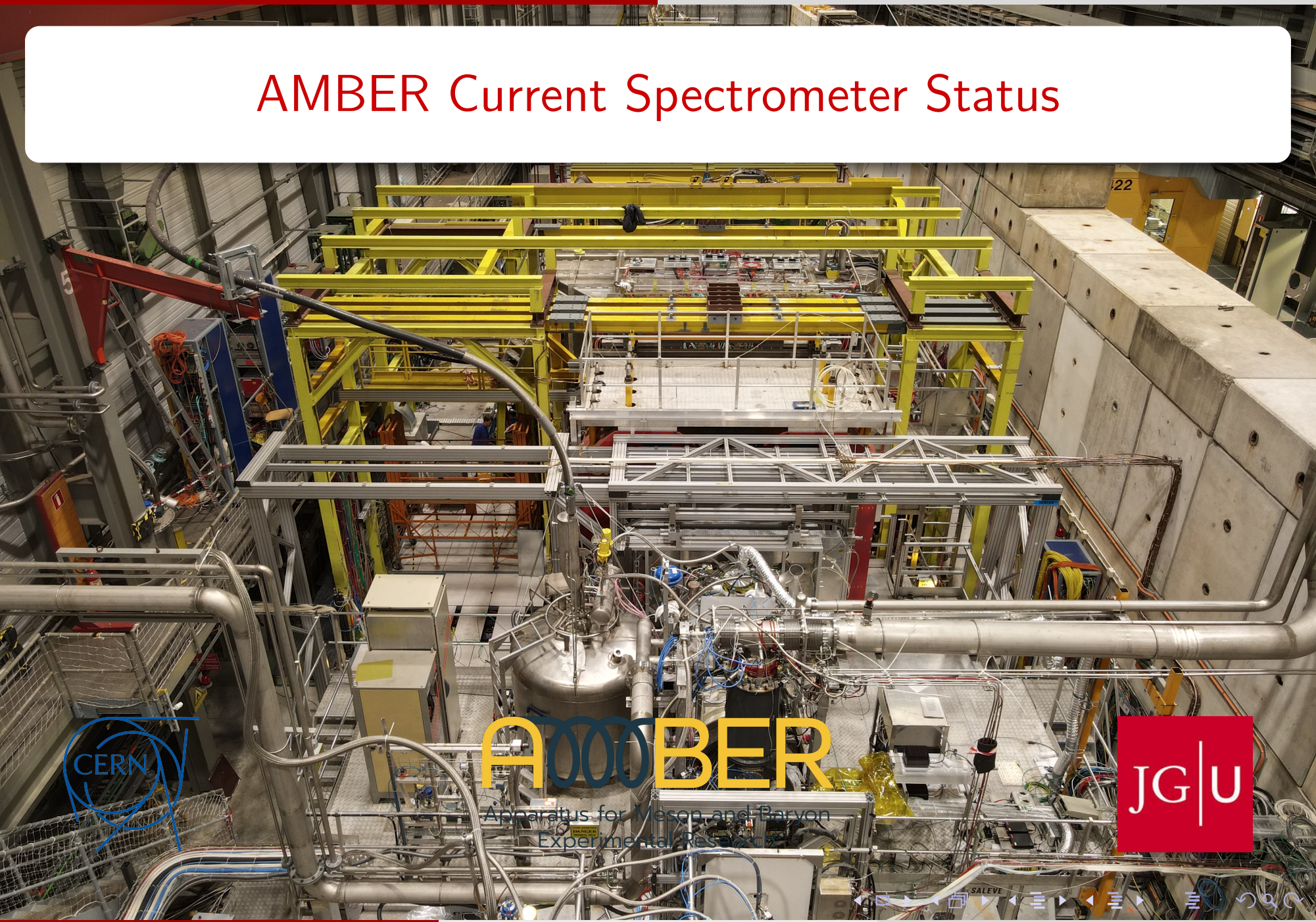
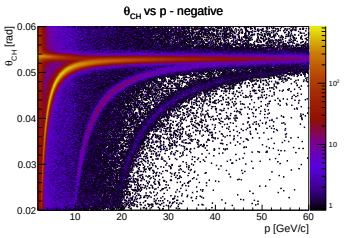
AMBER Current Spectrometer Status



AMBER Physics Program Phase-1

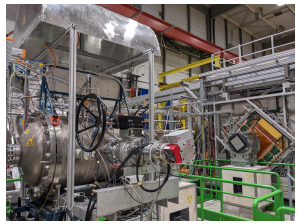
$\bar{p}$ production cross section (APX 2023/24)



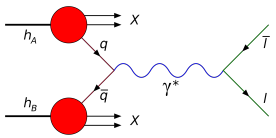
- 60-250 GeV/c positive hadron beams up to $\mathbf{10^5}\ \frac{\textbf{hadrons}}{\textbf{s}}$
- Liquid Helium, Hydrogen and Deuterium targets.
- CEDAR and RICH detectors for PID.

Proton form-factor through low Q^2 elastic muon scattering (PRM 2025+)

- 100 GeV/c positive muon beam up to $\mathbf{10^6}\ \frac{\textbf{muons}}{\textbf{s}}$
- 20 bar hydrogen **T**ime **P**rojection **C**hamber active target.
- High resolution pixel silicon/SciFi target telescope.

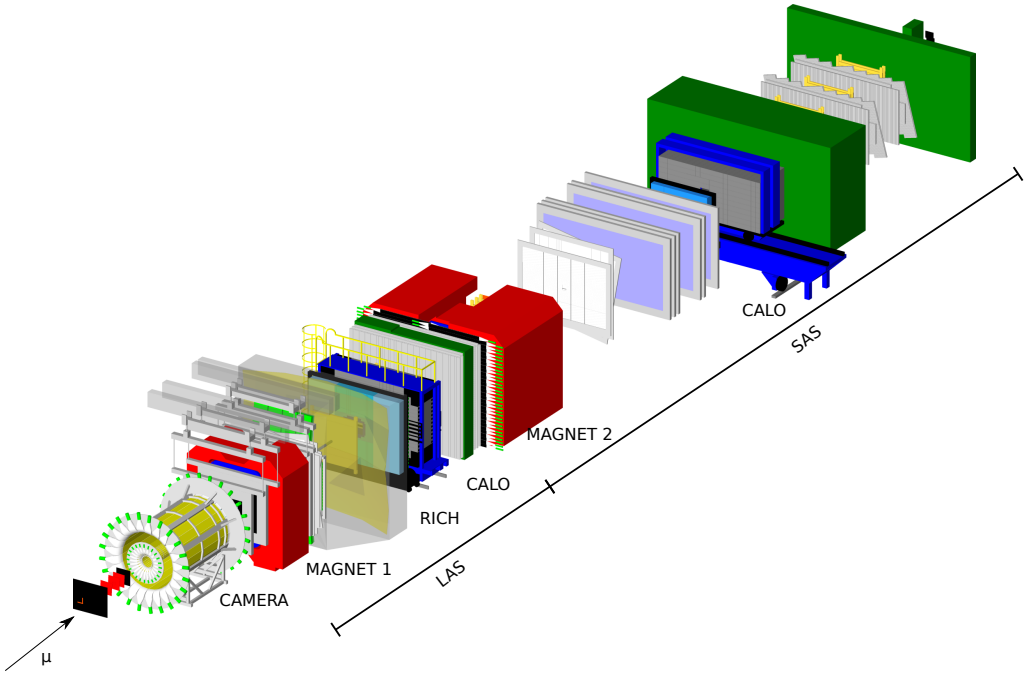


Pion PDFs through di-lepton production (DY 2028+)



- 190 GeV/c positive and negative hadron beams up to $\mathbf{10^8}\ \frac{\textbf{hadrons}}{\textbf{s}}$
- Carbon and Tungsten targets with interleaved silicon vertex detector.
- Hadron absorber and high performance CEDARs for PID.

AMBER Spectrometer (Upgraded Version of COMPASS)



