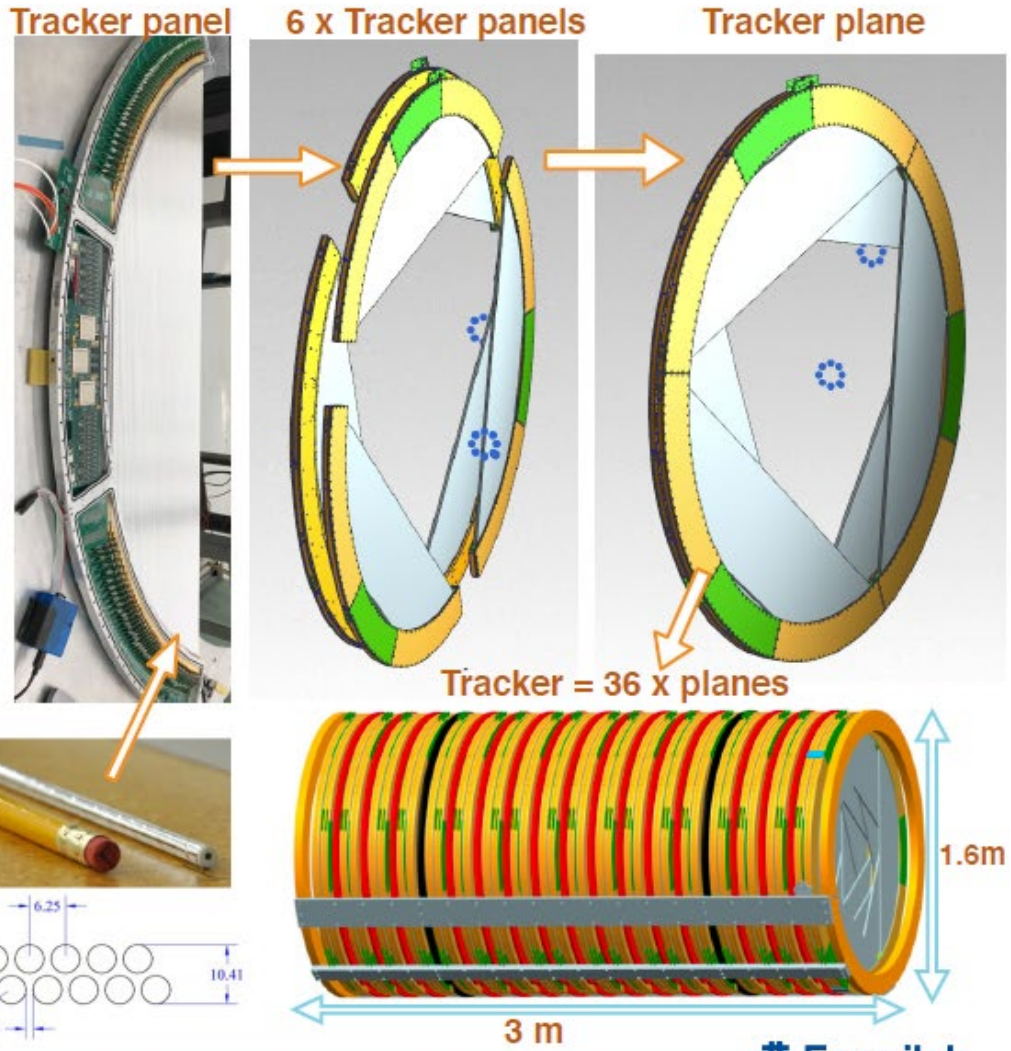
Coinvolgimento INFN su Mu2e Tracker

Tracker

Background suppression: DIO

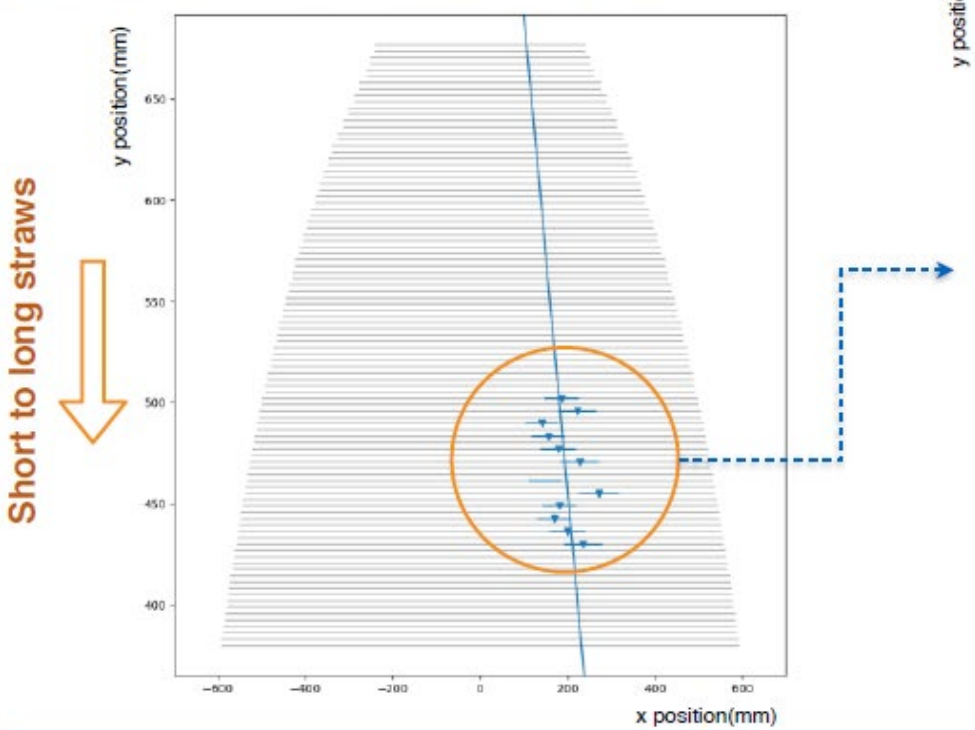
- Main detection element of Mu2e.
- Low mass tracker using straw drift tubes running ArCO2.
- 25 μm Tungsten wire as the anode.
- 21600 x 5 mm OD metalized Mylar straws;
  - Inner coat provides cathode
  - Outer coat provides shielding and reduce leaks.
- Highly segmented -> 36 planes -> each made from 6 panels.
- Momentum resolution < 180 keV/c.

