

# SoLID Collaboration Meeting '25 – Pre-R&D and Test Beam Plan

January-10-2025



Klaus Dehmelt - TJNAF

# Pre-R&D Activities

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- GEM readout → more general MPGD readout
- Tracking options
- MCP-PMT

→ to be combined with a Detector Beam Test in Hall C

# Pre-R&D Activities – MPGD Readout

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- GEM readout → more general MPGD readout
- Alexandre reported
  - Highest priority : GEM chip
    - Evaluate SALSA chip in high background environment
    - Continue testing VMM board signal to noise
    - Develop dedicated ASIC chip for GEM
    - Test with uRWell

# Pre-R&D Activities – MPGD Readout

- GEM readout → more general MPGD readout
- Alexandre reported **Salsa**

- Collaboration of Irfu CEA Saclay and U. of Sao Paulo.
- SALSAs
- 64-Ch, updated design from SAMPA V5, migrating to 65 nm CMOS.
- Peaking time: 50 – 500 ns
- Inputs:  $C_{in}$  optimized for 200 pF; Rates: 25 kHz/Ch; Dual polarity.
- ADC: 12 bits, 10 – 50 MSPS.
- Extensive data processing capabilities.
- Triggerless and triggered operation.
- Power: 15 mW/Ch
- Gbps links.
- I2C configuration.
- Evaluation board available this year - Might want a dedicated SoLID version to match tracker low gain operation and handle high rates at input
- Can bypass analog part but need to develop analog front end
- Data links somewhat limited
- Might want a dedicated version of SALSAs

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# Pre-R&D Activities – MPGD Readout

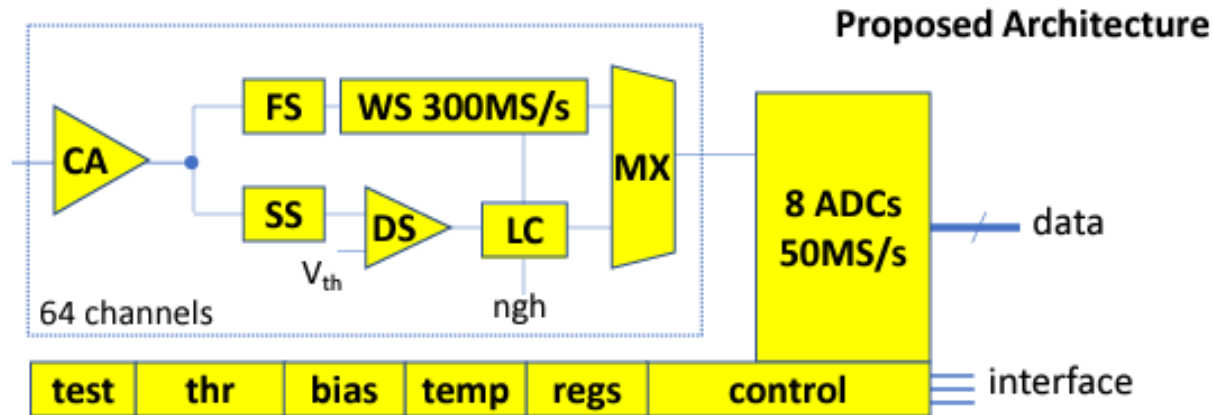
- GEM readout → more general MPGD readout
- Alexandre reported VMM test
  - Ordered two test board 1500 \$ x 2
  - Build 6 SoLID prototype boards
  - Evaluation board : can look at data with detector small subset of channels
    - Issue with external trigger but waiting for new firmware
    - Can check pedestal width
    - Signal to noise with detector with source and cosmics
    - Look at direct readout signals for 12 channels of detector
  - Prototype development for data performance, test direct output with detector and X-ray source

# Pre-R&D Activities – MPGD Readout

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- GEM readout → more general MPGD readout
- Alexandre reported New potential dedicated ASIC
  - High luminosity running need to run
  - Pile-up and deadtime can be significant
  - Dedicated chip
    - Optimized gain and dynamic range
    - Optimize shaping time for high rate operation : from 50 ns to 25 ns or better
    - Zero dead time
    - High speed links to allow streaming

# Pre-R&D Activities – MPGD Readout



## CA: charge amplifier

- optimized for 50-200pF
- programmable gain 25fC to 250fC

## FS: fast shaper

- programmable 5-20ns

## SS: slow shaper

- for discrimination (zero suppression)
- programmable 20-100ns

## DS: discriminator

- trimmable per channel
- external trigger option

## WS: waveform sampler

- 128 sampling cells (127 effective)
- continuous sampling until trigger
- 300MS/s → ~ 400ns waveform
- programmable pre-post trigger samples

## LC: local control logic

- internal or external trigger
- neighbor (sub-threshold) logic

## ADCs

- 8 operating at 10-bit 100MS/s
- waveform conversion time ~ 2.5μs

## Data

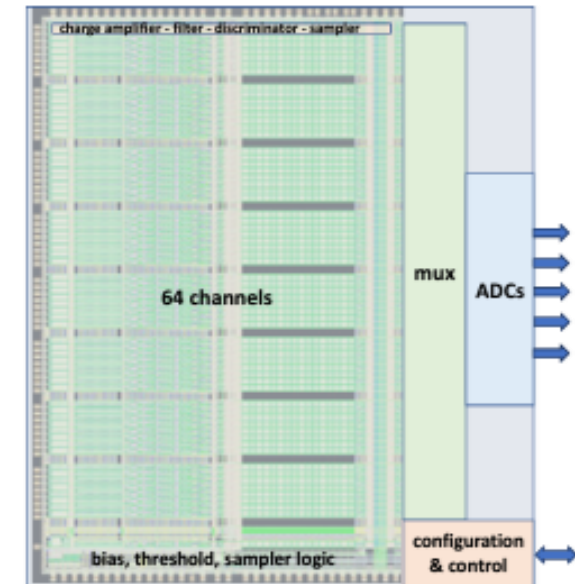
- channel, trigger, 127 samples = 1,280 bits per waveform
- up to 8 waveforms with sub-threshold neighbors = 10,240 bits
- up to 8 SLVS outputs operating in DDR at ~ 500MS/s
- conversion/readout time (dead time) ~ 2.5μs per event
- maximum event rate ~ 330kHz
- maximum data rate ~ 4Gb/s

## Architecture

- event-driven analog/digital with acquisition/readout
- SEU tolerant register and logic
- DSP-ready

## Power, Size, Technology, Schedule

- power consumption below 3mW/channel
- anticipated die size ~ 6x8 mm<sup>2</sup>
- technology TSMC 65nm 1.2V
- development time ~ 24 months (1<sup>st</sup> proto in 12 months)



## Design

- charge amplifier, shapers and samplers based on verified architectures
- ADCs from collaborative effort
- first prototype design time
  - ~ 12-13 months plus ADCs
  - ADC can be parallel effort
- second prototype design time
  - ~ 4-5 months

## Key Features

- power-efficient analog zero-suppression
- efficient data generation and transfer
- highly flexible, highly programmable



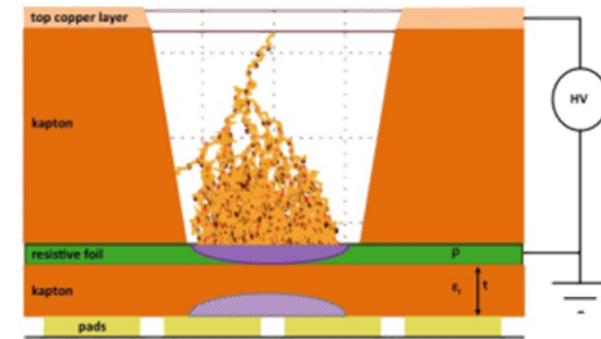
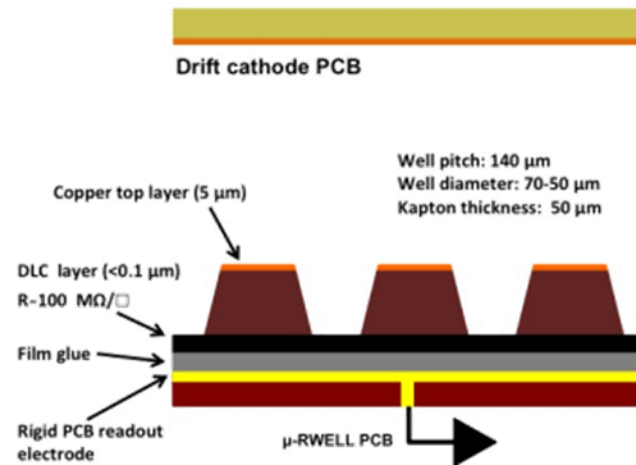
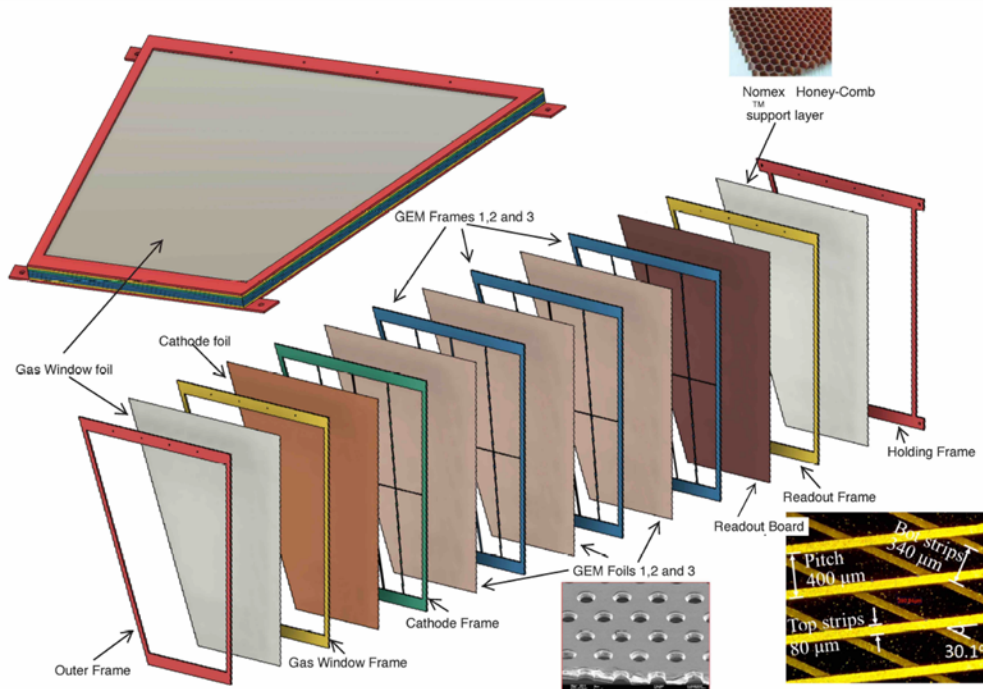
# Pre-R&D Activities – Tracking Options

