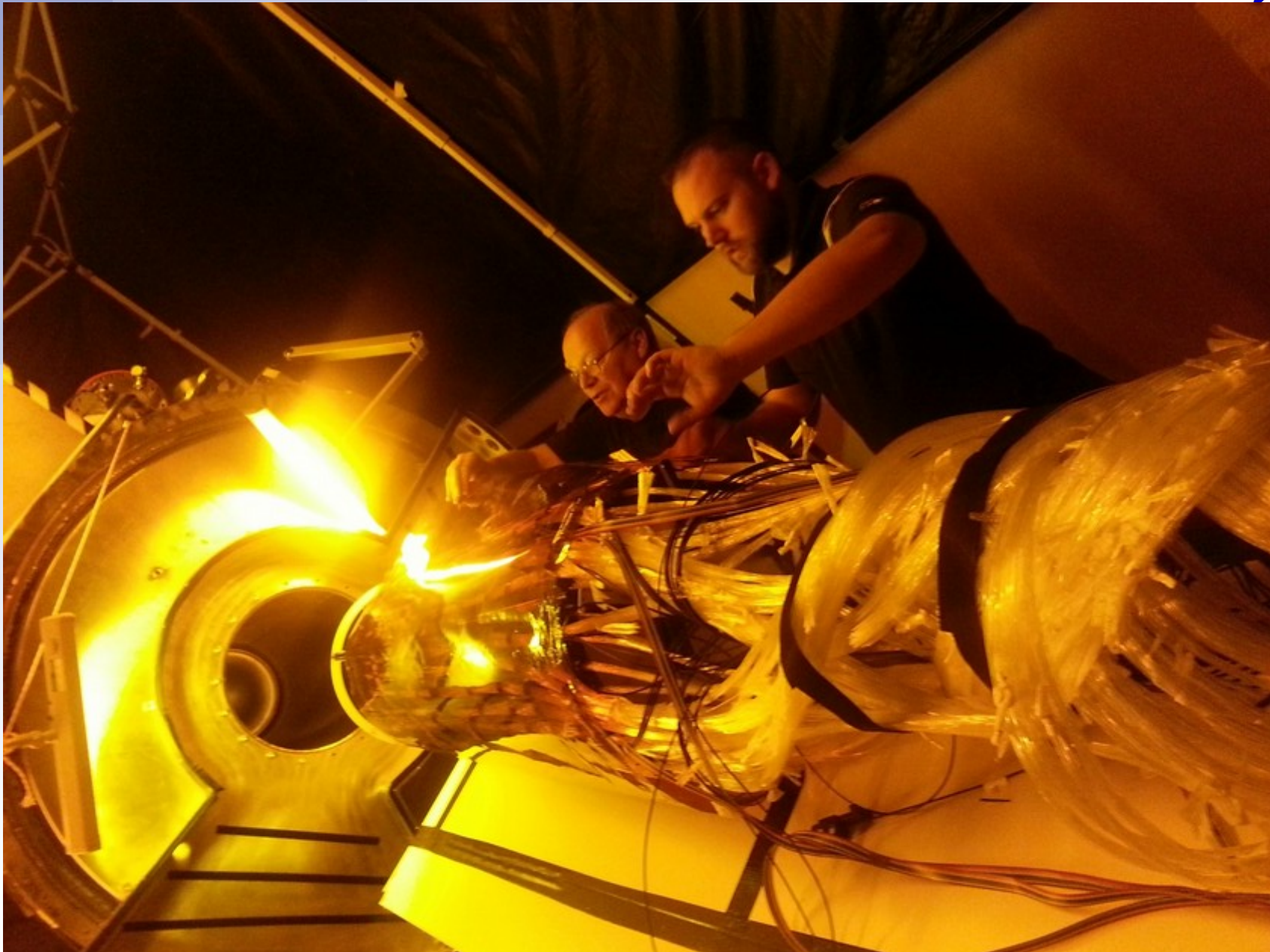
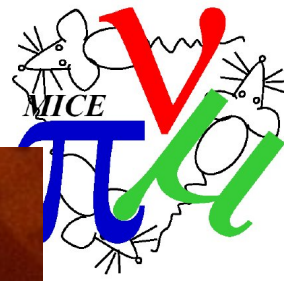


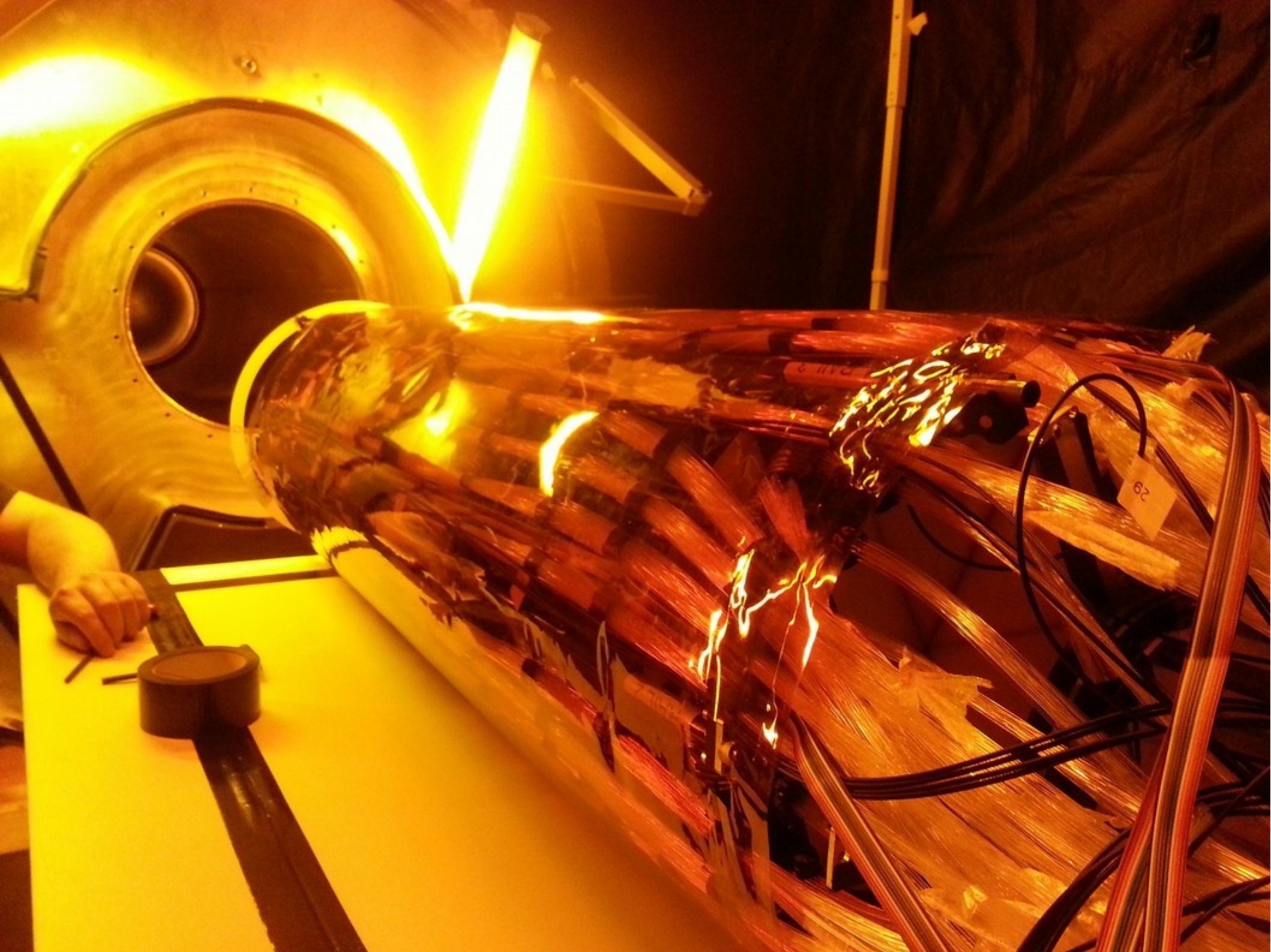
US Tracker Installation complete

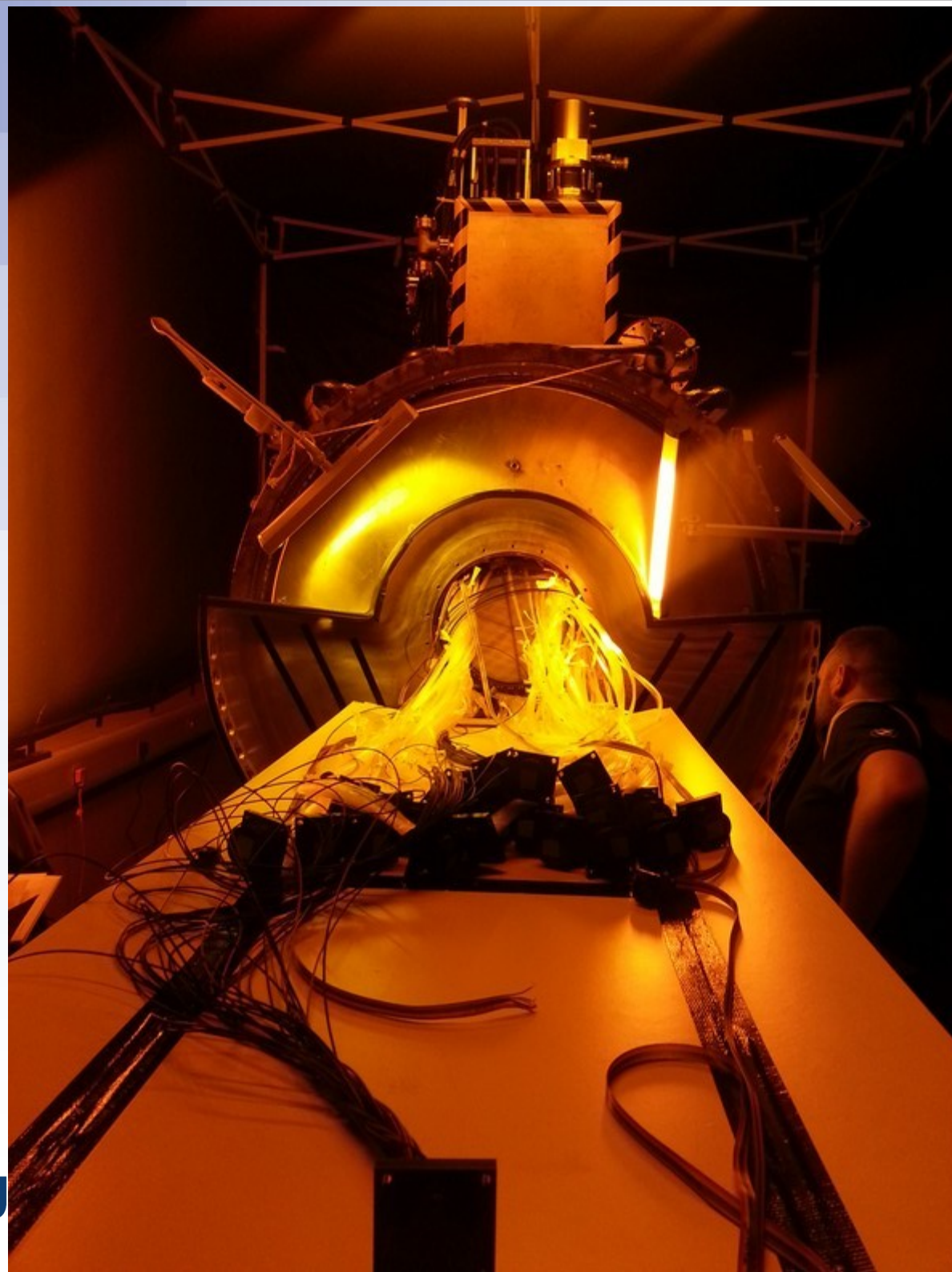
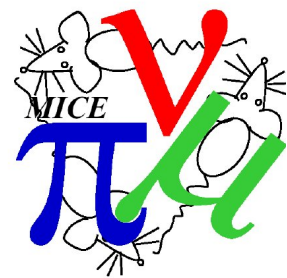
2 Weeks ahead of schedule!

