

The Vision over TRIUMF 2010



TRIUMF Centre for Molecular and Materials Science

CMMS
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The Vision over TRIUMF, 2025



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μ SR and β NMR Facilities



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TRIUMF CMMS Facility Overview: MuSR 2025, St. John's

Syd Kreitzman on behalf of the CMMS TEAM

- TRIUMF's 20/5 Yr Vision, and the CMMS role in it
 - Focus on Quantum and green/sustainable materials research;
 - Consolidate new M9 beamlines + Upgrade M15 luminosity
 - Prepare for β NMR user facility in 2028/9 when 30 weeks/yr is anticipated
- The People : Previous personnel compliment has been sustained
- Beamline Status Report:
 - M15: HV and controls revitalization completed; luminosity restoration 2018?
 - M9A: High luminosity surface μ^+ beamline now part of facility operations
 - M9H: In final stages of completion -> transversely polarized $\mu^\pm$ decay beam
 - β NMR: 7T spectrometer: normal operations
 - β NQR: .2T spectrometer /w field Pz||sample capabilities to resume this fall.
 - M20: Normal facility operations
 - Liquid Helium: CMMS beginning transition to cryo-free infrastructure



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The CMMS Team:

Facility Scientists:

1. **Bassam Hitti:** Deputy & Operations Manager
 - i. Experimental Setup, Operations and User Collaboration & Support (ESOUCS)
 - ii. Device electromagnetic simulation (i.e. Opera)
 - iii. Semiconductor Solid State Physics
2. **Donald Arseneau:** IT /DAQ & Programming
 - i. ESOUCS, Facility IT, DAQ and programming
 - ii. Spectrometer design
 - iii. Physical Chemistry and Fundamental Kinetics
3. **Gerald Morris:** Beamlines & Technical Manager
 - i. M20, β NMR beamlines coordinator, ESOUCS
 - ii. PSD Rep to Quality Management Committee
 - iii. Subsurface layers, CM Physics
4. **Iain McKenzie:** Research & Outreach BAE
 - i. Research Program
 - ii. EEC Secretary, User Community Liaison, Outreach
 - iii. USC, μ - Spectrometer Development (post M9H)
 - iv. Soft Material Interfaces, Dynamics of Free Radicals
 - v. SFU Chemistry Adjunct

5. **Kenji Kojima:** Research & Outreach BAE
 - i. Research Program
 - ii. Spectrometer design, , ESOUCS
 - iii. Semiconductors, quantum systems, interfaces
 - iv. CMMS Rep to PSD Safety
 - v. SBQMI/UBC associate
6. **Sarah Dunsiger:** Research & Outreach BAE
 - i. Research program, POLARIS coordinator
 - ii. NMR Facility Planning (5 Yr. Plan / CFI), ESOUCS
 - iii. Frustrated quantum systems /w heavy fermions, heterostructures for spintronics, chiral spin systems
 - iv. SFU Physics Adjunct
7. **Syd Kreitzman:** Facility Manager BAE
 - i. Facility management & liaison with TRIUMF Admin.
 - ii. Spectrometer/beam-line design, detector R&D
 - iii. MuSR spin relaxation theory
 - iv. BL1A Upgrade project lead

Facility Technicians:

8. **Mike McLay:** Design Technologist
9. **Deepak Vyas:** Millwright & Safety Coordination
10. **Rahim Abasalti:** Beamline & HiVac Specialist;

PhD Project Engineer: Mahdiar Khosravi; M9H



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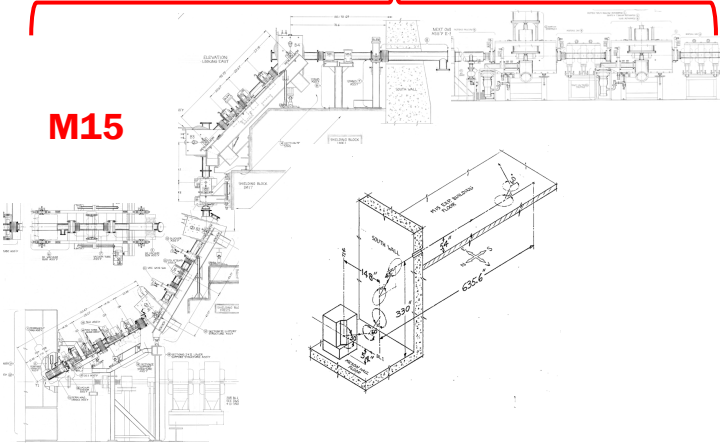
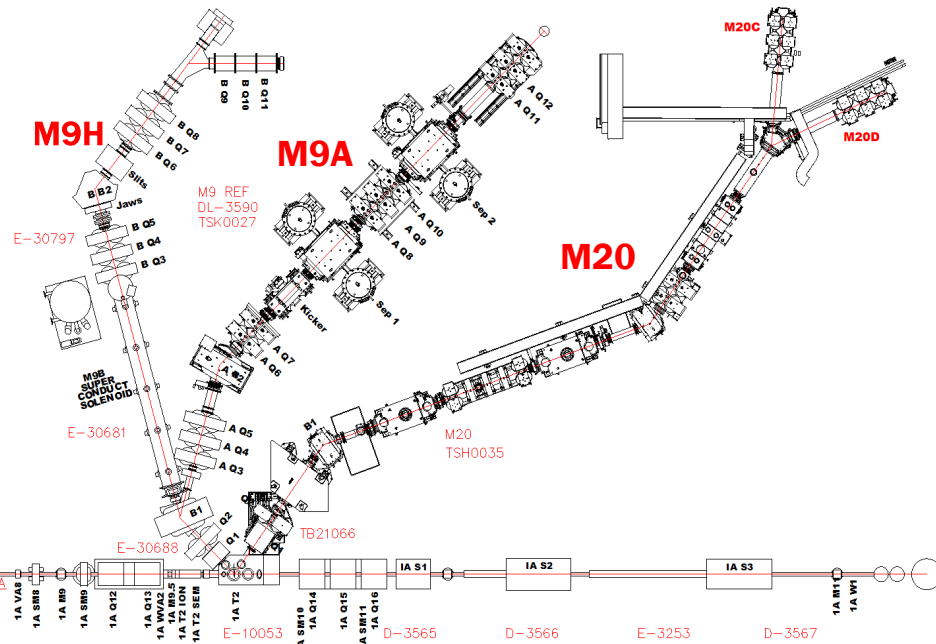
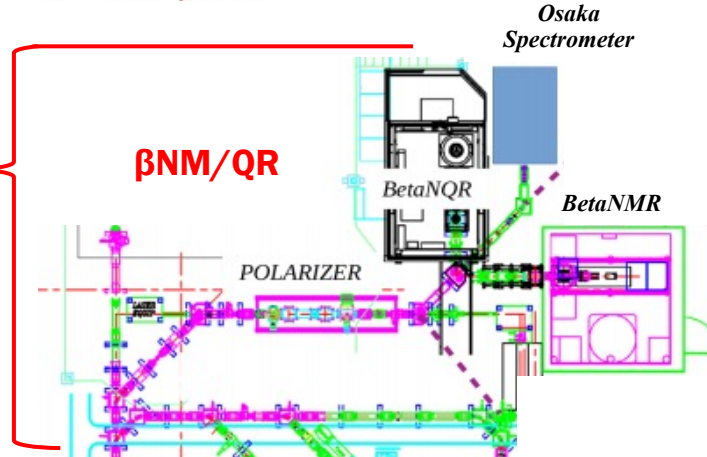
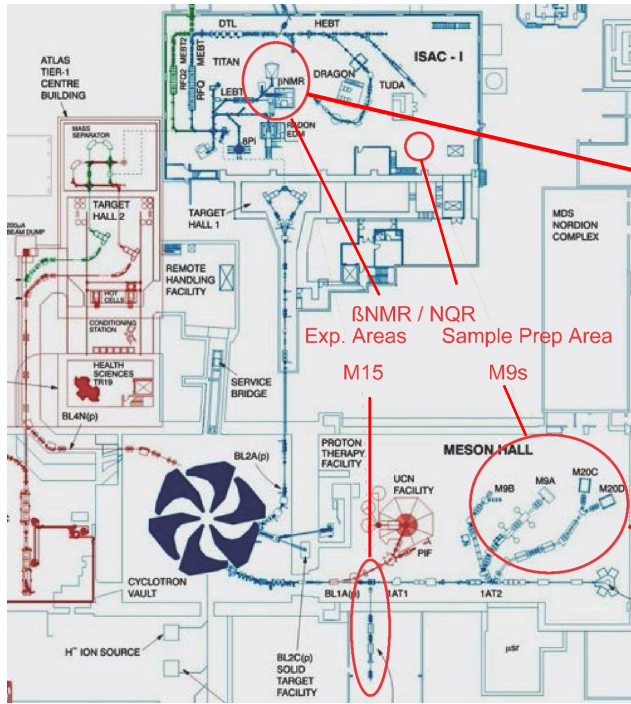
...The summer before COVID



