



Progress Report on SX from FNAL

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US/Japan Collaboration meeting on Slow Extraction

November 16, 2020

At Zoom

Outline

- General news
- Main news in Mu2e/RE project
- Progress in Mu2e/Accelerator upgrades
- Resonant Extraction progress and issues

COVID-19 impact

- “Safe Standby” mode in the lab, starting March
- Started slowly expanding operations in May
- Reached close to 100% operation in August *
- Reduced production efficiency
- Still in “Limited Operations “ phase (DOE limit 50% presence) *

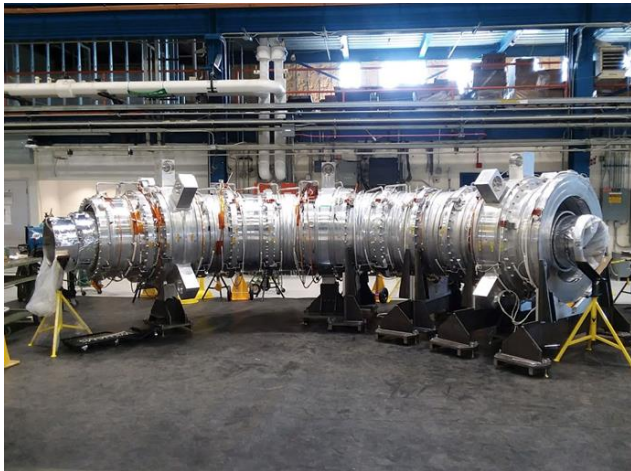


Mu2e impact

- About 30% hit to the work efficiency in 2020
- Biggest impact: TS and Detector construction
- Reduced workforce at the collaborating universities
- Reduced travel and participation of the international collaborators
-
- Solenoid production schedule slippage remains the main issue

Mu2e progress

- Solenoid production at General Atomic continued
- Transport solenoid is on track
- Heat and Radiation Shield production continued – on track
- PS and DS feedboxes delivered
- All the Calorimeter crystals delivered



Assembled TSU cold mass



PS and DS cryo distribution boxes



Heat and Radiation shield –
final assembly

Mu2e/Accelerator upgrades

- Accelerator operations paused during the first stages
- Accelerator Summer Shutdown: slow start, many issues
- All volume of the tunnel work for Mu2e completed

M4 beam line – Recent progress

- Ready to run beam to the Diagnostic Absorber
- Continue installations in the Final Focus



