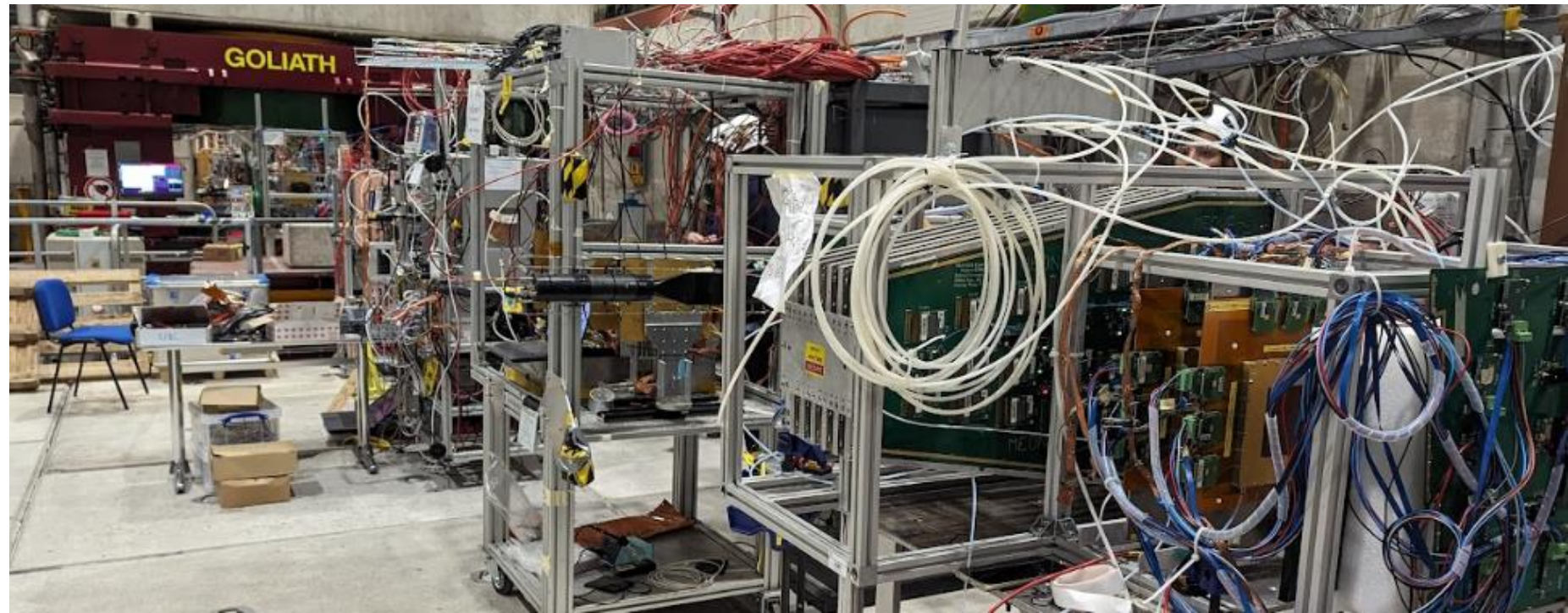


DRD1 test beam campaign 2024

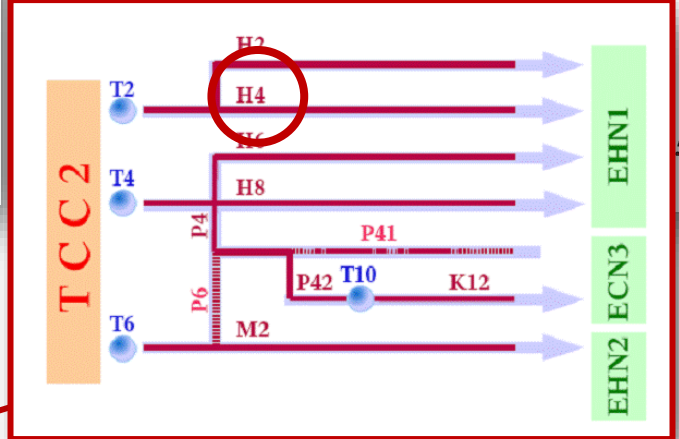
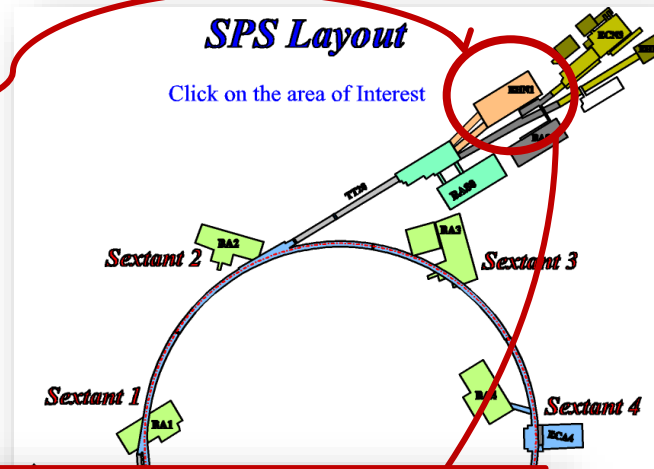
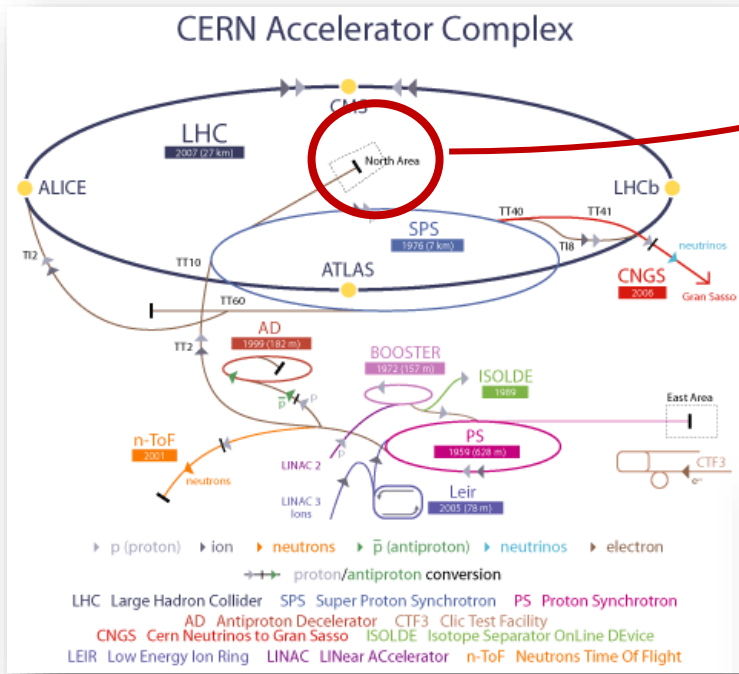
Yorgos, Karl(, Eraldo)



TB1: 10 – 24 April 2024
TB2: 26 June – 10 July 2024
TB3: 18 Sept. – 2 Oct. 2024

Location H4/PPE134

- **WG7 is for Common test facilities** (<https://drd1.web.cern.ch/activities-wg7>)
 - **PPE134 as a possible common test beam facility**
 - **GIF++ as a possible common irradiation facility**