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TRIUMF beamlines & CMMS Current Facilities



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Current Schedules

CMMS Beam Schedule for Fall 2024 - Schedule 147

(Sep 26, 2024)

[\[PDF version\]](#)

[\[Daily version\]](#)

Dates	Shifts	M9		M15		M20		ISAC	
(incl)	(8 hr)	Expt.	Appar.	Expt.	Appar.	Expt.	Appar.	Expt.	Appar.
3 Oct ^a (40) 10 Oct ^a	20	---	---	---		2369 YC	Lampf MsPiggy	---	---
10 Oct ^a (41) 15 Oct ^a	15	"	"	"	"	2394 NEH,JES 3 sh	"	"	"
15 Oct ^p (42) 22 Oct ^a	20	2397 BAF	SFUmu HG-c	2368 BAF 12 sh	DR	"	"	"	"
22 Oct ^p (43) 25 Oct ^a	8	"	"	2367 BAF	"	2357 ADB,SRD	"	"	"
29 Oct ^b (44) 5 Nov ^a	19	Test CMMS	"	1915 JES,SRD	" ZF	2331 KG	MsPiggy+Oven	"	"
5 Nov ^p (45) 12 Nov ^a	20	9999 CMMS	"	2118,2336,2361/2335 GML/LS	" ZF/LF	2351 LS	MsPiggy	β-NMR β-NMR	β-NMR
12 Nov ^p (46) 19 Nov ^a	20	2391,2406 KK	"	2335/2355 LS/JS	"	2300 AMH	"	"	"
21 Nov ^b (47) 26 Nov ^a	19	2406 KK,MYT	"	2394 JES	"	2393,2356 JS	"	---	---

CMMS Beam Schedule for Spring/Summer 2025 - Schedule 148

(Apr 23, 2025)

[\[PDF version\]](#)

Dates	Shifts	M9		M15		M20		ISAC	
(incl)	(8 hr)	Expt.	Appar.	Expt.	Appar.	Expt.	Appar.	Expt.	Appar.
3 Jun ^p (23) 10 Jun ^a	20	1812	SFUmu	2434,2364 JK	DR zf	2348,2448,2429 AMH,TMM	Lampf MsPiggy	---	---
10 Jun ^p (24) 17 Jun ^a	20	2363 AB	"	1862 JES	" zf	2401,2392,2434 JK	"	"	"
17 Jun ^p (25) 24 Jun ^a	20	2326,2352 SI	Helios	2437 ADB,SRD	"	2391/2446 KMK/JES	"	"	"
1 Jul ^p (27) 8 Jul ^a	20	2192 IDM	"	2448/2444 AMH/YU	"	2371 MM	"	2354 β-NMR	β-NMR
8 Jul ^p (28) 15 Jul ^a	20	2391 KMK	"	2444 YU	"	2457,2458 BAF	"	2400/2463/2167/1770 β-NMR	"
15 Jul ^p (29) 22 Jul ^a	20	2126 IDM	"	2462 HK,IDM	"	2359 YU	"	---	---
5 Aug ^p (32) 12 Aug ^a	20	2437 ADB,SRD	"	2409 MS	" zf	?/2409 TBA/MS	"	"	"
12 Aug ^p (33) 19 Aug ^a	20	2283 SRD	"	TBA	"	2409/2394 MS/JES	"	"	"
19 Aug ^p (34) 26 Aug ^a	20	2360 IDM	"	2357 ADB,SRD	"	2394 JES	"	"	"
26 Aug ^p (35) 2 Sep ^a	20	2126 IDM	"	2399 SHL	"	2394/2317 JES/SHL	"	"	"
2 Sep ^p (36) 9 Sep ^a	20	---	---	2317/? SHL/TBA	"	2349,2350 SHL	"	"	"