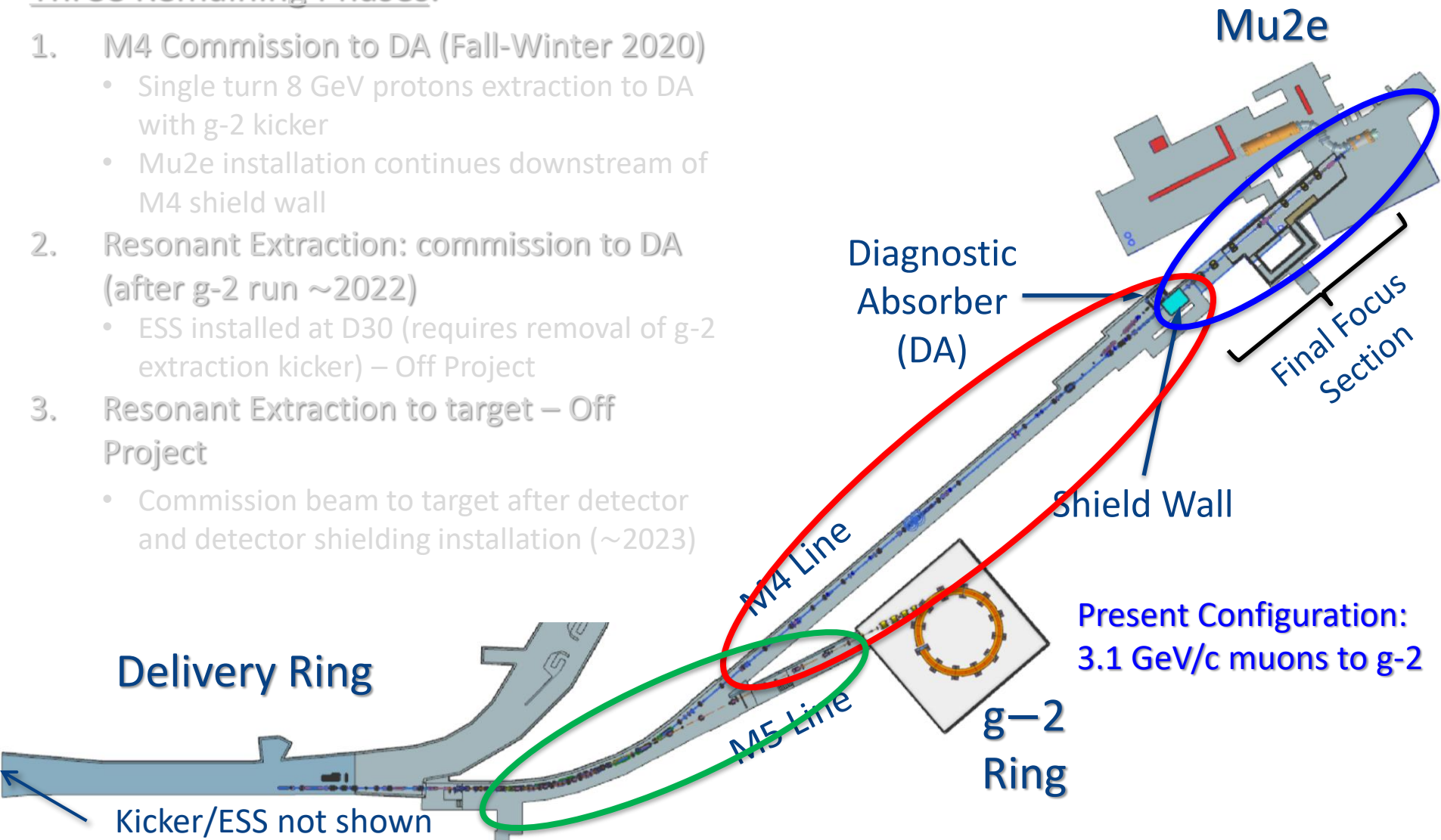
Views in the M4 beam line

Mu2e Operations → M4 Beam line

S. Werkema

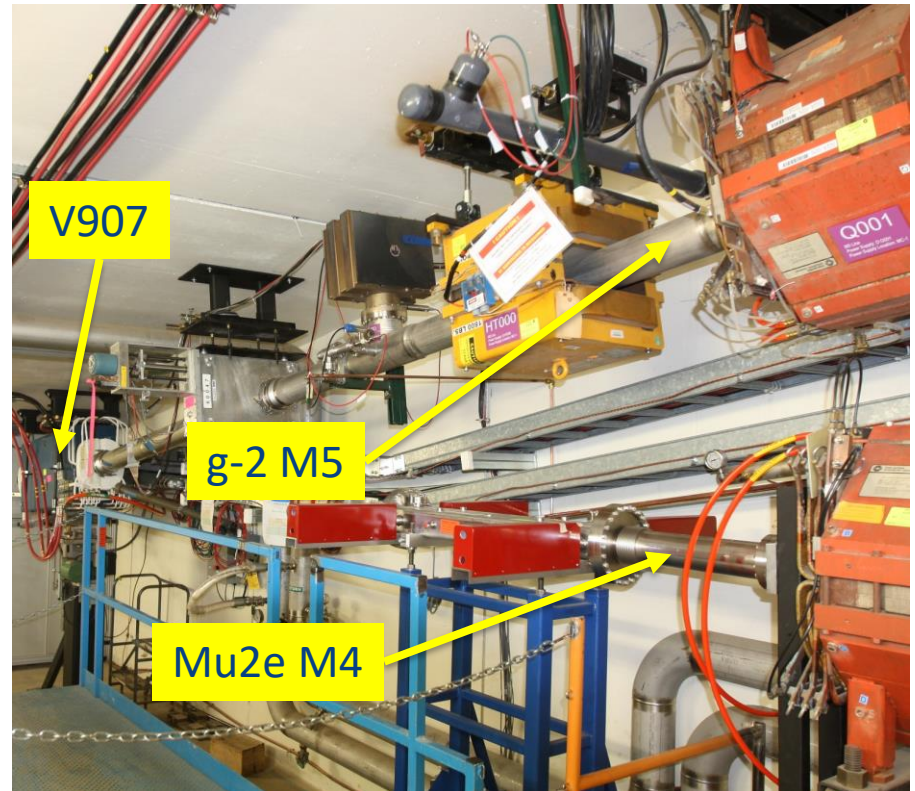
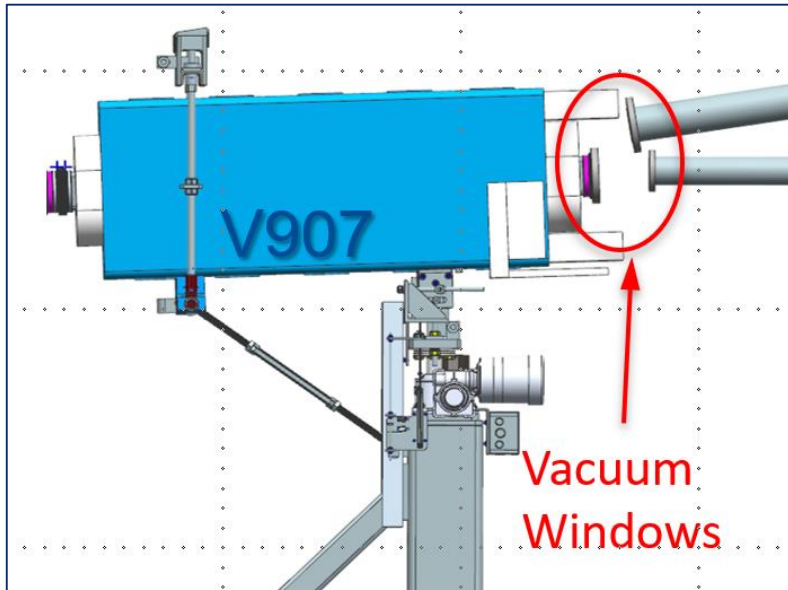
Three Remaining Phases:

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
2. Resonant Extraction: commission to DA (after g-2 run ~2022)
 - 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)



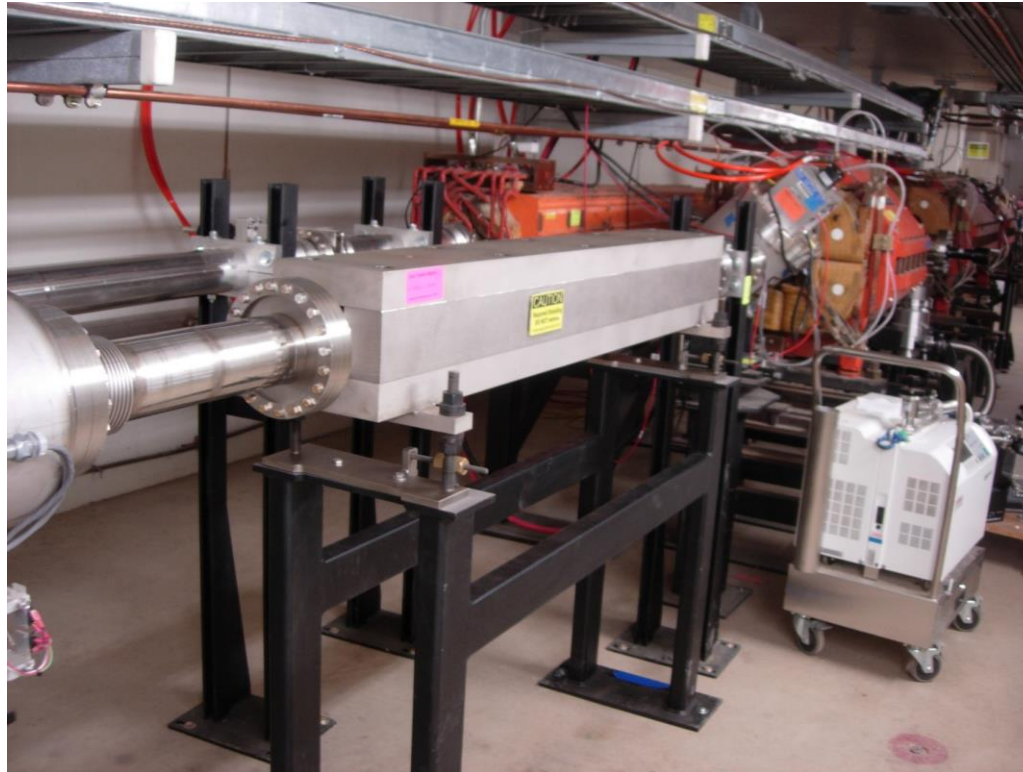
M4 beam line: switch at V907

- Missing part: vacuum windows
 - Fabricated, ready to install
 - Will install after g-2 starts running, to see the impact on their performance



Beam split into M4 and M5 from the V907 dipole. M4 continues horizontally. Extinction tail collimator is in the center of the picture (red actuator covers)

M4 beam line: Radiation safety mask



The M4 beam stop mask is installed. This is the critical device for ensuring that the shadow of the beam stop (upstream) fully covers the hole in shielding wall (downstream), so no beam can penetrate to enclosure beyond the shield wall during commissioning to the Diagnostic Absorber.