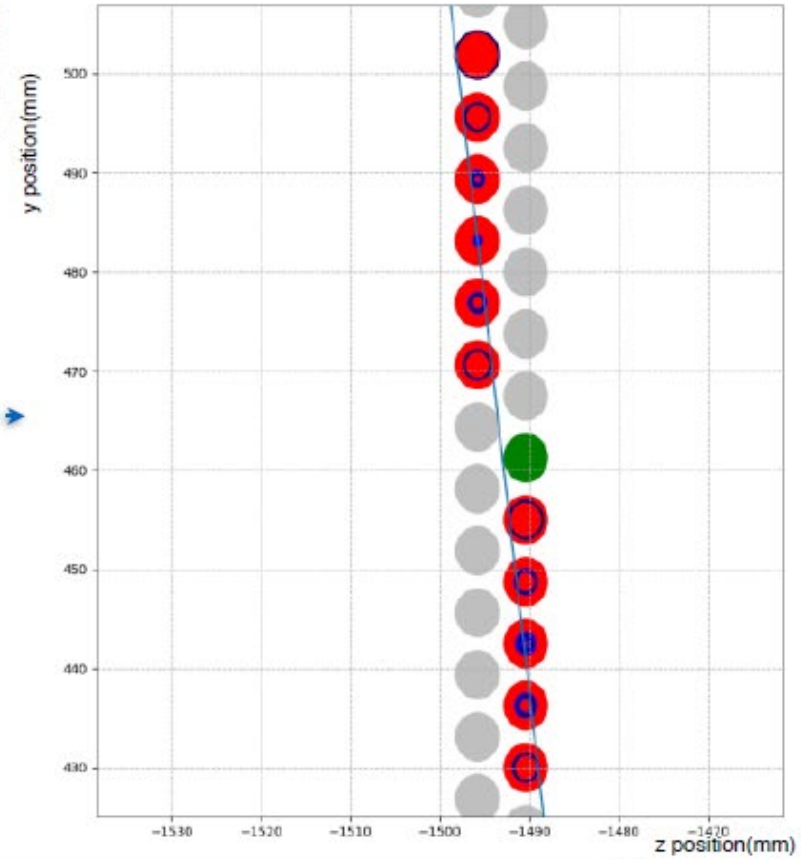


Fermilab

Cosmic track reconstruction

Panel orientation





Panel Summary – Aug 24 – Aug 31, 2020

2 panels completed; 2 panels started; 11 panels worked on throughout week

Panel	Mon. Aug 24	Tue. Aug 25	Wed. Aug 26	Thu. Aug 27	Fri. Aug 28	Mon. Aug 31
MN037	NA	Leak Test	Prep	Leak Test	Failed-Completed	
MN045	Leak Test	Completed				
MN046	Manifold	Flood 1	Flood 2	QC Prep	QC Prep	Leak Test
MN047	Pin Protectors	HV Test	Omega Clips	Manifold	Flood 1	Flood 2
MN048	Wires	Pin Protectors	HV Tests	Omega Clips	Manifold	Flood 1