Beam weeks /yr:

- 50 μ SR
- 4 β NMR/NQR



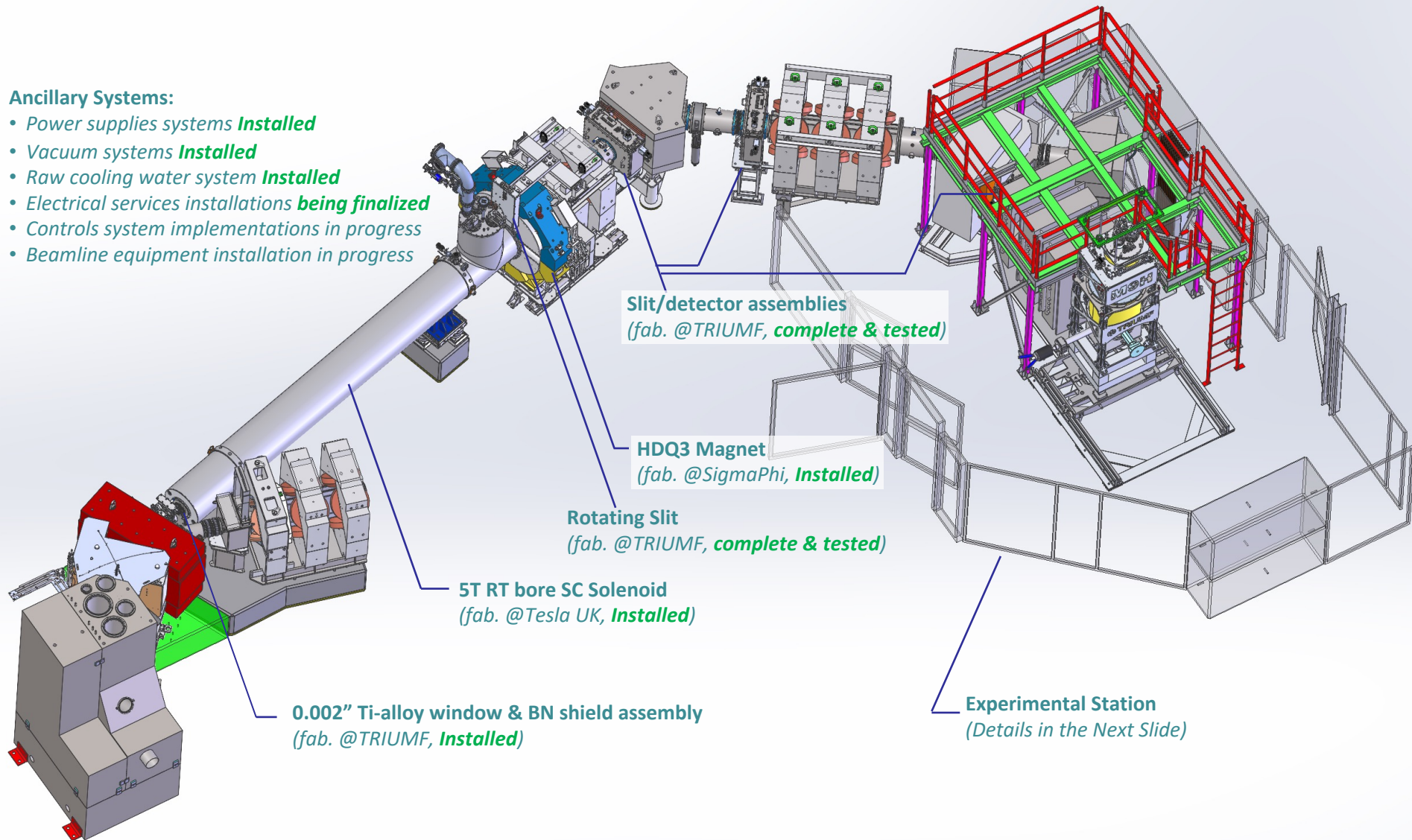
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M9H Beamline Project Update - At a Glance

Ancillary Systems:

- Power supplies systems **Installed**
- Vacuum systems **Installed**
- Raw cooling water system **Installed**
- Electrical services installations **being finalized**
- Controls system implementations in progress
- Beamline equipment installation in progress



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M9H Characteristics

- Decay μ^+ and μ^- : 40-120 MeV/c Arbitrary selectable spin polarization
- External fields : 0 - 4 T
- Cryogenic Options: 50mK - 295K
- Pressure Cells: 6 / 8 mm internal dia. 3.0 / 2.0 GPa
- Sample Environment Access: Axial or Transverse
- Zero field capability: True ZF (no remanent fields from SC magnet)
- Rates: Highly dependent on polarization and charge state.
TF polarization correlates with lower with available rate
For a fully TF polarized beam at 100MeV/c we are conservatively anticipating $> 30\text{K } \mu^+ / (\text{sec-cm}^2)$.



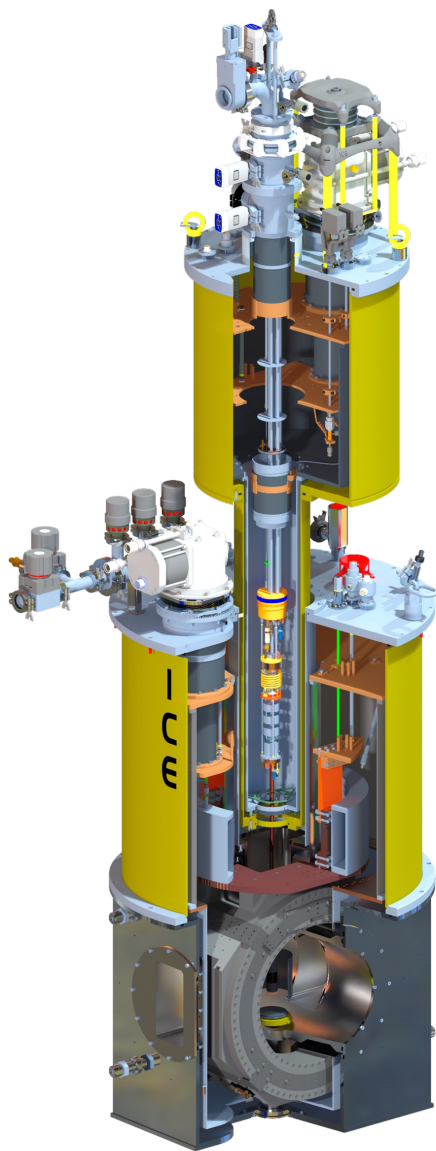
Installing the new solenoid



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New M9H Experimental End-station Sample Environment