2016/17 COMPASS GPD Setup

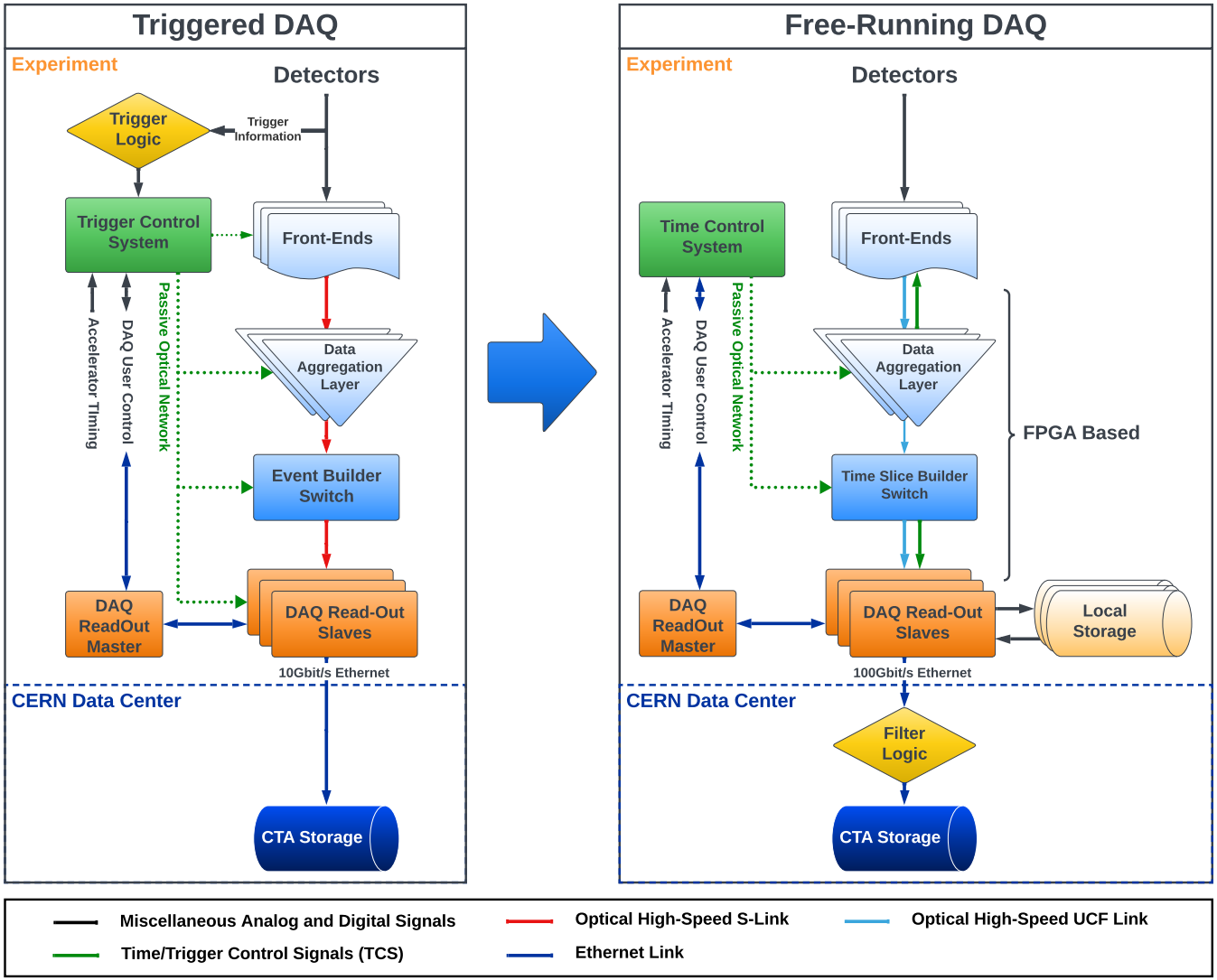
- Beam-line detectors:
  - **Beam Momentum Station**
  - **PID:** CEDARs
- Two-stage forward spectrometer:
  - **Variable Target Region**
  - **Tracker:** Silicons, SciFis, GEM, PixelMM, DriftChambers, Straws, MWPCs
  - **PID:** RICH, MuonWalls
  - **Calometry:** ECAL, HCALs
  - **Trigger:** Hodoscopes, Calorimeters
  - **Acceptance:** $\pm \approx 250$ mrad (H), $\pm \approx 180$ mrad (V)

$\approx$ 350 k Channels to be read-out!

+new detector developments for different physic programs:

- O(100M) Silicon Pixels (ALPIDE).
- O(0.6M) Silicon Stripes (Phenix VTX).
- GEM detectors with VMM read-out.
- Large area Micromegas detectors with custom ASIC.
- ...