MN049	Wires	Wires	Pin Protectors	HV Tests	Omega Clips	Manifold
MN050	Wires	Wires	Wires	Pin Protectors	Pin Protectors	Pin Protectors
MN051	NA-PAASB	Straws epoxied	Wires	Wires	Wires	Wires
MN052	NA-PAASB	NA-PAASB	Straws Installed	Straws Epoxied	Wires	Wires
MN053			Inner Ring	Heat/Straws	Straws epoxied	Wires
MN054					Inner Ring	Inner Ring

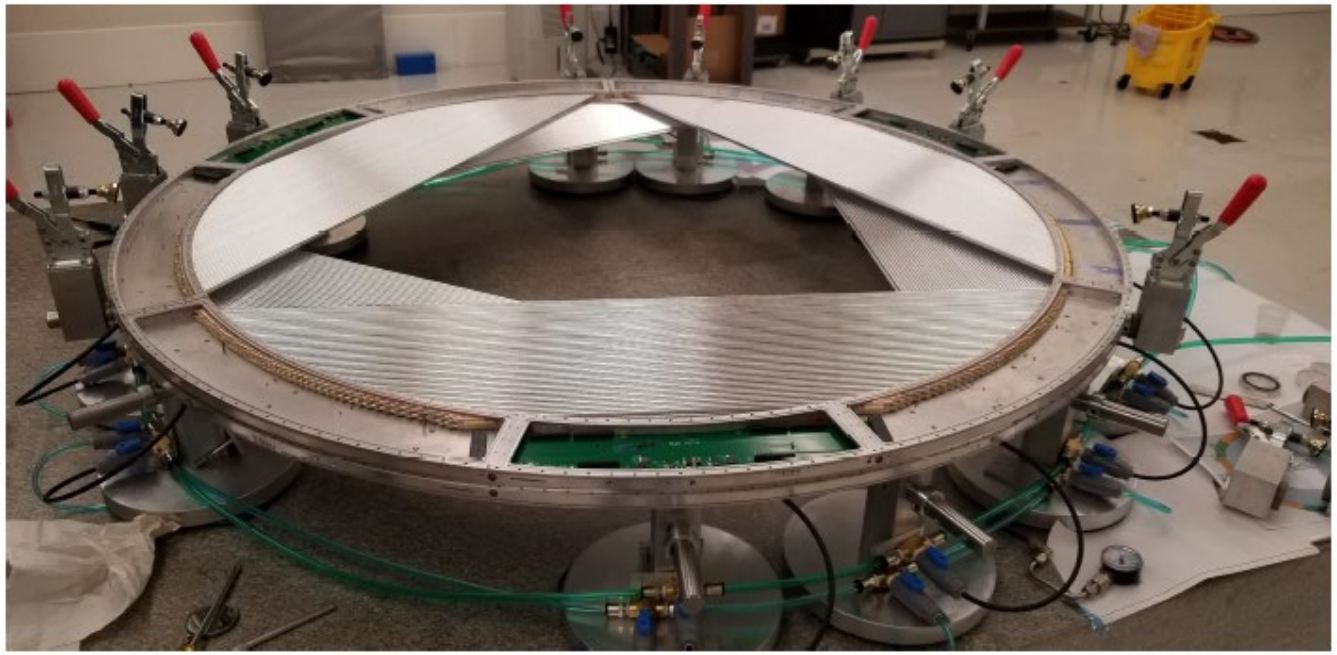
Panel Status

Full production line is happening, but the wires are taking longer than hoped.
Addition electronics are being made so get 3 soldering stations happening at once.