The M9H sample environment

4T cryofree magnet

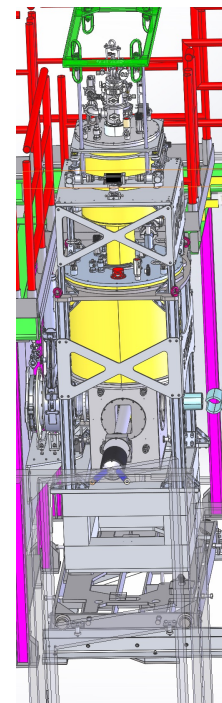
- LHe buffer for power loss mitigation
- Axial and Transverse access ports
- 10 ppm central homogeneity 1cm $\varnothing$
- .1ppm/hr drift

VTI Cryostat

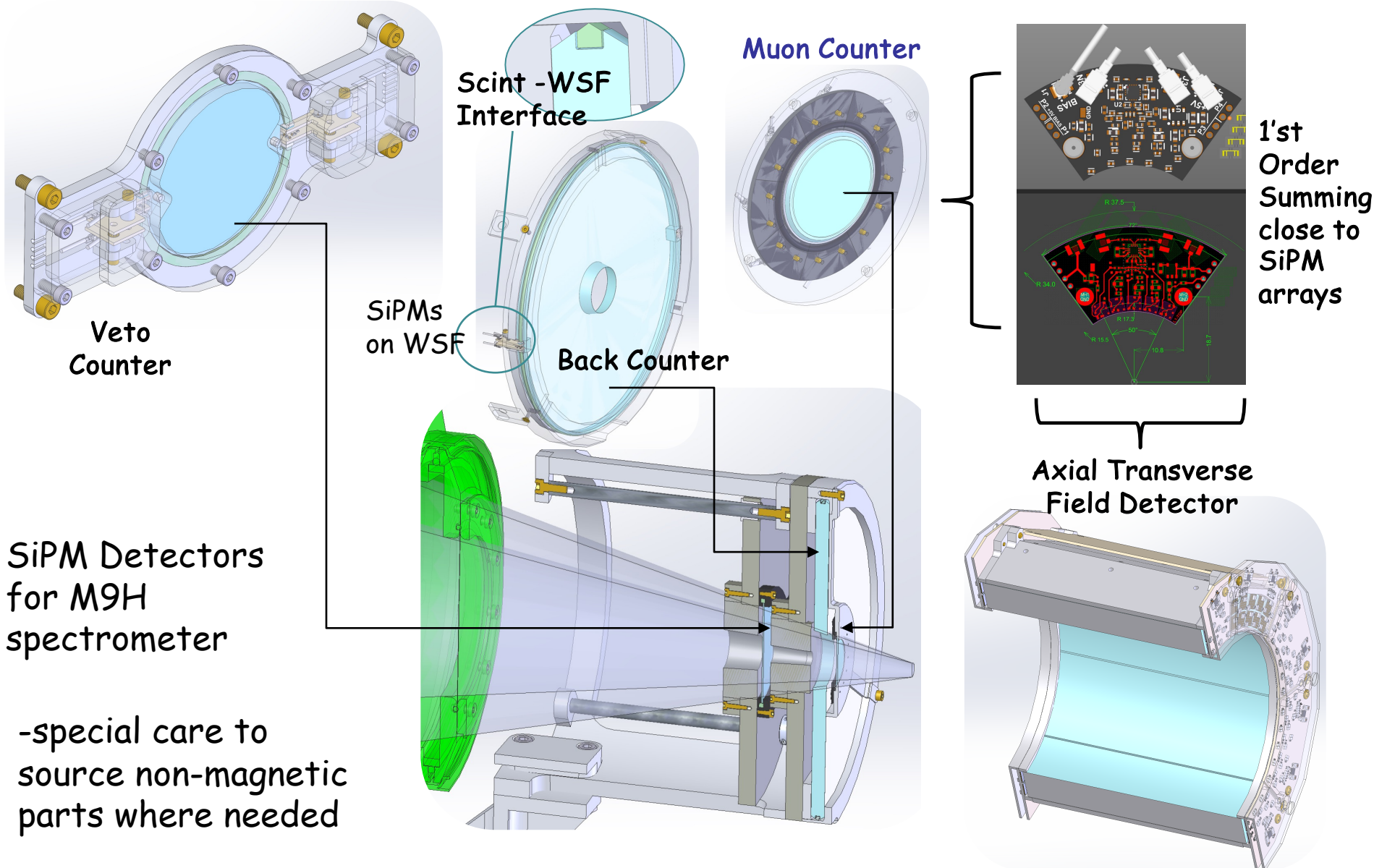
- DR, ^3He inserts or normal ^4He exchange gas environments
- "ICE Fast" cool down option

Dilution Refrigerator

- 50mK base temperature
- 40mm internal sample space



M9H End Station - Detector Assemblies



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Next Gen. DAQ Configuration

Active Collimator
8 6x6
SiPMs

Muon Beam Detector
10 3x3
SiPMs

Back Detector
via fast
WSF
4 3x3
SiPMs

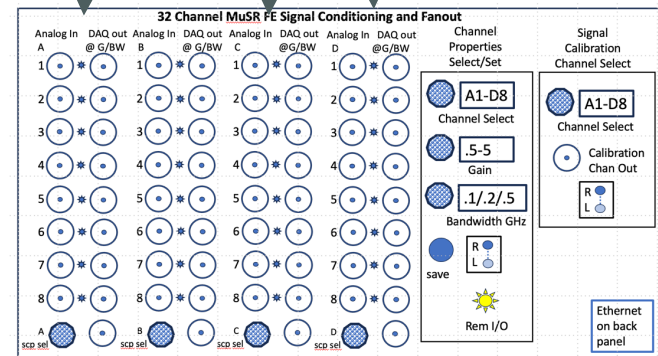
Summing Board in Spectrometer Vacuum

50 Ω vacuum feedthrough

Front End Detectors & DAQ Config Scheme

CMMS SiPM Summing Scheme

Beam Snout Vacuum Space



16 TOT analog inputs fitted onto "back" of DT5203

Optical fiber connection to concentrator for highspeed readout and data transfer to DAQ computer

