# Mu2e & calorimeter status 2020





Istituto Nazionale di Fisica Nucleare S.Miscetti , LNF/INFN Meeting with Mu2e-INFN-referees 9-September-2020

### Layout



- Mu2e experiment status
- Solenoids
- Tracker
- Schedule
- Covid-19 impact
- Calorimeter status
- Calorimeter schedule
- Covid-19 impact

#### \_\_\_\_\_

Others

- \_\_\_\_\_
- $\rightarrow$  Work on tracker
- → Caphri (muon stop counters)
- → Su2020 (Sensitivity Update)









2020 is a big year for the Project -> DOE IPR 2020 on the coming months

- All TS units will be delivered to Fermilab and tested. . On track
- TS cryostat will be delivered. On track
- HRS will be delivered.
- Cryo Feedboxes will be delivered. On Track
- All calorimeter crystals delivered.
- Tracker panel and plane production well underway.
  - → Getting there. Significant COVID impact.
- Production Target and support frame will be delivered. On track.
- Stopping Target will be assembled. On track.
- Detector support rails will be delivered.
- 60% of CRV Modules completed → Maybe 50%? + CRV LY issue
- Complete all but one CRR → Nope (.. On OUR side still 2 CRR to go)





#### **COVID Delays @ June 2020**

- Biggest impacts are to TS and Detector construction.
  → Full impact not yet realized as Pandemic continues.
- Most activity at Fermilab stopped for nearly 3 months
- Many subcontracted industrial firms continued working, with varying degrees of efficiency
  - Impact on General Atomics operations in Tupelo was modest.
    - Risk of shutdown in the future as COVID spread continues
- INFN personnel recalled to Italy and sheltered in place
  - Now returning to their labs in phases, similar to US.
    - Unclear when they can return to Fermilab
- Activity at most Universities were shut down for 3 months
  - Re-opening restricted undergraduate student labor until the Fall, at the earliest, at most institutions.

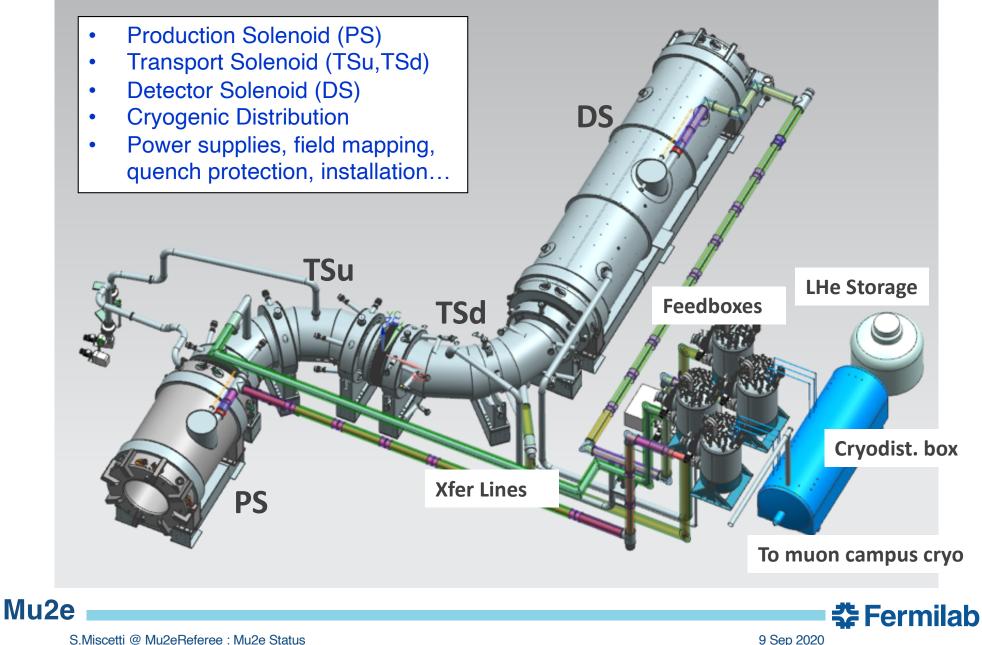






## Mu2e Solenoid Scope





# **Transport Solenoid (TS)**

- Test Units (ASG)
  - 12 out of 14 delivered to Fermilab
  - Remaining 2 units to be delivered this month
  - At Fermilab 8 units fully tested and accepted
- At Fermilab HAB first 7 test units have been placed over the TSu inner cryostat and mechanically connected
  - Excellent agreement between coil survey and predicted position based on CAD model



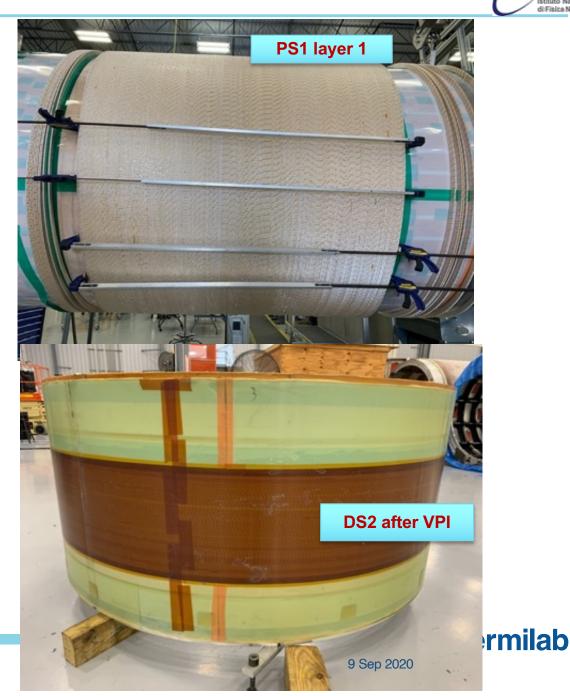
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# Production (PS) and Detector (DS) Solenoids

#### Production Solenoid Coils PS1,PS2, PS3

- PS3, PS2 completed
- PS1 first layer successfully wound and compacted
- Detector Solenoid Coils DS1-DS11
  - DS1, DS9 wound and compacted
  - DS2 coil wound, compacted and VPI (Vacuum Pressure Impregnation) successfully completed





# Production (PS) and Detector (DS) Solenoids

- PS and DS cryostat fabricated by Joseph Oat, New Jersey
  - Fabricated, vacuum and leak checks completed for DS, ongoing for PS
  - DS cryostat loaded on a truck for trip from vendor site in New Jersey to GA facility in Tupelo, Mississippi



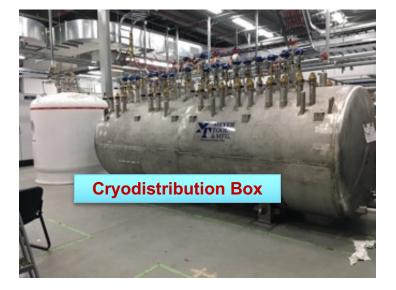
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# **Mu2e Cryo distribution**

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- Cryodistribution box
  - Cryogenic pipes and insulating vacuum connected to Muon Campus Cryo Plant via 150 m outdoor transfer line
  - Vacuum and leak checking in progress
- Feedboxes (PS, DS, TSu, TSd)
  - PS,DS delivered to Mu2e building
    - Acceptance tests ongoing
  - TSu, TSd fabrication complete
    - FAT completed
    - To be delivered this Fall
- Interior Transfer lines (not shown)
  - 7 out of 8 segments completed
  - Final segment will be completed this month
  - 3 segments delivered to Mu2e building for installation