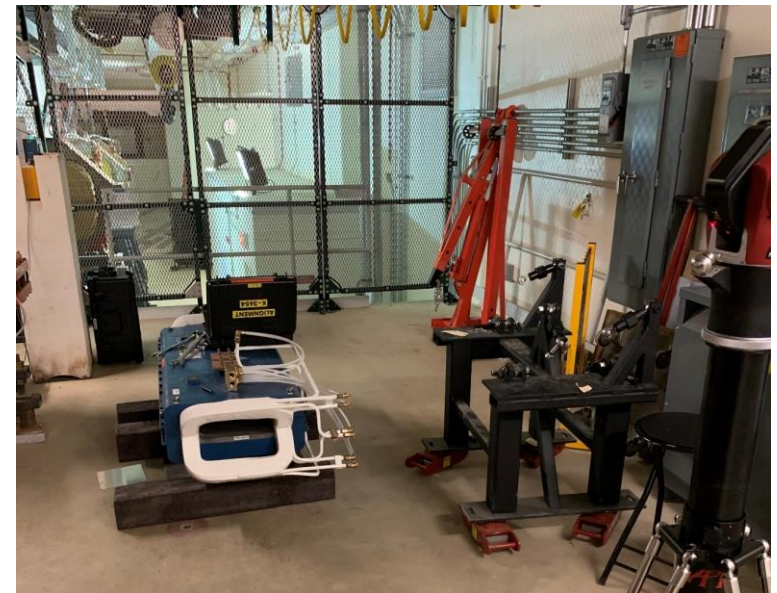


Installation continues in the Final Focus

Vacuum installation is currently underway with plans to be completed by April 2021.



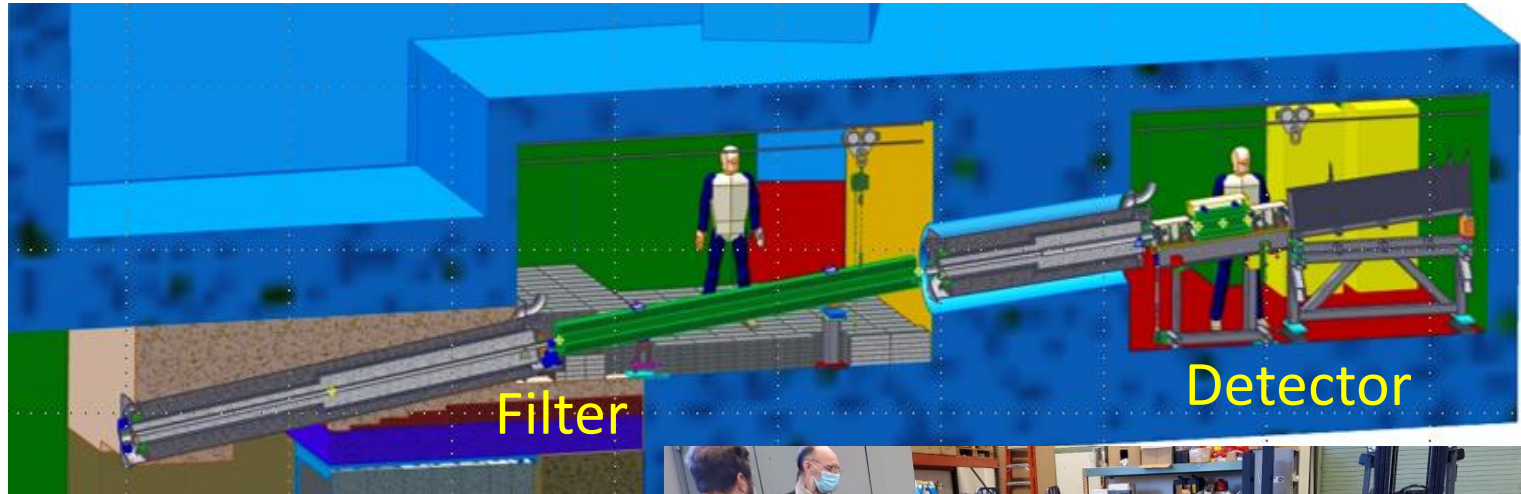
IDVW trim magnets from Buckley have been fabricated and tested. 4 of 7 have been installed.



Last large CDA magnet waiting to be installed in the M4 final focus

Accelerator Upgrades: Extinction Monitor

- Detector components are ready
- All parts of the Filter collimator arrived in October



- All in good shape
- Installation plan updated
- Will proceed with installation after the new plan is approved