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- Tracking options
- Huong and Yi reported

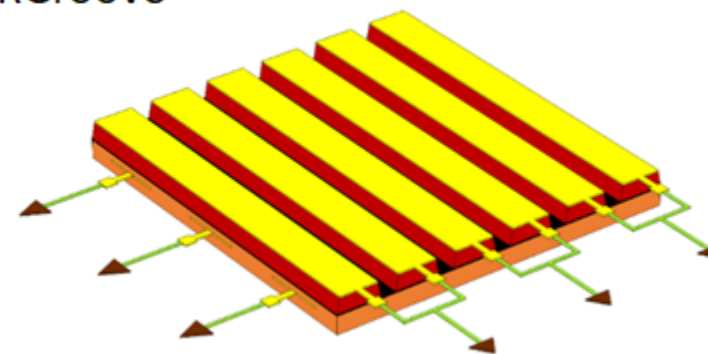
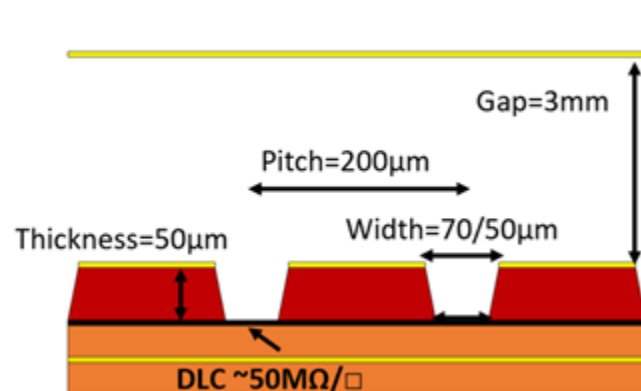
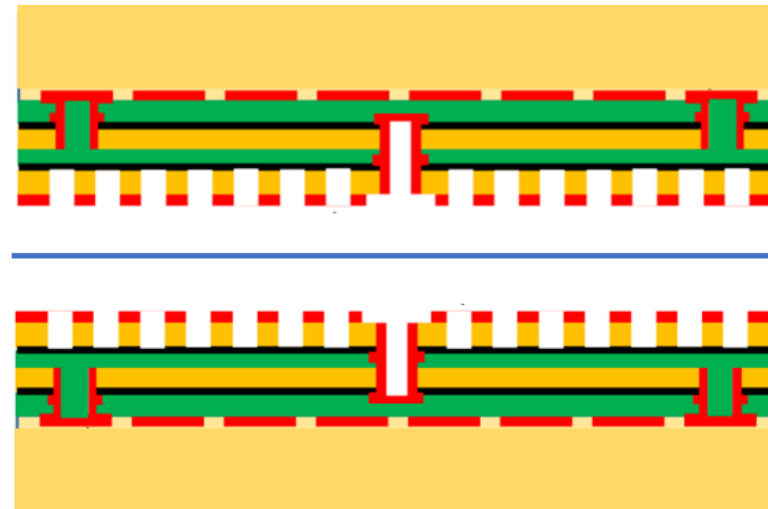
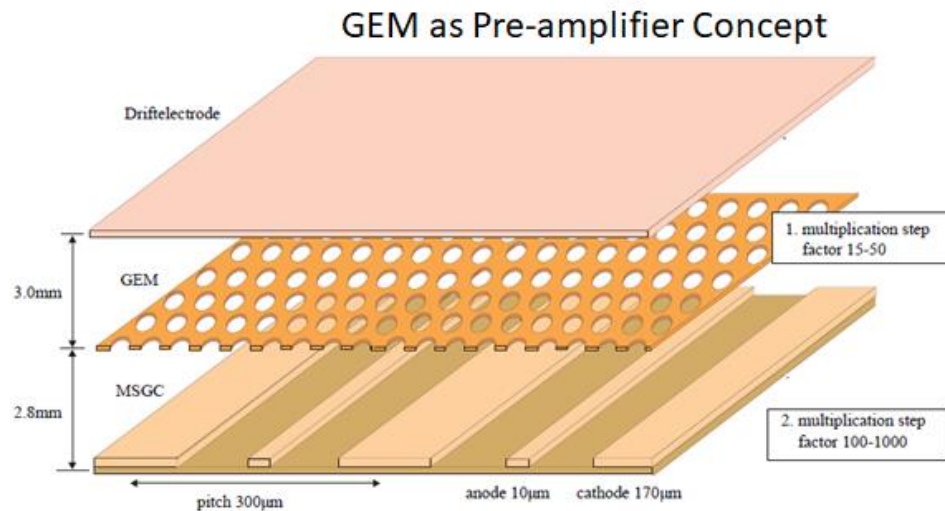
# Pre-R&D Activities – Tracking Options

- Default configuration: Triple-GEM
- Alternative configuration:  $\mu$ RWell and derivatives



# Pre-R&D Activities – Tracking Options

- Alternative configuration:  $\mu$ RWell and derivatives



# Pre-R&D Activities – MCP-PMT

- MCP-PMT
- Junqi reported
  - Argonne early MCP-PMT development for EIC-PID
  - LAPPD/HRPPD magnetic field test results
  - LAPPD validation in high-rate environment at JLab Hall C
  - Recent status of new 10x10 cm MCP-PMT fabrication facility
  - Planned Hamamatsu MCP-PMT test for SoLID SPD

## Future test:

- Prototype test of Argonne 10x10 cm MCP-PMT
- Full test of Hamamatsu MCP-PMT for SoLID SPD

# Pre-R&D Activities

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- GEM readout → more general MPGD readout
- Tracking options
- MCP-PMT