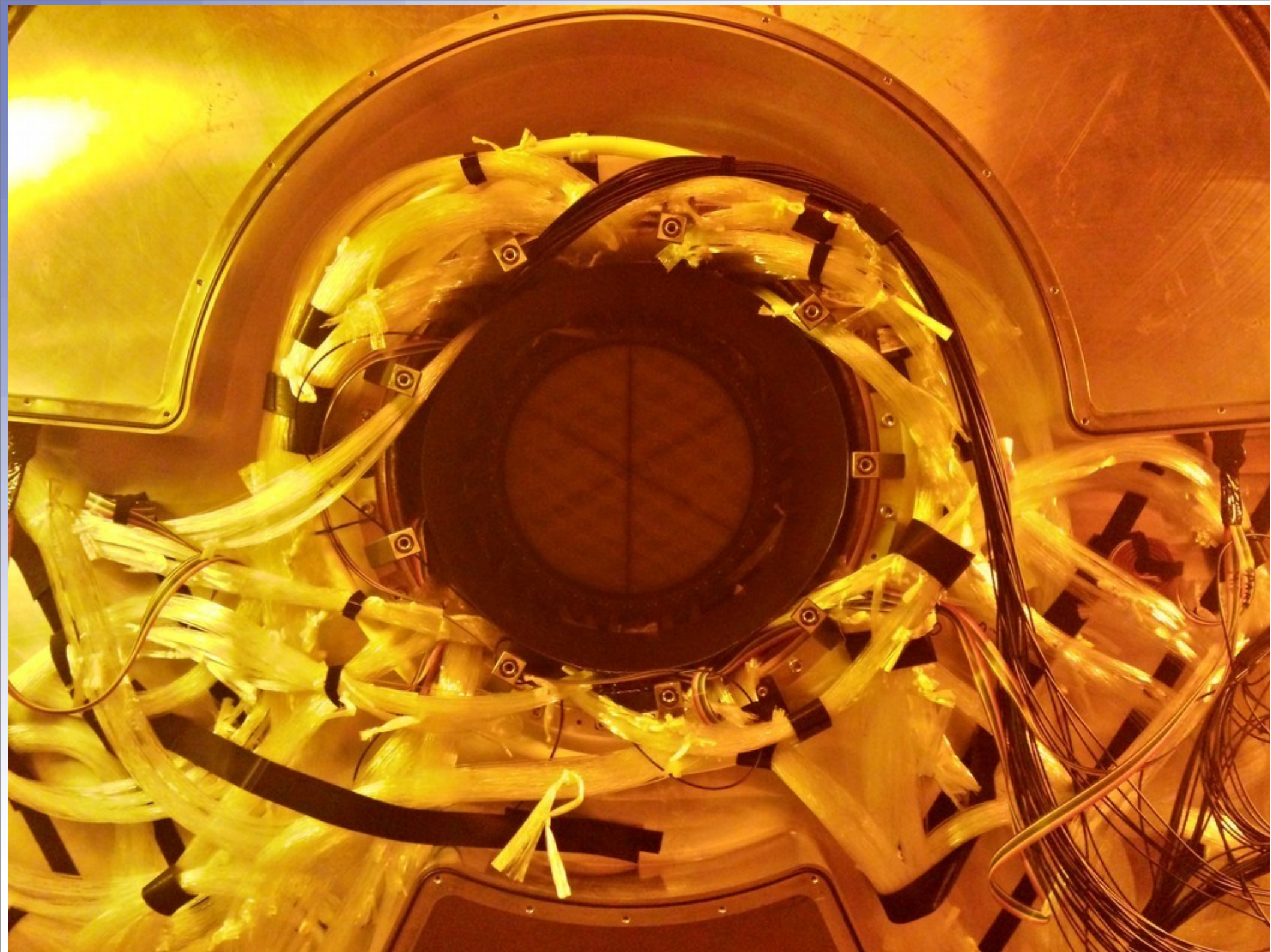


US Tracker installation

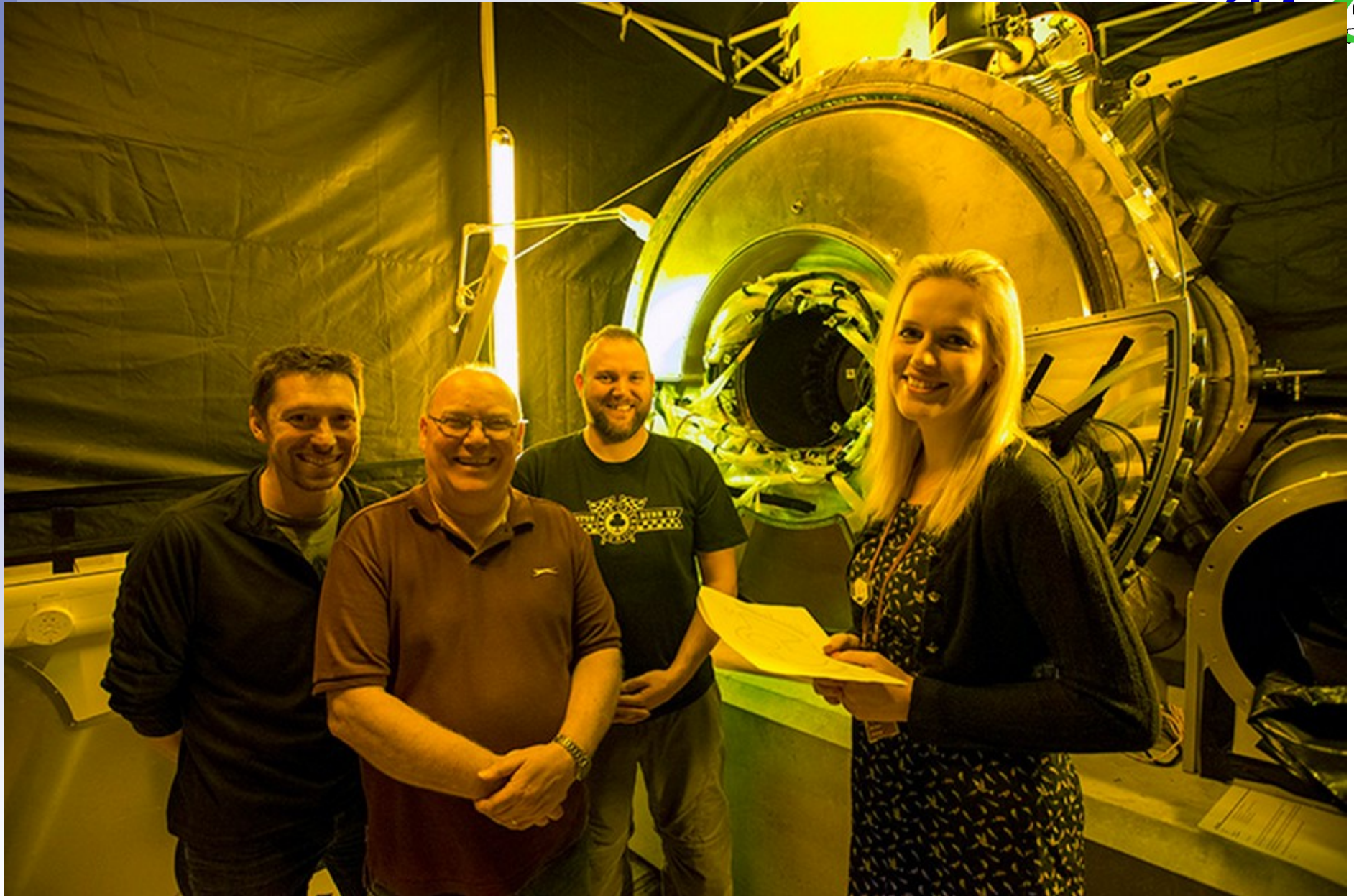




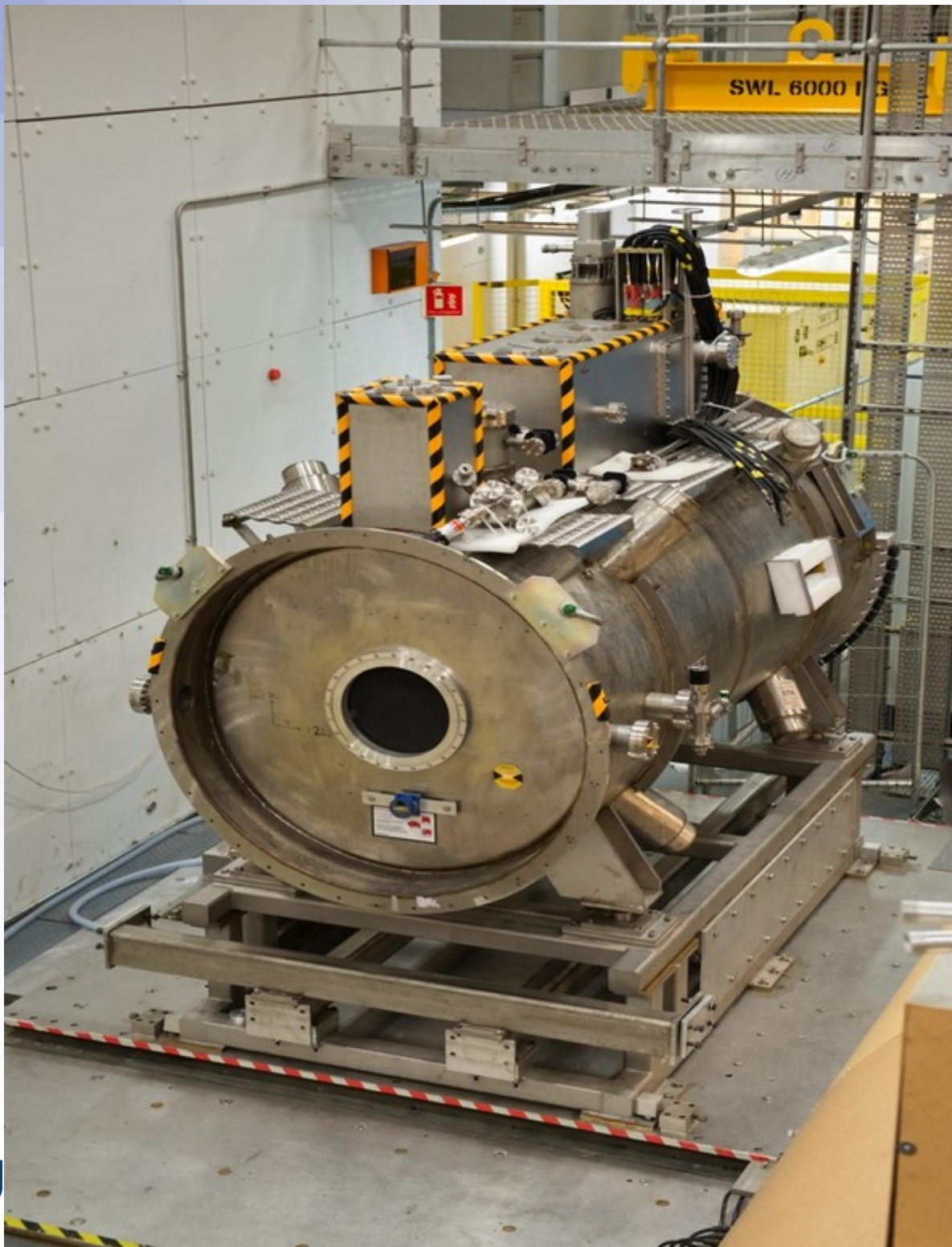
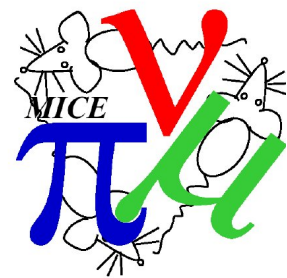




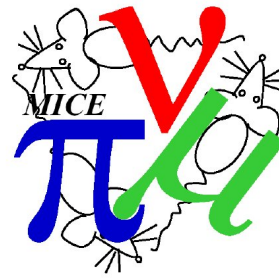
US Tracker installation



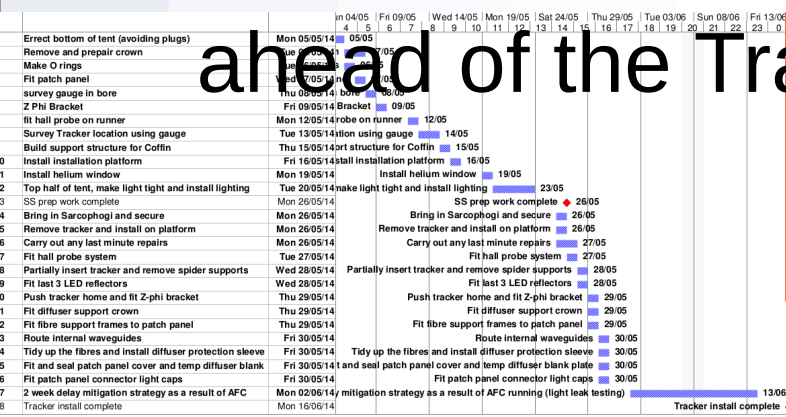




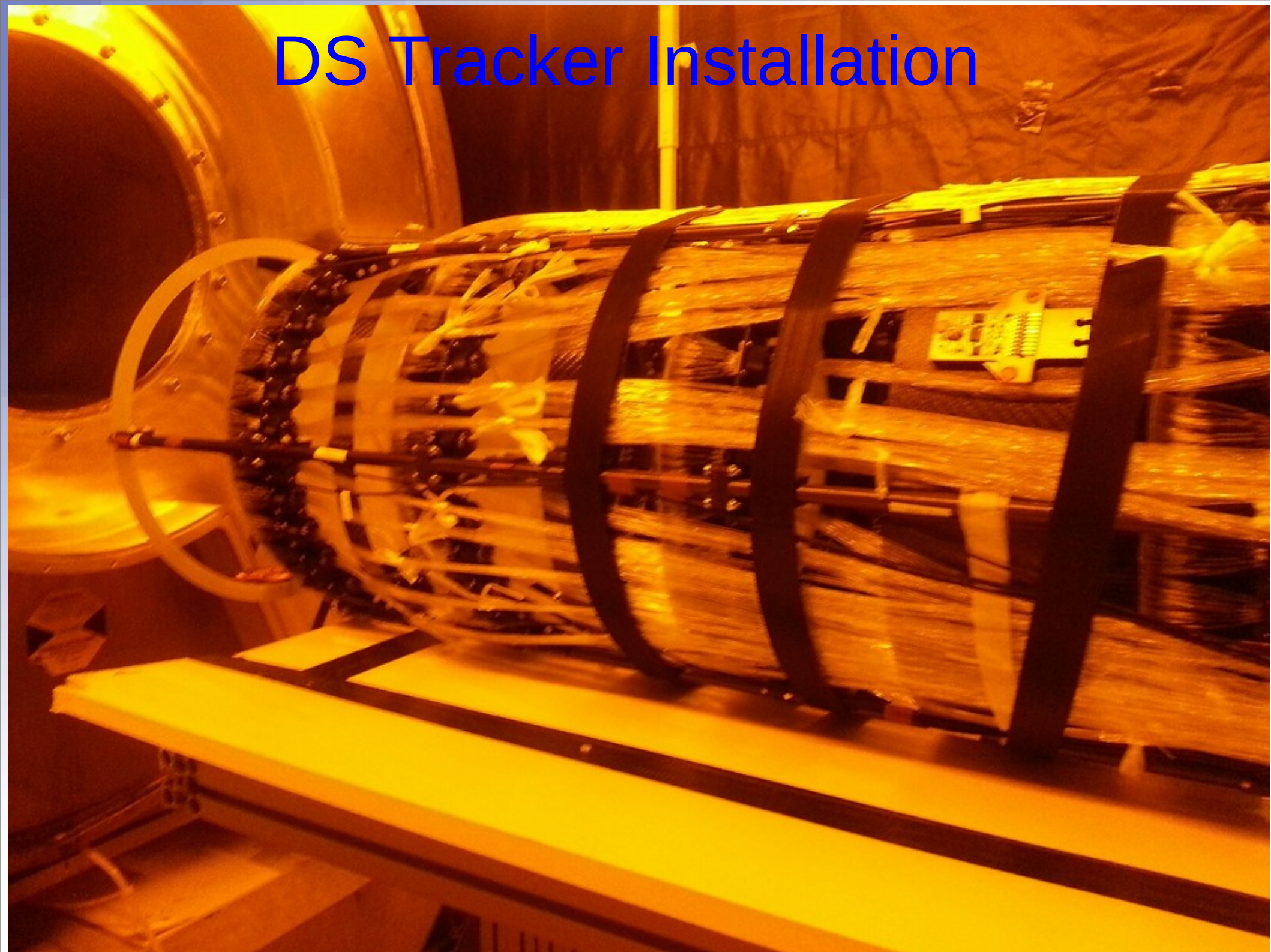
DS Tracker installation



- DS SS arrived on schedule May 2014.
- We have been working around the AFC commissioning and mapping in R9.
- Bore survey will be completed during the CM.
- Tent going up 30th June (will only take 1 day as only partly dismantled).
- Full installation planned for 1st July+.
- Installation will be completed by early July well ahead of the Tracker entering the critical path.