AMBER FriDAQ Development

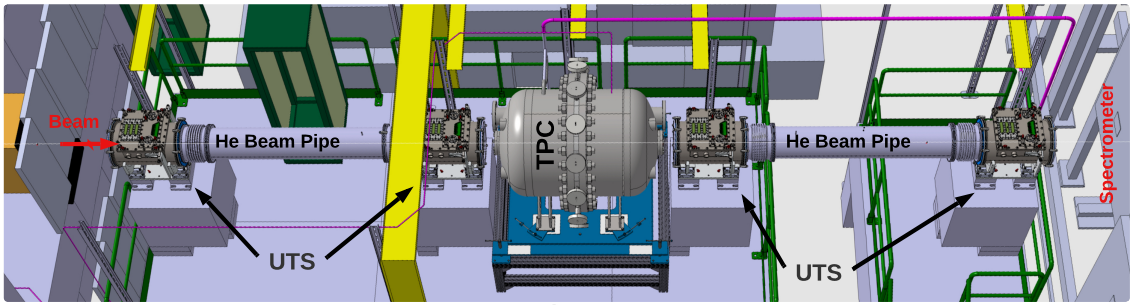


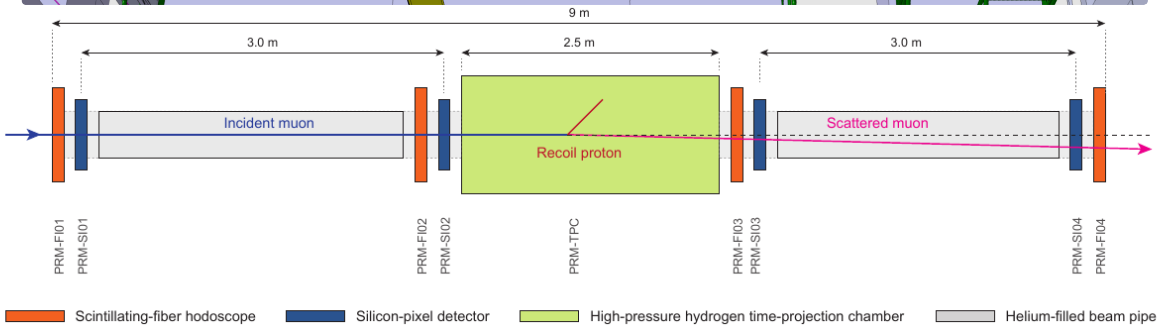
AMBER Detector Inventory

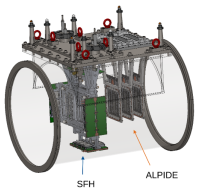
Station	# of dets.	Detection Type	Planes per det.	# of ch per det	Active Area /cm	Resolution	Location	Current Frontend	FrIDAQ Frontend	Responsible Group	New Group for Upgrade	Used in
Beam Momentum Stations (Plastic Scintillator + PMT)												
BMS01-04	4	Plastic Scitnillator Slabs + PMT	Y	64	6.0-12.0 x 9.0-23.0	σ_x = 1.3 – 2.5 mm, σ_t = 0.3 ns	Beam Line	F1 TDC 64ps	iFTDC 0.2ns?	Bonn	Frontend Bonn	PRM
BM05	1	Plastic Scitnillator Fibers + PMT	Y	64	12.0 x 16.0	σ_x = 0.7 mm, σ_t = 0.5 ns	Beam Line	F1 TDC 64ps	iFTDC 0.2ns?	Bonn	Frontend Bonn	PRM
BM06	1	Plastic Scitnillator Fibers + PMT	Y	128	12.0 x 16.0	σ_x = 0.4 mm, σ_t = 0.5 ns	Beam Line	F1 TDC 64ps	iFTDC 0.2ns?	Bonn	Frontend Bonn	PRM
Cerenkov Differential counter with Achromatic Ring Focus (CEDAR)												
CEDAR 1-2	2	Cherenkov + MAPMT	R	32			Beam Line	iFTDC 0.4ns	iFTDC 0.4ns	Warsaw/CERN	Warsaw/CERN	DY
Scintillating Fiber Stations												
SciFi 1,2	2	MAPMT	XY	192	3.9 x 3.9	σ_x = 130 µm, σ_t = 0.4 ns	Target Region	F1 TDC 128ps	iFTDC 0.2ns?	Bonn	Bonn	PRM,DY
SciFi 15	2	MAPMT					Target Region	F1 TDC 128ps	iFTDC 0.2ns?	Bonn	Bonn	DY
SciFi 3.4	2	MAPMT	XYU	384	5.3 x 5.3	σ_x = 130 µm, σ_t = 0.4 ns	LAS	F1 TDC 128ps	iFTDC 0.2ns?	Bonn	Bonn	PRM,DY
SciFi 5	1	MAPMT	XY	320	8.4 x 8.4	σ_x = 170 µm, σ_t = 0.4 ns	LAS	F1 TDC 128ps	iFTDC 0.2ns?	Warsaw	Warsaw	PRM,DY
SciFi 55	1	MAPMT					LAS	F1 TDC 128ps	iFTDC 0.2ns?	Bonn	Bonn	PRM,DY
SciFi 6	1	MAPMT	XYU	462	10.0 x 10.0	σ_x = 210 µm, σ_t = 0.4 ns	SAS	F1 TDC 128ps	iFTDC 0.2ns?	Bonn	Bonn	PRM,DY
SciFi 7	1	MAPMT	XY	286	10.0 x 10.0	σ_x = 210 µm, σ_t = 0.4 ns	SAS	F1 TDC 128ps	iFTDC 0.2ns?	Bonn	Bonn	PRM,DY
SciFi 8	1	MAPMT	XY	352	12.3 x 12.3	σ_x = 210 µm, σ_t = 0.4 ns	SAS	F1 TDC 128ps	iFTDC 0.2ns?	Bonn	Bonn	PRM,DY
SFH 1 -4	4	SiPMT	XXYY	768	9.6 x 9.6	σ_x = 150 µm, σ_t = ~0.6 ns	Target Region	N/A	iFTDC 0.2ns?	Munich		PRM
Silicon Detectors												
Cold Silicon Strip 01-03	3	Silicon strip	XYUV	1280	7.0 x 5.0	σ_x = 8 – 11 µm, σ_t = 2.5 ns	LAS	APV25	Not Used	Munich		???
Silicon Strip Vertex Detector	4	Silicon strip	R	159744	R ~ 4.4 - 16.9	σ_x = 20 µm, σ_t = 10 ns	DY Absorber		FPHX-???	Los Alamos		DY
Silicon Pixel Detector	4	Silicon MAPS ALPIDE	PPP	28.3M	9.0 x 9.0	σ_x = 8 µm, σ_t = 2.5 µs	Target Region	N/A	ALPIDE	??	-	PRM
Silcon Detectors Beam Telescope		?					Target Region	N/A	??	??		DY
Micro Megas												
PMM01-03		Micro Mega	XYUV+P	5120+5120	40 x 40	σ_x = 110-145 µm, σ_t = 14 ns	LAS	APV25	??	N/A	N/A	DY
Large Area MM		Micro Mega					SAS/LAS	-	Toast	Torino		DY
Drift Chambers												
DC00/01	2	Drift Chamber	XYUV	1024	180 x 127	σ_x = 190 µm	LAS	ASD8 + F1 TDC	??	N/A	N/A	DY
DC04	1	Drift Chamber	XXYYUUVV	2048	248 x 208	σ_x = 226 µm	LAS	ASD8 + F1 TDC	??	N/A	N/A	DY
DC05	1	Drift Chamber	XXYYUUVV	2304	248 x 208	σ_x = 226 µm	LAS	Taipe TDC	??	N/A	N/A	DY
W45	6	Drift Chamber	XY/XU/XV	500	500 x 250	σ_x = 0.5 mm	SAS	F1 TDC	iftdc ?	Aveiro	Aveiro?	DY
Straw												
ST03	1		XYU	892	323 x 280	σ_x = 190 µm	LAS	F1 TDC	iftdc ?	Prague	Prague	DY
RICH												
RICH-1	4	MAPMT	pads	2304	57.6x57.6	σ_{ph} = 2.20 mrad	LAS	F1 TDC	never discussed	Torino	Torino	potential use also DY
	8	MWPC	pads	5184	57.6x57.6	σ_{ph} = 1.85 mrad	LAS	APV25	never discussed	Trieste	Trieste	Phase 2
	4	Thick-GEM	pads	4896	57.6x57.6	σ_{ph} = 1.83 mrad	LAS	APV25	never discussed	Trieste	Trieste	Phase 2
Multi Wire Proportional Chambers												
MWPC A*	1	MWPC	XUVY	2768	178 x 120	σ_x = 1.6 mm	LAS	F1 TDC	iFTDC 0.8ns	Torino	Torino	DY
MWPC A	7	MWPC	XUV	2256	178 x 120	σ_x = 1.6 mm	SAS	F1 TDC	iFTDC 0.8ns	Torino	Torino	PRM,DY
MWPC B	6	MWPC	XU/XV	1504	178 x 90	σ_x = 1.6 mm	SAS	F1 TDC	iFTDC 0.8ns	Torino	Torino	PRM,DY
GEMs												
GEM 1-11	11	GEM	XYUV	3072	31 x 31	σ_x = 70 µm, σ_t = 12 ns	4xLAS/7xSAS	APV25	Not Used	Bonn	-	PRM,DY
PGEM 2-3	2	PGEM	XYUV+PPPP	2048+2048	10 x 10 + 3.2 x 3.2		LAS/SAS	APV25	Not Used	Bonn	-	PRM,DY
G3G/G4G	4	GEM	XYUV		31x31		LAS/SAS	-	VMM	Bonn		
ECAL												
ECAL0	1	Sandwich (PScinti+Lead) + MAPD	Cells				LAS	MSADC	MSADC w feat. extr. ?	Dubna	Dubna	??
ECAL1	1	Lead Glas + PMT	Cells	1500	244 x 183		LAS	SADC	MSADC w feat. extr. ?	Protvino	N/A	Phase 2
ECAL2	1		Cells	2972	245 x 184	$\Delta E/E = 0.06/\sqrt{(E/GeV)} \oplus 0.02$	SAS	MSADC	MSADC w feat. extr.	Protvino	N/A	PRM central part
HCAL												
HCAL1	1	PMT	Cells	480	420 x 300	$\Delta E/E = 0.59/\sqrt{(E/GeV)} \oplus 0.08$	LAS	SADC	MSADC w feat. extr. ?	Dubna	Dubna	DY for Trigger effi?
HCAL2	1	PMT	Cells	2972	440 x 200	$\Delta E/E = 0.66/\sqrt{(E/GeV)} \oplus 0.05$	SAS	SADC	MSADC w feat. extr. ?	Protvino	N/A	DY for Trigger effi?
Mini Drift Tubes (MDT)												
MW1	8	Mini Drift Tubes	X/Y	1184/928	473 x 405	σ_x = 3 mm	LAS	F1 TDC	Toast?	Dubna	Dubna	DY
Rich Wall 1	1	Mini Drift Tubes	XXYYXXYY		527 x 391	σ_x = 1.0 mm	LAS	MAD4 + F1 TDC	??	Torino	Torino	DY
Drift Tubes												
MW2	2	Drift Tubes	XYV	840	447 x 202	σ_x = 0.6 – 0.9 mm	SAS	F1 TDC	??	N/A	N/A	DY
Plastic Scintillator Hodoscopes												
Veto beamline	1	1x PMT	R	4		σ_t = 0.6 ns	Beam Line	F1 TDC 128ps	iFTDC 0.2ns ?	Mainz	Mainz	PRM,DY
Veto inner 1	1	1x PMT	R	4		σ_t = 0.6 ns	Target Region	F1 TDC 128ps	iFTDC 0.2ns ?	Mainz	Mainz	DY
Veto inner 2	1	1x PMT	R	8		σ_t = 0.6 ns	Target Region	F1 TDC 128ps	iFTDC 0.2ns ?	Mainz	Mainz	DY
Veto Outer1	1	2x PMT	X	36		σ_t = 0.6 ns	Target Region	F1 TDC 128ps	iFTDC 0.2ns ?	Mainz	Mainz	DY
Veto Up/Dwn	2	1x PMT	X	5		σ_t = 0.8 ns	Target Region	F1 TDC 128ps	iFTDC 0.2ns ?	Mainz	Mainz	DY
H1	1	2x PMT	Y	64	250.0 x 192.0	σ_x = 17.3 mm, σ_t = 0.4 ns	LAS	F1 TDC 128ps	iFTDC 0.2ns ?	Mainz	Mainz	DY
H2	2	2x PMT	Y	64		σ_x = 40.0 mm, σ_t = 0.6 ns	LAS	F1 TDC 128ps	iFTDC 0.2ns ?	Mainz	Mainz	DY
HO03	1	2x PMT (9813KB)	Y	36	200.0 x 100.0	σ_x = 20.2 mm, σ_t = 0.6 ns	SAS	F1 TDC 128ps	iFTDC 0.2ns ?	Mainz	Mainz	PRM,DY
HM04	1	1x PMT (EMI9954B), 2x PMT (XP2900)	X/Y	40+64	120.0 x 102.0	σ_x = 6.7-17.9 mm, σ_t = 0.6 ns	SAS	F1 TDC 128ps	iFTDC 0.2ns ?	Mainz	Mainz	PRM,DY
HL04	1	2x PMT (XP2900, 2090, 2020)	X	64	128.2 x 40.0	σ_x = 6.4-19.3 mm, σ_t = 0.6 ns	SAS	F1 TDC 128ps	iFTDC 0.2ns ?	Mainz	Mainz	PRM,DY
HO04	1	2x PMT (9813KB)	Y	64	480.0 x 225.0	σ_x = 43.3 mm, σ_t = 0.6 ns	SAS	F1 TDC 128ps	iFTDC 0.2ns ?	Mainz	Mainz	PRM,DY
HM05	1	1x PMT (EMI9954B), 2x PMT (XP2900)	X/Y	40+64	150.0 x 120.0	σ_x = 7.9-22.2 mm, σ_t = 0.6 ns	SAS	F1 TDC 128ps	iFTDC 0.2ns ?	Mainz	Mainz	PRM,DY
HL05	1	2x PMT (XP2900, 2090, 2020)	X	64	168.2 x 47.5	σ_x = 7.8-13.7 mm, σ_t = 0.6 ns	SAS	F1 TDC 128ps	iFTDC 0.2ns ?	Mainz	Mainz	PRM,DY
HI5	1	PMT (R7400)	X	64	35.3 x 51.0	σ_x = 3.5 mm, σ_t = 0.4 ns	SAS	F1 TDC 128ps	iFTDC 0.2ns ?	Mainz	Mainz	PRM,DY
Active Target												
AMBER TPC H2	1		PP	128	ø		Target Region	N/A	Struck FADC	N/A	N/A	PRM,DY
Passive Target												
Polarized Target	N/A		N/A	N/A	ø3 x 140	N/A	N/A	N/A	N/A	Yamagata	Yamagata	??
LH2	N/A		N/A	N/A	ø3 x 140	N/A	N/A	N/A	N/A	Yamagata/CERN	Yamagata/CERN	??

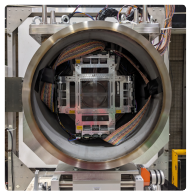
Proton Radius Setup

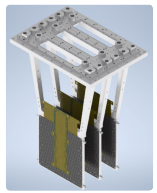
Only subset of the spectrometer will be used for PRM.

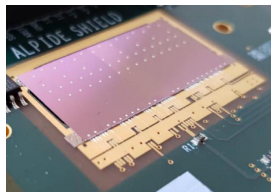












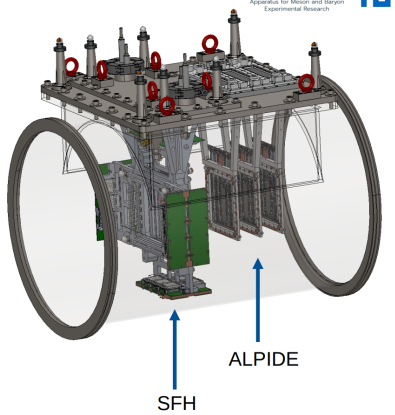
- **BMS**
  → momentum of incoming particle.
- **20 bar Hydrogen TPC**
  → active target to measure low-energetic recoil-proton.
- **Pixel silicon trackers**
  → small scattering-angles.
- **Scintillating-fiber trackers**
  → timing
- **GEMs, SciFis, MWPCs**
  → scattered muon kinematics.
- **Scintillator hodoscopes**
  → fast muon identification.
- **ECAL**
  → radiative effects.

Huge time resolution difference between tracking O(ns) and TPC $O(100\mu s)$!