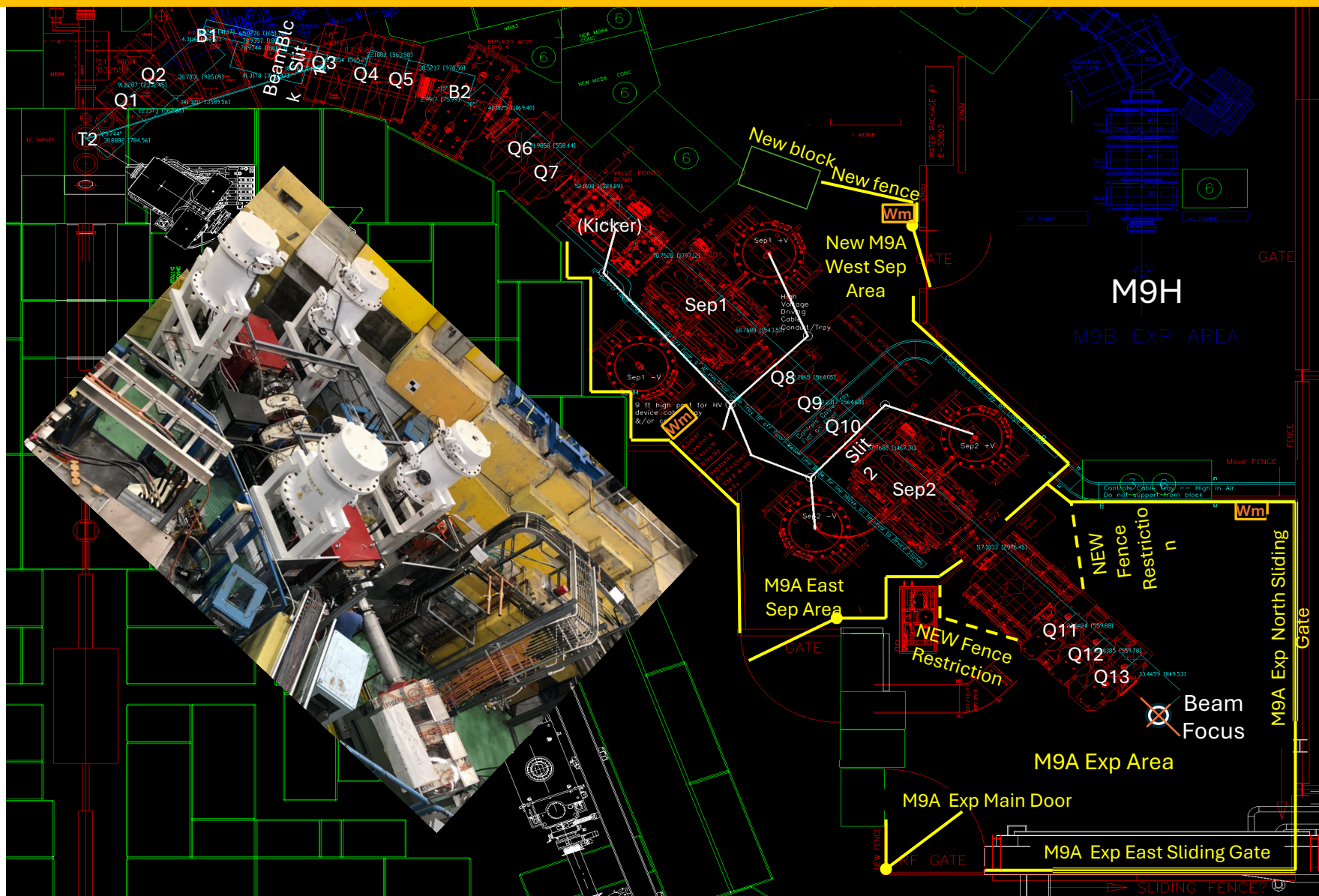
PICO TDC with <10ps timing resolution



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The M9A surface beamline

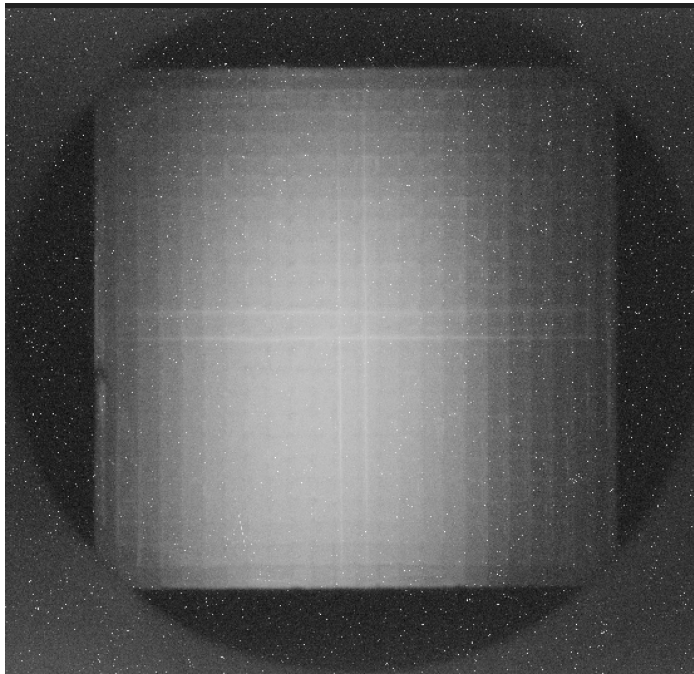


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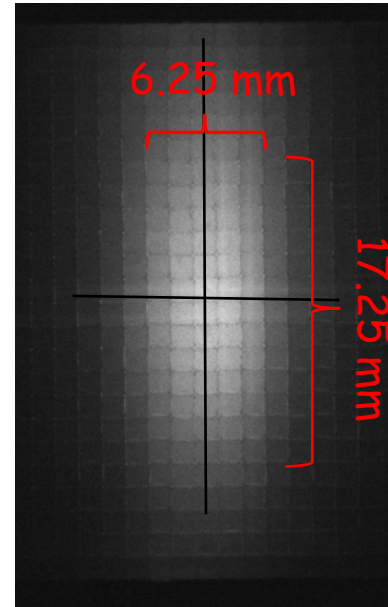
M9A Delivers Beam:

as imaged by a CCD camera observing a $27 \times 27 \times 1 \text{ mm}^2$ scintillating fibre array



Raw CCD image scintillating fiber bundle, tuned for max rate.