Additional soldering training to make sure we have enough students trained so we can field 6 students for 8 hours each day.

Vertical Slice Test

From Mete, at the Feb. Collaboration meeting



- Idea is to fully instrument one full plane of tracker (6 panels) and run for ~ 6 months

Vertical Slice Test

- Basically we want to run a full plane with pre-production parts through a full TDAQ slice.
- Will run first horizontally to test infrastructure, FEE / firmware
- Then will move to vertical position to collect/reconstruct cosmic
  - You can find detailed goals, parts, and schedules in mu2e-docdb-32725
  - word document / pdf describes the goals, parts, and schedule
    - excel spreadsheet lists goals, parts, schedules, and current status
  - We have collected all the information on goals for all the subparts of the Vertical Slice Test, along with equipment needed to realize it.
  - The document lists the goals as:
    - **Required** goals define the VST
    - **Desired** goals are additional goals we would like to complete during the VST
    - **Stretch** goals is what we will do given time / personnel constraints
    - "**IPA**" goals (Important Parallel Activities) are additional efforts needed to support the tracker that are not formally part of the VST, but ones we want to capture
- Note that the VST (and IPA goals) will continue during the production of planes/stations at Fermilab

Overall goals / plans

- In general, we want to verify our preproduction parts to ensure they meet the requirements for the detector
  - This includes:
    - High Voltage / Low Voltage distribution systems
    - DAQ firmware, connection to DTC/DAQ
    - High rate tests, DAQ bottlenecks
  - These tests are needed for verifying the preproduction parts and the Construction Readiness Review for the front end electronics
    - Especially the preamps/DRACs as these are large orders that need to go out by ~ end of year.
- Exercise operations of the plane
  - full slice of TDAQ, slow controls, calibrations, shifter documentation
    - Newly added tests: EPICs archiving using production EPICs server/disks (currently at FCC)
- Show we can reconstruct cosmic rays in a full plane. Connect survey/ calibrations to offline software.
- Run the panel long term (beyond the formal end of tests) to monitor any long term trends / issues

From July 2 statussed Schedule up to FEE CRR

	June			July					August						September			October				
	1	8	15	22	29	6	13	20	27	3	10	17	24	31	7	14	21	28	5	12	19	26
Complete gas hole cleaning on VST panels/certify MN033	X	X	X	not perfect, but good enough																		
Survey panels @ Duke (2 wks for survey, 1 week for shipping)			X	X	X	Panels measured, back at FNAL																
Fabrication LV distribution ring			X	X	X	X			dxs files to run routers are produced but need to be modified for													
Electrical check on MN32 to ensure it's back where it was,					X	X																
Leak check MN32/33						X	X															
Assemble plane and connect services								X	X	8/28 have 2 qts left? Should have enough to glue a plane.												
plane leak test									X	X												
Install / commission cooling line											X											
Complete intall on daq09 and move to lab 3.										X	X	X	X									
Install preamps												X	X									
Sheilding / grounding studies														X								
Panel ORC															X							
Firmware tests for ROC/DTC communication																X	X					
Demonstrate full length LV cables on at least 2 panels																	X	X	X	X	X	
ROC / Digitizer / DDR firmware tests and validation																	X	X				
Record charge injection pulse (deltaT and ADC measurement)																		X	X			
TDC readout validation, ADC performance (using source)																			X	X		
High rates																			X	X		
BER measurement																			X	X		
Continuously handle 1 KHz on average from each straw (noise rate set by low thresholds)																			x	X	X	X
Power consumption, heat load																	X	X	X	X	X	X
System tests (timing, power, cooling)																	X	X	X	X	X	X
Source measurements																		X	X	X	X	X
Collect raw data and store to disk																X	X	X	X	X	X	X
Tests Ready for FEE CRR																						X