Silicon Pixel Detector (PRM)

Unified Tracking Station (UTS)

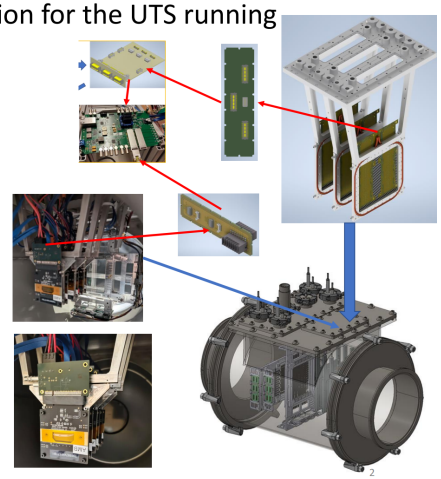
- Combined muon tracking for the proton radius measurement
- Silicon pixel detector (ALPIDE) and scintillating-fiber hodoscope (SFH) combined in unified tracking station in common vessel
- Three layers of pixel detectors in combination with four planes of scintillating fibers (2X, 2Y)
- In total 4 stations will be used



Update on the preparation for the UTS running

- Presently we expect to have 4x UTS stations
- To equip 4 UTS with 1 FLEX + 2 carrier cards each:
  - 8 Carrier cards
  - 8 supports for carrier cards
  - 4 Flex PCBs with 6 ALPIDEs each glued on carbon
  - 4 supports for carbon plates
  - 4 cables between Flex PCBs and transition cards
  - 12 support structure
  - 4 Transition card + converter card kits
  - 8 (4 as a minimal set) Firefly transition cards
  - 4 main mechanical plates
  - 12 Firefly cables
  - 12 RO modules
  - Power, cooling, cabling

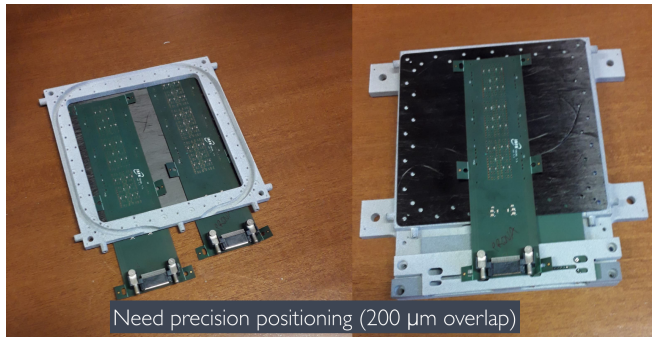
25/07/2023

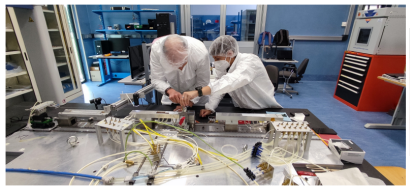


ALPIDE Parameters:

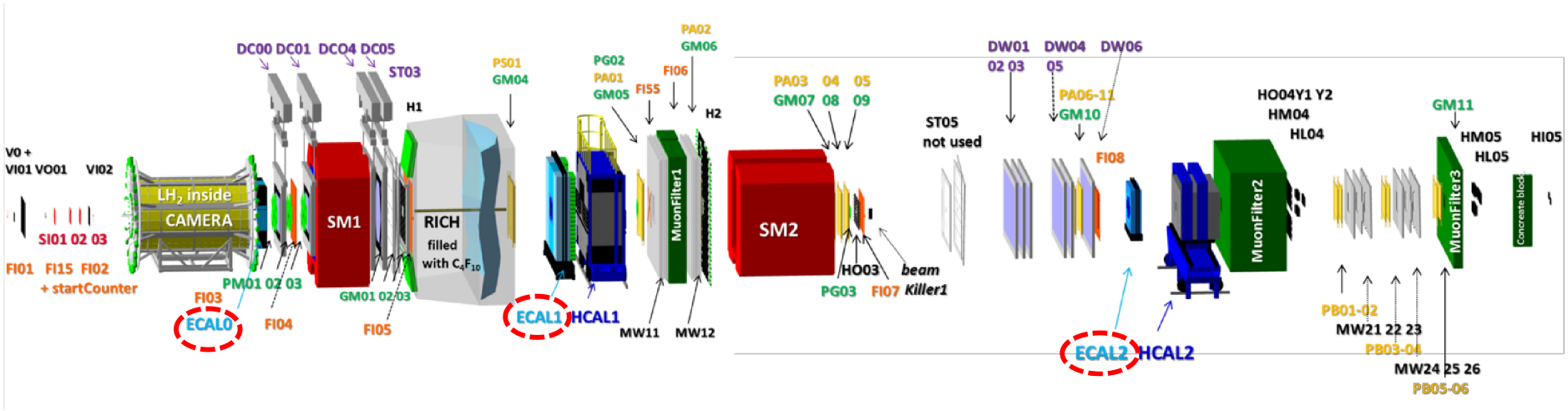
$9\text{x}9\,\text{cm}^2,\ \sigma_s \approx 8\mu\text{m}, \sigma_t \approx 2.5\mu\text{s}$

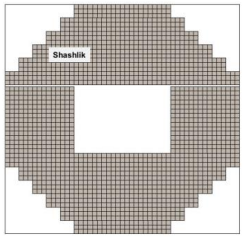
Project is in troubles due to funding issues and long term sickness of involved people. Mechanical integration and electronic cards are well developed but FPGA programming for interface to the FriDAQ and full integration of all components endangered. Help in form of manpower needed (FPGA programming, software development, hardware assembly) or alternative system which is easy adaptable to the UTS mechanical design and FriDAQ architecture is urgently needed!



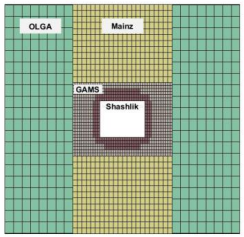


Electro Magnetic Calorimeter

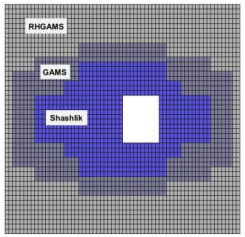




ECAL 0
2×2 m²
1746 cells



ECAL 1
4×3 m²
1708 cells

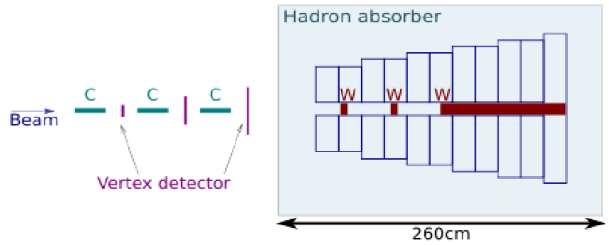


ECAL 2
2.5×2 m²
2972 cells

- Participation of Protvino Group (ECAL1+ECAL2) in AMBER will stop due to CERN counsel decision!
- Central part of ECAL2 (≈10x10 cells) needed to be operated for PRM!
- Full ECAL1+2 have to be operated or replaced for AMBER Phase-2

Development for new FriDAQ compatible MSADC frontends with feature extraction and compression on-going.

Drell-Yan Setup



3 carbon targets of 25cm length

2 tungsten targets of 6cm length

(alternative 2cm length W upstream)

AMBER Apparatus for Meson and Baryon Experimental Research — Drell-Yan setup

Hadron absorber for high intensity

Vertex detectors for Mass resolution

Two CEDAR detectors for beam PID

COMPASS-like spectrometer for acceptance

$8 \lesssim \theta^{\mu^\pm}/(mrad) \lesssim 40$

$25 \lesssim \theta^{\mu^\pm}/(mrad) \lesssim 140$

CEDAR tests from last year showed the necessity to add silicon trackers in front of the target to the setup to improve beam-PID!

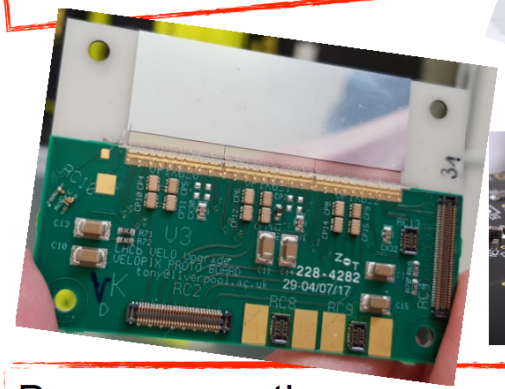
Silcon Detectors for DY Beam Telescope

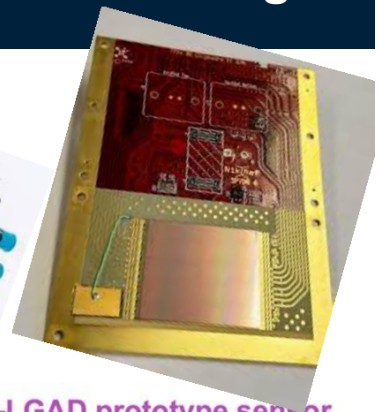
Recent new idea still in evaluation ... Bjorn's slides from PAW2024:

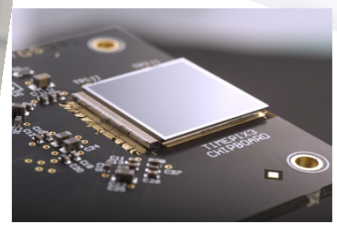
University of Glasgow

Requirements and candidate technologies

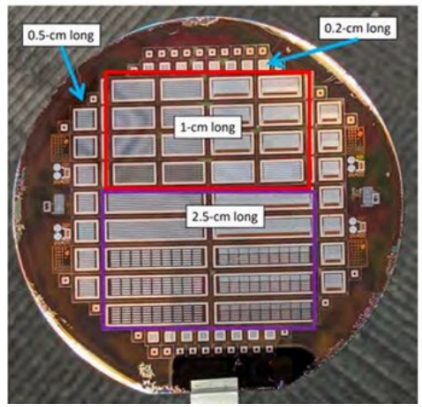
Physics case:
- 30 μm position resolution
- < 200 ps time resolution
- > 10 x 10 cm² active area