**SoLID\_preRD\_Fall2024** → Proposed Milestones and Budget

# Test Beam Plans – Hall C

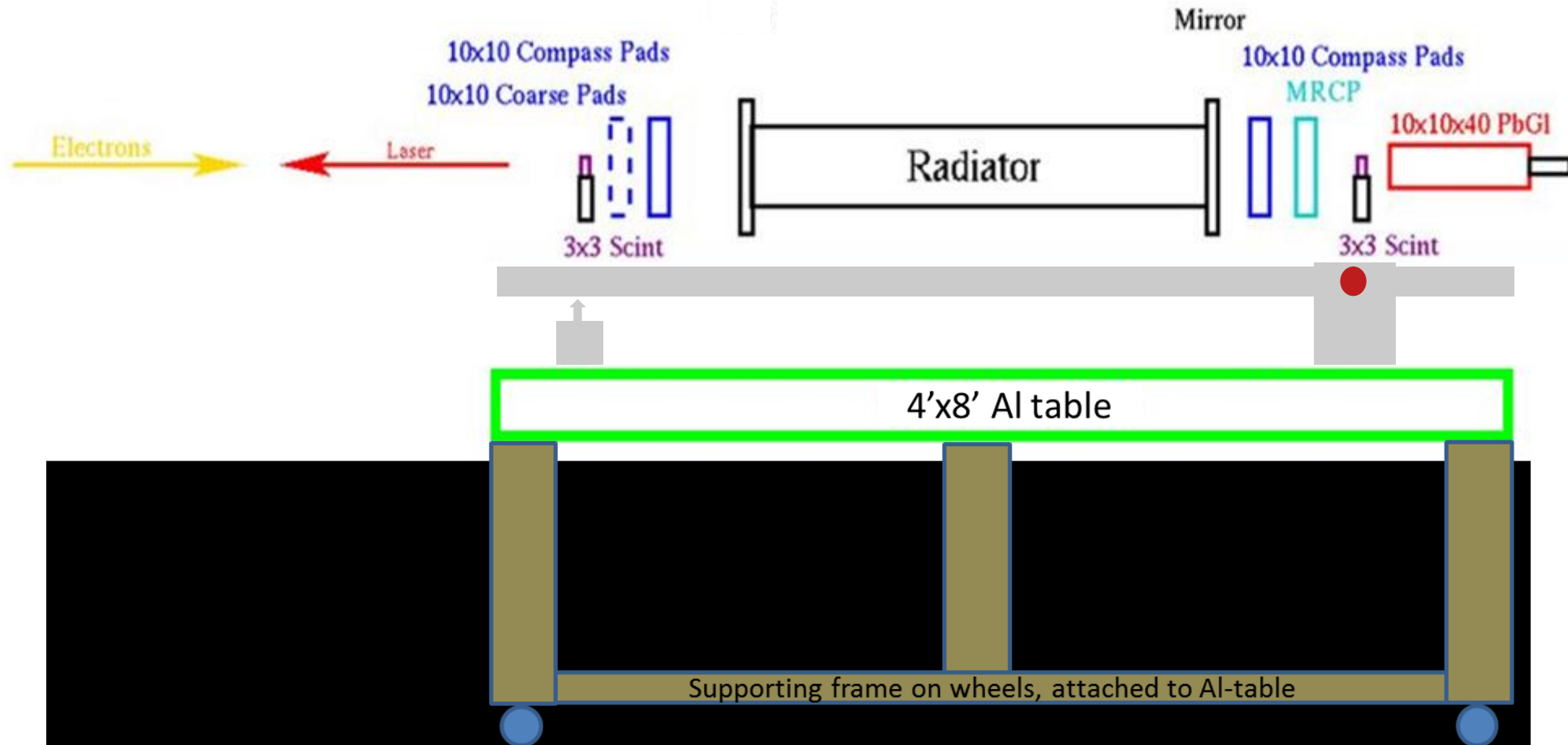
- Perform a sector test with SoLID sub-detectors



# Test Beam Plans – Hall C

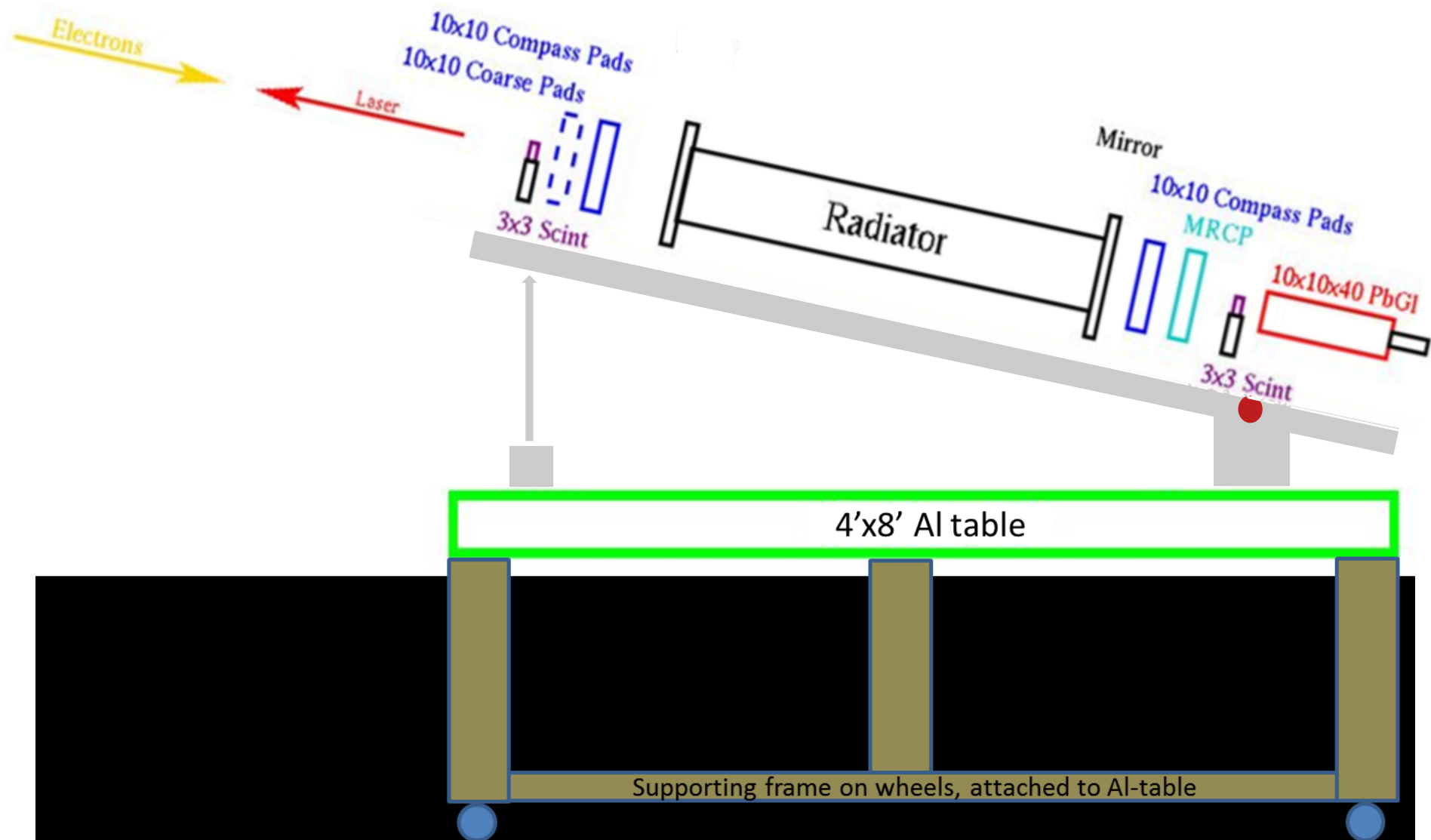
Experiments	PVDIS	SIDIS- <sup>3</sup> He	SIDIS-Proton	$J/\psi$
Reaction channel	$p(\vec{e}, e')X$	$(e, e'\pi^\pm)$	$(e, e'\pi^\pm)$	$e + p \rightarrow e' + J/\Psi(e^-, e^+) + p$
Approved number of days	169	125	120	60
Target	LH <sub>2</sub> /LD <sub>2</sub>	<sup>3</sup> He	NH <sub>3</sub>	LH <sub>2</sub>
Unpolarized luminosity (cm <sup>-2</sup> s <sup>-1</sup> )	$0.5 \times 10^{39} / 1.3 \times 10^{39}$	$\sim 10^{37}$	$\sim 10^{36}$	$\sim 10^{37}$
Momentum coverage (GeV/c)	2.3-5.0	1.0-7.0	1.0-7.0	0.6-7.0
Momentum resolution	$\sim 2\%$	$\sim 2\%$	$\sim 3\%$	$\sim 2\%$
Polar angular coverage (degrees)	22-35	8-24	8-24	8-24
Polar angular resolution	1 mr	2 mr	3 mr	2 mr
Azimuthal angular resolution	-	6 mr	6 mr	6 mr
PID ( $e^-$ )	detection eff. $\geq 90\%$ pion contam. $< 0.001$	detection eff. $\geq 90\%$ pion contam. $< 1\%$	detection eff. $\geq 90\%$ pion contam. $< 1\%$	detection eff. $\geq 90\%$ pion contam. $< 1\%$
PID ( $\pi^\pm$ )		detection eff. $\geq 90\%$ kaon contam. $< 1\%$	detection eff. $\geq 90\%$ kaon contam. $< 1\%$	
Trigger type	Single $e^-$	Coincidence $e^- + \pi^\pm$	Coincidence $e^- + \pi^\pm$	Triple coincidence $e^- e^+ e^+$
Expected DAQ rates	$< 20 \text{ kHz} \times 30$	$< 100 \text{ kHz}$	$< 100 \text{ kHz}$	$< 30 \text{ kHz}$
Backgrounds	Negative pions, photons	$(e, \pi^- \pi^\pm)$ $(e, e' K^\pm)$	$(e, \pi^- \pi^\pm)$ $(e, e' K^\pm)$	BH process Random coincidence
Major requirements	Radiation hardness 0.4% Polarimetry $\pi^-$ contamination $Q^2$ calibration	Radiation hardness Detector resolution Kaon contamination DAQ	Shielding of <i>sheet-of-flame</i> Target spin flip Kaon contamination	Radiation hardness Detector resolution