- Critical path is the availability of panels
  - right now they are being processed, then they will be sent to Duke for measurement
  - Turnaround time @ Duke 7-10 days (per Seog)
- First part of schedule focuses on FEE verifications / tests
  - if all goes well, assumes tests are complete for FEE CRR mid October

… and now

	June				July					August					September				October				November				
	1	8	15	22	29	6	13	20	27	3	10	17	24	31	7	14	21	28	5	12	19	26	2	9	16	23	30
Complete gas hole cleaning on VST panels/certify MN033	X	X	X																								
Survey panels @ Duke (2 wks for survey, 1 week for shipping)			X	X	X	Panels measured, back at FNAL																					
Fabrication LV distribution ring					X	X	X	X	X	X	X	X		dxf files to run routers are produced. 1/2 ring produced, need to ver													
Electrical check on MN32 to ensure it's back where it was, EC on 33, Modified AMB tests on other four panels (11/12/16/19)					X	X	X																				
Modified AMB tests on other four panels (11/12/16/19) in gas							X	X	X	X	X	X															
Leak check MN32/33											X	X	X														
Assemble plane and connect services													X	X	X		start with dry fits, check flatness, etc . Need special v										
plane leak test															X	X											
Test mockup plane (checking assembly fixture)											X	X		have problems with shackles -- have a solution for VST													
Modify mockup plane as tooling for cooling line, bend cooling lines													X	X		test epoxy installing procedure on mockup											
Install / commission cooling line															X	X			need to test working time of epoxy, how to								
Complete intall on daq09 and move to lab 3.													X	X	X												
Display EPICs variables in Phoebus/OTS/archive at FCC																X	X	X									
Install preamps / checkout low/high voltage					C/N decision				X								X	X									
Plane ORC																			X								
Sheilding / grounding studies																				X							
Firmware tests for ROC/DTC communication																					X						
Demonstrate full length LV cables on at least 2 panels																				X	X	X	X	X	X		
ROC / Digitizer / DDR firmware tests and validation																					X	X					
Record charge injection pulse (deltaT and ADC measurement)																						X	X				
TDC readout validation, ADC performance (using source)																							X	X			
Run at high rates and check bottlenecks in readout chain																							X	X			
BER measurement																							X	X			
Continuously handle 100 KHz on average from each straw (noise rate set by low thresholds)																									X	X	
Have 10% of straws at 400kHz and record data																										X	X
Power consumption, heat load																							X	X	X	X	X
System tests (timing, power, cooling)																						X	X	X	X	X	X
Source measurements																						X	X	X	record source m		
Collect raw data and store to disk																					X	X	X	X	X	X	X
Tests Ready for FEE CRR																											X

- Statussing schedule weekly (last status August 21)
  - including availability of materials, etc
  - schedule has slipped 4 weeks since July 2— basically due to processing the panels taking longer than we'd hoped.

Fermilab

Schedule after FEE CRR

	December				January			February						March	
	30	7	14	21	28	4	11	18	25	1	8	15	22	1	8
Tests Ready for FEE CRR	X														
Flag buffer overflows in the data	X	X													
Additional firmware/ DAQ tests			X	X											
Flip Vertically					X	X									
leak test						X									
DC-DC converter mechanical support finalize						X	X								
Exercise full DAQ chain as shown in text								X	X	X	X	X	X	X	
Cosmic ray measurements									X	X	X	X	X	X	
Track reconstruction with cosmic rays										X	X	X	X	X	
Measure data rate collection time and display online								X	X	X	X	X	X	X	
Display data in online histograms								X	X	X	X	X	X	X	
Include software trigger in EVB1 (stretch goal, done by others)											X	X	X	X	
End of VST formal goals															X

- Second part of schedule allows time for any additional firmware/DAQ tests
- Then we flip the plane vertically and record cosmic data
- Allows some time to include s/w trigger in EVB1, if desired.
- Note there is also a lot of work in connecting online/offline/data management that is not reflected in this schedule

Task identificati

Diversi aspetti dell'assemblaggio dei piani e stazioni sono ancor a da definire, un aiuto da parte dell'INFN sarebbe auspicabile (richiesto).