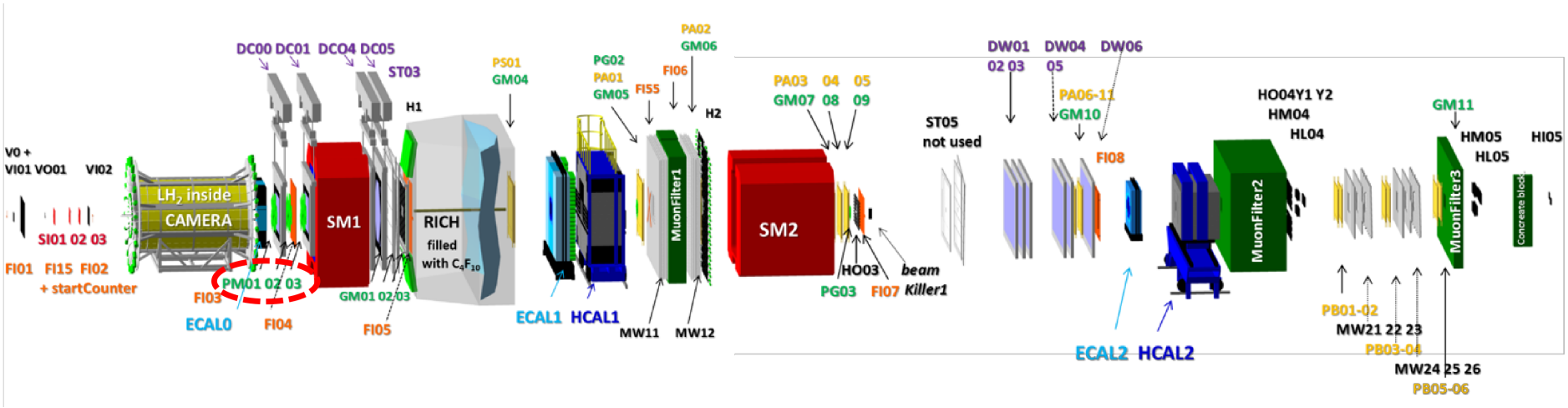


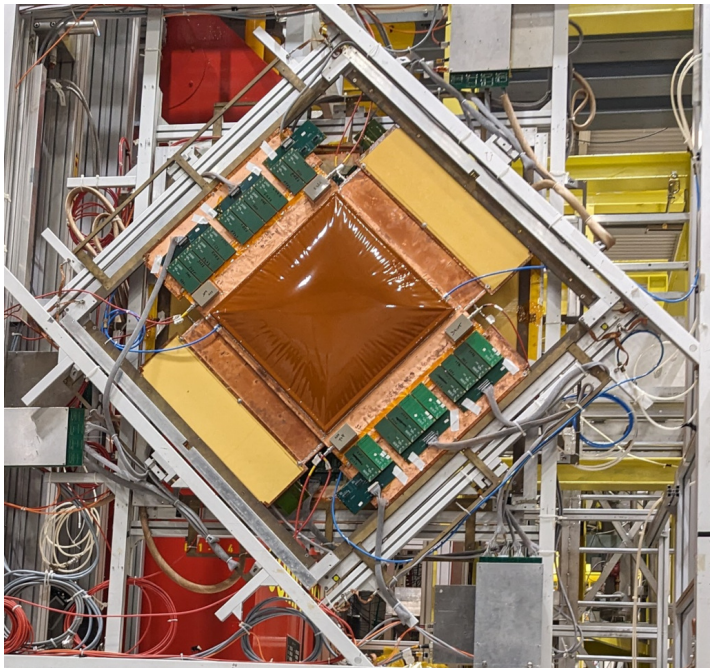
AC-LGAD prototype sensor



Beam properties:
- Stable, Gaussian beam
- 4.8x10⁸ particles/spill, 10⁷ Kaons
- ~ 10 x 10 cm² cross section

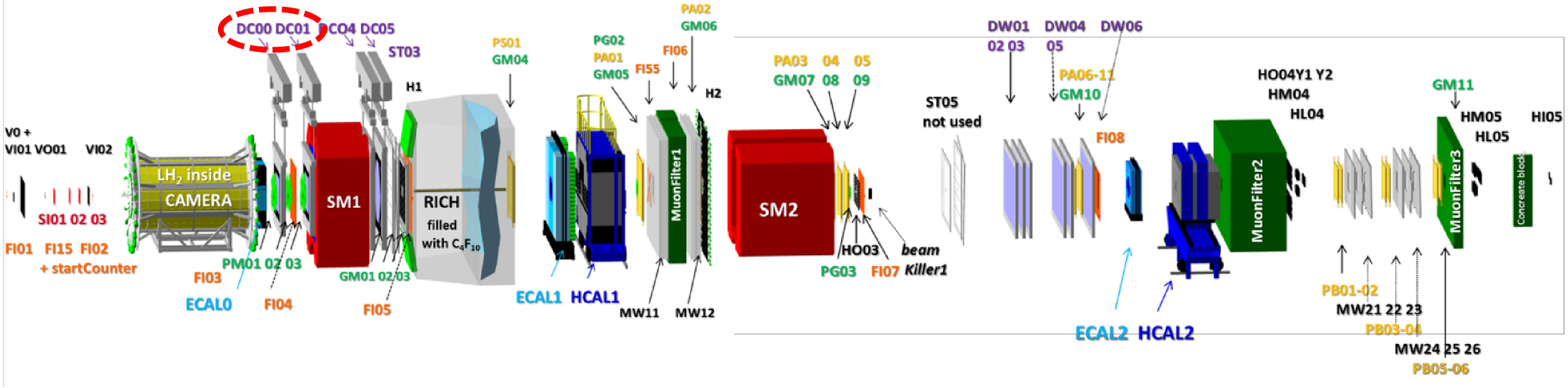
Pixel Micro Megas in LAS

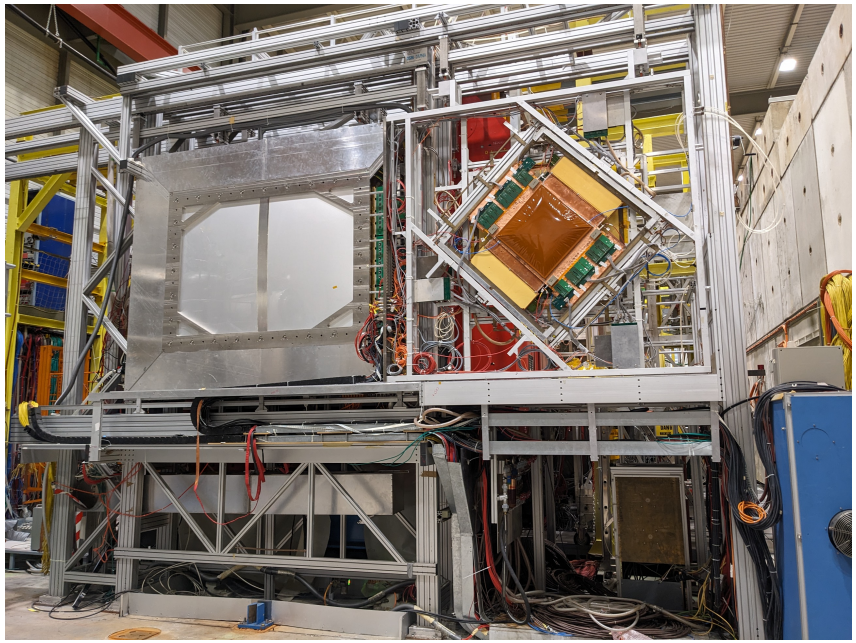




- Three small area trackers in LAS with four projections (XYUV) and pixelized center.
- Active Area: 40x40 cm^2
- $\sigma_s = 110 - 145\,\mu\mathrm{m}$, $\sigma_t = 14\,\mathrm{ns}$.
- Detectors are not FriDAQ ready (APV25)
- Saclay left AMBER, currently no responsible group
- Detector can be taken over from Saclay or new development needed.

Small Drift Chamber Trackers in LAS (DC00/01)





- Two large area trackers in LAS with four projections (XYUV).
- Active Area: $\approx$ 180x127 cm^2
- $\sigma_s = 190\,\mu$m.
- Both detector are aging (build in $\approx$2002).
- Not FriDAQ ready $\rightarrow$ New Front ends needed.
- Both station have regular issues with broken wires.

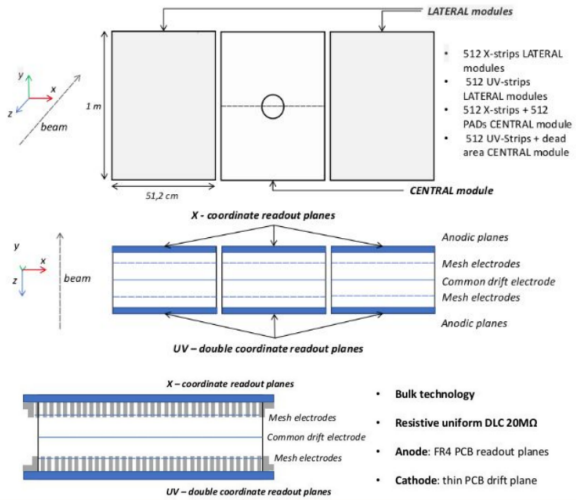
Replacement of MWPCs

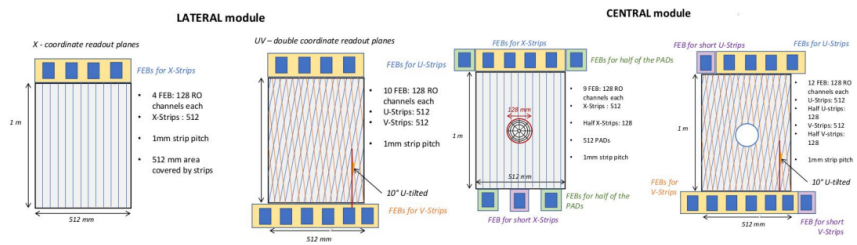
New large Micro Megas are under development by Torino to replace PA chambers.