Full beam has $> 2e6 \mu^+/\text{sec.}$,
too much for a TD experiment
rate limited to $< 1e5 \mu^+/\text{sec.}$,
... nice for I- μSR



De-speckled CCD image
Tuned for a small spot

Reduced beam has flux $625k \mu^+/\text{sec.}$
Prelim. central luminosity estimate
 $> 2k \mu^+/(\text{sec} \cdot \text{mm}^2)$.

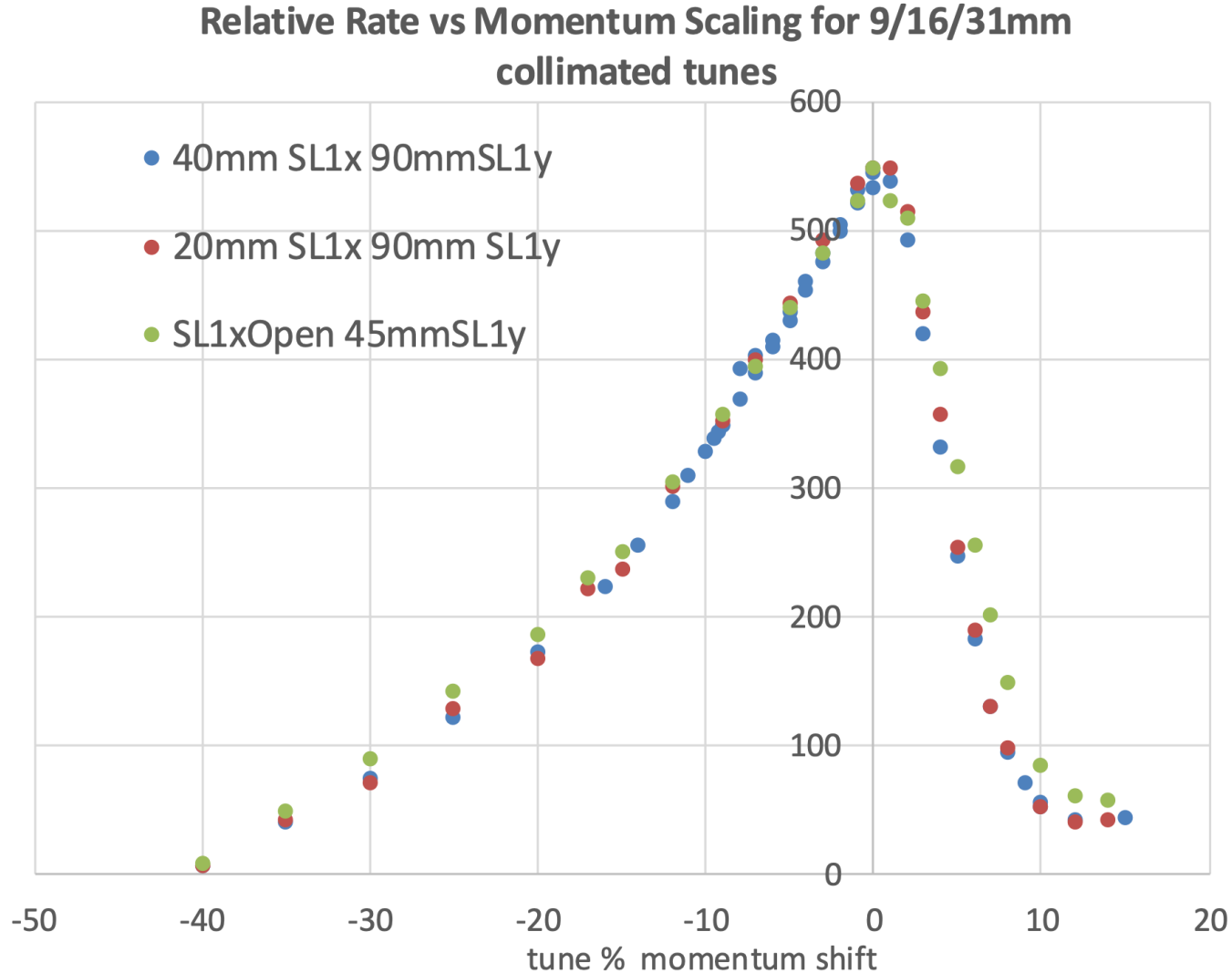
A competitive rate for "small
sample" μSR .