<https://sba.web.cern.ch/sba/>

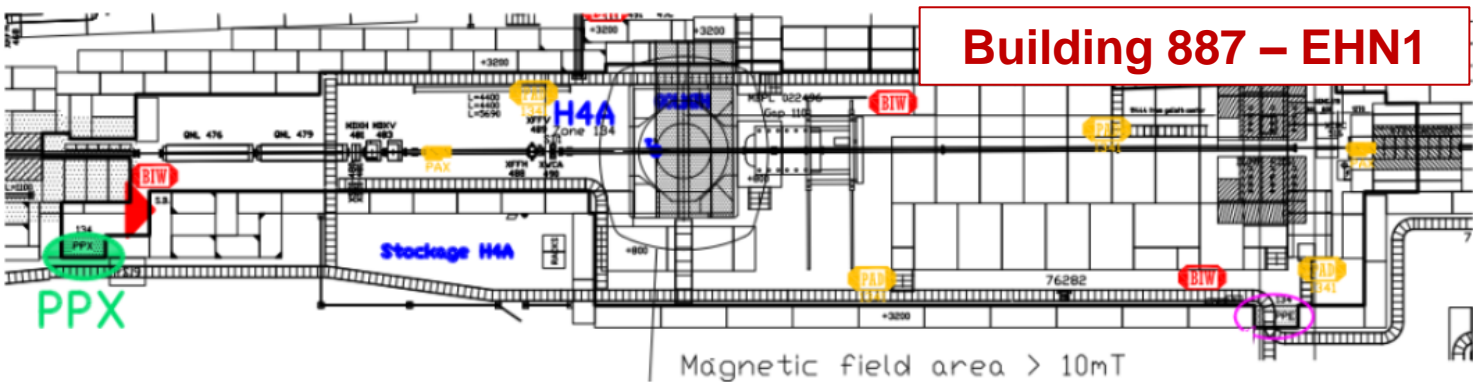


Fig.2: CERN North Area SPS Extraction line, H4 Beam line (PPE134/EHN1)

Common Test Beam at the CERN SPS/NA: CERN's PS and SPS can provide a variety of particle species with a wide momentum range. The collaboration plans to request common test beam time periods at the SPS. The H4/PPE134 experimental area in EHN1 is identified as the best location given the available beams, the space and the presence of a 1.5T Magnet with a large enough opening. The area has been used in the past by the RD51 Collaboration for regular common test beam campaigns.

DRD1 Test Beam Campaigns @ H4/SPS

Research to advance technological development of Gaseous Detectors
 Yorgos Tsiolitis (Yorgos.Tsiolitis@cern.ch), Eraldo Oliveri (Eraldo.Oliveri@cern.ch),
 Karl Jonathan Flöthner (karl.jonathan.floethner@cern.ch)

Generic and Application driven R&D

Muon/Tracking: GEM, Micromegas, uRWELL, cylindrical/planar uRGroove, TPC, Straw
 Timing: PICOSEC micromegas/uRWELL
 Calorimetry: MPGD DHCAL

Project Driven R&D & Commissioning

HL-LHC: CMS ME0
 Twin TPC for MIXE
 AMBER triple GEM (G4G)

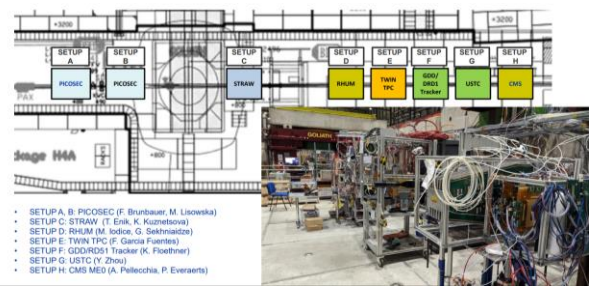
FE electronics and DAQ

VMM3a for TPC, Tiger, Mu2e, ASD. GEMROC, SAMPIC

2024 SPS Test Beam Campaign

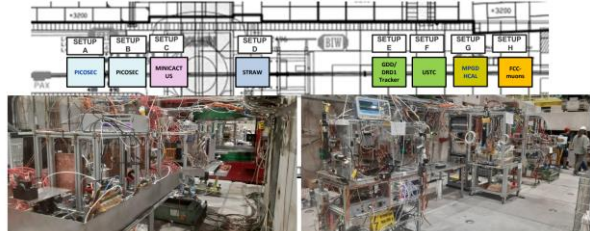
(to give you a better feeling of the use of the beam and what we do)