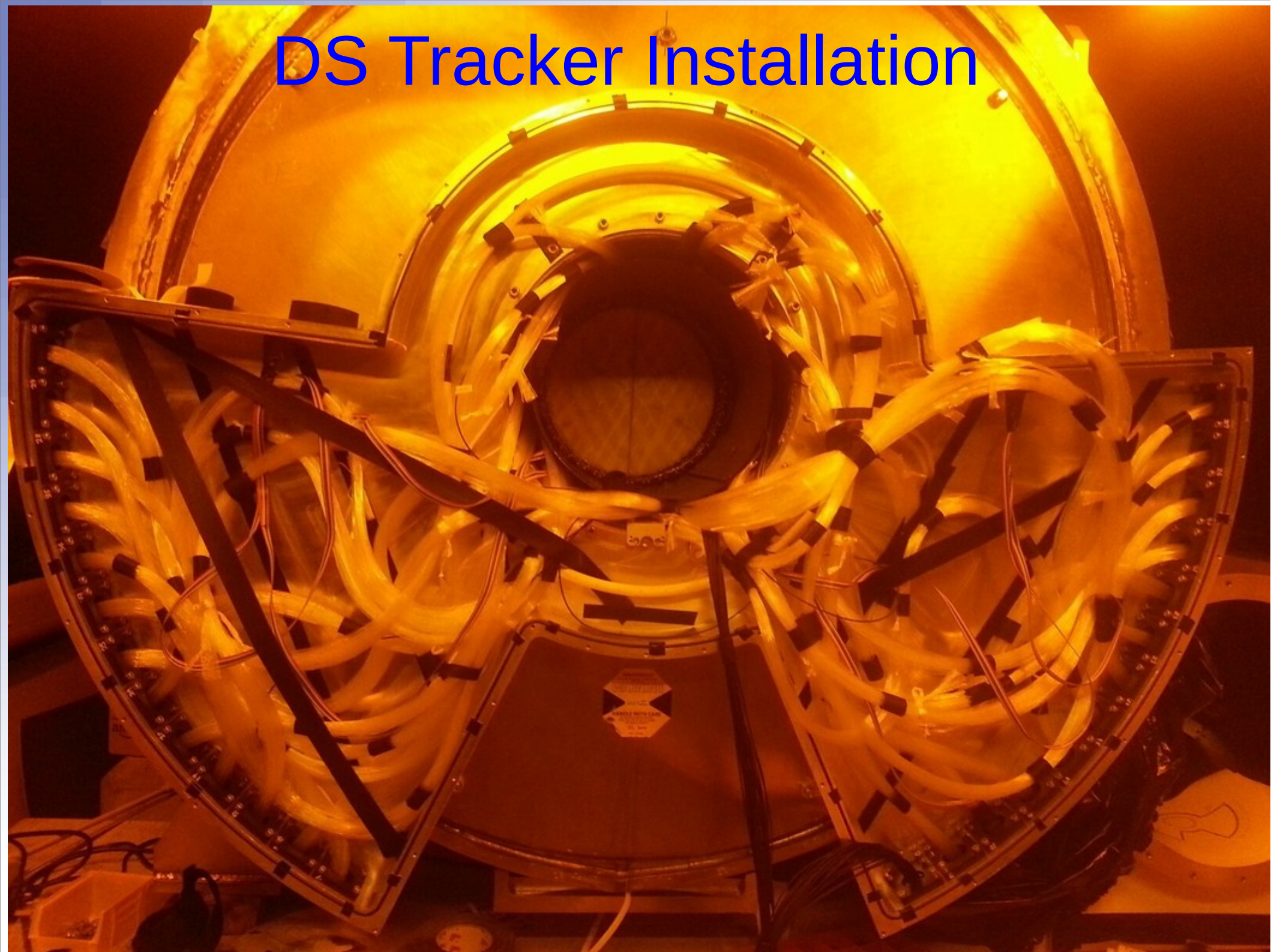
DS Tracker Installation



DS Tracker Installation



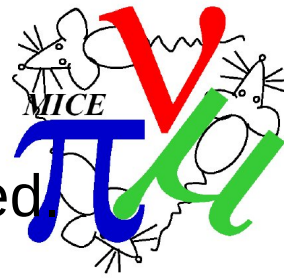
DS Tracker Installation



DS Tracker Installation



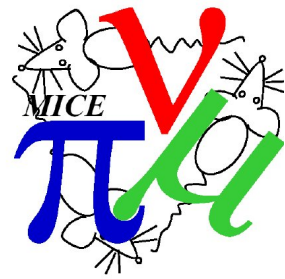
The Trackers



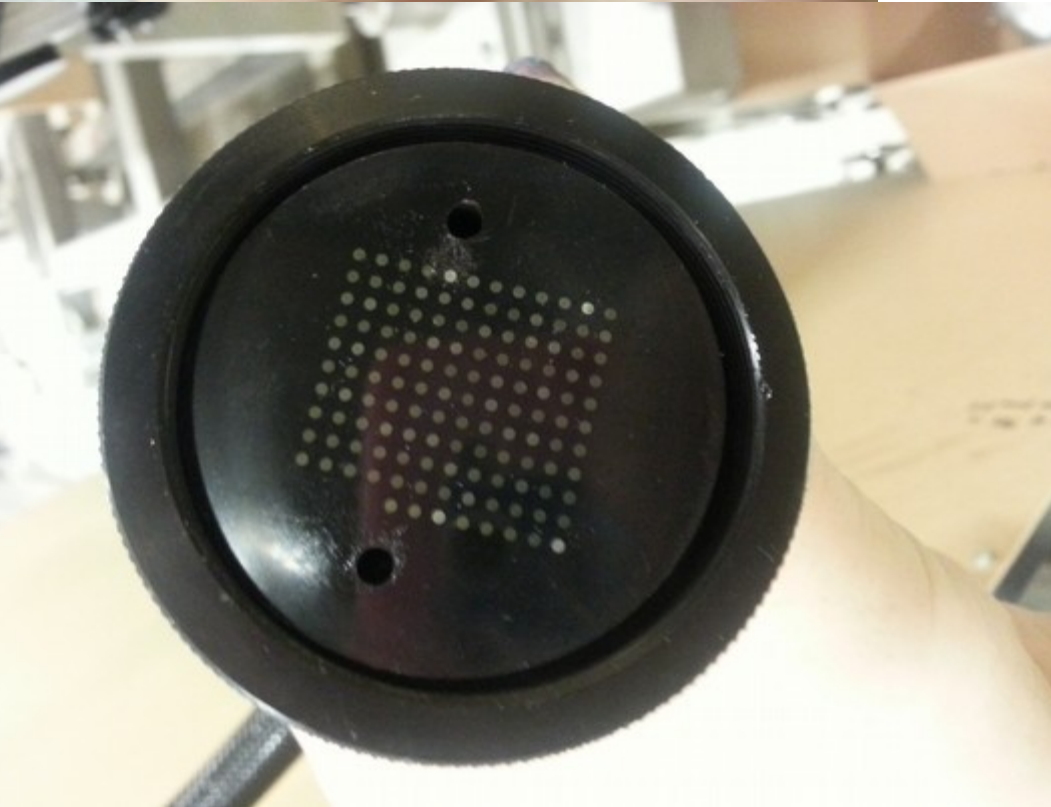
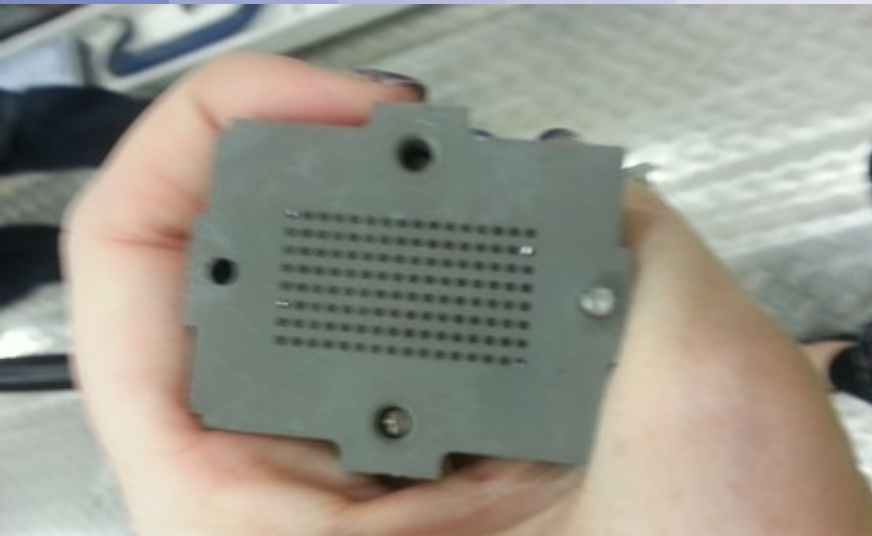
- The trackers are built, well understood and fully cosmics tested.
- Recent new additions to the tracker modules are:
 - The LED system (for calibration)
 - Hall probes for magnetic field monitoring
 - Full documentation available.
- Installation of SSU and SSD complete ahead of schedule.
- DSS (DS SS) was found to have a leak.
 - from the helium system into the insulating vacuum of 1×10^{-6} mbar/L/s.
 - When both systems were under vacuum there was only one small leak on the window of 5.5×10^{-8} mbar/L/s.
 - The leak rate also was very stable indicating there were no trapped volumes making the readings spike. Also when filling the helium system again was a steady rise to a very stable reading, indicating there was not a release of trapped volumes due to movement.
 - The situation is currently being analysed and we will comment more when we have it.

Lightguide Fibre QA

The Lightguides

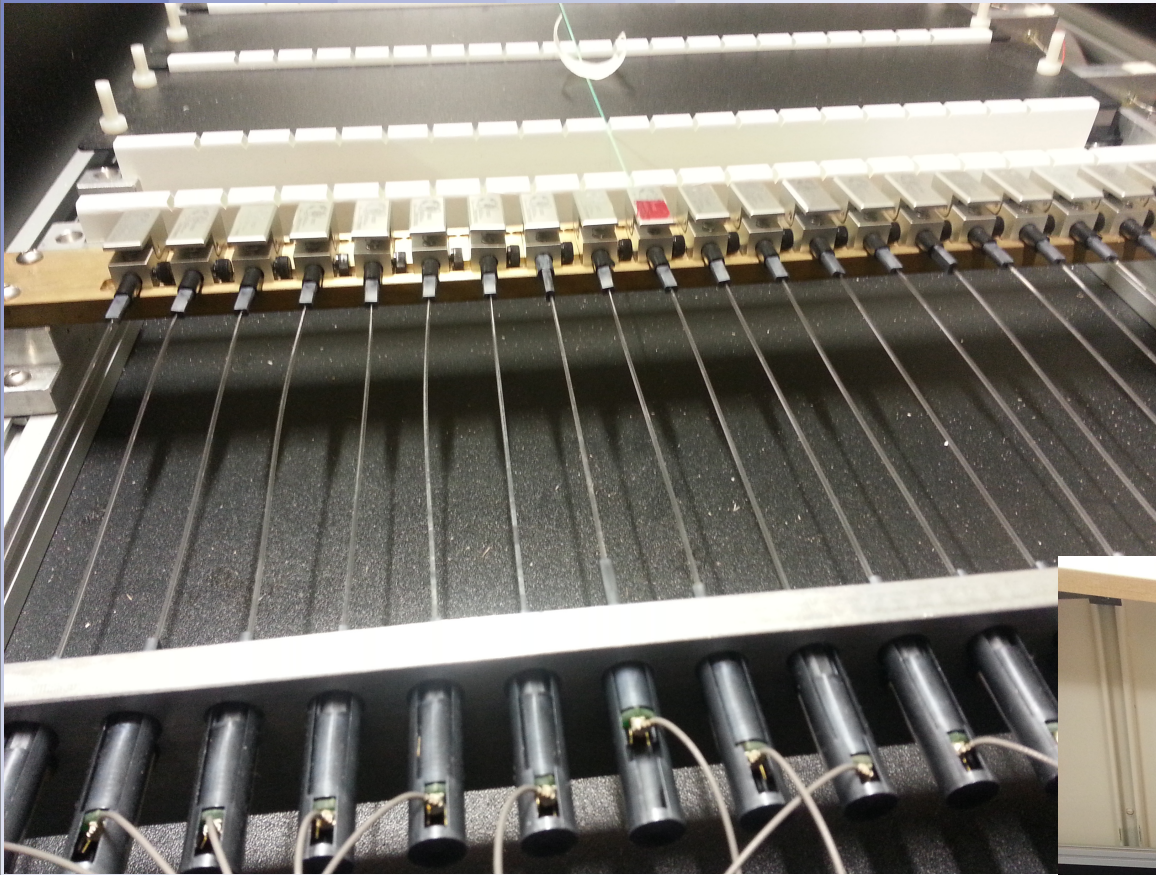
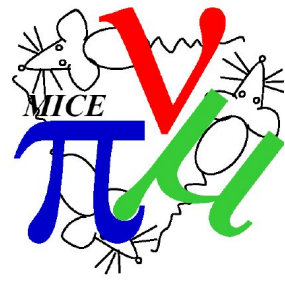