Total Score Chart

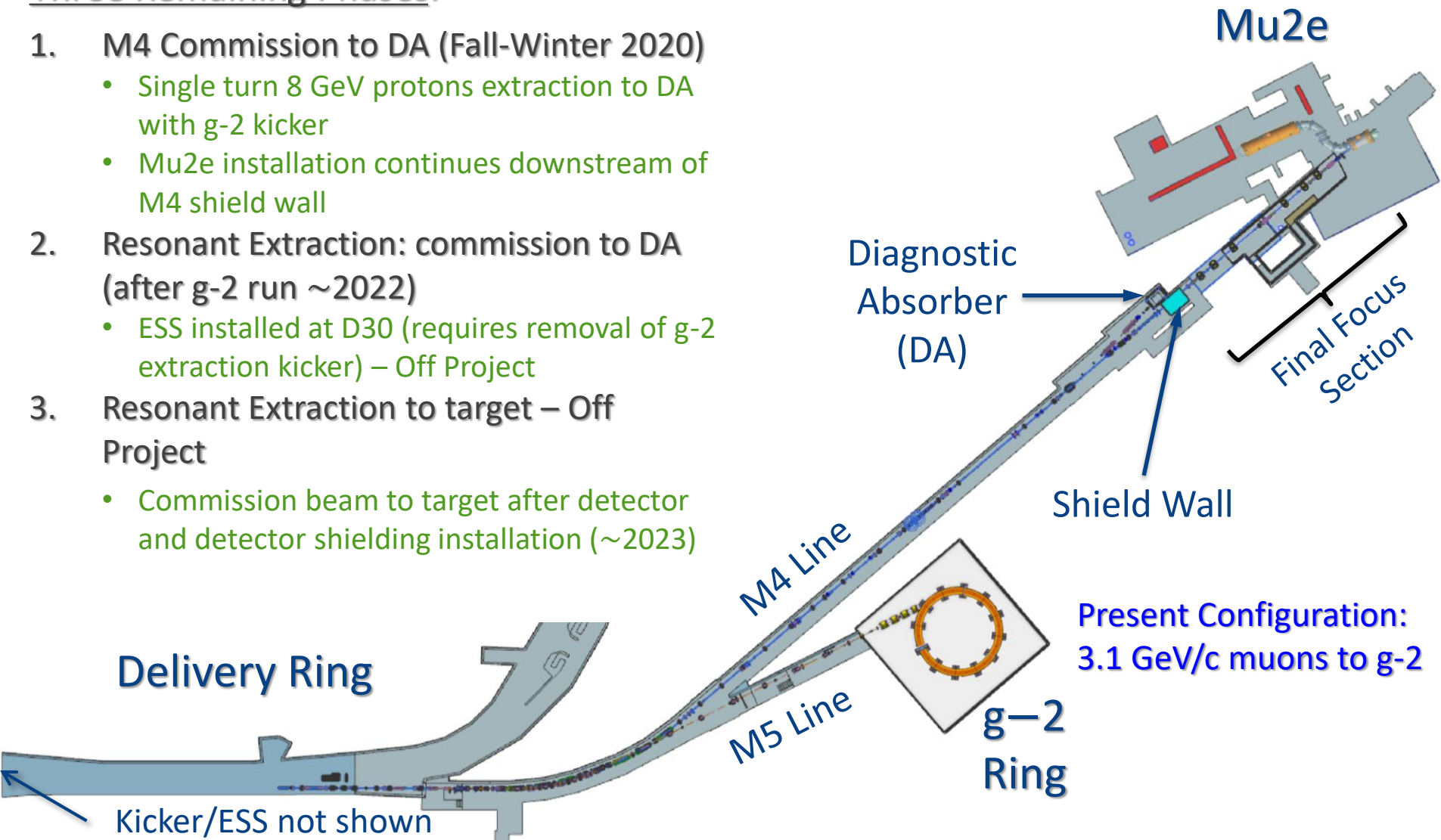
	% Complete	Remaining CRRs/ All
Instrumentation/Controls	95%	done
Radiation Safety	78%	1 (4)
Resonant Extraction	76%	1 (4)
RF	87%	done
Beam line	84%	1 (6)
Extinction	83%	done
Target Systems	80%	2 (8)
Accelerator Upgrades	83%	5 (26)

Mu2e Project → Mu2e Operations

S. Werkema

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Muon Campus Schedule

S. Werkema

★ ARR 1 – 13w

Accelerator
Thresh. KPP

★ ARR 2 – 8kw

CD-4

★ ARR3 Experiment

Prepare for Beam

Beam to M4 Diagnostic Absorber

Kicked Beam to M4DA

Res. Extract to M4DA



Install ESS

Require ≈ 1 year

FF Install

Prepare for Beam to Target

Commission with Beam

Physics Data Taking

Beam Studies
• M3 Beamline
• Collimation
• Lost due to COVID

SS20

Beam Studies
• Comm M4
• M3
• DR RE
• Comm Inst

SS21

Beam Studies
• RE to M4DA
• DR RE

SS22

Beam Studies
• RE to M4DA
• Extinction Comm

SS23

Beam Studies
• RE to Target
• Commission FF
Mu2e Physics Running

SS24

Mu2e Physics Running

g-2 Beam Operations

Phase 1:- 13W + DR comm

Phase 2: 13W to Diag Absorber

Phase 3:- 170W to Diag Absorber

Phase 4:
Commission to Target

Phase 5: Physics Data (HEP)