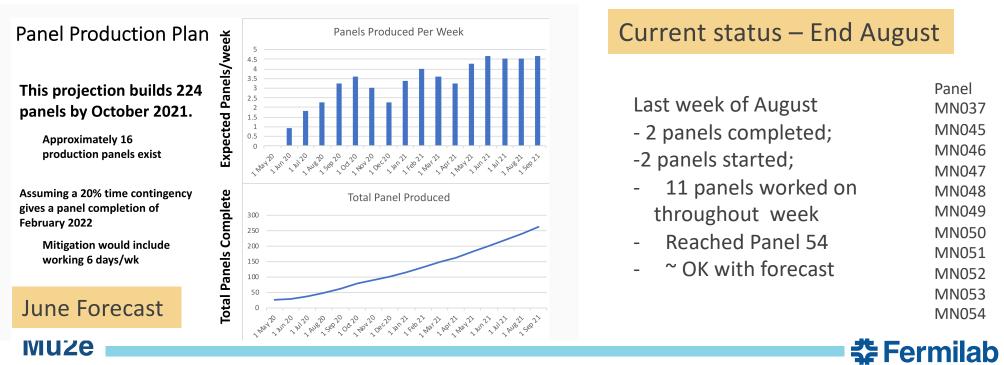


Mu2e

### **Tracker Delays**



- Biggest COVID detector impact is to the Tracker
- 6-month COVID delay to Tracker so far. Delays due to:
  - University of Minnesota shutdown
  - 70% efficiency upon reopening due to social distancing
  - Limited undergraduate student pool
- Trying to mitigate delays by hiring recent experienced graduates as technicians and offloading some QC to Fermilab  $\rightarrow$  will increase cost
  - Help required also to INFN (see Gianfranco)



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#### **GA Delays**



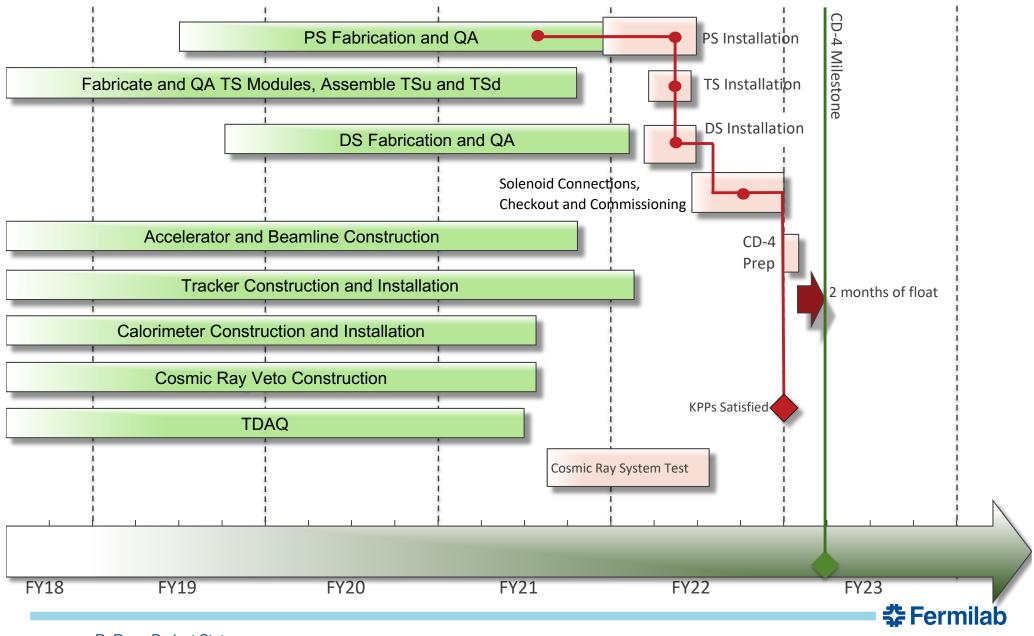
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- Prior to COVID, GA delays had reduced CD-4 float to 2 months.
- Mu2e worked with GA to develop a more credible schedule and discovered a significant logic problem in GA schedule
  - Corrected logic problem results in additional delays to projected delivery dates <u>that</u> <u>push project completion date ~5 months beyond CD-4 milestone.</u>
  - Includes impact of double shifts on 11 activities/operations in Tupelo
- GA performed an activity-level risk analysis.
  - Mu2e analysis of GA risks indicates potential for an additional 9-month delay, pushing project completion 14 months beyond CD-4.
- COVID has had a minimal impact on GA operations in Tupelo, but that could change as COVID continues to spread.
  - Lack of oversight from San Diego and Fermilab in Tupelo has impacted quality and delayed schedule by a few weeks.
- If COVID is still with us in 2022 it will impact Solenoid installation schedule at Fermilab.