- All fibres transmit light
- ~3/128 show signs of damage
- Effect likely due to cracks
- Extent of impact on light yield unknown – Purpose of QA

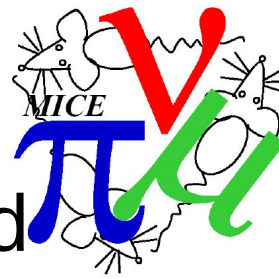


Lightguide Fibre QA

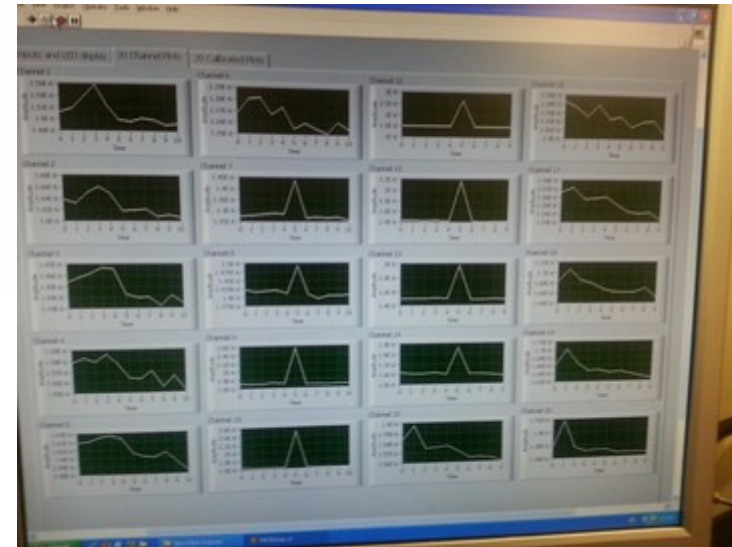
The Scanner



Lightguide Fibre QA



- We have a scanner that is well understood and being adapted.



- Fibre QA calibration, software development and planning this week and running early September.
- In case any major problems are discovered (at any point) we have a plan in place for production of spare lightguides.

Update
from
Craig

R1 Tracker cryostat service lab

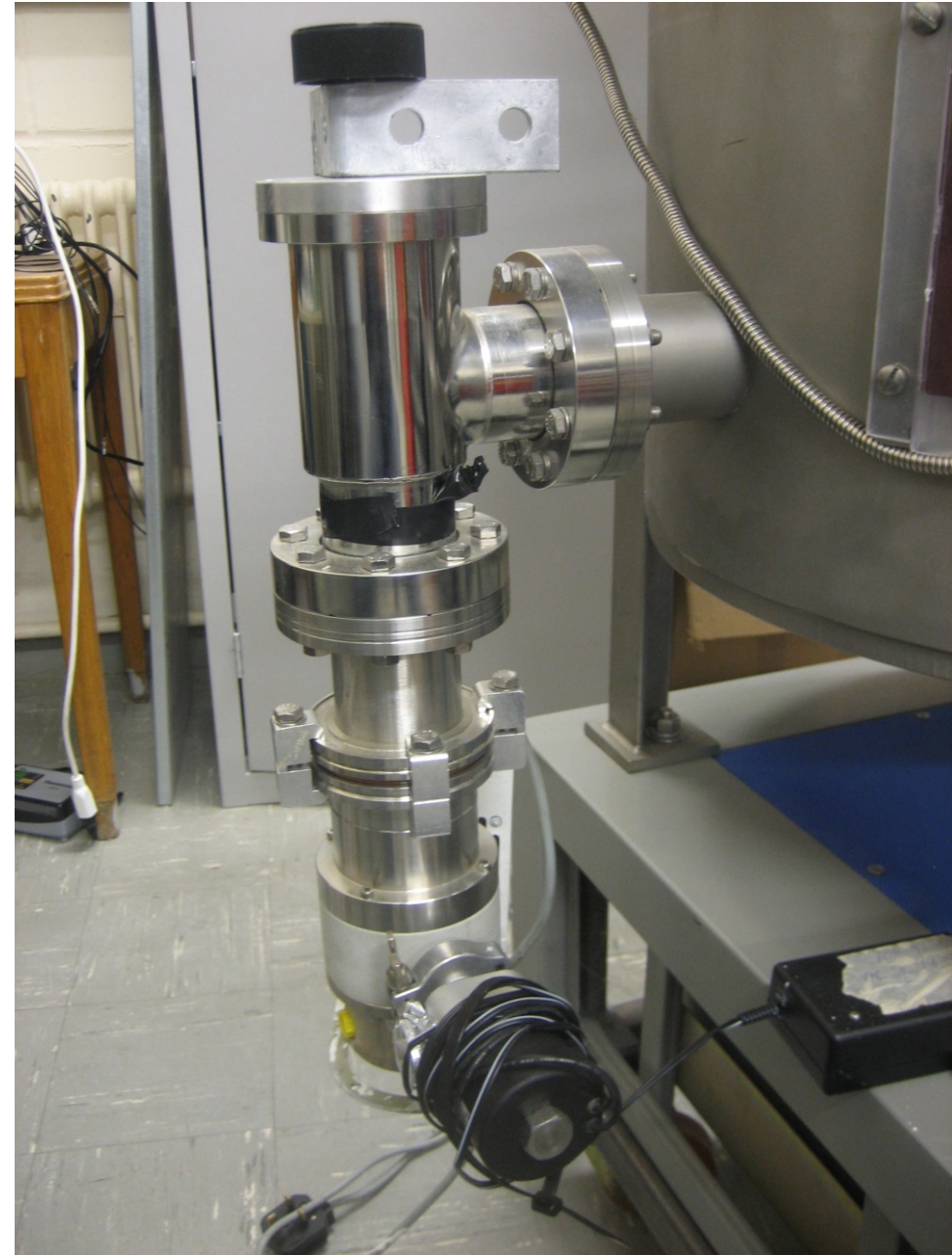
- Virtually all tracker equipment now gathered together and organised in here
- Arranged for He line and compressor hose tray to be run into lab from R9 for maintenance work
- Now have small He and N gas bottles in stock for checking vac system
- Main areas of preparation are Vacuum, Cryogenics and Electronics



Update
from
Craig

Vacuum system

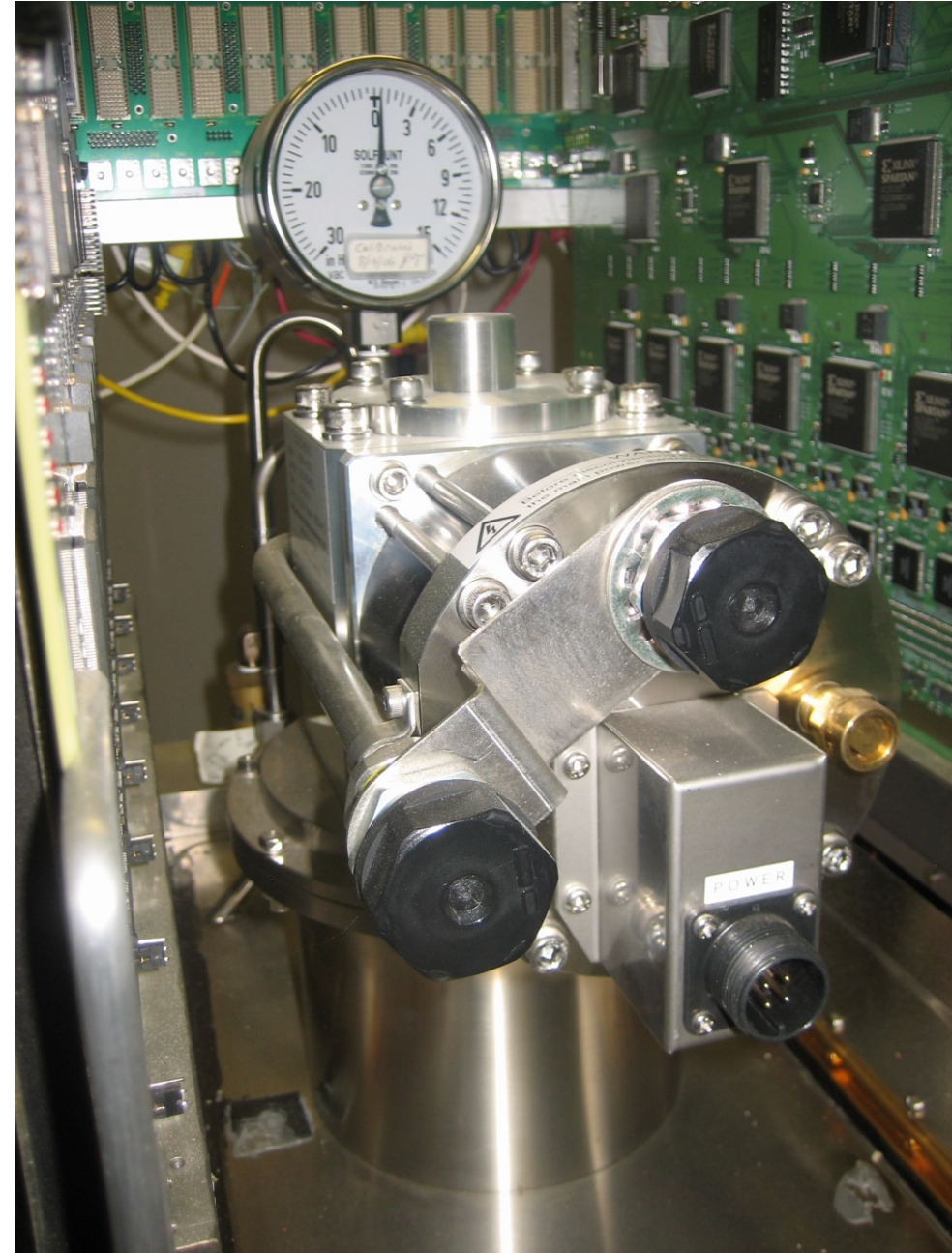
- Have replaced broken manual valve on cryostat1
- Replacing all old Pfeiffer turbos for new Leybold SL80 models with close coupled controller
- Checking Insulating vacuum and VLPC cassette integrity with pump down test
- Checking CCG vac gauge operation and cleaning if necessary
- Replacing condensate sensors for new more reliable model