A metà Luglio abbiamo discusso con R. Tschirhart, M. Yucel e A. Mukherjee per identificare le possibili attività su cui poter contribuire in maniera fattiva. Sono stati identificati 4 attività, anche tenendo conto delle limitazioni legate al COVID-19:

- a) Design and production of fixturing for tracker panel testing and final assembly.
- b) Design and assembly of the cooling ring for each tracker plane.
- c)Design and production of fixturing for assembling tracker planes into the final tracker frame.

Eventualmente c'è spazio per altri compiti

a) Plane/Station assembly tasks at Fermilab - *Developing a fixture for rapid installation of panel cover screws*

Descrizione (da Bob T.):

As of now our panel gas manifold cover installation process is long and prone to damaging to the aluminum threads in the manifold due to multiple rounds necessary when increasing the torque, kind of like replacing a wheel on a car. Alternatively we really should design a system that will apply enough pressure to the manifold cover and hold it in place while we install the screws. This will allow us to reach the desired o-ring compression level quicker using fewer rounds. We can send manifolds and covers for you to develop this tooling in Italy which you can bring with your or in advance of your arrival.

Commenti:
Lavoro di progettazione, di una piccola parte, che puo' essere fatto in larga parte anche in Italia.

b) Plane/Station assembly tasks at Fermilab - *Plane cooling ring installation technique, tooling, and installing cooling ring*

Descrizione (da Bob T.):

There are several important details that needs to be worked out with regards to cooling ring installation. These includes the bending of the copper cooling tube, installation on to the plane, installation of the sharp u-turn that receives the copper cooling ring ends and few other topics. One can work out the details of these processes in Italy given there is tubing and a mockup of the plane groove.

Commenti:
Lavoro in parte anche di progettazione che puo' essere fatto in larga parte anche in Italia.

c) Plane/Station assembly tasks at Fermilab - *Developing station assembly fixtures*

Descrizione (da Bob T.):

One of the last step in the assembly of station is the actual act of putting two planes on top of each other. Fixtures and methods need to be developed for the assembly of the station (two planes together) without having any issues in a reliable way.

Commenti:
Lavoro di progettazione che puo’ essere fatto in parte anche in Italia. Credo che la presenza al FNAL potrebbe essere almeno dopo Marzo

END

Anagrafica

F. Grancagnolo	*10%*
G. Tassielli	50%

Tecnici	MU	Di cui di progettisti
LECCE	2(+2)	2
LNF	2?	
TRIESTE	2?	

Richieste

MISSIONI:
- FNAL (2 C.M. + lavoro integraione esperimento) 3k
- FNAL tecnici per lavoro su tracker (6 M.U. 4 tecnici anche di altre sezioni) 15k
- FNAL tecnici, SJ all'avanzamento del lavoro e possibili coinvolgimenti in ulteriori attività di assemblaggio del tracker 9k SJ

CONSUMO:
- prototipizzazione e realizzazione sistema di montaggio coperture dei manifold del tracker 3k
- prototipizzazione e realizzazione infrastrutture per sistema di assemblaggio stazioni del tracker 3k
- prototipizzazione per R&D per tracker Mu2e-II 3k