Historical reminder of the project

A full-scale prototype/final **MM detector** composed of a lateral and central modules is expected to be ready by the second half of 2025

- The design and production of the structure and electrodes will be carried out by the MPT Workshop at CERN.
- The mechanical frame and the suspension structure will be carried out by Torino group with support of INFN To.
- A lateral module is expected in 2024 (contracted) and the central at the beginning of 2025 (will depend on the test of the lateral module).





Chiara Alice - AMBER technical board report new MM detector- 05.03.24 2

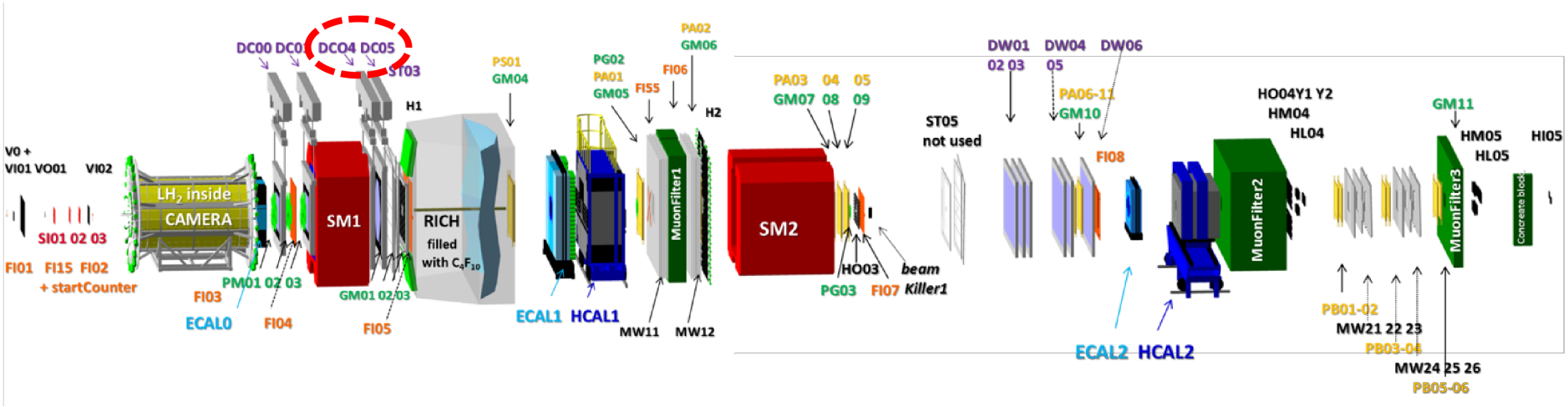
PB chambers are under refurbishment and will be equipped with CMAD+ifTDC read-out.

Proposal to replace PMM+DC00/01

Recent Idea to replace PMM+DC00/01 with new large area MM with padelized centres:

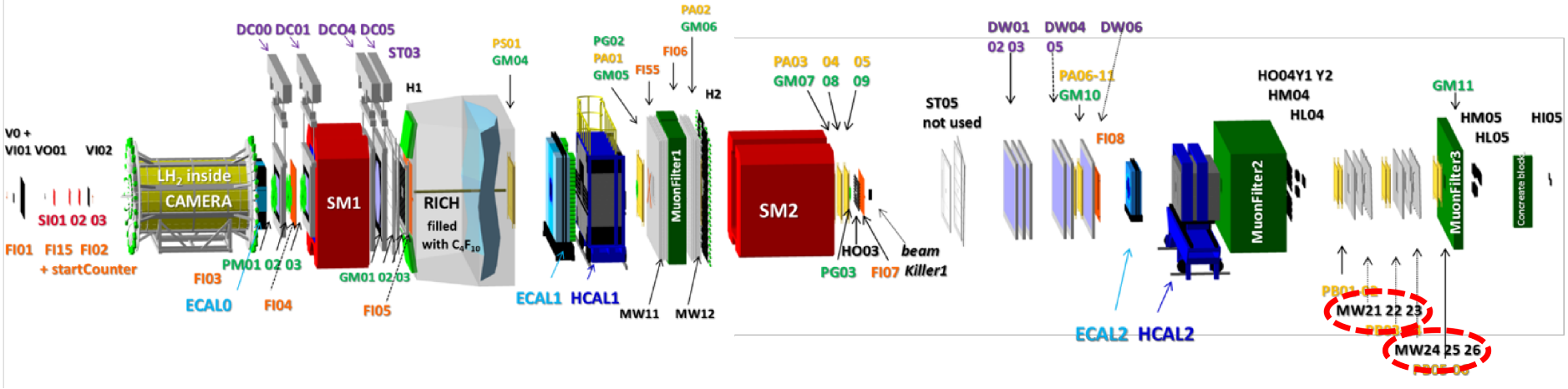
Development of large MM w/o padelized centres on-going but no group/founding yet for the replacement of DCs/PMM with large MM w. padelized centres...

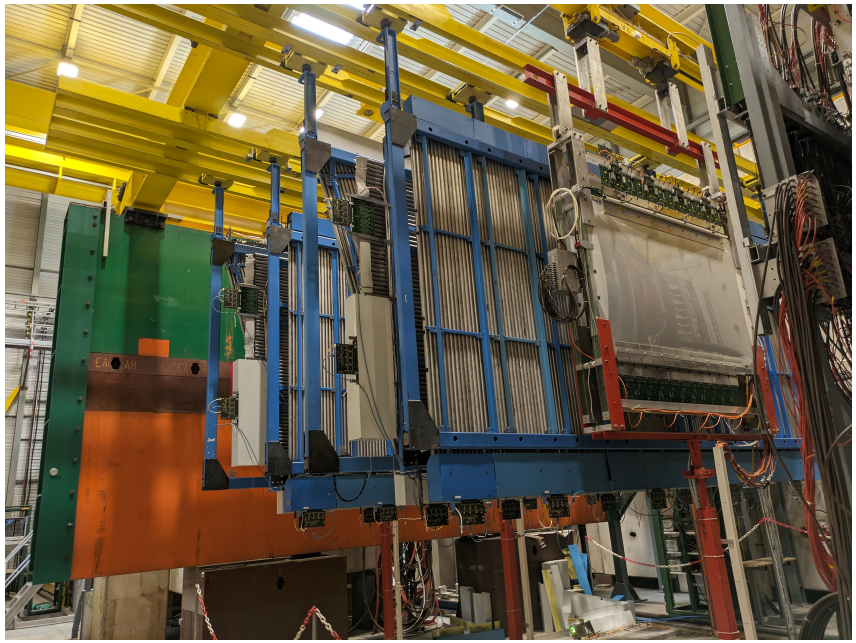
Large Drift Chamber Trackers in LAS (DC4/5)



- Two large area trackers in LAS with eight projections (XX'YY'UU'VV').
- Active Area: $\approx$ 250x210 cm^2
- $\sigma_s = 226\,\mu$m.
- DC4 from 2005, DC5 copy of DC4 from 2015.
- Not FriDAQ ready $\rightarrow$ New Frontends.
- Both station have regular issues with broken wires.
- Saclay/Illinois left AMBER.

Muon PID in SAS (MW2)





- Muon Identification with MF2 absorber in SAS.
- Two drift tube detector stations with three views (XYV).
- Active Area: $\approx$ 450x200 cm^2.
- $\sigma_s = 0.6 - 0.9$ mm.
- Not operated since 2022 due to missing responsible group and detector ageing.

ECRs and Studies for DY (CERN) I

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EDMS NO.	REV.	VALIDITY
3129053	0.3	DRAFT

REFERENCE: SPSX-V-ES-002

Date: 2024-09-20

USER REQUIREMENTS

User Requirements for the Vacuum System of the M2 Beamline

ABSTRACT:

This document outlines the user requirements for the consolidation and upgrade of the vacuum system in the M2 beamline to facilitate a hadron beam of higher intensity to be delivered to the EHN2 experimental hall. The current request describes the vacuum system requirements that would reduce multiple scattering along the beamline and drastically improve the tagged kaon intensity at the AMBER experiment.

DOCUMENT PREPARED BY:	DOCUMENT TO BE CHECKED BY:	DOCUMENT TO BE APPROVED BY:
Fabian Metzger Giulia Romagnoli Silvia Schuh	Dipanwita Banerjee, Johannes Bernhard, Philippe Boisseaux-Bourgeois, Ramon Folch, Miguel Diogo Dos Santos, Angelo Petrellese (BE-EA) Inaki Ortega Ruiz (SY-BI) Philippe Schwarz (TE-MSC) Oleg Denisov, Jan Friedrich, Björn Seitz, Moritz Veit, Rainer Wanke (AMBER) NA-CONS Team	Markus Brugger EATM

DOCUMENT SENT FOR INFORMATION TO:

- NA-CONS
- EATM

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EDMS NO.	REV.	VALIDITY
2868386	0.1	DRAFT

REFERENCE: SPSX-J-EC-0002

Date: 2023-08-22

ENGINEERING CHANGE REQUEST

Shielding Improvement for the High Intensity Hadron Operation of M2

BRIEF DESCRIPTION OF THE PROPOSED CHANGE(S):

The Drell-Yan operation of the AMBER Phase 1 experiment, which has been approved by the SPSC for operation in the EHN2 hall, requires a hadron beam of higher intensity to be delivered to M2. The current request describes the shielding modification needed to make the high intensity beam operation compatible with the requirements of the Radiation Protection as well as the reduction of multiple scattering to improve the particle tagging by CEDAR detectors by completing the vacuum in the beamline.