Update
from
Craig

Cryogenic system

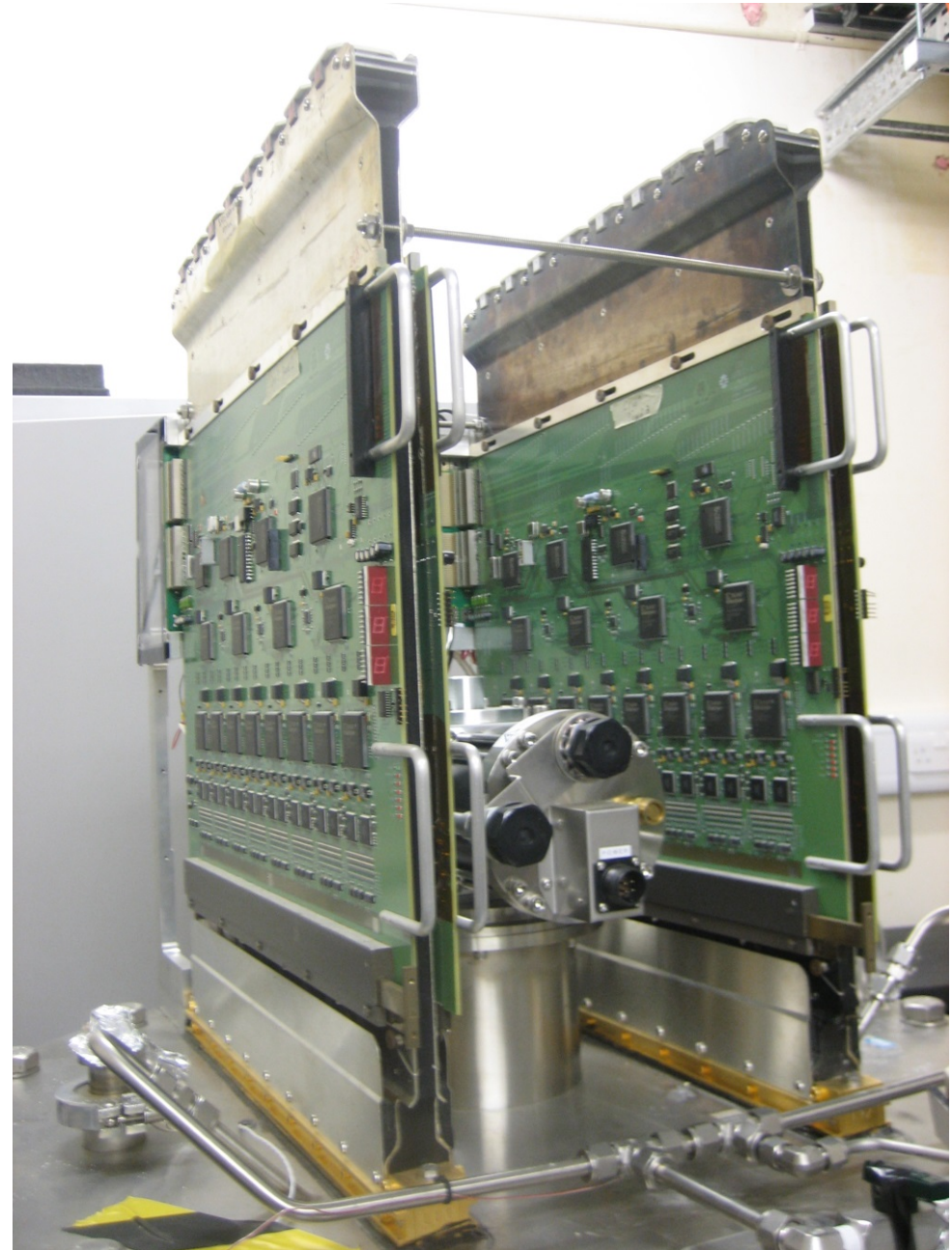
- Compressor adsorber change and cold head swap out booked for July/August service
- Ordered 8 x 10M extension lengths for Helium flexlines. Exp end of July
- We will not cool the cryostats in lab as every temperature cycle increases risk of cassette seal leaks
- Aim to get cryostats prepared in the lab for deployment to hall around end of Sept. This allows plenty of time to cool the cryostats and deal with any problems

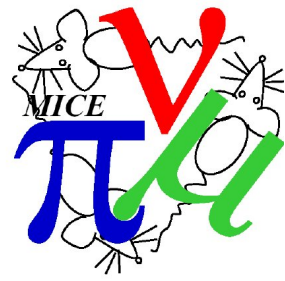


Update
from
Craig

Electronics

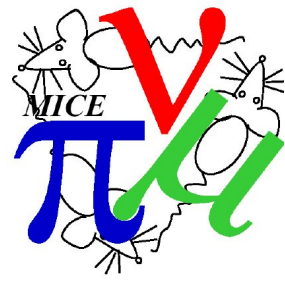
- David Adey visit first 2 weeks Sept.
- Test AFE boards & spares
- Check slow controls software
- Check DAQ software
- Test all the VME rack equipment
- Could do LED signal injection tests?
- Discussion and planning of cable runs
- Discussion of forthcoming calibration/commissioning tests we'll need to carry out in the hall





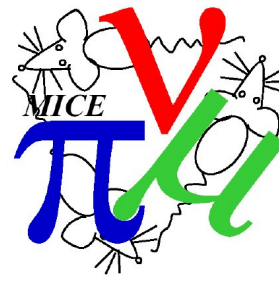
Tracker Software

Software since last CM



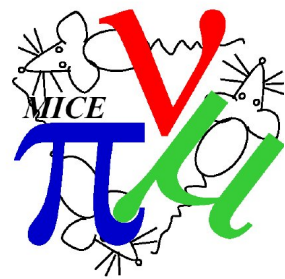
- Excellent results from emittance recon—MC study by C. Hunt, agreement 0.05% upstream deviation, 0.03% downstream deviation.
- Single particle amplitudes also show strong agreement.
- More work is needed to make this a more realistic determination of performance e.g. by adding noise, ADC smearing, etc
- Online plots under are defined, agreed and development.
- New API removing JSON string layer now implemented for tracker.
- Integration test improvements - pattern recognition and Kalman now covered by looking at chi sq histogram properties.
- There are some geometry, Calibration and CDB issues ongoing.

Conclusions



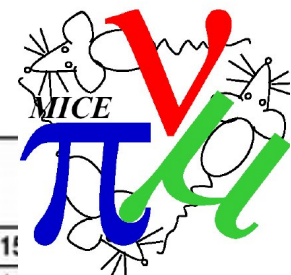
- Tracker installation of US SS completed ahead of schedule.
- USS and Tracker 2 installed in MICE hall.
- DSS arrived May 2014.
- DSS and Tracker 1 installed ahead of schedule.
- Hall installation and detector commissioning schedule competed and we are already working through it.
- Step IV readiness plan understood for some time.
- Fibre QA has started (calibration rise) and full testing planned for September.

Tracker Commissioning Plan



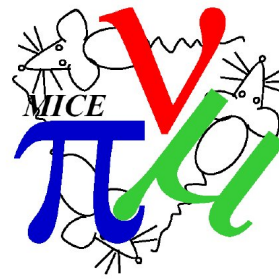
Make LED Calibration boxes			Mon 12/05/14	Mon 19/05/14
Construct 2nd LED box (Drill box, pot fibres & PCB and Solder)			Mon 12/05/14	Tue 13/05/14
34	0%	Polish 2 sets (Qty20) of LED fibres in small connectors	Mon 12/05/14	Mon 12/05/14
35	0%	Pot & Polish 2x10 sets of LED fibres in PP connectors	Tue 13/05/14	Tue 13/05/14
36	0%	Cable up LED box in hall (VME, ethernet, fibres)	Wed 14/05/14	Wed 14/05/14
37	0%	LED box hardware & software debug (as not used before!)	Thu 15/05/14	Fri 16/05/14
38	0%	Run LED calibration with PMT?	Mon 19/05/14	Mon 19/05/14
39	0%	Upstream SpecSol offline activities in hall	Thu 01/05/14	Thu 15/05/14
40	0%	Plan Offline LED Calibration test with PMT?	Mon 12/05/14	Mon 12/05/14
41	✓ 100%	Upstream SpecSol placed in Offline position in hall	Mon 05/05/14	Mon 05/05/14
42	0%	Carry out Offline LED calibration test?	Tue 20/05/14	Mon 26/05/14
43	0%	Trial connect and reform south side external waveguides?	Mon 05/05/14	Mon 05/05/14
44	0%	Compressors in hall	Mon 01/09/14	Mon 20/10/14
45	☰ 0%	3 phase mains connections at compressor positions in place?	Mon 01/09/14	Mon 01/09/14
46	☰ 0%	Chilled water piping & flowmeters at compressor positions in place?	Mon 01/09/14	Mon 01/09/14
47	☰ 0%	Framework in place for stack of two compressors	Mon 01/09/14	Mon 01/09/14
48	0%	Move compressors to hall and place in position	Mon 01/09/14	Mon 01/09/14
49	☰ 0%	Connect chilled water & mains	Tue 02/09/14	Wed 03/09/14
50	0%	Run Helium lines (30M) from compressors to cryostat (S & N separately?)	Thu 04/09/14	Wed 15/10/14
51	0%	Run electrical line (30M) from compressors to cryostat (S & N separately?)	Thu 04/09/14	Thu 04/09/14
52	0%	Connect compressors to DL interface box	Tue 02/09/14	Tue 02/09/14
53	0%	Leak test system (S & N separately)	Thu 16/10/14	Mon 20/10/14
54	0%	DL Tracker cryostat interface box (Interlocks)	Mon 12/05/14	Tue 04/11/14
55	0%	DL Tracker cryostat interface box in place in RR2?	Mon 12/05/14	Mon 12/05/14
56	0%	Connect up smoke detector sensing pipework	Fri 24/10/14	Mon 27/10/14
57	0%	Commission Vesda smoke detector in situ	Tue 28/10/14	Wed 29/10/14
58	0%	Get Vesda system officially commissioned & accreditation test	Thu 30/10/14	Fri 31/10/14
59	0%	Connect Vesda system alarm relay to DL interface box	Mon 03/11/14	Mon 03/11/14
60	0%	Connect 115V transformer to Lid Heater box	Thu 23/10/14	Thu 23/10/14
61	0%	Connect up Lid Heater outputs to DL interface box	Fri 24/10/14	Fri 24/10/14
62	0%	Connect up Oxford ITC503 to RS232 via Ethernet to DL interface box	Tue 04/11/14	Tue 04/11/14
63	0%	Connect Wiener (AFE) mains supply to DL interface box	Fri 24/10/14	Fri 24/10/14
64	0%	Use Wiener mains interlock TTL signal?	Mon 12/05/14	Mon 12/05/14
65	0%	Connect phone dialler?	Mon 12/05/14	Mon 12/05/14
66	0%	Tracker racks in hall (require both for N or S operation)	Mon 02/11/14	Wed 05/11/14