8 setups



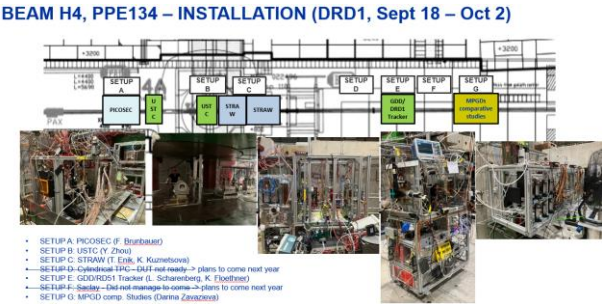
[https://indico.cern.ch/event/1409215/contributions/5922965/subcontributions/479395/attachments/2843563/4973590/DRD1-April24-TestBeam-H4-Summary-Updated%20\(2\).pdf](https://indico.cern.ch/event/1409215/contributions/5922965/subcontributions/479395/attachments/2843563/4973590/DRD1-April24-TestBeam-H4-Summary-Updated%20(2).pdf)

8 setups

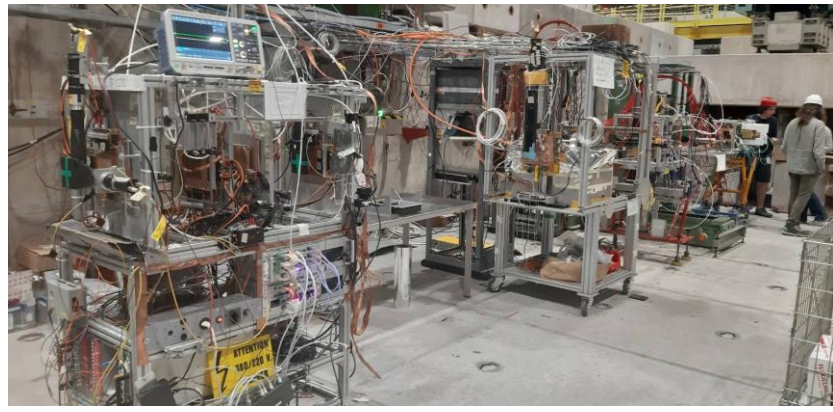
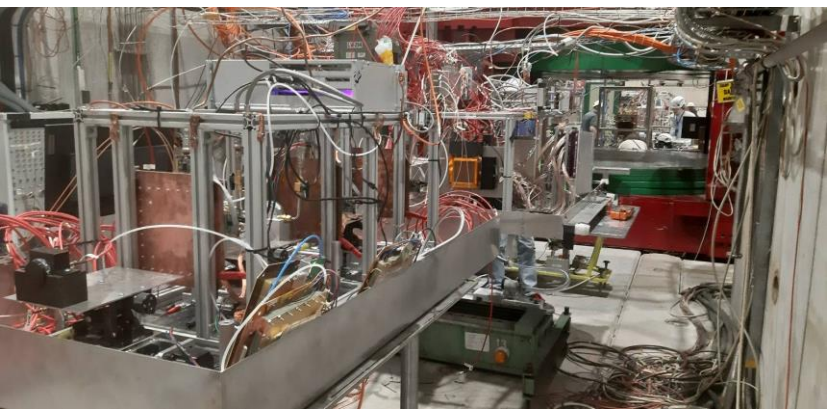


<https://indico.cern.ch/event/1436361/contributions/6044369/subcontributions/492820/attachments/2894558/5074788/DRD1-June-July24-TestBeam-H4-Summary-withStraws.pdf>

5 setups



<https://indico.cern.ch/event/1462524/contributions/6157737/subcontributions/508550/attachments/2939656/5164466/DRD1-September24-TestBeam-H4-SUMMARY.pdf>



Participating Groups 2024

The Ultra-low Material Budget GEM-TPC in Twin

F. Garcia, K. Floethner, M. Heiss, M. Meurer, E. Oliveri, L. Scharenberg, B.Zeh, X. Zhao

PHYSICS PROGRAM

ArCO ₂ (70/30)	HeCO ₂ (90/10)	HeCO ₂ (70/30)
Muons	Field scans 240 ~ 345/cm	Muons
Pions	Muons	Muons
Rate scans ~100k ~ 10M per spill	Rate scans ~100k ~ 10M per spill	Rate scans ~100k ~ 10M per spill
Entrance window beam scan	Entrance window beam scan	Entrance window beam scan