FY20

FY21

FY22

FY23

FY24

FY25

LBNF and PIP-II Shutdown

Status of the SX preparations

Resonant Extraction: Magnets and Power supplies

- All sextupoles are installed in the Delivery Ring
- All cable work in the tunnel is completed
- This completes installation of all magnets for the Slow Extraction



Resonant Extraction: Spill Regulation system

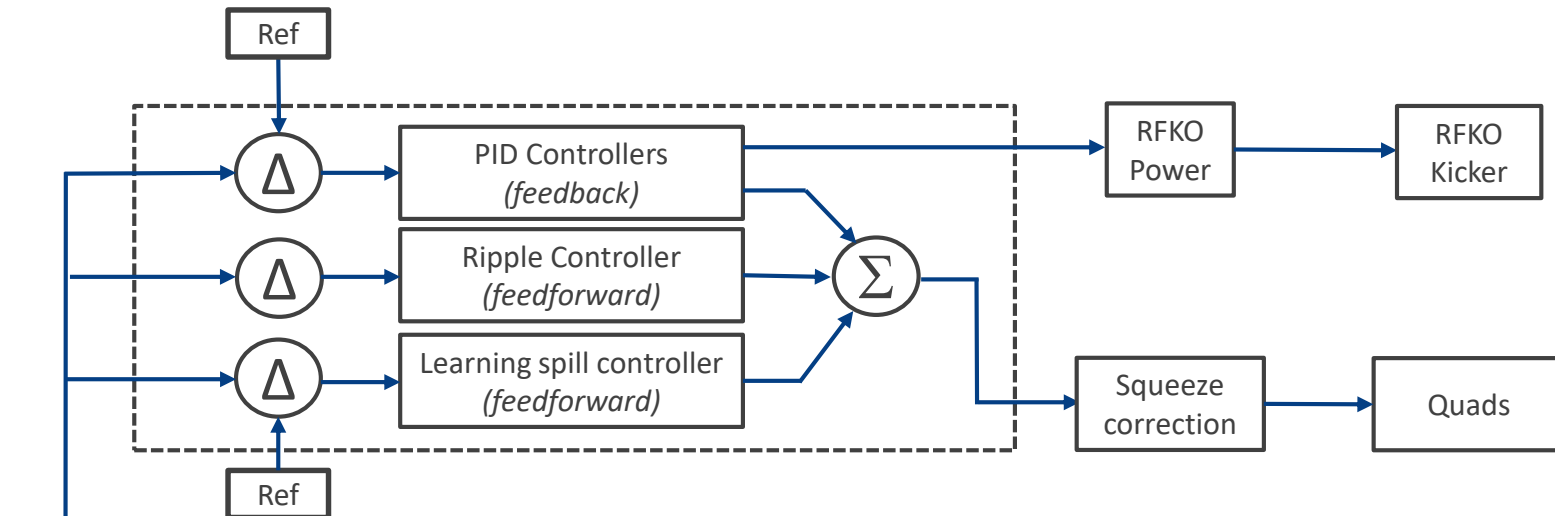
- RFKO* kicker installed in D10
- Spill Monitor (WCM*) moved to D10
- Power amplifiers for RFKO procured

*WCM=Wall Current Monitor

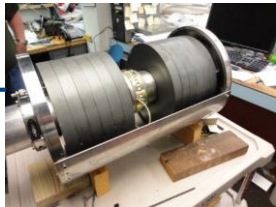
*RFKO=RF Knock-Out, spill regulation device



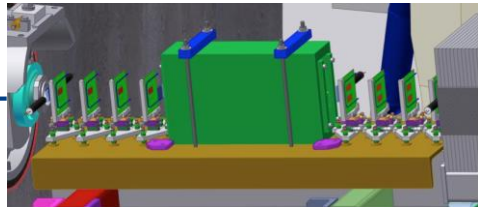
Resonant Extraction: Spill Regulation system