## **Pre-COVID Schedule**



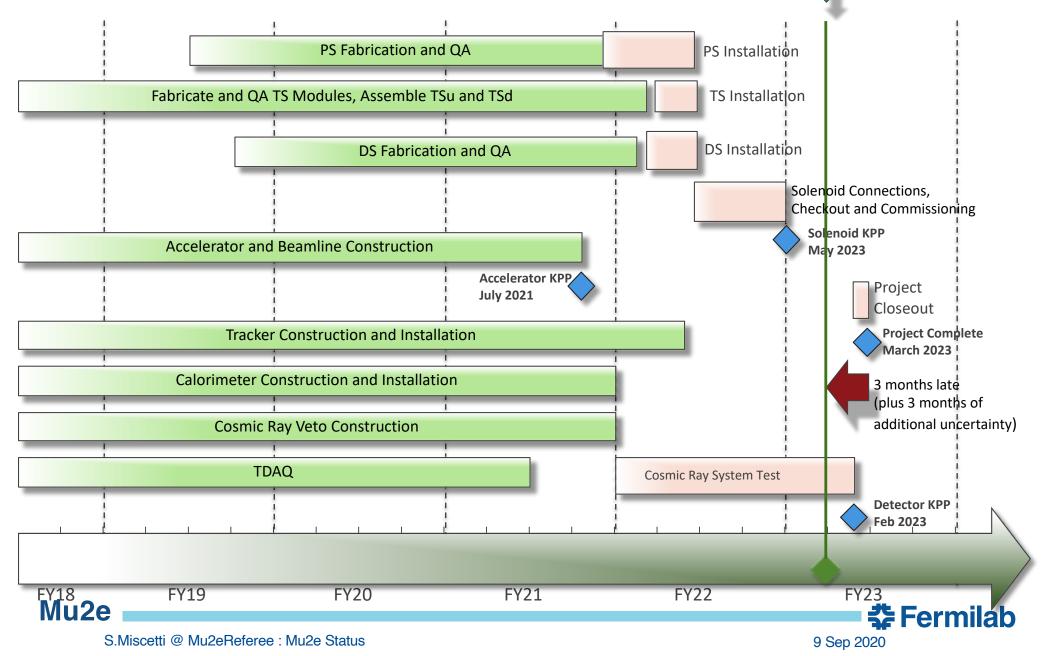
R. Ray - Project Status

6/19/20

# **COVID Impact (Estimate to date)**

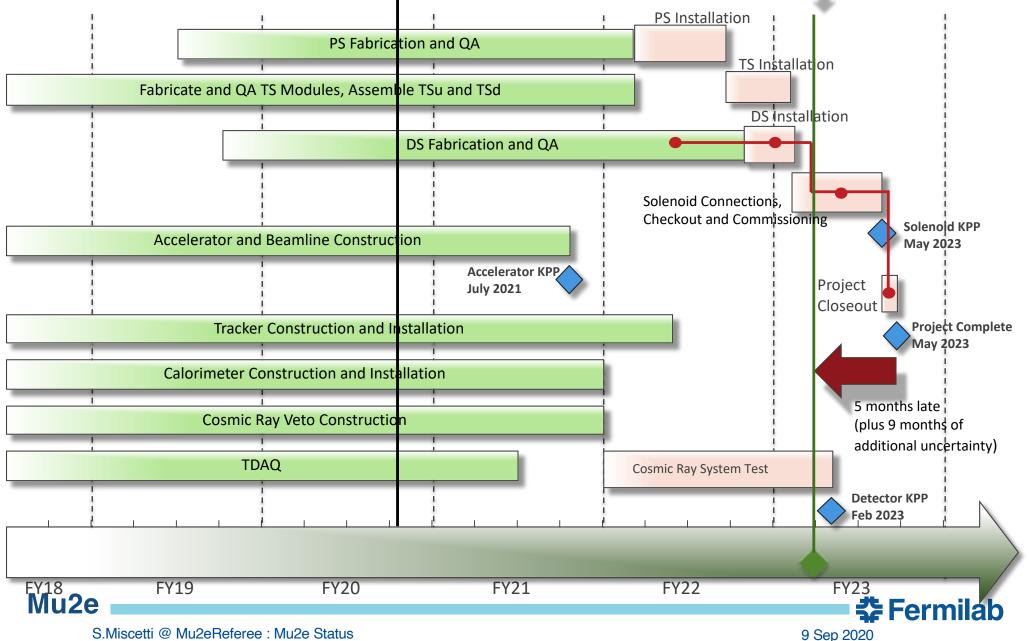


Impacts Detectors and TS

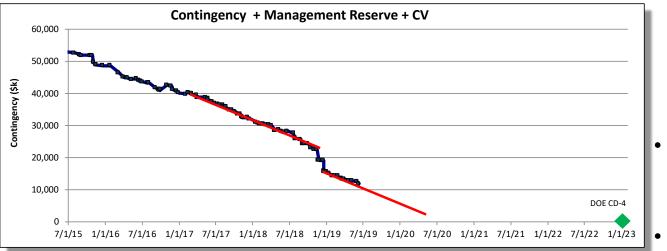


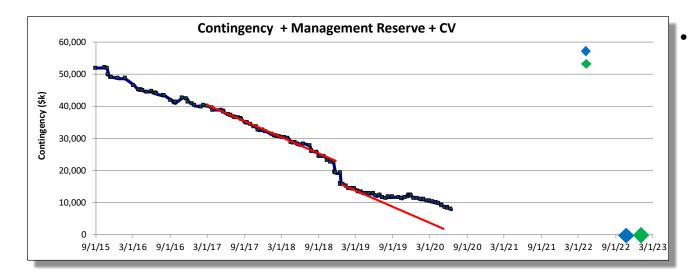
#### **GA Delay Plus Realized COVID Impact**





### Contingency @ June 2019 vs June 2020





- Improved, but many remaining risks.
  - Does not include HAB buy-back

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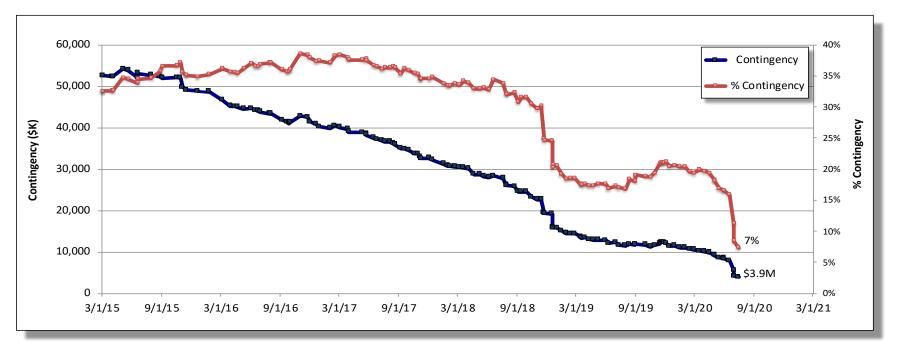
Does not include June's BCR that will include COVID impacts and impact of 7-month GA delay



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## Contingency @ July 2020



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- This chart includes July's BCR that takes into account COVID impacts and impact of 7-month GA delay
- HAB payback not completed yet : O(+6 M\$) bringing back contingency to 10 M\$ (i.e. 15% of remaining work)
- Extrapolation to when we get "broke" will be set back to 2022 but not consistent with CD-4 date

#### → There is a not-negligible possibility to be re-baselined

- → COVID costs (schedule, manpower, M&S) are being captured and will be used to be supported by DOE. In our case glue cost, shipments and so on.
- → DOE IPR review expected in > 1 month. It is possible that a re-baseline will happen after that



## COVID Impact → Project Cost

Mu2e Project												
July 31, 2020												
Currency in: \$K		Cumulative to Date										
Work Package.WBS (2)	Budget	Earned	Actuals	SV (\$)	SV (%)	CV (\$)	CV (%)	SPI	CPI	% Planned	% Complete	% Spent
475.01 Project Management	23.727	23.727	24.349	0	0%	-621	-3%	1,00	0,97	84%	84%	84%
475.02 Accelerator	39.921	36.694	39.631	-3.227	-8%	-2.937	-8%	0,92	0 <i>,</i> 93	90%	83%	83%
475.03 Conventional Construction	19.753	19.753	18.591	0	0%	1.163	6%	1,00	1,06	99%	99%	99%
475.04 Solenoids	86.124	81.786	94.124	-4.338	-5%	-12.338	-15%	0,95	0,87	83%	79%	81%
475.05 Muon Beamline	10.463	10.212	10.116	-251	-2%	96	1%	0,98	1,01	55%	53%	53%
475.06 Tracker	11.006	9.835	13.681	-1.171	-11%	-3.846	-39%	0,89	0,72	74%	66%	80%
475.07 Calorimeter	4.950	4.326	4.526	-624	-13%	-200	-5%	0,87	0,96	90%	78%	73%
475.08 Cosmic Ray Veto	9.281	7.974	8.023	-1.307	-14%	-49	-1%	0,86	0,99	96%	83%	82%
475.09 Trigger & DAQ	5.490	5.426	5.907	-65	-1%	-481	-9%	0,99	0,92	90%	89%	91%
Total	210.717	199.733	218.947	-10.984	-5%	-19.214	-10%	0,95	0,91	84%	80%	81%
Management Reserve												
ТАВ												
			At Complete									
			BAC	EAC	VAC							
Report Options			28.404	28.930	-526							
Report Name: Mu2e_Earned Value_L2			44.222	47.588	-3.367							
Project File: Mu2e			19.886	18.724	1.163							
Filter:			103.342	116.583	-13.241							
Criteria: Work Package. WBS (2)			19.089	19.105	-15							
Calendar: 18 Required Set			14.792	17.106	-2.315							
Cost Sets: Scheduled, Performed, Actuals, Estimate at complete			5.526	6.221	-695							
			9.654	9.729	-76							
			6.130	6.503	-373							
			251.045	270.490	-19.444							
			300	0								
			251.345	270.490								
			22.332	3.187								
			273.677	273.677								