ALTRI_CONS:
- tool per officina 1 k

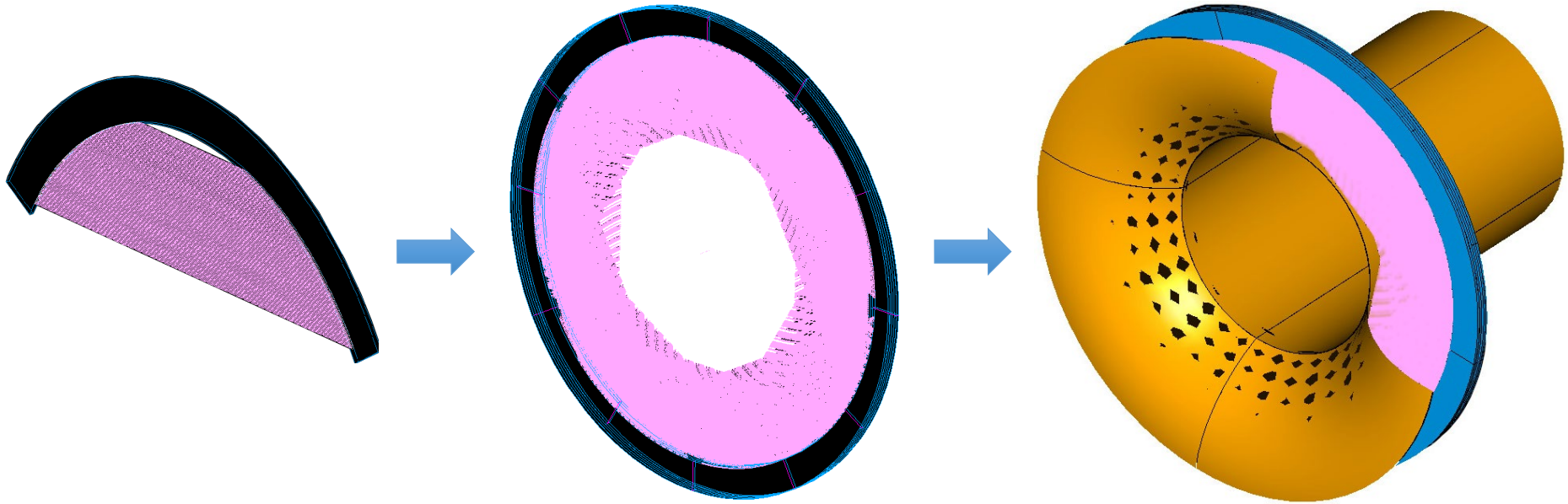
TRASPORTI:
- spefizioni sistemi di assemblaggio per il tracker 2k

Mu2e-II

Con l'obiettivo di presentare una proposta piu' concreta per Mu2e-II a snowmass 21 è stato istituito un comitato per scrivere le LOI e organizzare e gestire il lavoro:

1) (G. Tassielli) membro del comitato
2) (G. Tassielli) co-conveneer del workgroup sul tracker

Ho sviluppato una idea e fatto dei calcoli preliminari per una possibile alternativa del tracciatore per Mu2-II. L'idea è stata presentata alla collaborazione ed ha riscosso interesse. Bisogna lavorare su simulazioni e test per sviluppare l'idea.



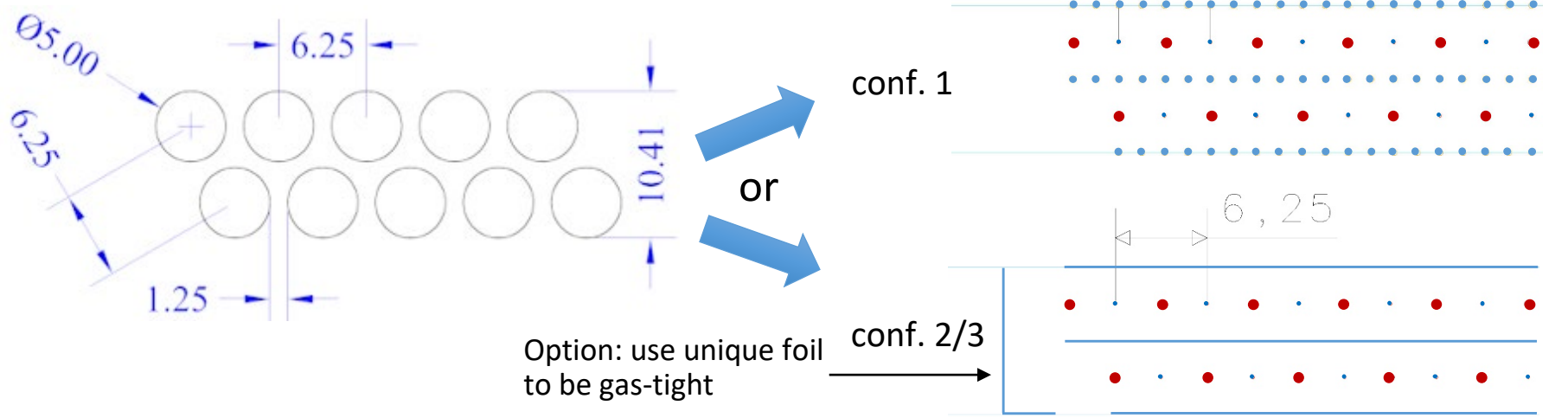
A tracker option for Mu2e-II - panel

Assumption:

- 20 µm W wires
- 50 µm Al wires
- 40 µm Al wires
- 2.5 µm Mylar with 500 Å Al

Instead of using straws for the cathodes use:

- all thin wires (conf. 1)
- thin metalized Maylar foils and thin wires (conf. 2/3)



Simple construction (as used for MEG-II drift chamber):

- with a wiring robot, build 3 layers of cathode wires (or use 3 foils)
- build 2 layers of anode and cathode wires
- machine 4 planar spacer layers
- stack the wire layers and the spacer layers (in the right sequence) on a support frame.
- use dowel pins and screws to align and to lock (no glue, apart from conf. 3).

Mu2e-II tracker options

- He - i-C_4H_{10} 90% - 10% gas mixture is assumed
- average 35 hits per track
- add the contribution of the gas in the gas vessel but outside of the panels (conf 3 assume pure He)
- add two times the inner wall of the gas vessel

Number are in 10^{-3} X/X_0

	Mu2e	8μm straw	8μm straw no gold, 8 psi	Conf 1	Conf 2	Conf 3
Single sensitive element	0.197	0.135	0.108	0.019	0.035	0.035
additional gas				1.5	1.5	0.3
2 x inner wall				1.6	1.6	1.6
average per track	6.9	4.7	3.8	3.8	4.3	3.2

Notes: the gas vessel material (uniform) at the entrance ($<0.8\cdot10^{-3}$ X/X_0) doesn't contribute to the resolution, it should be compensated from the proton absorber. The same amount of material should be considered for the extrapolation to the calorimeter

Alcune altre possibili attività

Panel Production and Quality Control - *Participate in panel production*

Descrizione (da Bob T.):

Join to the panel assembly team at the University of Minnesota.

Commenti:
Fornire man power a UMn per l'assemblaggio dei pannelli, quindi mandare le persone a Minneapolis.
Non credo che ci qualifichi particolarmente e vedo abbastanza poco conveniente mandare le persone a Minneapolis. Forse l'UMn potrebbe pagare l'alloggio.

Manpower (stime preliminari):
immagino 1-2 (12-24MU) persone «costantemente» a Minneapolis

Alcune altre possibili attività

Panel Production and Quality Control - *Electrical qualification of tracker panels*

Descrizione (da Bob T.):

Electrical qualification of tracker panels that have been produced by UMn, alignment-surveyed at Duke. This work would occur at Fermilab.

Commenti:
Effettuare test di qualifica elettrica, credo sia sulla tenuta dell'HV e sul lato dell'elettronica di FE

Manpower (stime preliminari):
almeno 1 (12MU) persona «costantemente» a Fermilab

Alcune altre possibili attività

Plane/Station assembly tasks at Fermilab - *Accurate positioning of tracker stations into the tracker frame*

Descrizione (da Bob T.):

Accurate installation of stations into the frame can be possible in two ways; either one can lower the stations into the frame very accurately, perhaps using GPSs and IMUs, or one can build the frame and accurately measure the actual geometry, possibly with a large enough CMM. Developing the technique and tooling to achieve this goal seems to be involved enough that it can be done in parallel to work in lab 3. As discussed before one can use Lab 5 space and crane to work on the scheme to load stations into the frame without independent of lab 3 clean room activity.

Commenti:
Forse solo una piccola parte della progettazione puo' essere fatta anche in Italia. Sarebbe un commitment importante da prendere come INFN ma il manpower richiesto e l'impegno richiesto forse non è nelle nostre disponibilità attuali.

Manpower (stime preliminari):
a spanne 3 MU tra tecnico(con capacità di progettazione)/tecnologo in Italia + 12 MU a Fnal ?