# Test Beam Plans – Hall C

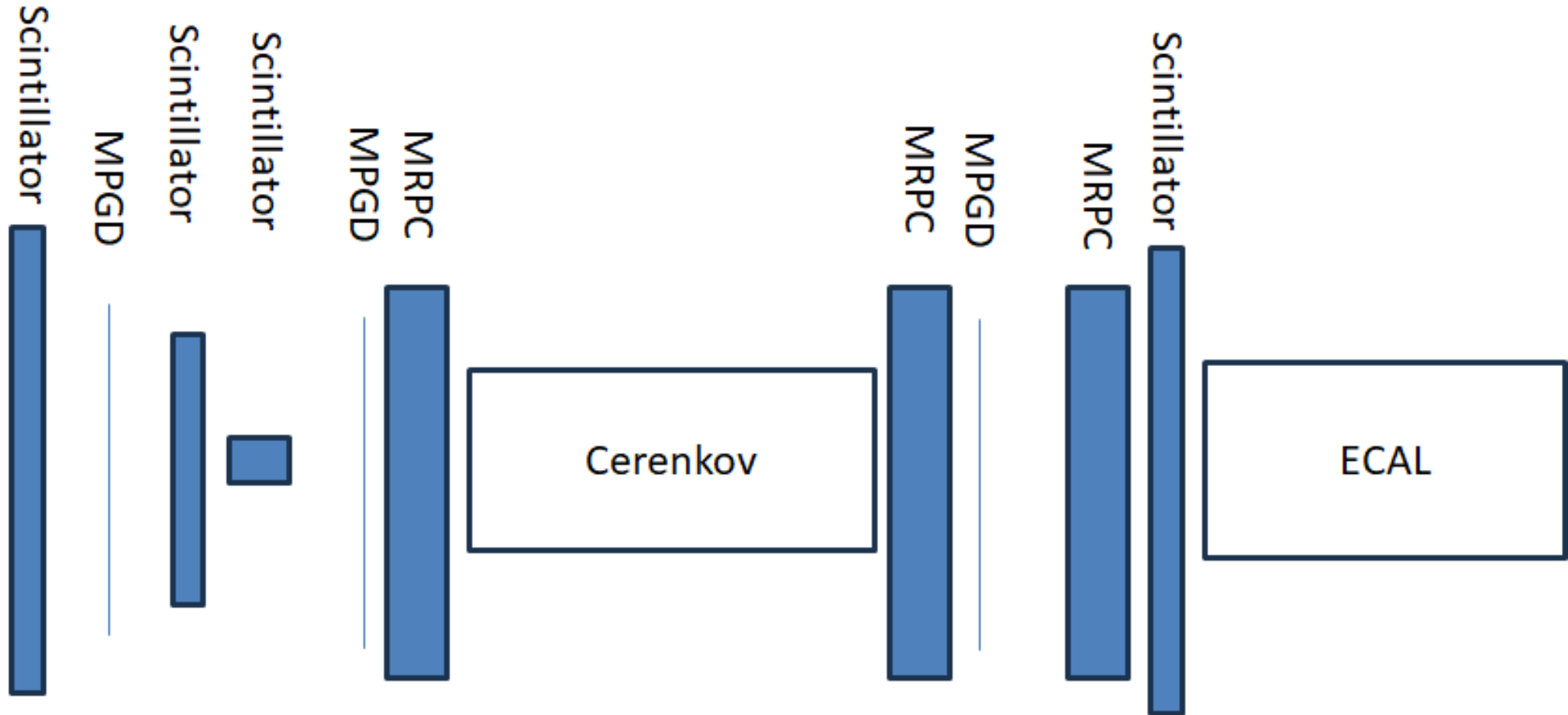




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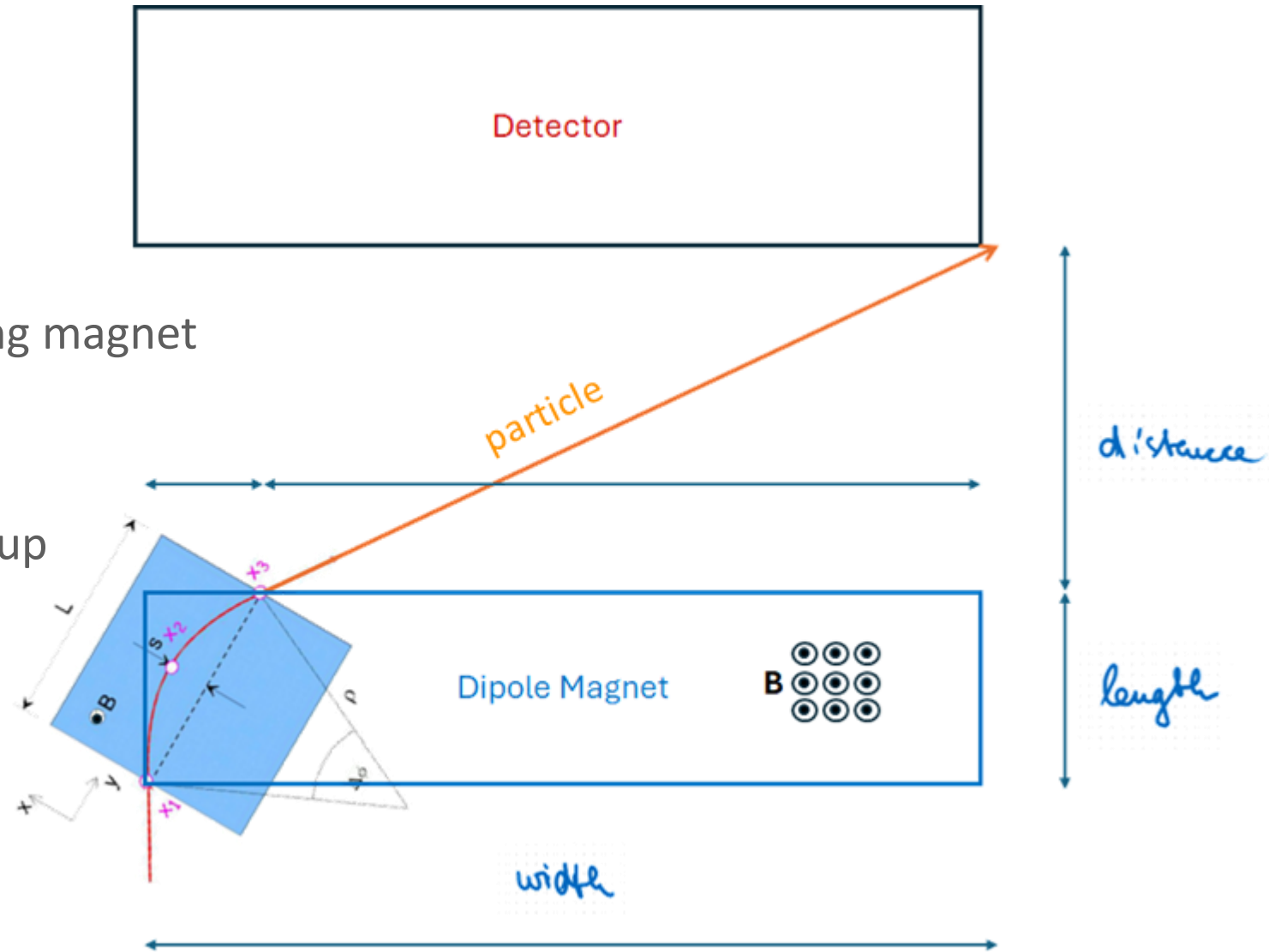
# Test Beam Plans – Hall C