Pion beam @ 370k per spill in HeCO₂ (90/10)

X-coordinate: $\sigma = 0.104217 \pm 0.000508 \mu\text{m}$
Y-coordinate: $\sigma = 0.12553 \pm 0.00068 \mu\text{m}$

HGB4-2 Reconstructed Beam Profile

Straw setups

Setup-1 Setup-2

- AZALEA Telescope
- DUT: a new uSPD straw array (10 mm) or individual tubes (10, 20 mm)
- Electronics under tests: Sampic, MuZe, ASD (from sMDT setup)
- Timepix
- MM tracker and sMDT
- Old straw array (5, 10, 20 mm) and uSPD
- Electronics under tests: Tigres, MuZe, ASD
- GEMROCS

New uSPD prototype Old Combine prototype

PICOSEC Micromegas

PICOSEC Micromegas – a gaseous detector that aims at reaching a time resolution of **tens of picoseconds**

- Objective:** Robust multi-channel detector modules for large-area detection systems requiring good time resolution
- Experimental setup:** tracking/timing/triggering telescope: GEMs + MCP PMT + PICOSEC MM detectors
- Test beam campaign April 2024 measurements:**
 - Single-pad resistive MM (CERN_BB): 30 MQ/10 x 15 mm dia. → 10 mm MM + CsI time resolution $\sigma \approx 12$ ps
 - Single-pad photocathodes studies (CERN_CEA_Bari): CsI with CrTi, DLC, nanodiamonds → DLC $\sigma \approx 30$ ps
 - Single-pad μ RWELL (JLAB): 7 different prototype geometries tested with CsI photocathodes → $\sigma \approx 23$ ps
 - Large area detector (USTC): 20x20 cm² MM with different photocathodes: DLC, B,C, CsI → with CsI $\sigma \approx 25$ ps
 - Gas studies: Ne/iso mixture at different ratios as an alternative to the std gas Ne/C₂F₄ (80:10:10) → $\sigma \approx 17$ ps
 - New readout electronics (CERN_BB_SBU): integrated preamp on the outer PCB → $\sigma \approx 13$ ps, DR54 vs 12bit, 565/5

Clean (wireless) setup (before connecting cables)

Single-pad resistive MM 20 MQ + CsI $\sigma \approx 12$ ps

Single-pad + DLC photocathode $\sigma \approx 30$ ps

20x20 cm² MM with + CsI $\sigma \approx 25$ ps

Gas studies $\sigma \approx 17$ ps

Preliminary test beam results of μ RWELL-PICOSEC (JLab LDRD)

K. Granov PI (JLab), A. Pandey PI-COSEC

Working principle of μ RWELL PICOSEC

- Optimization of μ RWELL technology and achieving tens of picosecond time resolution
- Testing different combination of pitch, outer diameter and inner diameter of the wells
- Different shape of the wells (square and round)
- Different readout pad (plain and strip)
- Different drift gaps to be measured
- Assembled and tested μ RWELL with plain and grided readout pad, round shaped hole
 - 120 μm pitch, 100 μm OD and 80 μm ID
 - 100 μm pitch, 80 μm OD and 60 μm ID
- Fused silica window, MgF₂ as crystal and CsI photo cathode
- Gas mixture of Neon: C₂F₄ = 80: 10:10 and drift gap of 170 μm
- CIVIDEC and customized pre-amp board has been used

Test beam setup

A time resolution of 23.5 ps has been achieved with μ RWELL PICOSEC prototype

- The result has been obtained for the prototype with 120 μm pitch, 100 μm OD and 80 μm ID and plain pad
- Analysis of other prototypes are ongoing

GDD/DRD1 Telescope

(compass-like triple GEM detectors with Ar/CO₂ 70/30)