Spill Monitoring



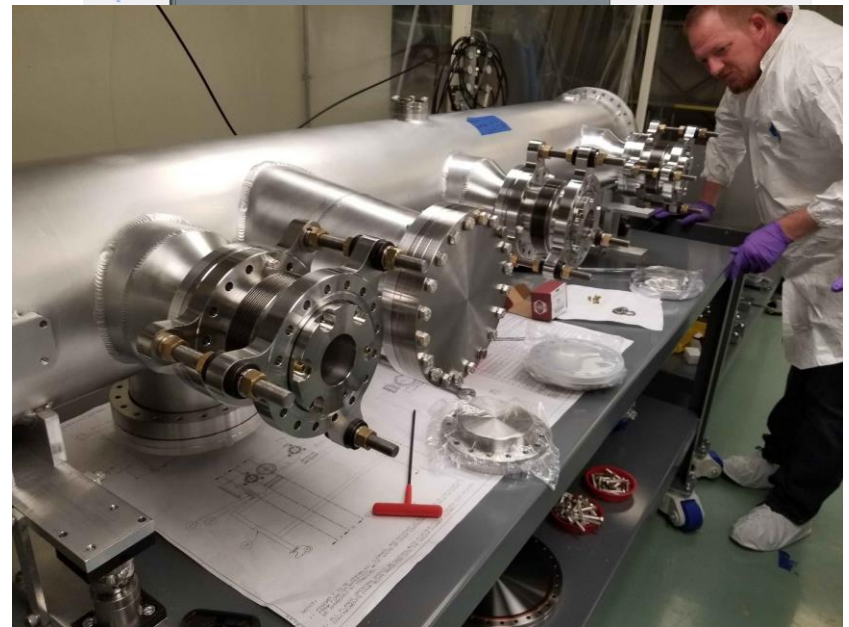
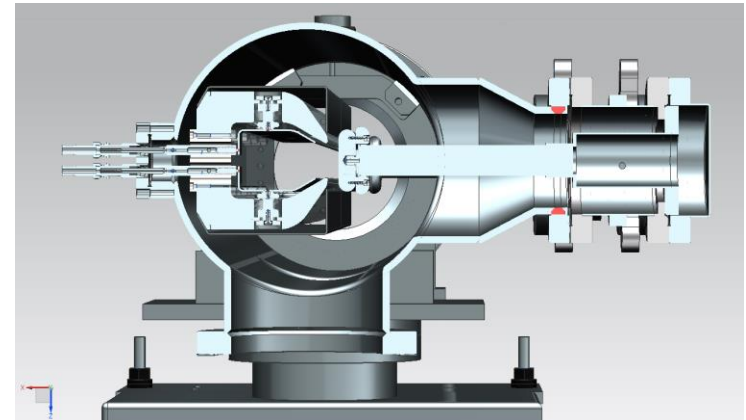
Beam line spill monitor (a la J-PARC)



- SRS fully concentrated in one SB
- Architecture: Aria10 SOC/SOM board
- Optical input for SM signal
- Up to 10kHz BW
- Possible ML applications
- Board received from fabrication

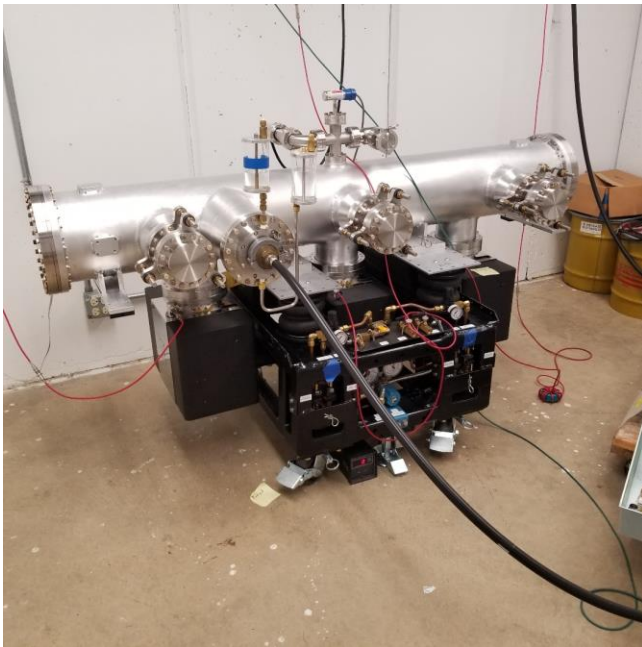
Electrostatic Septum

Number of septa	2
Total length	3m
Total kick	0.002 rad
Main Voltage	100kV (150kV)
Clearing Field	10kV (20kV)
Motion system	External
Septum plane	Foils
W/Re	25u X 1mm
Spacing	2.5mm
Tension/Retraction	2lb
Retraction	
Single spring	
Retraction time	2ms
Diffuser	0.5m