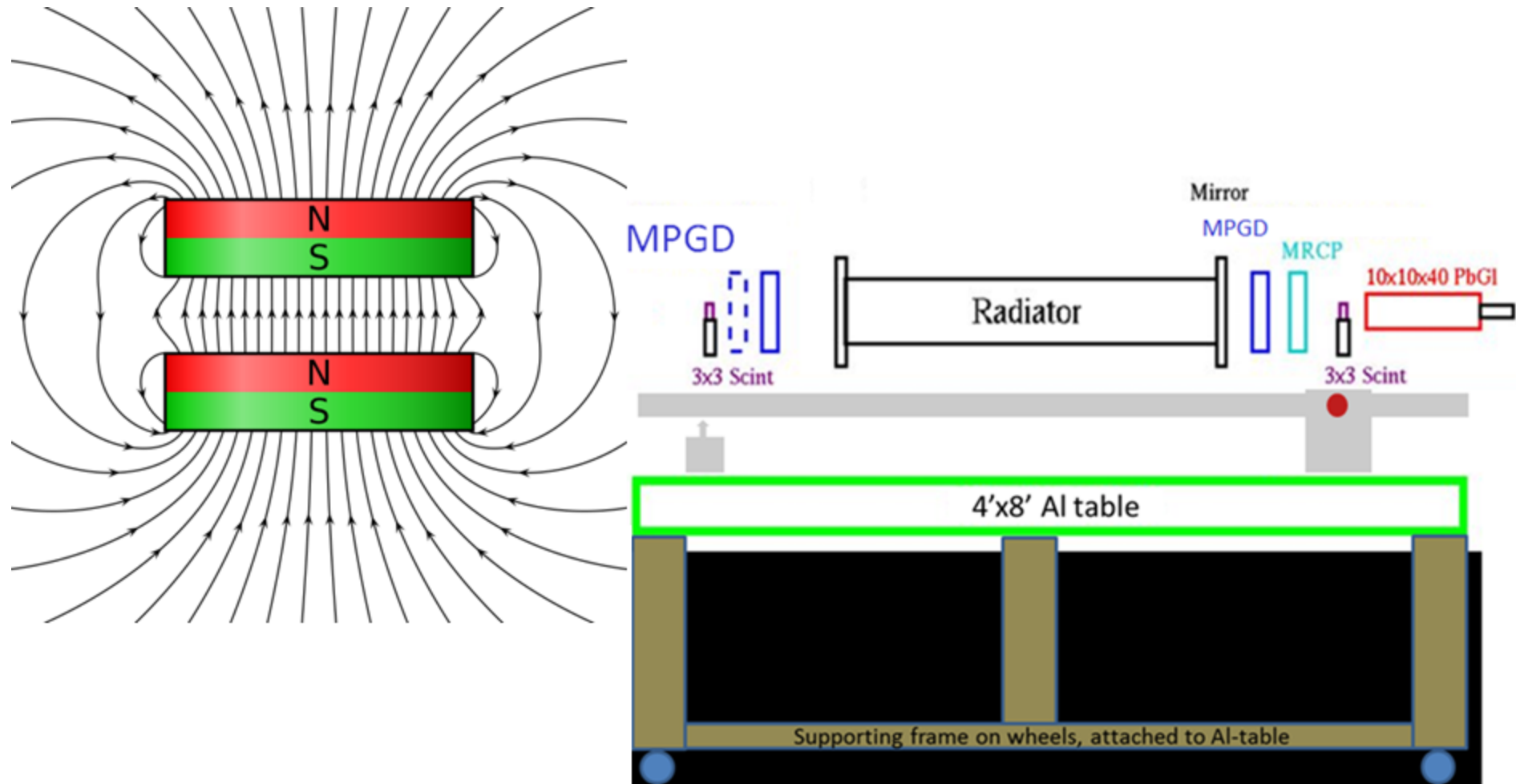
# Test Beam Plans – Hall C

- Background reduction

- Remove Møller electrons → sweeping magnet
- Dipole magnet
  - ✦ Aperture, gap, field strength
- Accommodated around detector setup



# Test Beam Plans – Hall C



# Test Beam Plans – Hall C

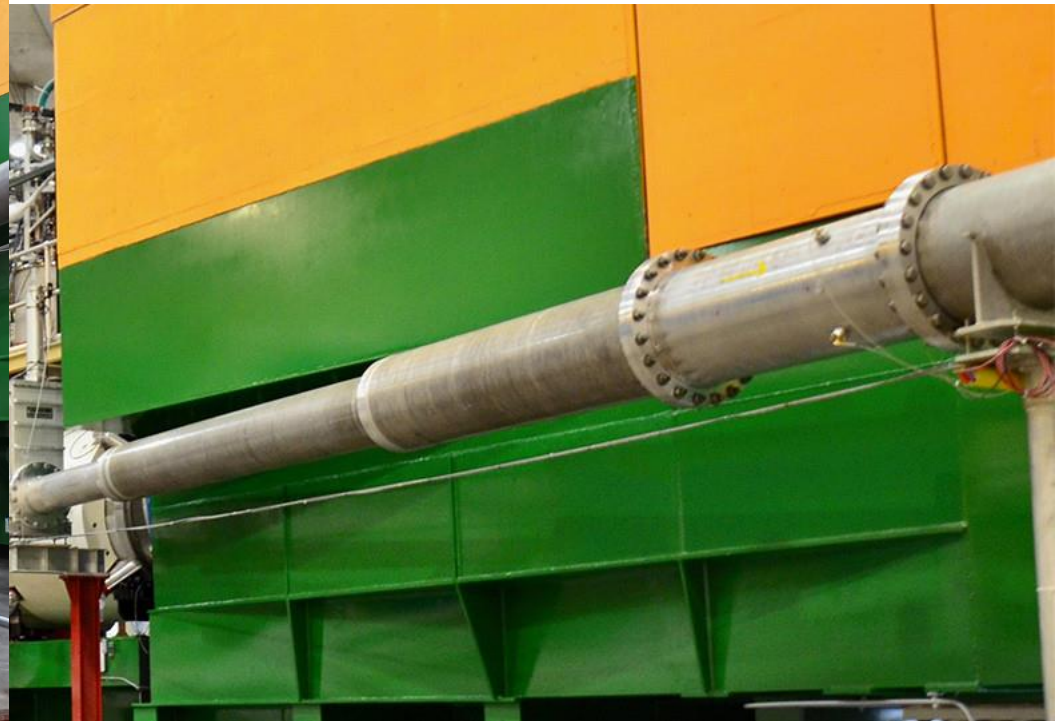


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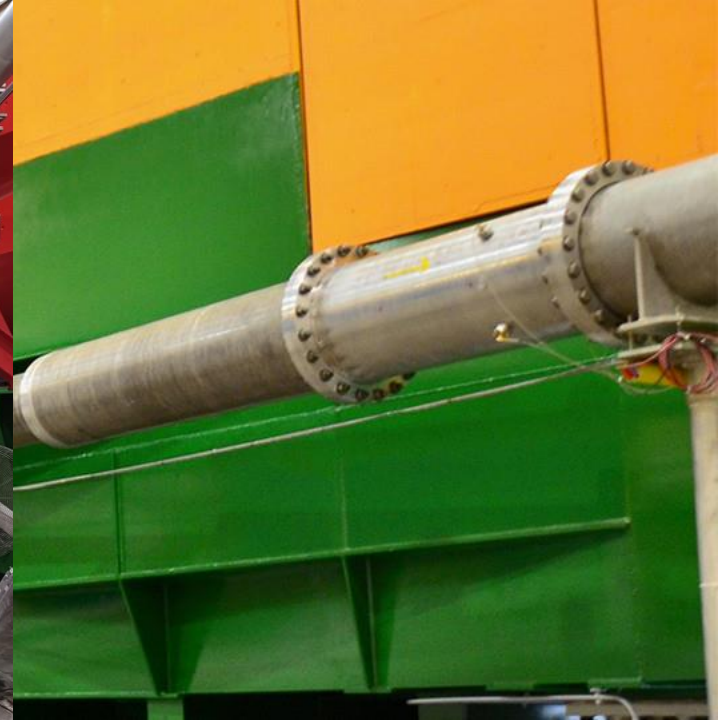