#### Project is 82% complete



Mu2e



## **Internation Financial Committee (IFC)**



- International Financial Committee established (Chair – N.Pastrone, INFN rep. R.Tenchini)
- Met for the first real run this summer
- Discussion still on-going howeve it looks like we will start paying our MOF starting since 2021 with a rampup phase (from 15-20% in 2021).
- I am still waiting for Nadia, Roberto to discuss about this.
- Our effort will be to count the QC (Qualified Counts) to pay our percentage (at flattop ~ 5-6 k\$/each QC)/year.
- Spare provided or being provided will be used to make INFN in-kind contributions. This should be equivalent to O(280 k\$) of MOF
- → Discussion with Nadia & Roberto will clarify if we might use the surplus in Missioni to prepare a consistent contributions to our future MOF.







CALORIMETERSYSTEM





### Progresses .. Independently from COVID (1)



- $\Box$  Work on crystals continues  $\rightarrow$  all crystals received!
- □ In the meantime we are working on preparing the SiPM gluing @ LNF
  - $\rightarrow$  Anna has shipped all toolings back to LNF and they have been received
  - ightarrow 100 SiPMs are in our hands
  - ightarrow glue is being kept on hold from the producer
  - ightarrow new freezer just arrived ightarrow see Fabio

#### **Progresses on FEE**

- ightarrow first 80 FEE boards arrived
- ightarrow first 7 FEE-MB cables in our hands and tested in vacuum + HV
- $\rightarrow$  CRR recommendations replied on Monday  $\rightarrow$  green light for production

#### Test of Light Tightness

 $\rightarrow$  done with the FEE-plate prototype, OK

#### Test of rad-hardness for Laser fibers

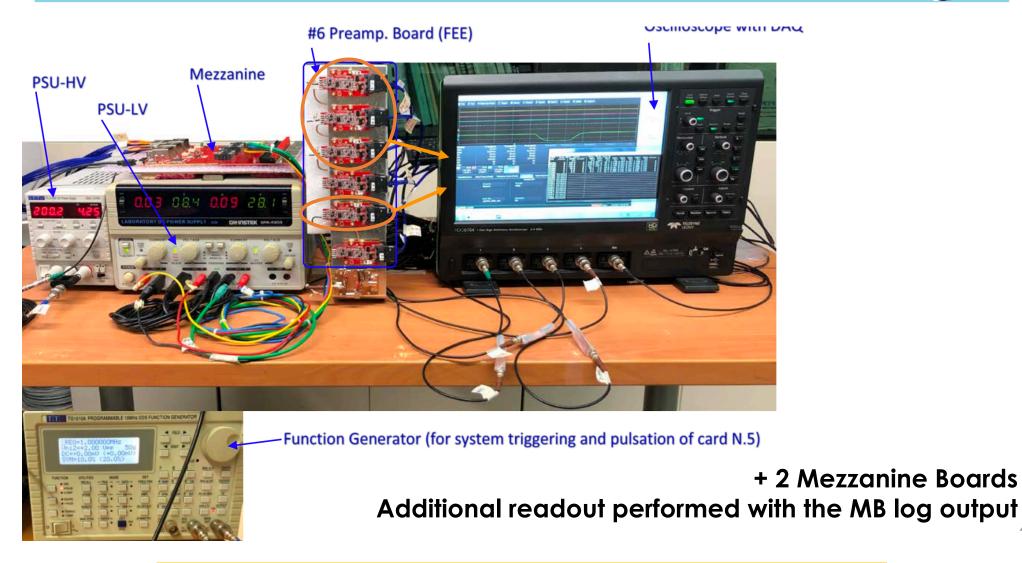
→ 10 (out of 110) fibers from the bundle prototype irradiated at 100 krad, no changes on rel. uniformity. Needle length tested. Updating drawing for prod.

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## Progresses : FEE-1 , exp test at Calliope





FEE tested up to 100 krad, MB tested up to 20 krad

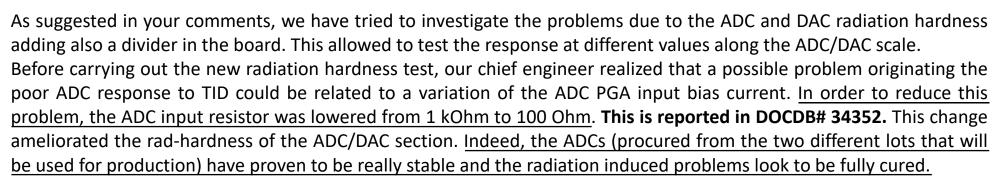


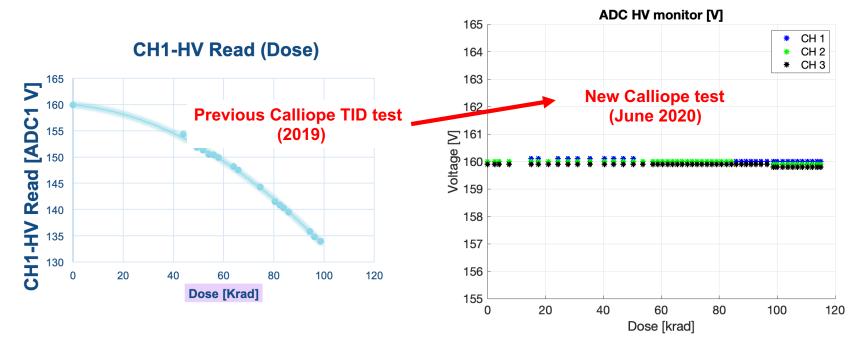
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## Progresses : FEE-1, reply to CRR, FEE rad-hard









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### Progresses : FEE-2, reply to CRR, ship to JINR



#### <u>R.4 The methods and means of shipping from Dubna (or Italy) to the US have not</u> been completed yet.

- 1. A trial run should be performed as soon as possible, in advance of the actual production, to ensure that there are no issues with imports, customs, VAT, etc. A trial run would provide time to deal with issues and contingencies.
- 2. This should not hold up the construction of amplifiers, but should be worked out well before amplifiers begin arriving from the vendor.