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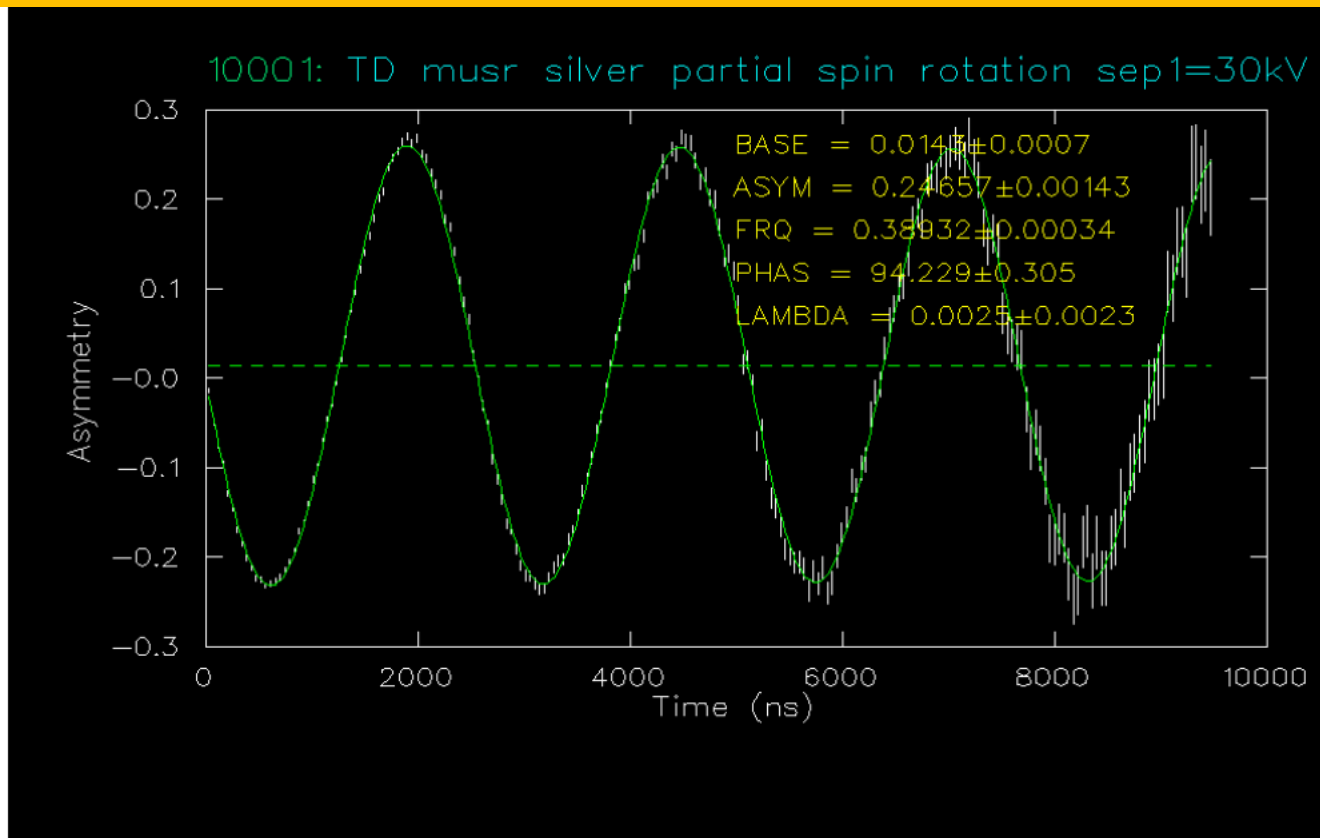


Momentum Acceptance Scan of M9A



The First MuSR run on M9A

... Donald Arseneau is responsible for his data.



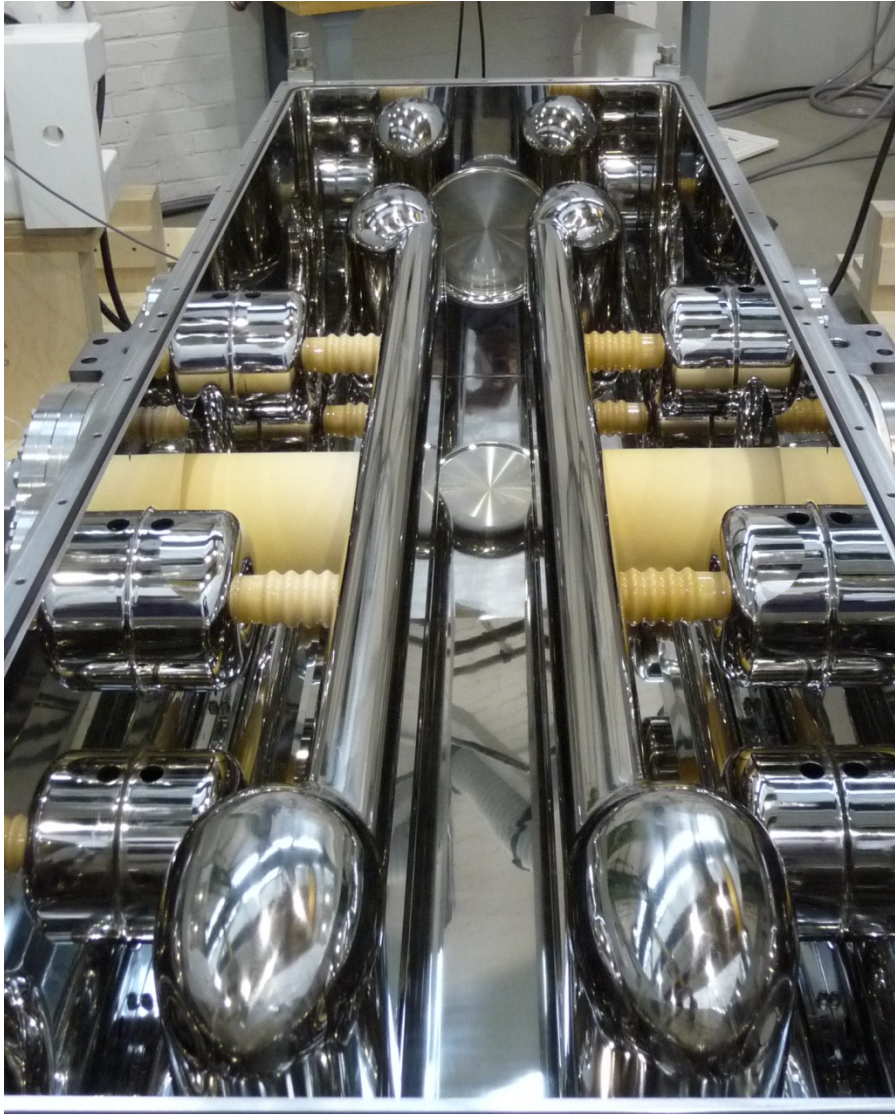
μSR Run Control on m9a			
Run number: 10001	Acq. status: Running	Run: 10001	Started: Fri Oct 27 09:53:25 2023
Acq. type: real	Exper. type: TD-μSR	Type: real	Saved: Fri Oct 27 10:33:28 2023 (40 min)
Rig is LAMPF	Mode is Ir.391	State: Running	File: /data/m9a/2023/010001.msr (v27)
Title: TD musr silver partial spin rotation sep1=30kV		Autorun: disabled	Progress: 10437300 of 13000000 counts
Sample: Gerald's silver	Orientation:	Title: TD musr silver partial spin rotation sep1=30kV	
Field: 100 G	Temperature: RT	Sample: Gerald's silver	Orient: Field: 100 G Temperature: RT
Experimenter: dja	Experiment number: 9999	2 histograms Length: 25600 bins (10.000 μs) Bin size: 0.390625 ns	
Write Data		Saved histogram contents: 10437300 counts in total	
Run Show Change Extras Quit		1 2	
		Left Right	
		5198090 5239180	
		Scaler: mu_inc mu_stop mu_g Lg Rg B_g F_g U_g D_g Tlion	
		Total: 69504676 69486080 48954569 0 0 0 0 0 0 0	
		Rate: 28702 28694 20132 0 0 0 0 0 0 0	