Pre-R&D and Test Beam Plan - Jan. 10, '25

# Test Beam Plans – Hall C

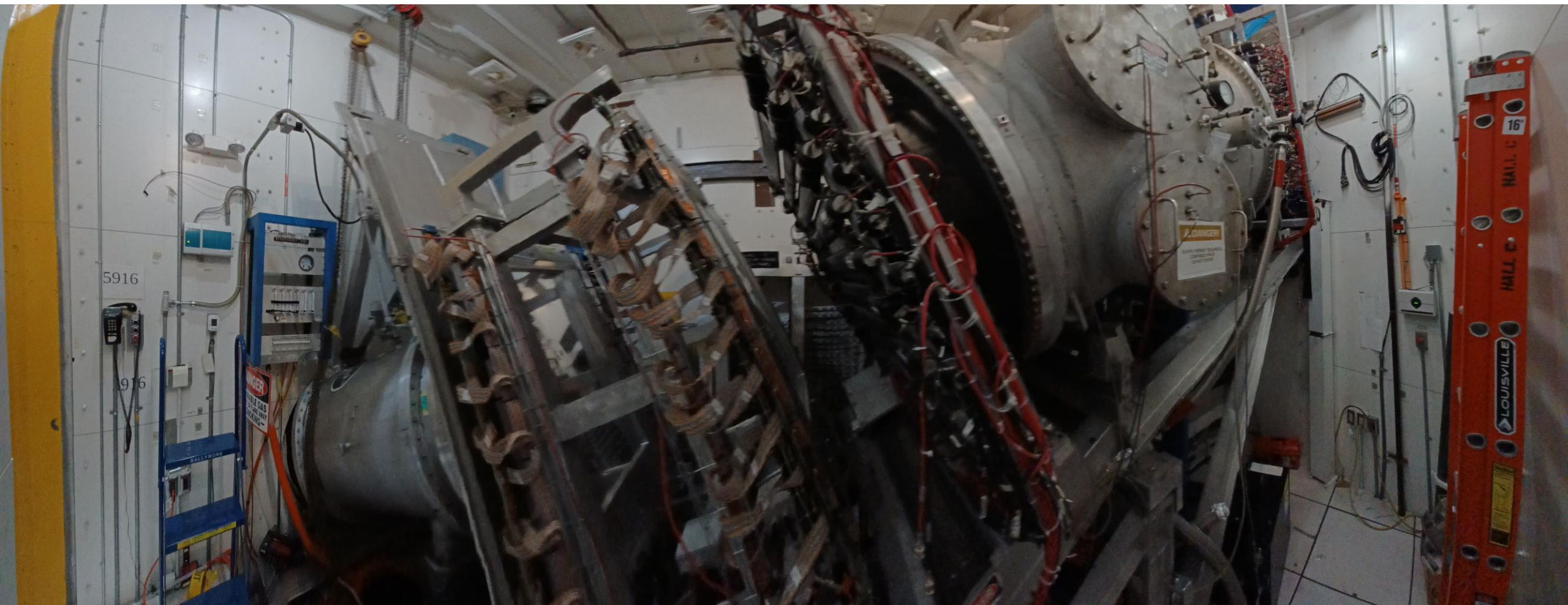


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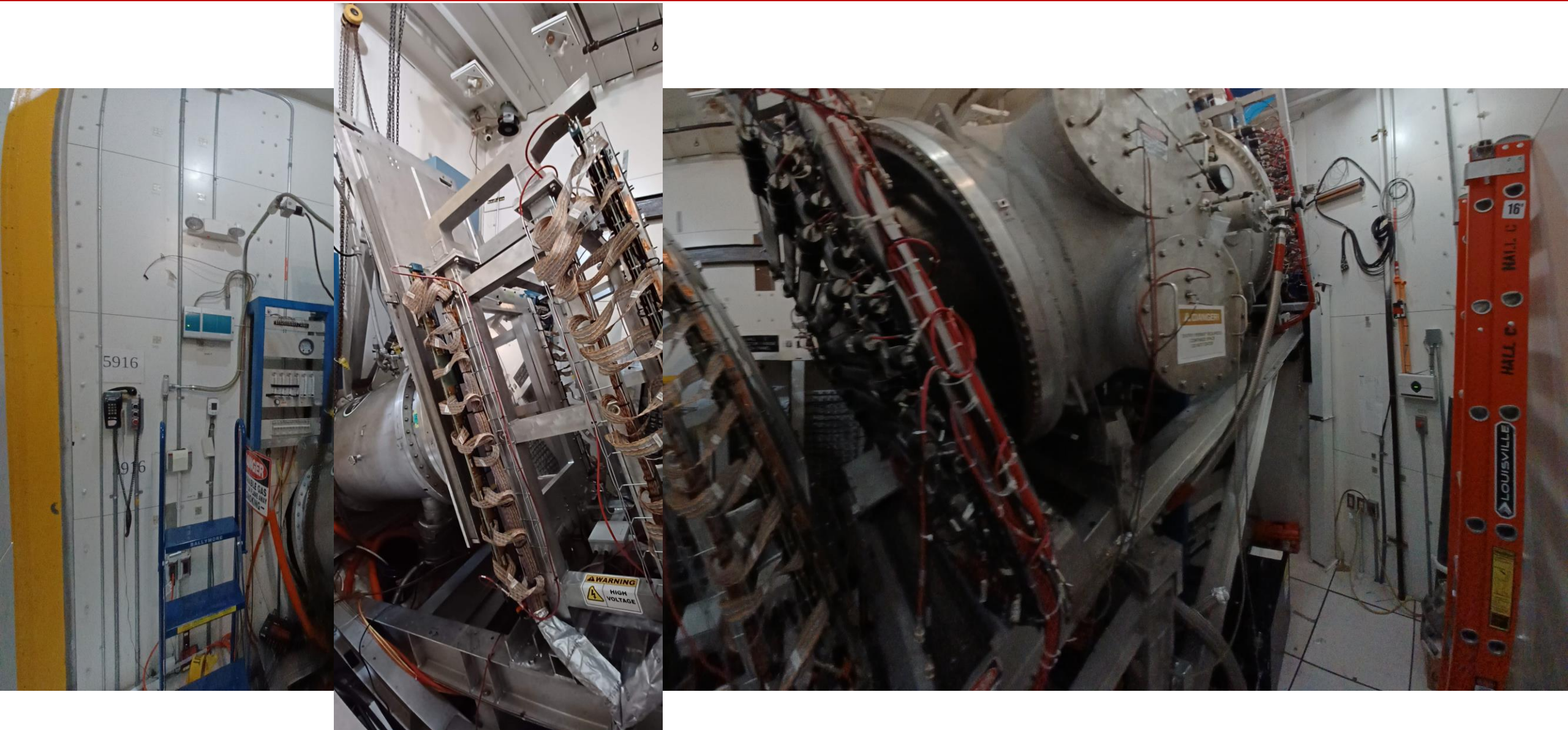




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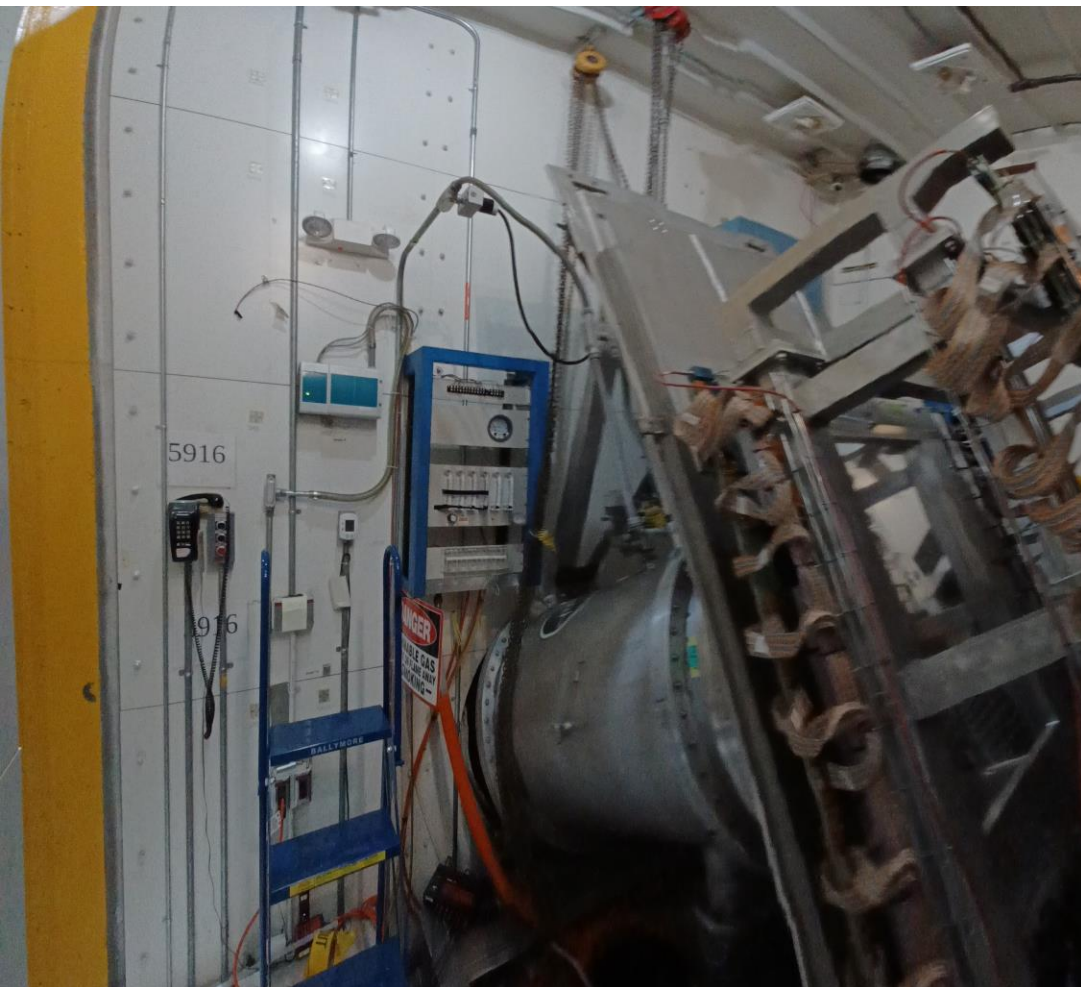