We have already tested a full run of shipment by sending 10 preamplifiers from LNF to JINR and from JINR to FNAL, using 10 samples from V2 pre-production. **The channels were sent from LNF to JINR on March 2020**, but due to COVID-19 outbreak, our JINR team succeeded to get hold of them only in July and **send them to FNAL on the 9<sup>th</sup> of July** by AIR-Shipment. The package was received on the 18<sup>th</sup> of July by the Channel Distribution Corportation in Benselville (IL) and then identified on the 14<sup>th</sup> of August by FNAL importing Agent (E. Besler & CO). **Finally, the package was brought to our shipment and receiving on the 21<sup>th</sup> of August.** Few mistakes were done in this first try that we have now clearly identified and propagated to the JINR group. The rules are now to write explicitly on the shipment documents:

- 1) the sentence for avoiding paying Custom duties on it:
  - "These are goods/materials subjected to Harmonize Custom Tariff Code 8543.90.88.85"
- 2) the name of our Agent (E. Besler & Co. )

#### To conclude, we now know how to handle this from LNF-JINR and from JINR-FNAL.

#### However, due to the COVID-19 situation, we are not sure to have a stable INFN presence at FNAL in the fall.

So we are still discussing if it makes sense to assemble all the SiPM-FEE structures at LNF instead than in US. In this case, we will make a triple shipment round for the preamps: LNF-JINR, JINR-LNF, LNF-FNAL. This final step will be decided during September after testing the SiPM-gluing at LNF and after deciding if travelling or not to US.



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#### Progresses : VS-test with Module-0



## We are equipping <u>37 Module-0 crystals</u> with the <u>very</u> <u>final components</u>, in order to

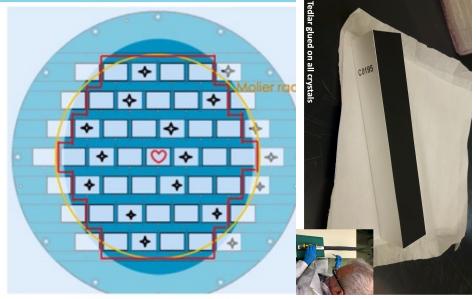
- o Test the final assembly procedure
- o Validate the electronic readout chain
- Test the prototype performances with CRs
- Check crystals performance/deterioration in 3 years

74 production SiPMs have been randomly selected (2 SiPMs/crystal)

 Completely characterized at FNAL during production QC phase (Vbr, Id, GainXPDE ...)







- 5 MB ready next week
- 10 final cable under procurement
- 3 Dirac Boards V2 will

Be used for final slice test



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## Progresses .. Independently from COVID (2)



#### A lot of progresses on mechanics and electronics

- → most of the pieces built or being built (CF ring, front-plate, IR steps, crates) interaction with Source piping in progress
- $\rightarrow$  Test of FEE plate in Pisa + test of light-tightness @ LNF
- ightarrow measurement of load test and stress on crystals in Pisa
- $\rightarrow$  drawings of IFB flange OK. Not yet green light from IT
- $\rightarrow$  Outgassing tooling @ LNF
- $\rightarrow$  Status of DIRAC project
- $\rightarrow$  Status of DIRAC firmware
- $\rightarrow$  Status of TRAD

- See Elena
- Although we managed to interact with the firms, COVID made a large hit on us. Dates for delivery have been adjusted.
- → Our best estimate today is that the Peek plate and the CF rings will be ready for December (see Fabrizio)





Mu<sub>2</sub>e

## Interactions INFN-FNAL with COVID



□ In order to complete the assembly we need to have INFN team back to US

Ron has asked me to evaluate two options:
 Opt-1. revise the schedule assuming INFN team will be back in the fall
 Opt-2. revise the schedule assuming this cannot be done and if there is any work to be done from other teams (FNAL techs/engineers, Caltech Postdocs) and in case evaluate the cost or delay in the schedule for the arrival of the INFN team.

I have done a first revision on schedule for Opt.1

Opt-2 is still being studied. However if INFN team cannot be back to US in the Fall we cannot conclude the preparatory jobs for SiPM-gluing and FEE assembly so that <u>it will be important to decide how to handle this operation first</u>. We are working to setup everything at LNF if we cannot travel to US to see if we can build a valid option for n.2

 INFN has clearly stated that travelling outside CERN is discouraged. It is not forbidden but we should prove it to go to safe places and act with all possible Covid-19 safety measures. Discussion with INFN upper management needed (see next)



## Covid-19 situation in US



Received by Julie few links to NY-Times and other sites to get information for US Covid-19 status and also for regional and local situation.



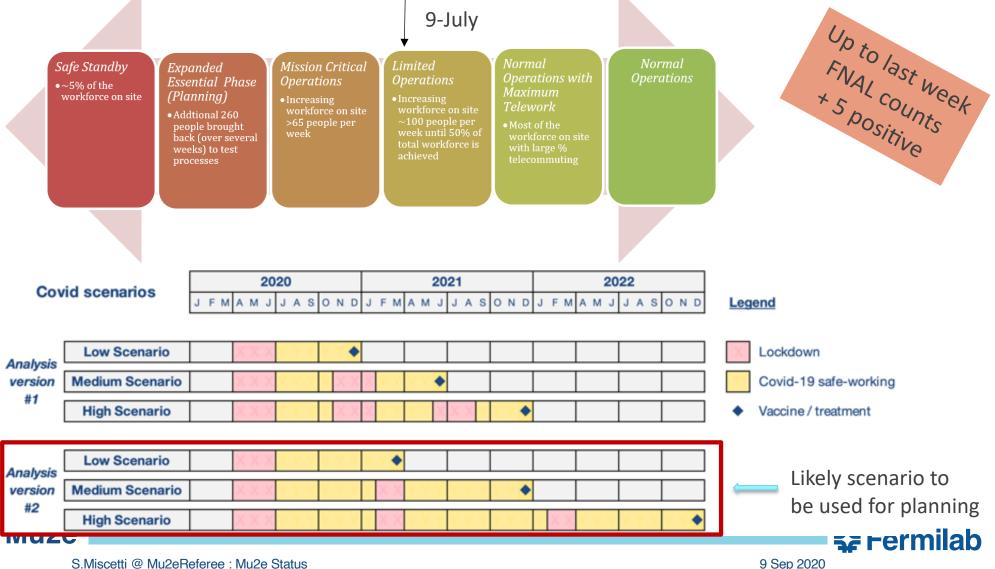
	Total. cases		Weekly Weekly cases Cases/100000 ab						
Cook	127,616	2,478	4,569	89					
Marion	286	769	33	89					
White	128	946	12	89					
Lake	14,697	2,110	603	87					
Adams	786	1,201	56	86					
Mercer	103	667	13	84					
Grundy	501	981	42	82					
Iroquois	310	1,143	22	81					
Woodford	289	751	31	81					
Montgomery	254	894	22	77					
Lee	244	716	26	76					
Brown	23	350	5	76					
Livingston	207	581	27	76					
Kane	11,354	2,133	394	74					
DuPage	14,770	1,600	678	73					

- Covid-situation in other US states are worse than in Illinois but the status is not yet as flat as it should be. Increase of new cases is still evident. Also locally near to FNAL (Cook/DuPage counties) the situation is better but not calm (80 cases/week/100000 vs 15 cases/week/100000 in Italy)
- We have to discuss about the flights and find a team that accept to travel. Then in case stay for a long term (at least 0.5 month). Travelling up to FNAL look to me as the riskiest part.
  Mu2e

### Covid-19 situation at FNAL & Covid scenarios

Fermilab is gradually re-opening. In the last months they are passed from few to 50 % of workforce. COVID-19 safety instructions have to be followed? Covid-19 testing before entering FNAL from outside.

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#### How to proceed?