DOCUMENT PREPARED BY:	DOCUMENT TO BE CHECKED BY:	DOCUMENT TO BE APPROVED BY:
Claudia Ahdida HSE-RP Arnaud Devienne HSE-RP Dipanwita Banerjee BE-EA Alexander Gerbershagen BE-EA Sylvain Girod BE-EA	Michael Lazzaroni, Johannes Bernhard, Philippe Boisseaux-Bourgeois BE-EA Oleg Denisov EP-UFT Jan Friedrich EP-UFT	Markus Brugger BE-EA EATM IEFC

DOCUMENT SENT FOR INFORMATION TO:

EATM members
IEFC members

SUMMARY OF THE ACTIONS TO BE UNDERTAKEN:

- Installation of additional shielding walls and access door around AMBER target
- Definition of the access procedures to the AMBER target area
- Completing of vacuum of the M2 beamline

Note: When approved, an Engineering Change Request becomes an Engineering Change Order.
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EDMS Document Number: 2670569 – v1.0

ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE
EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
Laboratoire Européen pour la Physique des Particules
European Laboratory for Particle Physics

Occupational Health & Safety and Environmental Protection Unit

Technical Note
16 February 2023

Radiation Protection assessment of shielding improvements at EHN2 for Amber Drell-Yan run

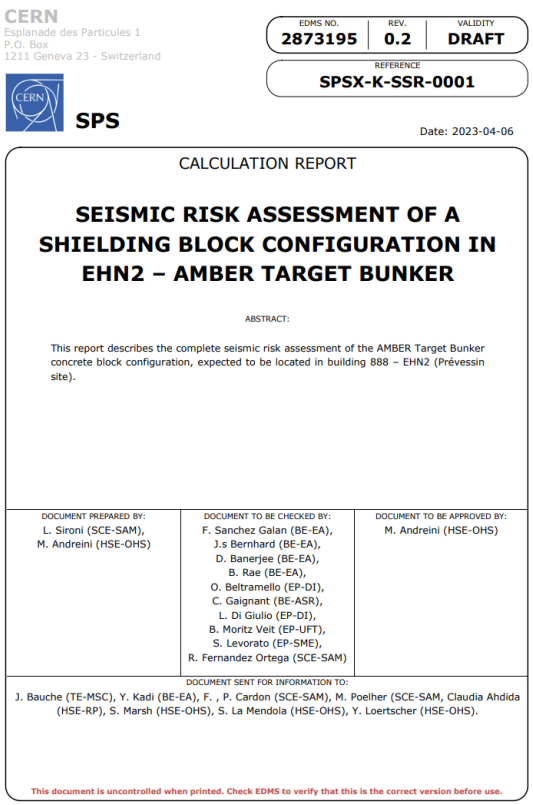
prepared by:	verified by:	approved by:
A. Devienne (HSE-RP) C. Ahdida (HSE-RP) F. Malacrida (HSE-RP)	C. Ahdida (HSE-RP)	H. Vincke (HSE-RP)

Summary

In the context of the PBC project, a QCD facility named AMBER/NA66 was developed as a successor of the COMPASS experiment. AMBER is located in the surface hall EHN2 in the CERN SPS North Area. The approved physics program of AMBER includes, amongst others, measurements of the pion-induced Drell-Yan process. This process shall be studied with a high-intensity 190 GeV/c pion beam impinging on a tungsten and several carbon targets followed by a 2.2 m long absorber. A total of 3.07×10^{14} pions on target per year shall be reached. This corresponds to a beam intensity increase by 68% with regards to the latest 2018 COMPASS Drell-Yan run. During the latter, the annual net ambient dose equivalent at the nearby environmental monitoring station close to the CERN fence reached 75% of the annual limit of 1 mSv. A radiation survey inside of the EHN2 hall and in its vicinity further allowed identifying several locations with elevated radiation levels. To increase the beam intensity delivered to EHN2 while staying compliant with CERN's radiation protection code regarding doses to the personnel and members of the public, detailed studies for improving the shielding in EHN2 were performed. These studies include the evaluation of the prompt dose rates in the accessible areas of EHN2 and next to it, at the CERN fence, and at the surrounding publicly accessible places. In addition, the residual dose rates inside of the target area were evaluated for different cooling times to determine adequate access requirements. Finally, the air activation inside the EHN2 hall and the exposure of members of the public due to air releases into the environment were assessed. The studies were performed with the FLUKA Monte Carlo particle transport code and the ActiWiz Creator tool.

EDMS **2670569** **v.1** status **Released** access **Internal_rafc**
EHN2_AMBER_TN.pdf modified **2023-02-16 11:11**

ECRs and Studies for DY (CERN) II



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SPS

EDMS NO.	REV.	VALIDITY
2873195	0.2	DRAFT

REFERENCE: SPSX-K-SSR-0001

Date: 2023-04-06

CALCULATION REPORT

SEISMIC RISK ASSESSMENT OF A SHIELDING BLOCK CONFIGURATION IN EHN2 – AMBER TARGET BUNKER

ABSTRACT:

This report describes the complete seismic risk assessment of the AMBER Target Bunker concrete block configuration, expected to be located in building 888 – EHN2 (Prévessin site).

DOCUMENT PREPARED BY:	DOCUMENT TO BE CHECKED BY:	DOCUMENT TO BE APPROVED BY:
L. Sironi (SCE-SAM), M. Andreini (HSE-OHS)	F. Sanchez Galan (BE-EA), J.s Bernhard (BE-EA), D. Banerjee (BE-EA), B. Rae (BE-EA), O. Beltramello (EP-DI), C. Gaignant (BE-ASR), L. Di Giulio (EP-DI), B. Moritz Veit (EP-UFT), S. Levorato (EP-SME), R. Fernandez Ortega (SCE-SAM)	M. Andreini (HSE-OHS)

DOCUMENT SENT FOR INFORMATION TO:

J. Bauche (TE-MSC), Y. Kadi (BE-EA), F. , P. Cardon (SCE-SAM), M. Poelher (SCE-SAM, Claudia Ahdida (HSE-RP), S. Marsh (HSE-OHS), S. La Mendola (HSE-OHS), Y. Loertscher (HSE-OHS).

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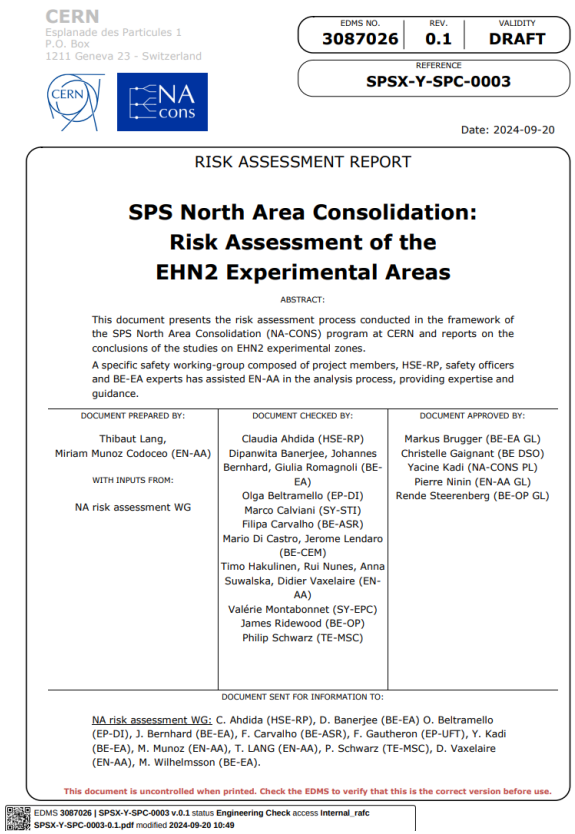

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NA cons

EDMS NO.	REV.	VALIDITY
3087026	0.1	DRAFT

REFERENCE: SPSX-Y-SPC-0003

Date: 2024-09-20

RISK ASSESSMENT REPORT

SPS North Area Consolidation: Risk Assessment of the EHN2 Experimental Areas

ABSTRACT:

This document presents the risk assessment process conducted in the framework of the SPS North Area Consolidation (NA-CONS) program at CERN and reports on the conclusions of the studies on EHN2 experimental zones.

A specific safety working-group composed of project members, HSE-RP, safety officers and BE-EA experts has assisted EN-AA in the analysis process, providing expertise and guidance.

DOCUMENT PREPARED BY:	DOCUMENT CHECKED BY:	DOCUMENT APPROVED BY:
Thibaut Lang, Miriam Munoz Codoceo (EN-AA) WITH INPUTS FROM: NA risk assessment WG	Claudia Ahdida (HSE-RP) Dipanwita Banerjee, Johannes Bernhard, Giulia Romagnoli (BE-EA) Olga Beltramello (EP-DI) Marco Calviani (SY-STI) Filipa Carvalho (BE-ASR) Mario Di Castro, Jerome Lendaro (BE-CEM) Timo Hakulinen, Rui Nunes, Anna Suwalska, Didier Vaxelaire (EN-AA) Valérie Montabonnet (SY-EPC) James Ridewood (BE-OP) Philip Schwarz (TE-MSC)	Markus Brugger (BE-EA GL) Christelle Gaignant (BE DSO) Yacine Kadi (NA-CONS PL) Pierre Ninin (EN-AA GL) Rende Steerenberg (BE-OP GL)

DOCUMENT SENT FOR INFORMATION TO:

NA risk assessment WG: C. Ahdida (HSE-RP), D. Banerjee (BE-EA) O. Beltramello (EP-DI), J. Bernhard (BE-EA), F. Carvalho (BE-ASR), F. Gautheron (EP-UFT), Y. Kadi (BE-EA), M. Munoz (EN-AA), T. LANG (EN-AA), P. Schwarz (TE-MSC), D. Vaxelaire (EN-AA), M. Wilhelmsson (BE-EA).