Karl Jonathan Flötner, Max Meurer, Lucian Scharenberg with special thanks to Hans, Doro and Jerome

Extended Telescope with Satellite @13m distance

- Enabled due to PBX (external power of front-end electronics)
- Clear correlations in time/position
- Could directly be used for tracking reference for DUT

Triple GEM Tracking Detector for AMBER (G4G)

- Trigger-less readout with the VMM3a
- Stable operation with 1.5 IC THL
- One quadrant was measured of the 30cm x 30cm active area

Weizmann Institute of Science setup

Comparative study of resistive MPGD technologies

- Common VMM3a-SRS readout
- DRD1 (triple GEM) tracker
- 2688 total channels
- Mounted on DESY table
- Gas mixtures: ArCO₂/iC4H10, ArCO₂, ArCO₂/CF₄
- Measurements
 - Efficiency scan (vs. amplification voltage, vs drift field) with muons
 - Rate scan with pions
 - Uniformity scan across the area

RHUM test-beam – April/2024

MAIN OBJECTIVES

- Test of the **Capacitive Sharing Principle**
- First tests of the NEW BigONE Double DLC Micromegas -pad readout (50x40 cm²) – Aka Paddy200C
- Further tests on 2 x Paddy400 (20x20 cm²): Two detectors coupled sandwiched – sharing the same volume and one cathode

FIRST RESULTS ON SPATIAL RESOLUTION WITH CAPACITIVE SHARING

Spatial Resolution $\sim 1/30$ of the pad size

Spatial Resolution $\sim 1/20$ of the pad size

C- μ RGroove

Active area: Diameter=131.0mm, Length=100.0mm

U readout V readout

CMS GEM: stack for the ME0 station

- ME0 station for the CMS Phase-2 upgrade:
 - 36 stacks of six triple-GEM detectors (18 per endcap) instrumenting a total surface of 22 m²
 - Physics goal: high-rate muon trigger for CMS endcap muon spectrometer (up to 2.8)
- Testing first full prototype of ME0 stack. Measuring:
 - Muon segment efficiency vs external tracker (> 99%)
 - Single layer time resolution (~ 12 ns)
 - Segment time resolution combining multiple layers

MiniCactus Monolithic CMOS DMAPS for timing R&D

Charge collecting diode and readout front-end on same silicon substrate

- Pixel sizes: 0.5 mm x 1 mm, 1 mm x 1 mm and 0.5 mm x 0.5 mm diams
- 3 different preamps (CSA1, CSA2, VPA)
- New multistage discriminator with programmable hysteresis
- Improved layout w.r.t. MiniCactus v1 for better mixed-signal coupling rejection

Measurements:

- HV scans (S/N, time resolution vs HV)
- Pixel scans (comparison of FE readout options)
- Three different sensor thickness (200, 175, 150 μm)

FCC-ee group testing μ RWELL and TIGER electronics

Detector under test:

- 4 μ RWELL w/ 40 cm strip length
- 1D strip pitch of 0.4/0.8/1.2/1.6 mm

Readout under test:

- TIGER FEE
- GEMROC FPGA

Goals of the testbeam:

- Define the state of art of μ RWELL+TIGER for IDEA Muon system optimization studies
- Compare the APV-25 performance studies with TIGER
- Performance in Ar-CO₂ and Ar-CO₂/CF₄ comparison
- Collect data to compare experimental measurement and simulation

Measurements:

- Gain scan to evaluate the amplification/saturation/performance
- Drift scan to evaluate the signal collection
- Threshold scan to optimize S/N

μ RGroove studies

Gap=3mm

Pitch=200 μm

Thick=50 μm Width=70/50 μm

DLC=50MQ/ \square

Siqi He, RDS1 Mini-Week, 02/27/2023

10cm x 10cm

50cm x 50cm

USTC- μ RGroove group: Yi Zhou, Siqi He

- Decoupled X&Y readout strips, no charge sharing problem
- Compatible with all the techniques developed for the μ RWELL manufacture and easy to produce with lower cost
- Easier to clean

For 10cm x 10cm XYV-version prototype:

- Gas: Ar/iC4H10 (90/10).
- Spatial resolution: ~80 microns.
- Efficiency: 96% for cathode, 93% for readout strips

DRD1 H4 – Short Feedback from the 2024 run

Our Feedback to the Colleagues
from the Beams Department

Aimed vs collected statistics (if applicable)

- In 2024 we had three beam periods with excellent beam – all setups profited and finished there physics program (apart from losses caused by the setups – no losses due to beam operation)

Highlights & Major issues faced (we had excellent shared BBQs with GIF)

- Remarkable support from North Area teams – Installation and dismounting is really demanding
- **Support from Liaison physicists outstanding as always**
- No problems with muon beam purity and no problems by changing beam files (in the past, collimators got stuck from time to time; since the addition of XCIO.022.450 we did not face any issues with that)
- No major issues faced during 2024 because of a maximal setup count of 8 at a time
- For maximum Muon Rate one has to pay attention to PAXNA14404 (reduces to 15uSv/h in case of GIF access with three spills this can be exceeded).
 - Intermediate solution found with GIF++ (XCSH.022.068 can be adjusted) --> could be automated/avoided?

Desiderata for 2025

- More setups/groups are expected to participate due to the now larger collaboration (DRD1 >> RD51)
 - We expect to face problems which occurred in the past with 8+ setups because of the overall higher demands (# of power (220V/50Hz) sockets, # of Outlets/Available IPs, # of Remotely controllable tables, # of installed CAT7 cables)
 - Upgrade of gas system is planned before next beam time
 - +10 gas lines (+10 return)
 - Possibility of shorter lines for flammable gas (technically possible - to be checked with safety)
- **As early as possible information about change in beam conditions** (e.g. planned LHC fillings or other reductions/losses in beam)
-> lets us schedule access more efficient
- (foot and drinks in the snack machine in EHN1 also on the weekend – machines sometimes empty or card reader does not work)

we hope for more colleagues
from "non-MPGD" groups

DRD1 test beam campaign 2025

Requested/"Expected" Beam Time

TB1: 2 weeks in April 2025

TB2: 2 weeks in June/July 2025

TB3: 2 weeks in Sept./Oct. 2025

Expectations for 2025

- Upgrade of Gas System (+10 lines)
- 8+ groups per TB
(hopefully more "non"-MPGD groups)

First steps if you want to join the campaign in 2025:

- Subscribe to the WG7 mailing list: <https://drd1.web.cern.ch/activities-wg7>
- Contact us as soon as possible if you need help/have questions about preparations:
Yorgos.Tsipolitis@cern.ch or karl.jonathan.floethner@cern.ch or DRD1-WG7-convenors@cern.ch