#### We are now investigating if we can be @ FNAL or not before end of 2020:

- $\rightarrow$  Letter to FNAL director written on Monday to understand how to proceed with Visa
- $\rightarrow$  Reply received from Ron to prepare the list to get the FNAL permission.
- $\rightarrow$  We will now discuss with the INFN president to get INFN permission
- → Number of people travelling will be reduced to the minimum needed (3-4 people for one or two flights)

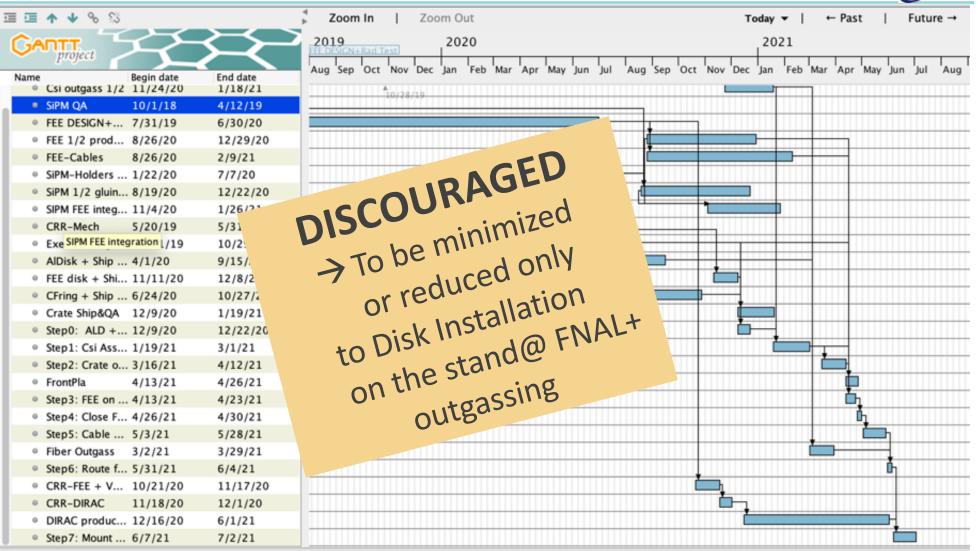
→Investigate what of the current work could be done in Italy (SiPM gluing, FEE installation on SiPM, routing cable test, mechanical dry run)

- → We are not yet ready for a final answer. Hope to have it in 10 days i.e. in time for sblocchi and restituzioni before 24/9/2020.
- Depending upon the choices we could change the mission \$\$ to give back to INFN. This could require an additional request +\$\$ for increase in transportation (request to be add sj in Pisa and LNF)
  Mu2e



#### Updated schedule w INFN team in the Fall





Assumes: we can make SipM-gluing and FEE at FNAL in the Fall. FEE-plate and Ring in December.

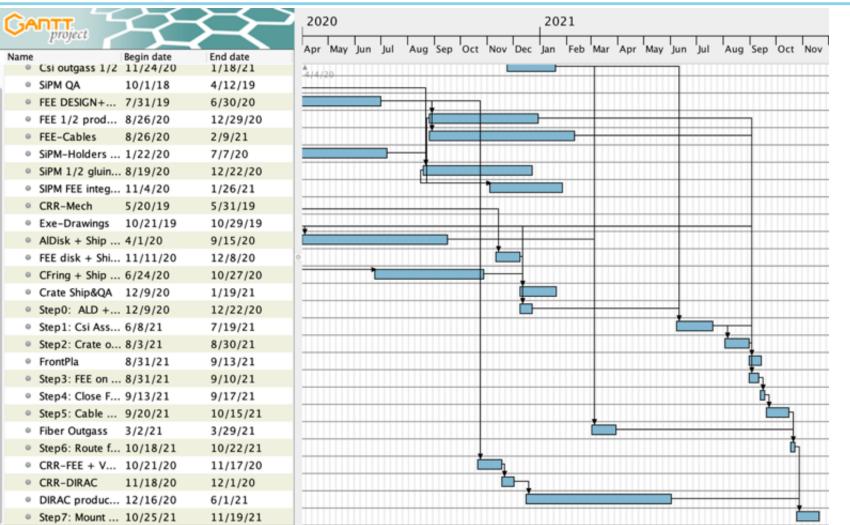
Csl mounting end-2020/beginning 2021





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#### Updated schedule w/o INFN team in the Fall



Assumes: we make SipM-gluing and FEE at LNF in the Fall. FEE-plate +IR in April-May 2021 CsI mounting is shifted to June 2021. We guess that is very "difficult" to mount mechanics w/o our team We get a hit of additional 4 months. This goes OK in within 2 months with official schedule Mu2e

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#### What we need to do in the next months?

- 0. Complete production of all mech. parts
- October-November **1. Complete CRR for electronics** 
  - a. PCB review for DIRAC
  - b. PRE-CRR
  - c. CRR for MB+DIRAC
- **Start FEE production** 2.

 $\rightarrow$  schedule under preparation.

- $\rightarrow$  expect to start Set.15, complete for Xmas
- 3. Assembly the FEE-SIPM units
- 4. Start FEE-MB and service cables production
- 5. Complete VS test at Module-0 + DCS layout
- 6. Complete Laser integration
- Start up MB+DIRAC production 7.
- 8. Prepare CRR for cooling station

Most of these tasks can be done in Italy and it is a lot of effort!!!

If we succeed to do this for the spring 2021 it will be a great progress 

Mu<sub>2</sub>e

9 Sep 2020

**娄**Fermilab



## Mu2e Calorimeter financial status



- Dedicated discussion during the afternoon session.
- However, we are completing our requests for CA
- We are practically getting to the "established"-boundary
- Additional financial coverage is now discussed also for:
  - → Normalization system (CAPHRI)

summary								
	2016	2017	2018	2019	2020	2021	TOTAL	Somma WBS
Crystals	€34,0	€228,0	€0,00	€0,00	€0,00	€0,00	€262,00	€2.890,00
Photosensors	€84,0	€605,0	€0,00	€0,00	€0,00	€0,00	€689,00	
Mechanics	€70,0	€108,0	€234,00	€70,00	€168,00	€80,00	€730,00	
FEE	€20,0	€20,0	€20,00	€340,00	€68,00	€0,00	€468,00	
WaveForm	€20,0	€5,0	€56,00	€390,00	€79,00	€1,00	€549,00	
LASER	€0,0	€0,0	€100,00	€25,00	€55,00	€12,00	€192,00	
TOTAL	€228,0	€966,0	€410,00	€825,00	€370,00	€91,00	€2.890,00	Somma Anni

→ Mu2e-II R&D

Dopo restituzioni, sblocchi e assumendo nuove richieste OK -10 kEuro to complete the Core





#### Other items: tracker

- Tracker is in a problematic State (independently from COVID)
- Help required to all Mu2e institutions and also to INFN
- → Gianfranco will summarize it In its own presentation

Stefano Miscetti Laboratori Nazionali di Frascati dell'INFN, Via Enrico Fermi 40, 00044, Frascati, Italy

#### Dear Stefano,

We very much appreciate the discussion with you and Dr. Gianfranco Tassielli regarding areas in the Mu2e Tracker sub-project where INFN can make important contributions in addition to the critical and leading contributions that INFN is now making in the Mu2e calorimeter project. In particular, in discussion with the Mu2e tracker team, Dr Tassielli has identified the following areas where the INFN team can the make important contributions which are listed here:

a) Design and production of fixturing for tracker panel testing and final assembly.

b) Design and production of fixturing for tracker plane testing and final assembly.

c) Design and assembly of the cooling ring for each tracker plane.

d) Design and production of fixturing for assembling tracker planes into the final tracker frame.