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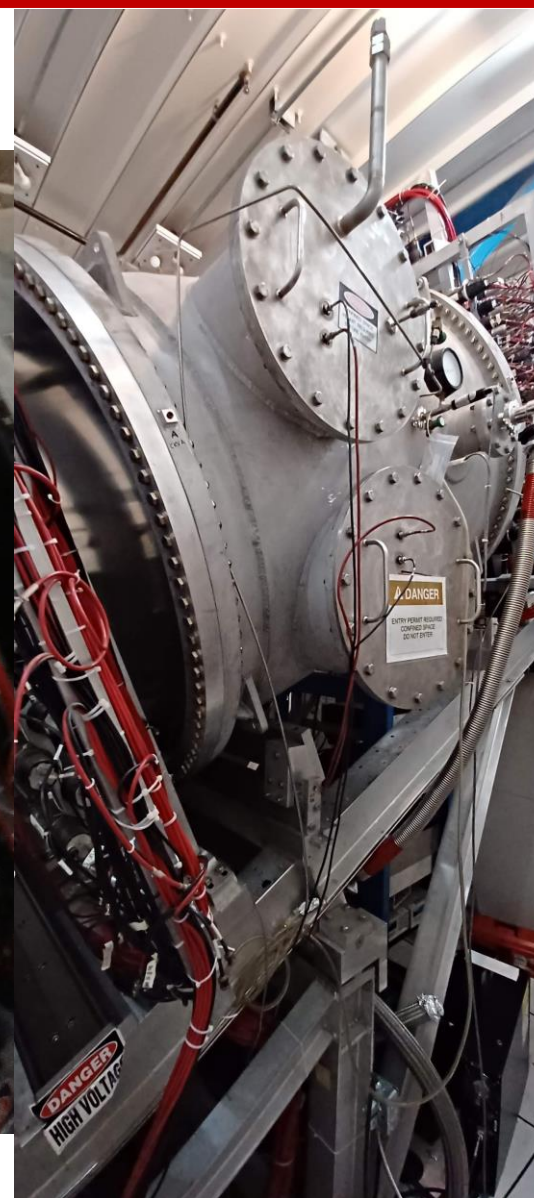
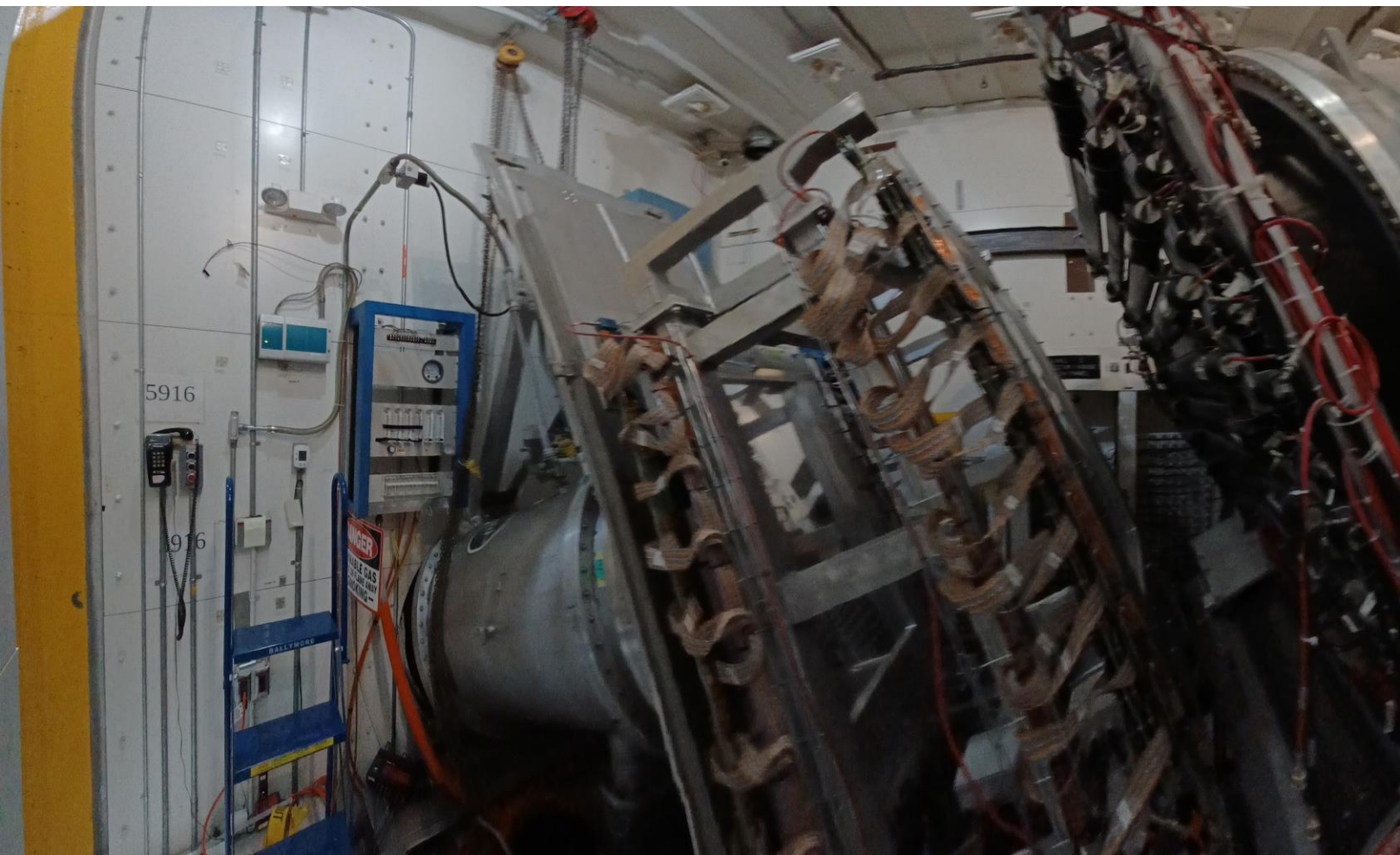


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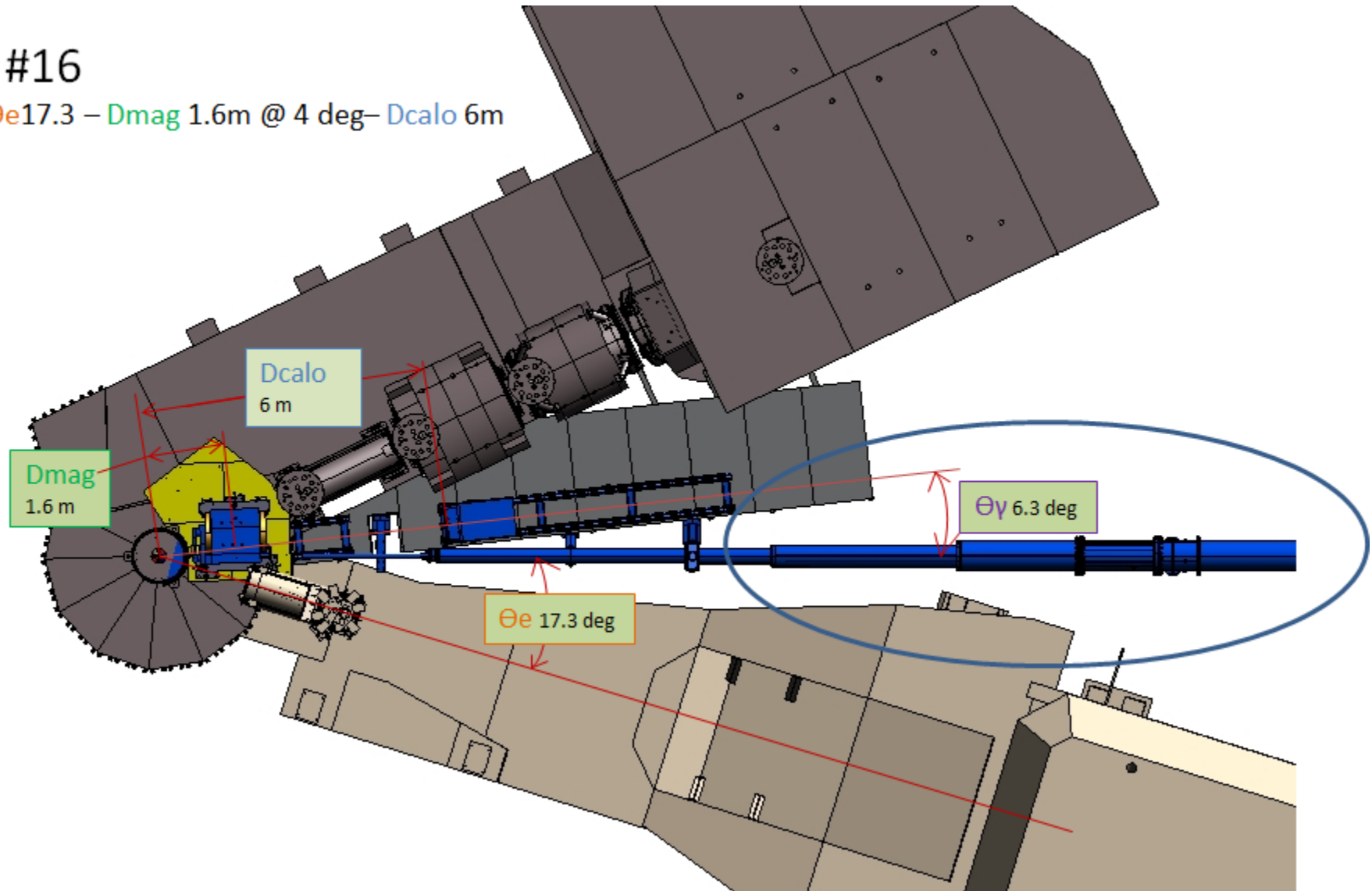


# Test Beam Plans – Hall C



# Test Beam Plans – Hall C

- DVCS #16
- $\Theta_{\gamma} 6.3$  –  $\Theta_e 17.3$  –  $D_{\text{mag}} 1.6\text{ m}$  @ 4 deg –  $D_{\text{calo}} 6\text{ m}$