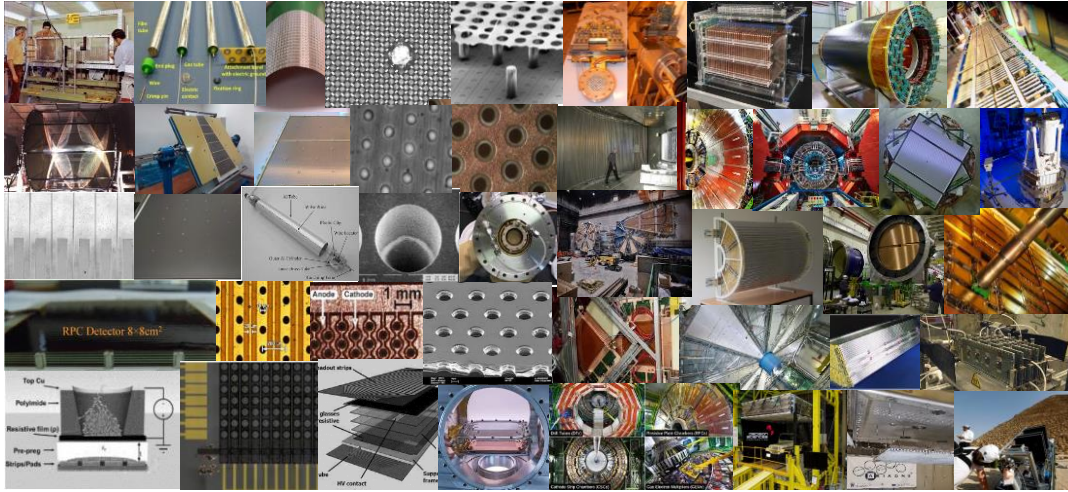


**Thanks for your Attention
and see you next Year!**

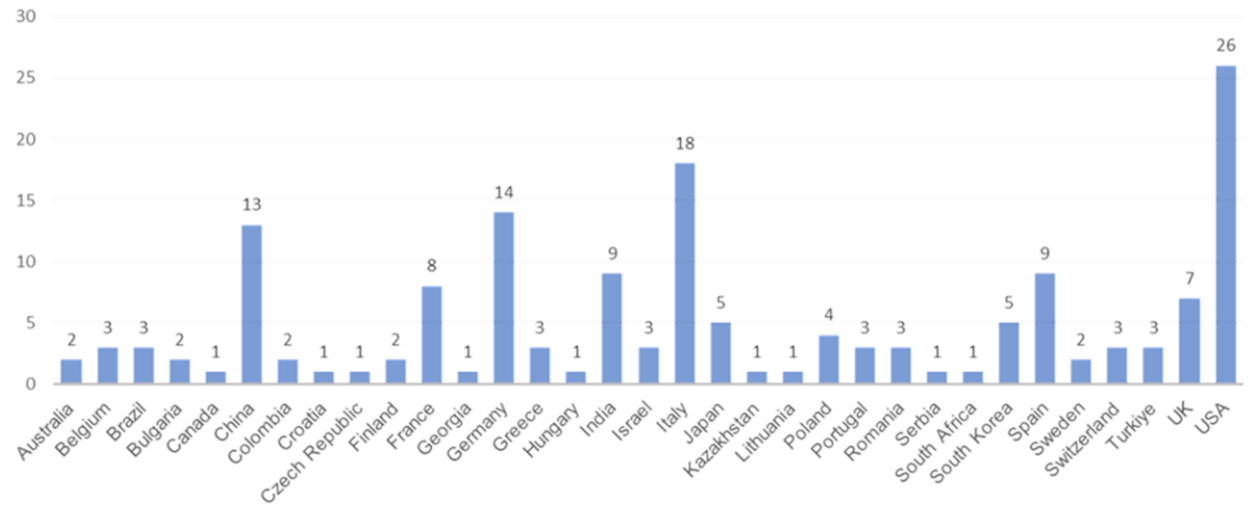
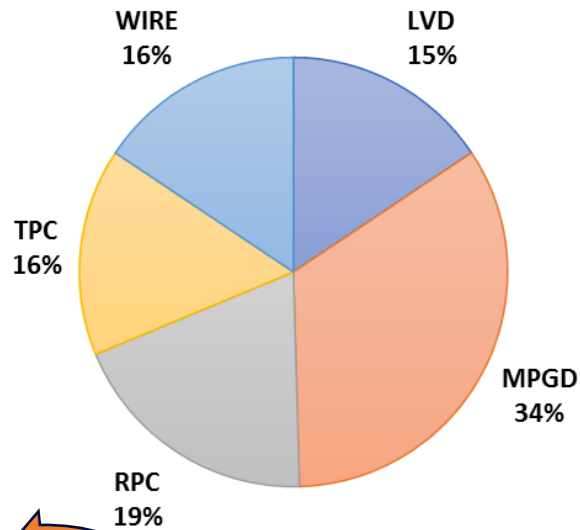
DRD1: A very large and diversified set of technologies and solution, a very large and diversified community

<https://drd1.web.cern.ch/>

Courtesy of Eraldo



- More than 160 Institutes
- More than 30 Countries
- More than 700 members
- 5 Industrial, Semi-Industrial and Research Foundations



Countries of DRD1 Institutes (today)