We look forward to greater engagement of INFN into the Mu2e tracker project which together with the Mu2e calorimeter are the key detector components of the Mu2e Project at Fermilab.

Sincerely,

Robert Tschirhart Level-2 Lead for the Mu2e Tracker Sub-Project Fermilab

cc: Ron Ray, Mu2e Project Manager



tsch@fnal.gov

Mobile: 630.864



## **Other items: CAPHRI-1**



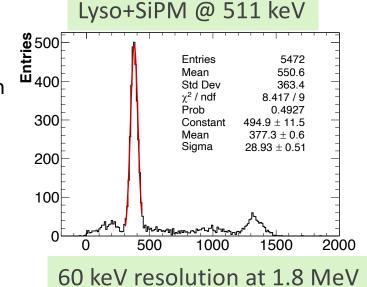
#### Caphri stands for Calorimeter Precise High Resolution Intensity detector

**The question is:** Can the calorimeter perform a precise measurement of the muon capture rate looking at 1.8 MeV photon peak? measure also the Proton Intensity Variation ?

- Basic idea: adding 2 or 4 HPC (High Precision Crystal, LYSO/LaBr) inside the calorimeter
- Useful on Disk-0 since it has good acceptance for photons coming from the stopping target
- Better if these HPCs are placed at high radius to reduce mixed-beam-background contamination
- **Dimension limited to 34x34x200 mm<sup>3</sup>** (i.e. replacing one Csl crystal)
- No coupling with grease to sensors (keep same quality used for CsI crystals)

#### What has been done:

- → Experimental test of prototypes for energy resolution
- → Studied MC to evaluate beam-background on selected position
- → Determined Muon Capture monitoring capability at 1.8 MeV
- → Determined the monitoring of POT intensity looking with the same data stream at integral calorimeter variables (Nhits)
- → Calculated the data-throughput needed to save this to a dedicated "data-stream"

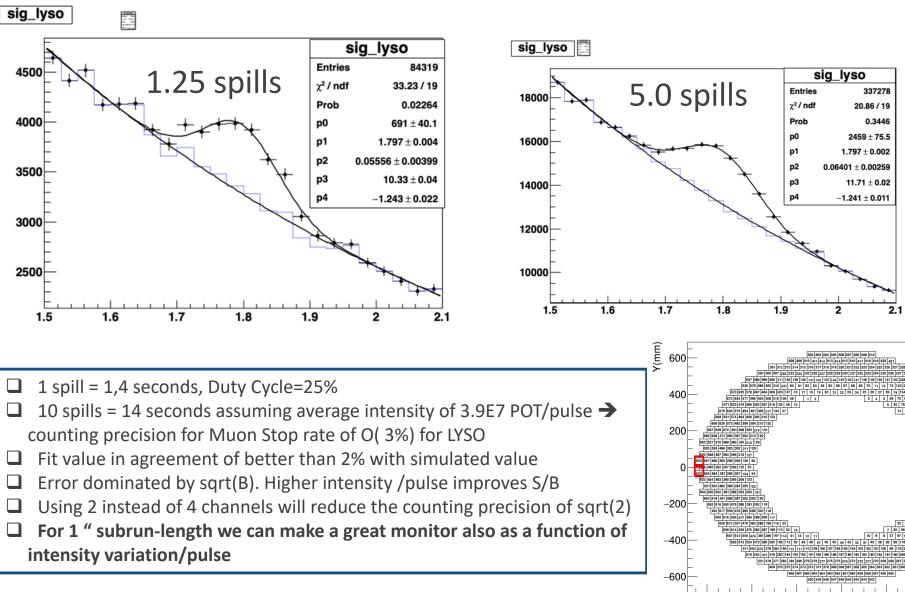


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### **Other items: CAPHRI-2**







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-200

400

600 X(mm)

-400

-600

~~ 10 kć



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# SU2020: Why do we need it?

Latest blessed sensitivity evaluation for  $\mu \rightarrow e$ - dates back to July 2017 (doc-db 7464-v13).

Since then many things have changed:

- run plan (Run I LBNF 2 years shutdown Run II)
- beam intensity profile: SDF=60% and initial reduced intensity
- reduced shielding (regular concrete) in Run I
- Hayman 2 production target: ~20% less stopped muons per POT
- Thicker AI foils in stopping target: ~5% more stopped muons
- CRV aging

Mu<sub>2</sub>e

- proton and deuteron yield from muon capture (ALCAP+TWIST)
- ECAL waveforms and reconstruction software

No blessed sensitivity evaluation for  $\mu \rightarrow e+$  exists



### SU2020: What do we want to do?

We want to update what has been done for CD3 for  $\mu \rightarrow e$ - and extend the study to  $\mu \rightarrow e$ + This implies evaluation of:

- Single Event Sensitivity (SES)
- 90% CL upper limit
- $5\sigma$  discovery reach

And must be supported by

- Background evaluation with statistical and systematical errors
- Exaustive Documentation

Given the uncertainty on the detector upgrades for Run II we focus our effort on **Run I** (before the 2 years shut down)



3

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# Conclusions-1: MU2E general



#### □ The Mu2e project is 82% complete but COVID-19 has badly impacted us

- → Winding of PS/DS are on-going. Still their delivery poses serious delay
- → TS is proceeding well. TSU fully installed in HAB building
- ➔ Tracker panel production is getting momentum but with a forecast of tracker completion for spring 2022.
- Calorimeter Assembly has been delayed by 1.5 years w.r.t. its original schedule and starts impacting the schedule. Still it is at least six months ahead of tracker. Estimated installation fall 2021.

□ A continuous drop on contingency is happening since beginning 2019

- → albeit HAB pay-back there is a serious risk to be re-baselined (DOE-IPR 2020)
- $\rightarrow$  interaction with g-2 schedule are becoming evident
- □ Mu2e current schedule foresees:
  - ➔ installation of the detectors for end of 2021
  - → a long phase of commissioning in extracted position
  - + commissioning with beams at end of 2023



#### □ Mu2e Calorimeter is progressing well with:

- $\rightarrow$  Conclusion of crystal delivery
- $\rightarrow$  Startup of FEE construction
- $\rightarrow$  Construction of the large mechanical part
- $\rightarrow$  Completion of CRR for digital electronics

Difficulty is now related to the travelling to US due to Covid-19 for assembling the disk

We will work in the next weeks to investigate better the situation and proposed a recovery plan.