# Test Beam Plans – Hall C

From M. Jones during  
Hall C Hypernuclear Experimental Readiness Review 2024

- FY25 start Jan 24<sup>th</sup> 2025 to July 21<sup>st</sup> 2025 ( 25 Weeks)
  - E12-11-107 Tagged DIS with Large Acceptance Detector
  - E12-06-104 & E12-24-001 R-SIDIS on p,d,C,Cu with HMS/SHMS
- FY26 assume 25 weeks and start in Nov 2025-May 2026. **(guess work for dates)**
  - Run HMS/SHMS experiments
  - E12 -06-107 Complete Pion CT
  - E12-14-002 Run standard beam energies for NucR
  - E12-22-001 N-Delta at low  $Q^2$ , Special beam energy to match Hall B.
  - E12-23-001 VCS at low  $Q^2$ , Special beam energy to match Hall B.
- FY27 assume 30 weeks and start in Sept 2026
  - Run standard HMS/SHMS experiments Sept –Dec 2026
  - Hypernuclear installation in Jan 2027 – Aug 2027 ( 8 months)
  - Start Hypernuclear experiments in Sept 2027

# Summary Pre-R&D and Test Beam Plan

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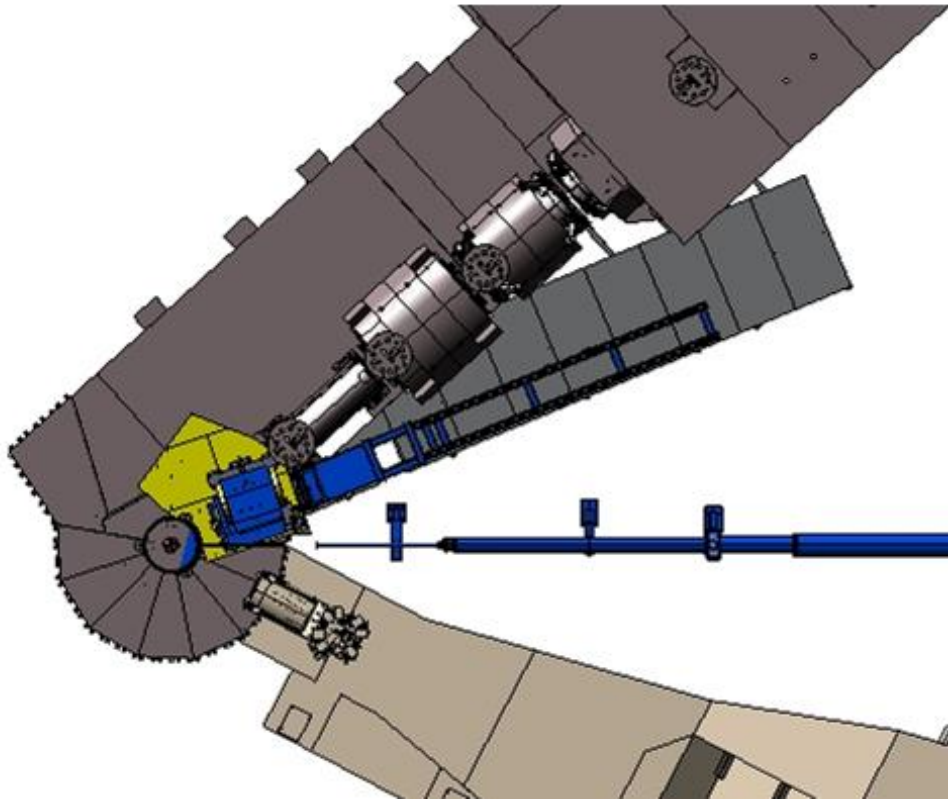
- **Pre-R&D topics**
  - GEM readout → more general MPGD readout
  - Tracking options
  - MCP-PMT
  - Need to be finalized in document to be sent to G. Rai
- **Test beam plan**
  - Concept available
  - Detailed requirements and requests to be worked out
  - Resources to be identified and finalized



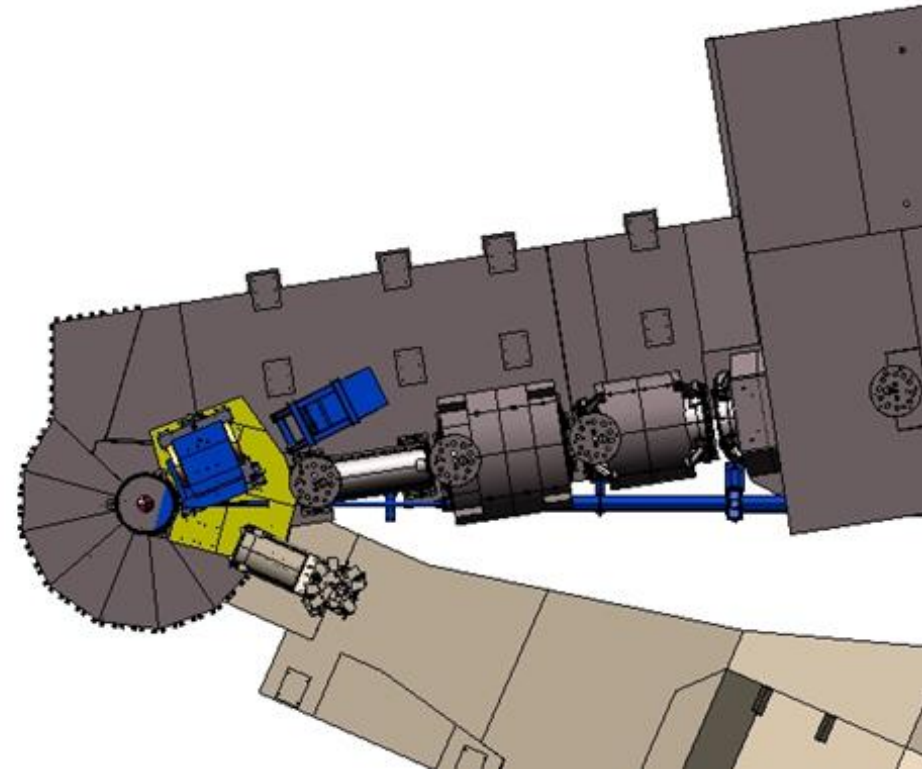


# Test Beam Plans – Hall C

- WACS/PION #4C
- $\Theta_{\gamma}22.5 - \Theta_e27.8 - D_{\text{mag}} 1.6\text{m} @ 4 \text{ or } 5.5 \text{ deg}$   
 $D_{\text{calo}} 3\text{m}$

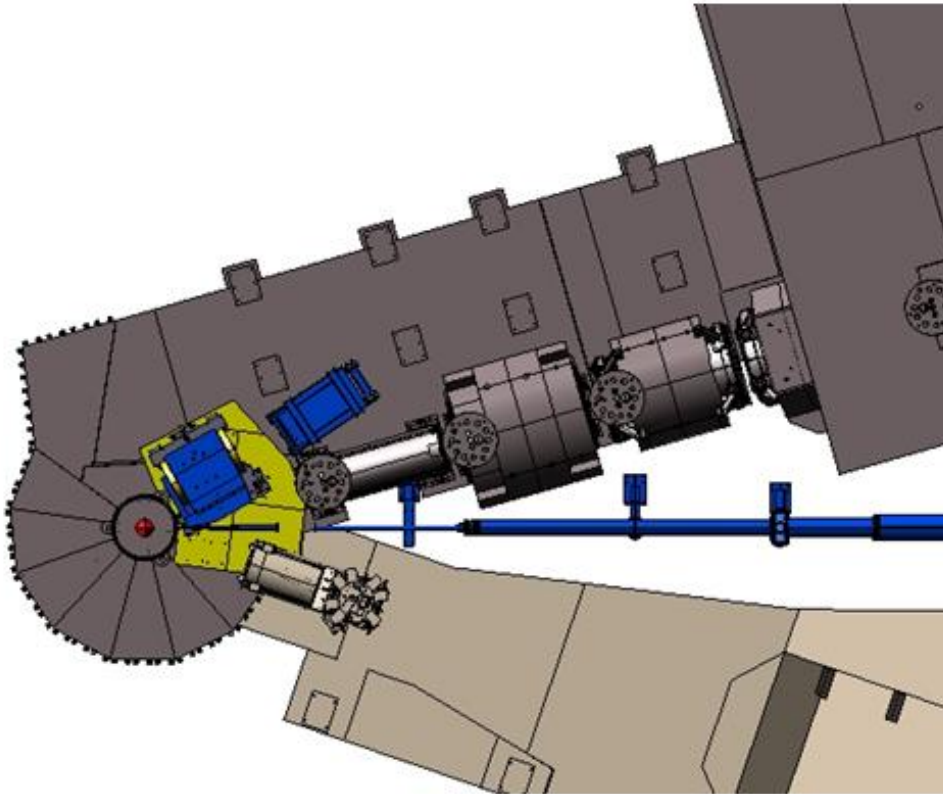


- WACS/PION #4D
- $\Theta_{\gamma}26.9 - \Theta_e23.7 - D_{\text{mag}} 1.6\text{m} @ 5.5 \text{ deg}$   
 $D_{\text{calo}} 4\text{m}$



# Test Beam Plans – Hall C

- WACS/PION #4E
- $\Theta_{\gamma}34.0 - \Theta_e18.9 - D_{mag} 1.6m @ 5.5 \text{ deg}$   
Dcalo 4m



- WACS/PION #5A
- $\Theta_{\gamma}11.0 - \Theta_e41.7 - D_{mag}1.6m @ 4 \text{ or } 5.5 \text{ deg}$   
Dcalo 11m