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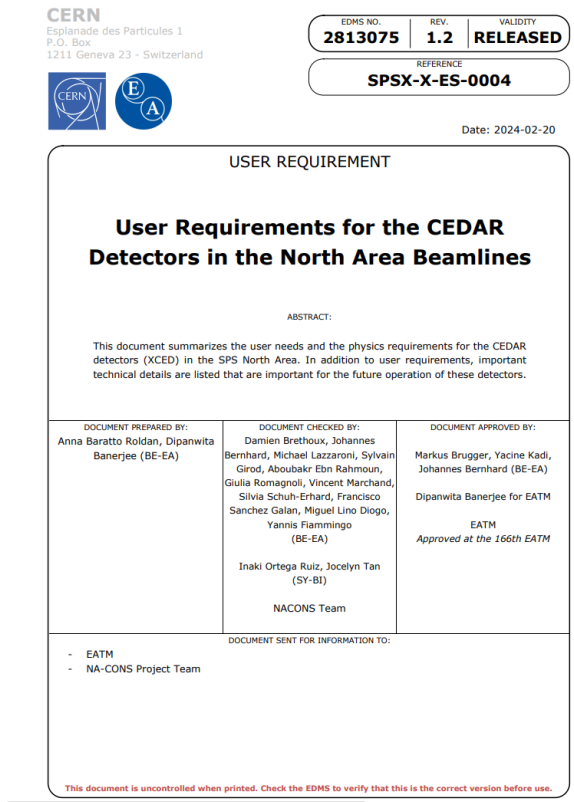

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EDMS NO.	REV.	VALIDITY
2813075	1.2	RELEASED

REFERENCE: SPSX-X-ES-0004

Date: 2024-02-20

USER REQUIREMENT

User Requirements for the CEDAR Detectors in the North Area Beamlines

ABSTRACT:

This document summarizes the user needs and the physics requirements for the CEDAR detectors (XCED) in the SPS North Area. In addition to user requirements, important technical details are listed that are important for the future operation of these detectors.

DOCUMENT PREPARED BY:	DOCUMENT CHECKED BY:	DOCUMENT APPROVED BY:
Anna Baratto Roldan, Dipanwita Banerjee (BE-EA)	Damien Brethoux, Johannes Bernhard, Michael Lazzaroni, Sylvain Girod, Aboubakr Ebn Rahmoun, Giulia Romagnoli, Vincent Marchand, Silvia Schuh-Erhard, Francisco Sanchez Galan, Miguel Lino Diogo, Yannis Fiammingo (BE-EA) Inaki Ortega Ruiz, Jocelyn Tan (SY-BI) NACONS Team	Markus Brugger, Yacine Kadi, Johannes Bernhard (BE-EA) Dipanwita Banerjee for EATM EATM *Approved at the 166th EATM*

DOCUMENT SENT FOR INFORMATION TO:

- EATM
- NA-CONS Project Team

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EDMS 2813075 | SPSX-X-ES-0004 v.1.2 status Released access Internal_rafc
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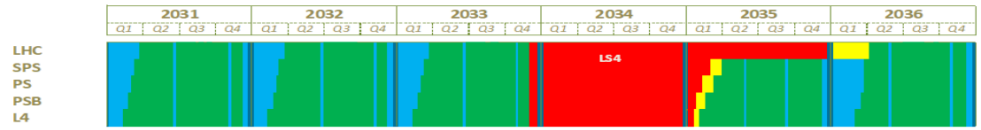
Running plans (LS3RR)

LS3RR working group recommendation received - **shifting LS3 by one year!**

... to be approved by the council!

Revised timeline being considered

- Provisional schedule
  Feasibility and acceptability being evaluated
- Start in October 2026, ions run in September 2026
- Beam back in the LHC in July 2030
  - LHC experiments caverns closure : 16.06.2030
  - LHC beam vacuum valves opening : 28.06.2030
- LS4 delayed by one year



LS3RR Summary

North Area LS3 Activities – M2 Beamline EHN2

Shift LS3 → positive impact on schedule

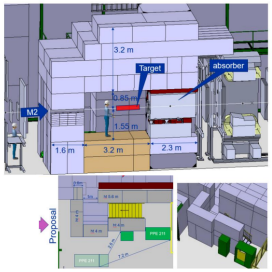
M2 Beamline and EHN2

Several activities will take place, partially funded by NACONS thanks to synergies

Requests pending MTP and LS3 budget approval critical for DRELL-YANN operation

OPERATION:

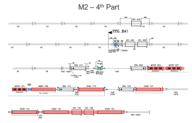
- CEDAR optics and mechanics upgrade (NACONS)
- XBPF installation (NACONS)
- Re-alignment M2 beamline
- Patch panel modifications to PPE211 EHN2/M2/BA82



PENDING APPROVAL...

DRELL-YANN run in AMBER

- Vacuum upgrade (partly within NACONS) (user requirement EDMS 3129053) → ECR needed end 2024
- Bunker shielding target in EHN2 (ECR EDMS 2868386)
- Shielding consolidation and modifications in EHN2 (access chicane, ..) (ECR EDMS 2868386)



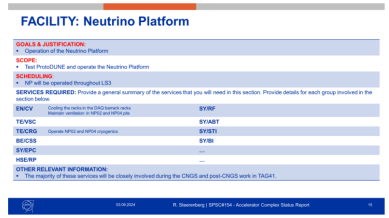
Few vacuum upgrade related activities could be anticipated to the YETS25-26
Bunker and shielding consolidation → major request for transport shielding blocks → potential critical point

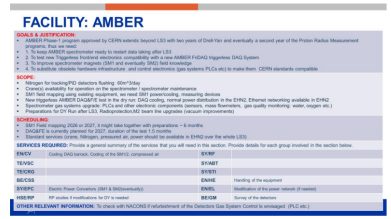
North Area LS3 Operation

Neutrino Platform: NP will be operated throughout LS3

Services needed:

- cooling DAQ barrack racks, ventilation in pits, cryogenics → coordination with EN-CV: rental of air-cooled chiller like in YETS (share with GIF++?)





AMBER:

Services needed:

- Cooling DAQ barrack racks, Cooling of the SM1/2 (field measurements), compressed air and network → coordination with NACONS activities

the respective 'requested/ideal timing/scheduling' still needs to be confirmed for a few cases (NACONS is priority)

North Area LS3 Summary

STATUS	ACTIVITY	REQUESTOR	DOCUMENT TYPE	STATUS	Integration Model	Groups	Comments
APPROVED	M2 modifications for consolidation/operation	Operation	Eng specs.	Eng design on going	Yes, to be done	BE-EA, SY-BI, EN-HE, HSE, EN-MME, BE-GM	Consolidation needed
PENDING APPROVAL	M2 beamline for DRELL-YANN run in AMBER	AMBER	ECRs + eng specifications	Eng design on going	Yes, on going	BE-EA, SY-BI, EN-HE, HSE, EN-MME, BE-GM	New upgraded design
PENDING APPROVAL	MUonE final run with 40 stations	MUonE	ECR needed	Pending approval	Yes, to be done	BE-EA, TE-MSC, EN-HE, BE-GM	Magnets on rails to make space for exp installation
PENDING APPROVAL	NA64 positron/hadron setups in EHN2	NA64	ECR needed	Pending approval	Yes, to be done	BE-EA, EN-HE, BE-GM	Experiment space to be allocated
PENDING APPROVAL	GIF++ extension	GIF++	ECR needed	Pre-study to be started	Yes, done	EN-HE, BE-EA	Extension of bunker area
PENDING APPROVAL	NA60 modifications	NA60	ECR needed	TBC	TBC	?	?
PENDING APPROVAL	H6 focusing modifications	Operation	ECR needed	Pre-study done	Yes, nedded	TE-MSC, BE-EA, BE-GM, SY-EPC, EN-EL	2 quads additional to be installed
PENDING APPROVAL	2 CEDARs on H4 beamline	NA64	ECR needed	Request received	Yes, needed	SY-BI, BE-EA, EN-HE	2 XCEDs to be installed on H4 beamline

Operation during LS3: MADMAX, GIF++, NP, AMBER

Not approved experiments/activities: to be confirmed soon to plan activities: AMBER, MUonE, GIF++, NA64, NA60, H6 focusing…

Shift LS3 → very positive impact on schedule
(given criticality of TCC2 equipment for operation with an additional year)

News from the EATM: SOX working group

During the 173rd EATM meeting the new Spill Optimisation for eXperiments (SOX) working group was presented (Mandate BE department).

Goal: Define and implement measures to deliver the desired flux and quality to the different CERN facilities in context of a new dedicated experiment (SHiP) $\rightarrow$ deliver $5 \cdot 10^{19}$ protons/year (unprecedented).

Needs: Users are ask to provide a documentation of present and future experimental spill requirements, requried proton-fluxes and spill quality bottlenecks to define key performance indicators (KPI) of a good spill (e.g. Effective spill length, flatness of spill, beam purity, beam position fluctuations, etc ...) for the different physics programs.

Two of the possible major changes after LS3:

- Doubling of the SFT spill length of 4.8s to 9.6s
- Introducing a short spill during SHIP supercycle of 1.2s alternating with the normal SFT supercycle of 4.8(9.6)s. While the short cycle could either provide the same instantaneous flux or up to four times of the normal instantaneous flux from SPS side (not taking into account RP limitations or limitations of the experiment).

Mail to Physics groups, TB, DAQ Group and Phase-2 group was send $\rightarrow$ only very little feedback $\rightarrow$ **dead line end of 2024!**

https://indico.cern.ch/event/1445507/contributions/6085066/attachments/2910774/5106809/SOX_intro_EATM_20240813.pdf