ADDITIONAL ADDITIONAL MATERIAL





# **Other issues**



- Accelerator : ESS and g-2 schedule
- LY of CRV



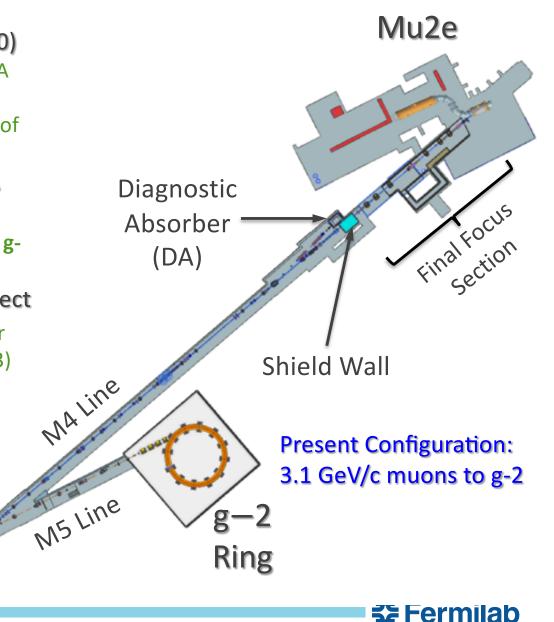


### Mu2e Project → Mu2e Operations



#### Three Remaining Phases:

- 1. M4 Commission to DA (Fall-Winter 2020)
  - Single turn 8 GeV protons extraction to DA with g-2 kicker
  - Mu2e installation continues downstream of M4 shield wall
- Resonant Extraction: commission to DA (after g-2 run ~2021)
  - ESS installed at D30 (requires removal of g-2 extraction kicker) – Off Project
- 3. Resonant Extraction to target Off Project
  - Commission beam to target after detector and detector shielding installation (~2023)



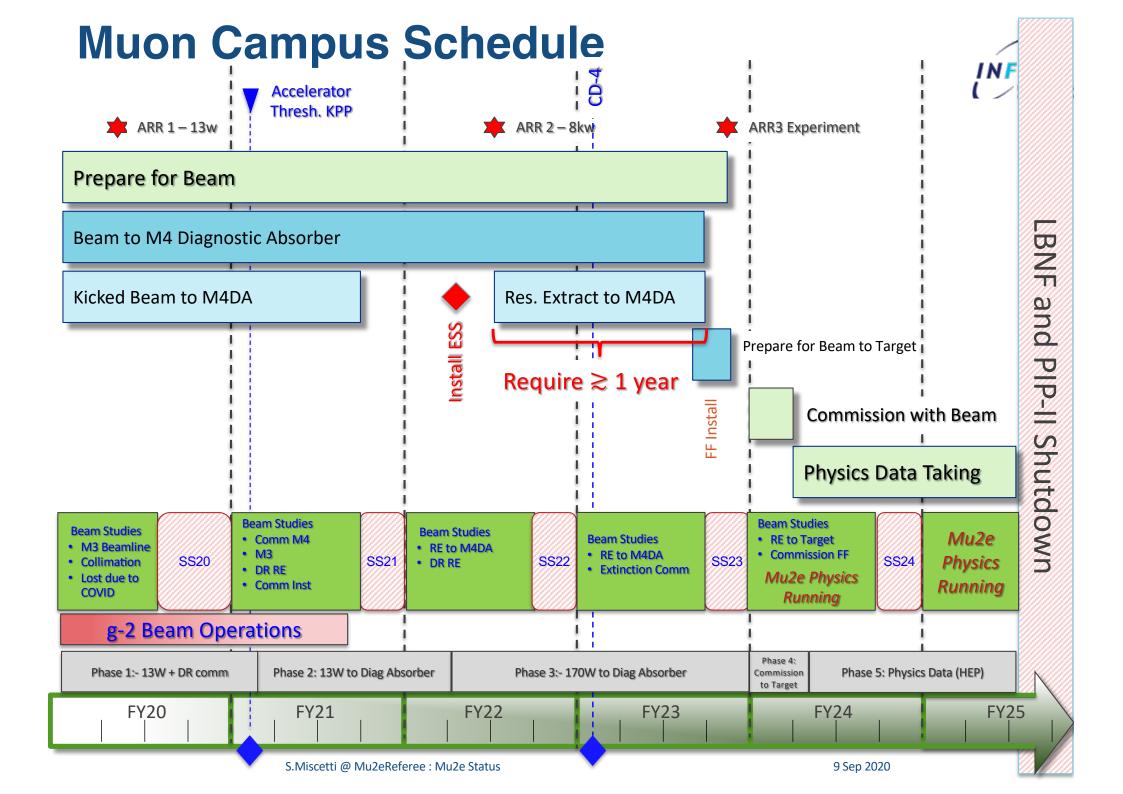
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**Delivery Ring** 

Kicker/ESS not shown

wuze



# **Electrostatic Septum and new kickers**



- ESS is very difficult to build/run and is in delay (Jan 22 instal)
- If g-2 wants to have its Run-5 we will collide
- Very good interactions btw spokes to find solutions
- 1 new kicker will solve the problem providing flexibility btw g-2 and Mu2e running
  - $\rightarrow$  the new Kicker is under design
  - $\rightarrow$  Cost is of O( 1 M\$)

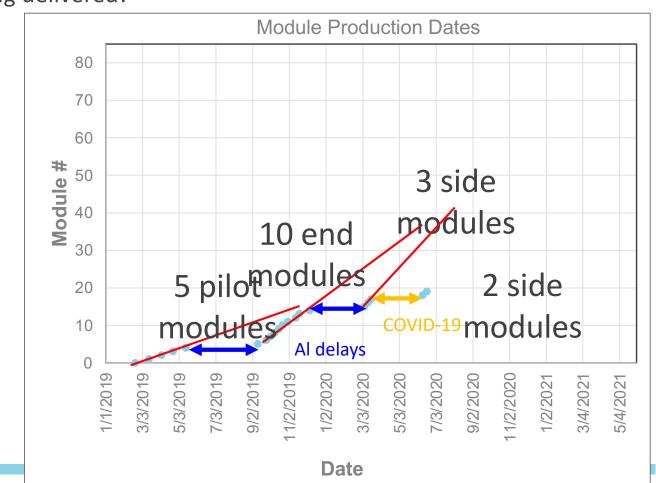




### **CRV Module Fabrication (June 2020)**

- After a hiatus of 86 days UVA is back in production two weeks ago (Note: Al unavailability delays were 120 and 91 days)
- We have made 20/83 (24%); 2 since shutdown
- Note: Al is being delivered!

Mu<sub>2</sub>e







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# CRV

- We've all heard a lot about light yield
- Dropping ~8.9%/yr from source; much less from test beam
- Size/source of yield drop hard to pin down: doc-db 28266:

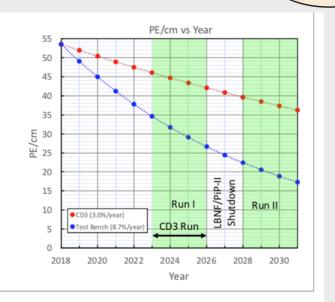


Figure 26: Light yeild per cm vs year. The red curve is the CD3 estimate; the blue curve our best estimate of 8.7%/year from bench-test studies Shaded regions refer to Run Plan A.

It is difficult to reconcile these results to a consistent narrative. What one can conclude is that significant aging is not unusual; the opposite is indeed the case. In fact, small aging rates are unusual, the MINOS aging of 3%, for example is the low end of the spectrum. There does not seem to be any particular aspect of scintillation counter, read out with or without WLS fibers, that appears to cause aging.



- Options summarized by CRV group in doc-db 28266
  - bigger diameter fibers
  - "pot" counters to slow down exposure to air
  - other options
  - everything has advantages/disadvantages/different risk/reward levels
  - and what do we do post-LBNF shutdown, or if shutdown is delayed and counters are degrading?