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Interior on the M9A Wien HV filter & testing in 2010



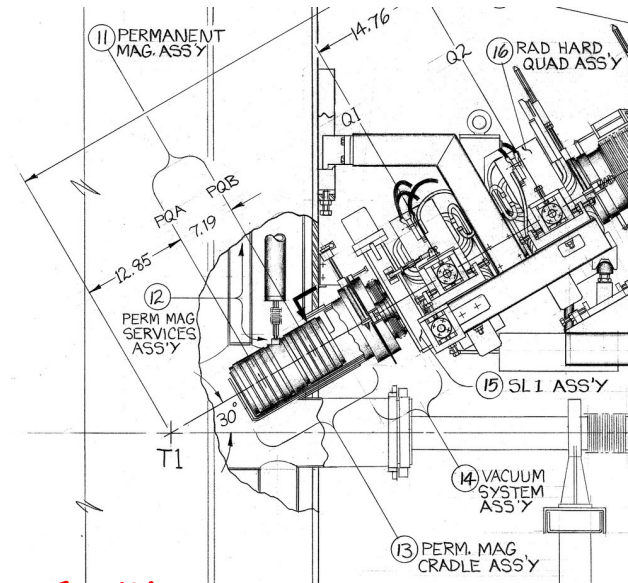
The electrostatic plates in the M9A Wien Filter are designed to limit the strength of the electric fields emerging from their surfaces to a limit of 85KV/cm.

With an operating voltage of about $\pm 270\text{KV}$ this required special shaping at the ends of the electrodes where the 3D radii of curvature are highest ... causing the highest fields.



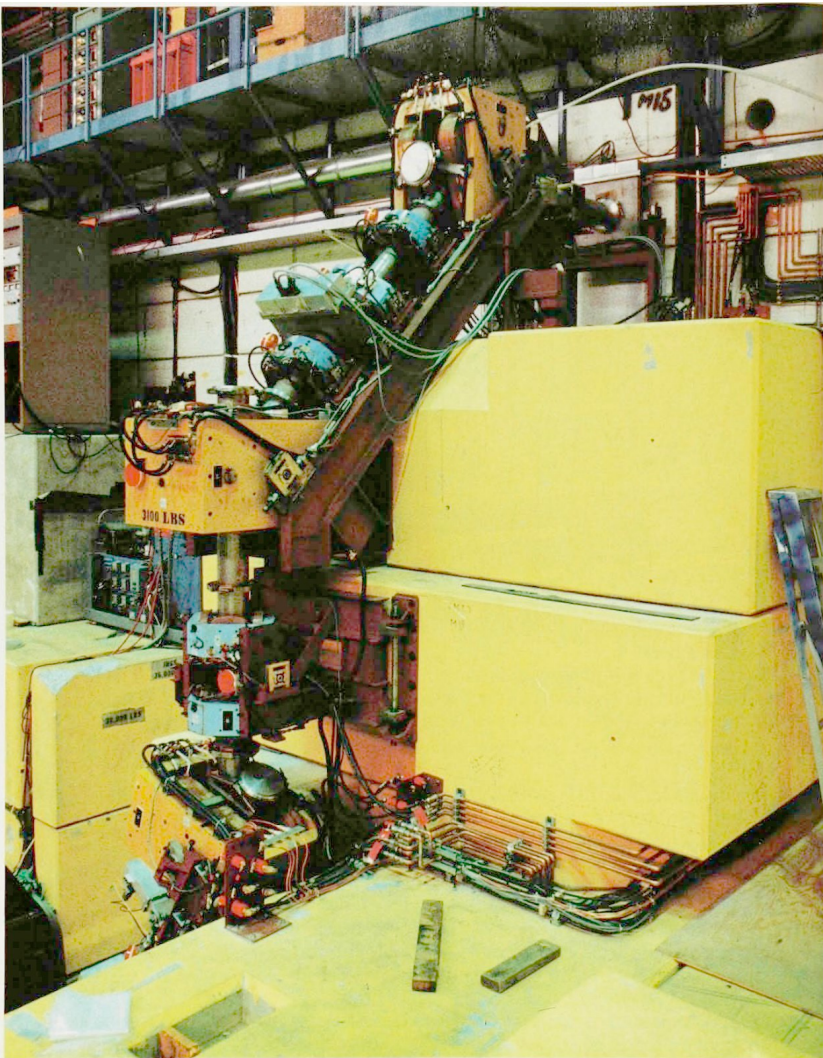
M15 world's first surface muon beam facility circa 1984

To achieve high luminosity, it was constructed with permanent quads (PQ) looking directly down onto the "top" of T1 target.



~41 yrs on:

- significant loss of luminosity due to PQ magnet radiation damage
- Beam line HV & controls outdated (but)



New beam line at TRIUMF dedicated to the production of surface muons. The beam elements transport the surface muons from a target in the main external proton beam, below the shielding blocks, upward and out of the experimental hall and into a separate building for muon spin rotation and muon decay experiments. Jaap Doorbos designed the beam line. Figure 1



Now, Partially Rejuvenated ..

- HV stacks / driver / feedthrough replacement ✓
- Control System Replacement ✓
- Steering components for final triplet ✓
- Damaged HV electrodes replaced ✓



Left: Oil free HV feedthrough

Right: New HV stacks & controllers

Below: Beamline back in operation



Restoration of high luminosity operations via front-end permanent quad replacement ... in progress.
Funding 2026? Next conference ?





Thank You !

Merci !

Grazie !

Vielen Dank !

ありがとうございました !

धन्यवाद !

감사합니다 !

Дякую !

Tack !

Bedankt !