Tracker Commissioning Plan



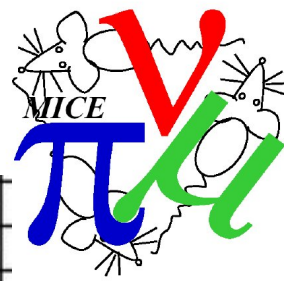
ID	% Complete	Task Name	Start	Finish
1	2%	Tracker Hall Integration	Thu 01/05/14	Fri 20/03/14
2	5%	Pre Installation work	Mon 12/05/14	Mon 03/11/14
3	0%	General Maintenance	Mon 12/05/14	Wed 14/05/14
4	0%	Gather all Tracker equipment in lab space and do stock check	Mon 12/05/14	Wed 14/05/14
5	0%	Get Electronics spares VME/NIM/Instruments?	Mon 12/05/14	Mon 12/05/14
6	6%	Cryostat related preparation	Mon 12/05/14	Tue 08/07/14
7	25%	Warwick QA of external waveguides	Mon 12/05/14	Fri 06/06/14
8	0%	Gather spares for making new external waveguides	Mon 12/05/14	Fri 23/05/14
9	0%	Quote/Book/Wait service with SHI cryogenics	Mon 12/05/14	Fri 06/06/14
10	0%	Get new aeroquip Helium lines - 8 x 10M extra plus union and Spares?	Mon 12/05/14	Mon 12/05/14
11	0%	Re-gas pressurise compressor with BIP Helium	Mon 12/05/14	Mon 12/05/14
12	0%	Mend broken manual pressure valve	Mon 12/05/14	Mon 12/05/14
13	0%	Service & clean CCG pressure sensors	Mon 12/05/14	Tue 13/05/14
14	0%	Service compressor - New Adsorber?	Mon 09/06/14	Tue 10/06/14
15	0%	Service cold heads	Mon 09/06/14	Tue 10/06/14
16	0%	Connect up new SL80 turbo pump to cryostat x4	Mon 12/05/14	Mon 12/05/14
17	0%	Mount & Connect TD400 turbo controller to Turbo x4	Tue 13/05/14	Tue 13/05/14
18	0%	Lab test of cryostat vac, cooling & electronics. Need He gas & Comp	Wed 11/06/14	Tue 08/07/14
19	0%	Electronics preparation	Mon 12/05/14	Tue 13/05/14
20	0%	Buy and connect up rack smoke detector?	Mon 12/05/14	Mon 12/05/14
21	0%	Buy another Vesda VLF250 or decide on single pipeline run?	Mon 12/05/14	Mon 12/05/14
22	0%	Run in 4 DAQ ISIS 1RF trigger cables from MLCR to Tracker rack	Mon 12/05/14	Mon 12/05/14
23	0%	Run in fibres between Tracker rack and Controls & DAQ computers	Mon 12/05/14	Mon 12/05/14
24	0%	Test AFEIt boards, upgrade firmware, check locator pins	Mon 12/05/14	Tue 13/05/14
25	0%	Services preparation	Mon 12/05/14	Mon 03/11/14
26	0%	Check Tracker rack & cryo positions and design for cryo stands	Mon 12/05/14	Mon 12/05/14
27	0%	Organise Mains distribution at Tracker rack positions	Tue 13/05/14	Wed 14/05/14
28	0%	Lay cable trays between rack and cryo position	Tue 13/05/14	Wed 14/05/14
29	0%	Arrange BIP grade Helium gas line to Tracker rack	Tue 13/05/14	Tue 13/05/14
30	0%	Global vac pipework in place end June 2014	Mon 30/06/14	Mon 30/06/14
31	0%	DL vac controls rack & software (NW corner) in place around Nov 2014	Mon 03/11/14	Mon 03/11/14
32	0%	Make LED Calibration boxes	Mon 12/05/14	Mon 19/05/14
33	0%	Construct 2nd LED box (Drill box,pot fibres & PCB and Solder)	Mon 12/05/14	Tue 13/05/14

Tracker Commissioning Plan



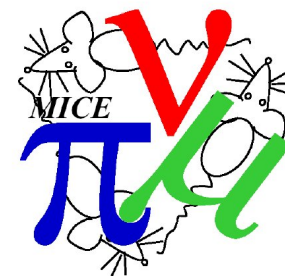
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57	0%	Comission Vesda smoke detector in situ	Tue 28/10/14	Wed 29/10/14
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Tracker Commissioning Plan

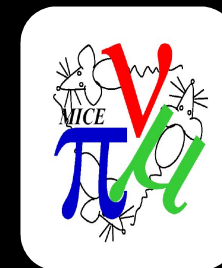


Tracker racks in hall (require both for N or S operation)			Mon 03/11/14	Wed 05/11/14	
67		0%	Place tracker rack in position in hall	Mon 03/11/14	Mon 03/11/14
68		0%	Arrange Helium gas line from Tracker rack to cryo	Tue 04/11/14	Tue 04/11/14
69		0%	Ship back David Adey kit from the US	Mon 03/11/14	Mon 03/11/14
70		0%	Populate VME crates with modules	Tue 04/11/14	Tue 04/11/14
71		0%	Connect fibre between Tracker rack and controls computer	Wed 05/11/14	Wed 05/11/14
72		0%	Connect fibre between Tracker rack and MLCR based DAQ computer	Wed 05/11/14	Wed 05/11/14
73		0%	Connect 1553 cables from VME module to AFE backplane	Wed 05/11/14	Wed 05/11/14
74		0%	South side cryostats install	Mon 30/06/14	Thu 06/11/14
75	📅	0%	South side PRY in place by Mid Oct 2014	Mon 20/10/14	Mon 20/10/14
76		0%	Cryostat stands - South side in place	Mon 20/10/14	Tue 21/10/14
77		0%	Move South side cryostats to hall and place in position	Wed 22/10/14	Thu 23/10/14
78		0%	Connect up CCG to MKS gauge in Tracker rack	Thu 06/11/14	Thu 06/11/14
79		0%	Connect up Cold head Electrical & Helium lines with new washers	Fri 24/10/14	Fri 24/10/14
80		0%	Connect temperature sensors to Oxford ITC503 in Tracker rack	Thu 06/11/14	Thu 06/11/14
81		0%	Mount 4 x AFEIIT PCB's	Fri 24/10/14	Fri 24/10/14
82		0%	Connect mains power to Wiener AFE PSU	Fri 24/10/14	Fri 24/10/14
83		0%	Cryostat Vacuum system	Mon 30/06/14	Tue 04/11/14
84		0%	Connect TD400 Turbo controller to DL vac rack	Mon 03/11/14	Mon 03/11/14
85		0%	Mount & Connect 24V for turbo controller at cryostat or DL vac rack	Tue 04/11/14	Tue 04/11/14
86		0%	Connect up MKS937 pressure gauge controller trip relay to DL vac rack	Tue 04/11/14	Tue 04/11/14
87	🚫	0%	Connect Pneumatic fail safe pressure valve behind turbo?	Mon 30/06/14	Mon 30/06/14
88		0%	Connect Pneumatic fail safe through to valve island and onto DL vac rack	Mon 03/11/14	Mon 03/11/14
89		0%	Connect Roughing/Backing line to fail safe valve	Tue 04/11/14	Tue 04/11/14
90		0%	South side External Waveguides connect	Mon 12/05/14	Wed 29/10/14
91		0%	Upstream spectrometer solenoid in place on cooling channel?	Mon 12/05/14	Mon 12/05/14
92		0%	Make dark working environment	Mon 12/05/14	Tue 13/05/14
93		0%	Reform and connect external waveguides to fit from PP to Cryostat	Fri 24/10/14	Tue 28/10/14
94		0%	Errect trellis to support external waveguides	Wed 29/10/14	Wed 29/10/14