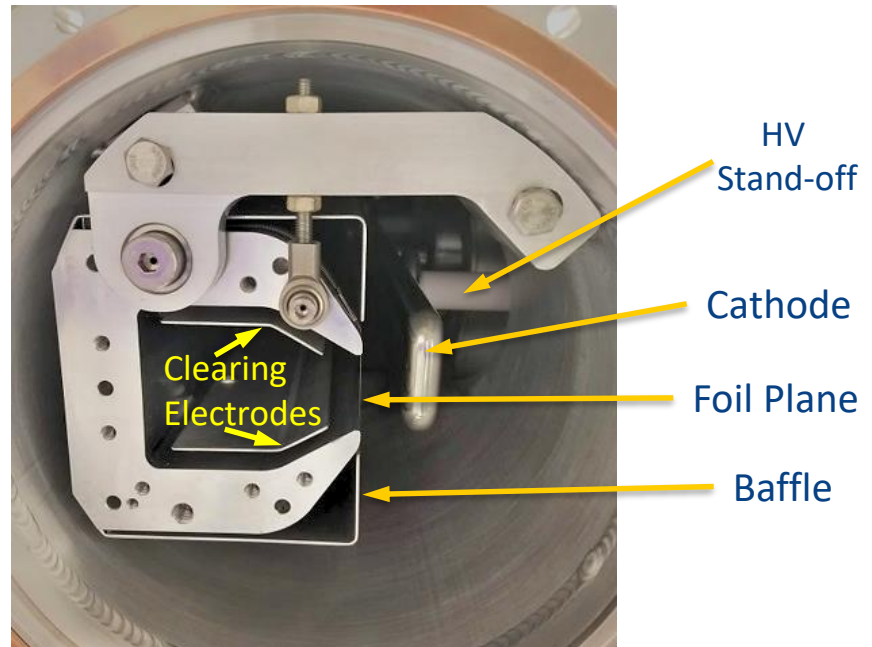


Resonant Extraction: ESS prototype

- Testing is in progress at the NWA – the AD vacuum lab
- Need to demonstrate the $>100\text{kV}$ capability
- Several issues have been identified
- Task force formed in May
- Due to technical issues testing took long time



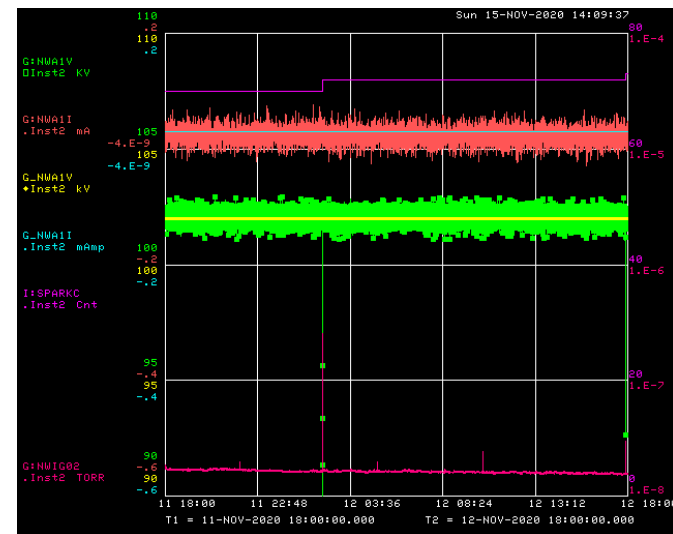
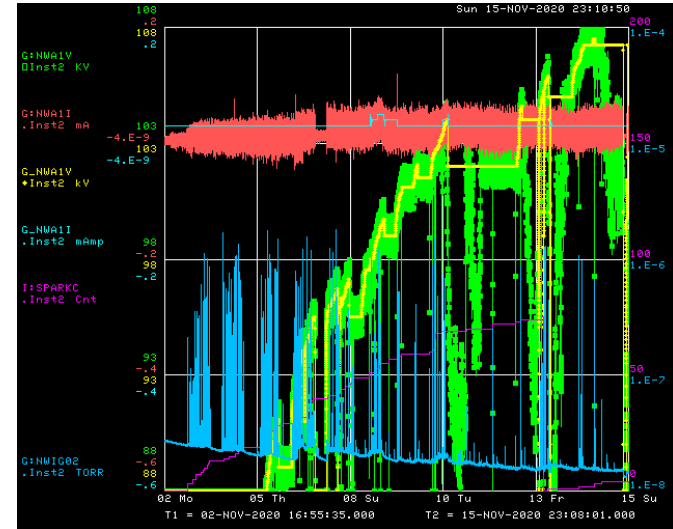
Septum prototype in the testing cave



Septum view inside

Conditioning the full septum - November

- The goal reached this week
- Lots of stories in this plot
- Max reached so far HV 107kV
- Stable run 24 hours at 102kV
- Three main concerns:
 - Vacuum activity
 - Huge long vacuum spikes
 - High current bursts
- We are preparing to start the septa fabrication
- Details in a separate talk



Summary

- Consequences of the CY2020 impact on the lab and the Mu2e project are still being evaluated
- At this point Mu2e implementation continues
- All the summer shutdown tunnel works completed as planned
- Technical problems with the septum held the production. Gearing towards the septum fabrication now.

Backup slides