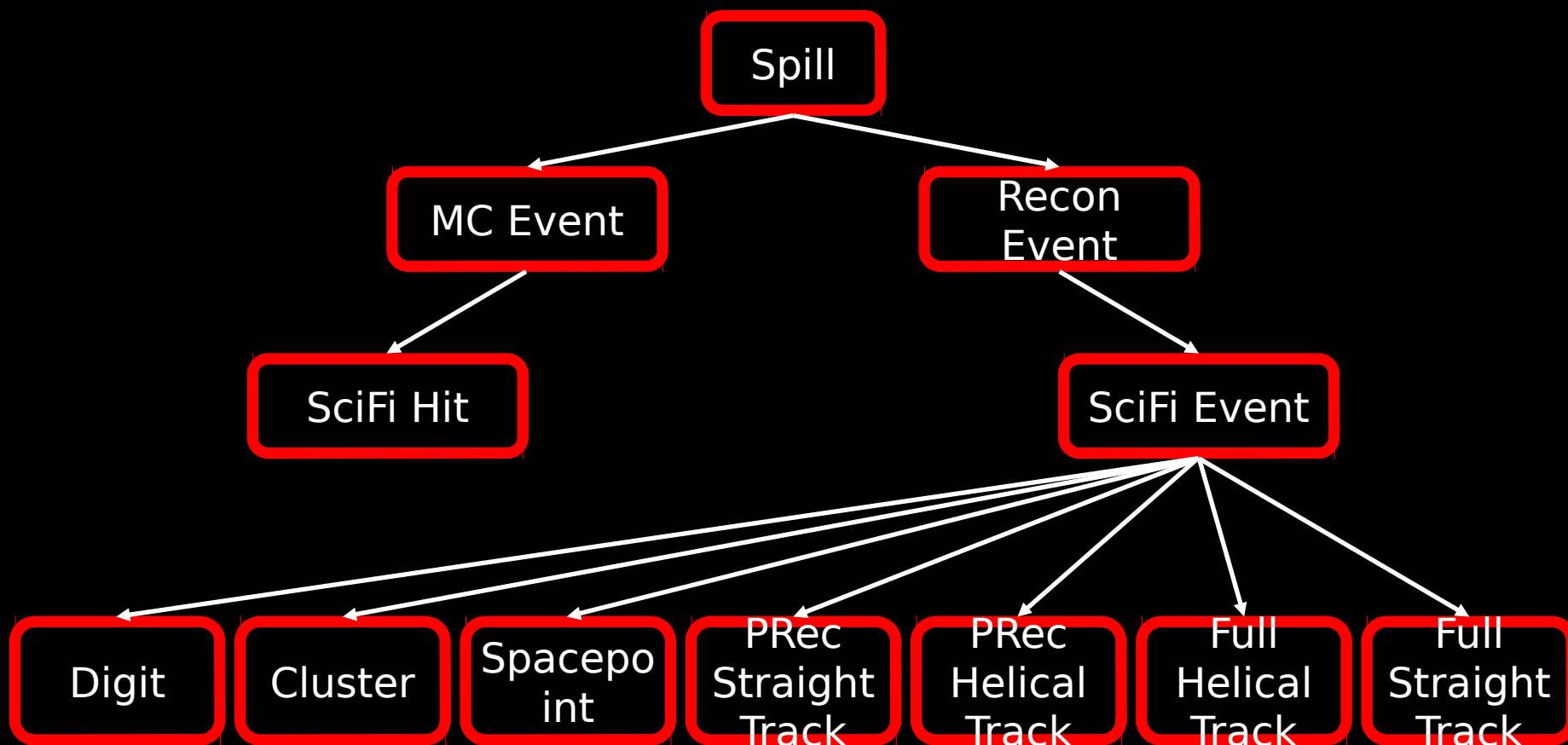
Tracker Commissioning Plan



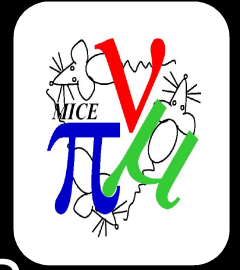
North side cryostats install			Mon 30/06/14	Thu 05/03/15
		North side PRY in place by Feb 2015	Fri 27/02/15	Fri 27/02/15
		Cryostat stands - North side in place	Fri 27/02/15	Mon 02/03/15
		Move North side cryostats to hall and place in position	Tue 03/03/15	Wed 04/03/15
		Connect up CCG to MKS gauge in Tracker rack	Thu 05/03/15	Thu 05/03/15
100		0% Connect up Cold head Electrical & Helium lines with new washers	Thu 05/03/15	Thu 05/03/15
101		0% Connect temperature sensors to Oxford ITC503 in Tracker rack	Thu 05/03/15	Thu 05/03/15
102		0% Mount 4 x AFE IIT PCB's	Thu 05/03/15	Thu 05/03/15
103		0% Connect mains power to Wiener AFE PSU	Thu 05/03/15	Thu 05/03/15
104		0% Cryostat Vacuum system	Mon 30/06/14	Tue 04/11/14
105		0% Connect TD400 Turbo controller to DL vac rack	Mon 03/11/14	Mon 03/11/14
106		0% Mount & Connect 24V for turbo controller at cryostat or DL vac rack	Tue 04/11/14	Tue 04/11/14
107		0% Connect up MKS937 pressure gauge controller trip relay to DL vac rack	Tue 04/11/14	Tue 04/11/14
108		0% Connect Pneumatic fail safe pressure valve behind turbo?	Mon 30/06/14	Mon 30/06/14
109		0% Connect Pneumatic fail safe to valve island and DL vac rack	Mon 03/11/14	Mon 03/11/14
110		0% Connect Roughing/Backing line to fail safe valve	Tue 04/11/14	Tue 04/11/14
111		0% North side External Waveguides connect	Thu 13/11/14	Tue 10/03/15
112		0% Downstream spectrometer solenoid in place on cooling channel?	Thu 13/11/14	Thu 13/11/14
113		0% Make dark working environment	Thu 13/11/14	Thu 13/11/14
114		0% Reform and connect external waveguides to fit from PP to Cryostat	Thu 05/03/15	Mon 09/03/15
115		0% Erect trellis to support external waveguides	Tue 10/03/15	Tue 10/03/15
116		0% Pre-beam Commissioning	Thu 06/11/14	Fri 20/03/15
117		0% South side operations	Thu 06/11/14	Wed 26/11/14
118		0% Test AFE slow controls (Adey)	Thu 06/11/14	Mon 10/11/14
119		0% Test Tracker safety interlocks	Fri 07/11/14	Mon 10/11/14
120		0% Cool down procedure	Tue 11/11/14	Fri 14/11/14
121		0% LED Calibration & other	Mon 17/11/14	Mon 24/11/14
122		0% Initial ISIS RF timing with TOF mimic?	Tue 25/11/14	Wed 26/11/14
123		0% North side operations	Fri 06/03/15	Fri 20/03/15
124		0% Test AFE slow controls (Adey)	Fri 06/03/15	Fri 06/03/15
125		0% Test Tracker safety interlocks	Fri 06/03/15	Fri 06/03/15
126		0% Cool down procedure	Mon 09/03/15	Thu 12/03/15
127		0% (Full) LED Calibration & other	Fri 13/03/15	Fri 20/03/15
128		0% Step IV beam commissioning starts : ISIS cycle starts 17th March	Tue 17/03/15	Tue 17/03/15



Data Structure I

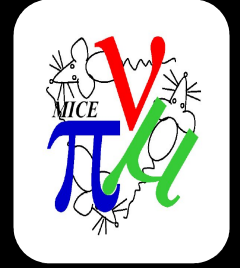


Data Structure II



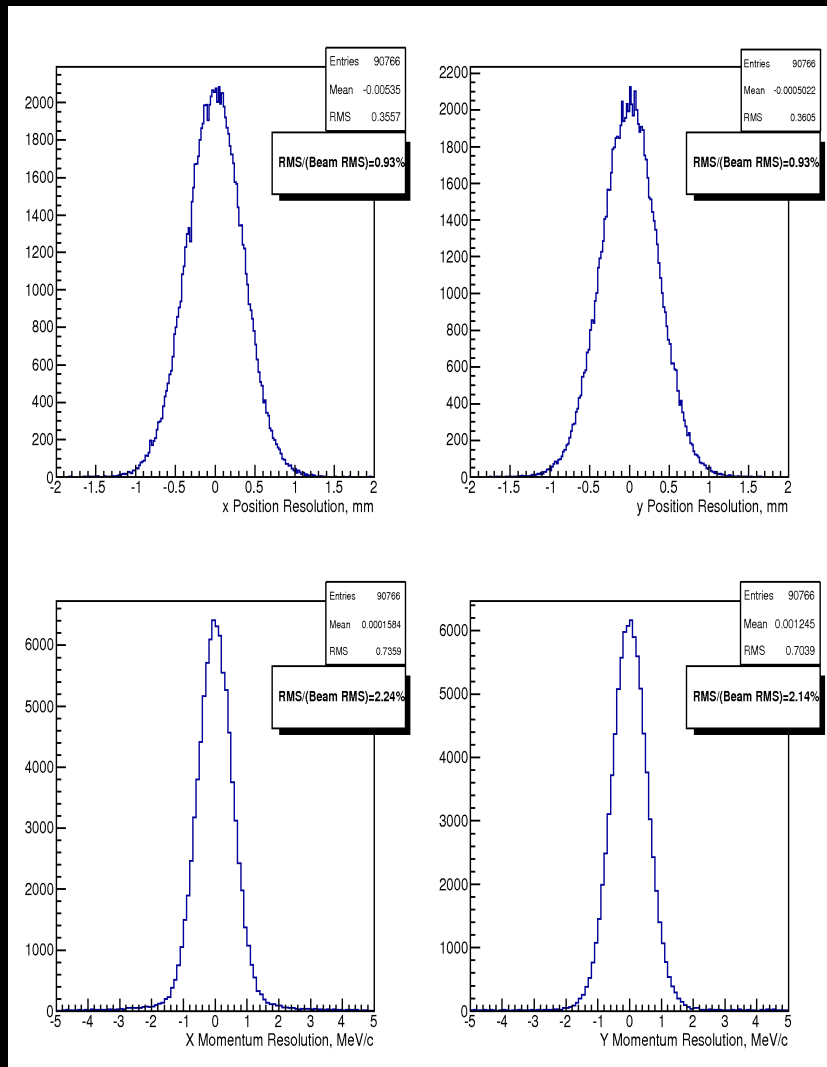
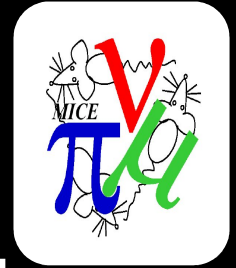
- **Hits** – Monte Carlo objects formed when a particle traverse a detector
- **Digits** – Detector response to a channel hit
- **Clusters** – Groups of digits from adjacent channels in same plane
- **Spacepoints** – 2 or 3 clusters from different planes on the same station, giving an (x,y) position
- **PRec Tracks** – Tracks found by Pattern Recognition
- **Full Tracks** – The final tracks produced by the Kalman fitter

Reconstruction



- **Digitisation** – unpack the real data or digitise MC data
- **Clustering** – look for adjacent channel hits and group them
- **Spacepoints Reconstruction** – look for intersecting clusters on different planes
- **Pattern Recognition** – use a linear least squares circle fit in x-y, and straight line fit in s-z to associate spacepoints with tracks
- **Final track fit** – use a Kalman filter to smooth and filter the tracks, accounting with multiple coulomb scattering and energy loss

Kalman



- Resolution of the track parameters computed as the difference between MC truth and reconstruction values
- The distribution RMS to beam RMS ratio is shown
- Requirement of being able to measure 10% change in beam emittance to 1% accuracy means that transverse momentum resolution must be better than 10% of the beam RMS
- Results show we are well within this requirement!