

# Summary of WG5 testbeam activities

Timestamp	Contact name	Contact email	Activity name	Please select your preferred time slot	Please specify to which DRD3 WG
4/8/205 18:22:07	Anna Macchiolo	anna.macchiolo@ce	TI-LGAD	Week 22(May 28-June 4)	WG2
4/7/2025 17:37:59	roberta arcidiacono	roberta.arcidiacono@ce	DC-RSD	Week 22 (May 28 - June 4)	WG2
4/9/2025 16:31:24	Gaetano Barone	gaetano.barone@cern.c	LGAD/AC-LGAD readout and operational conditions	Week 23 (June 4 - June 11)	WG2
8/6/2025 16:36:28	Stefano Terzo	sterzo@ifae.es	Mini-cactus-V2 testing	Week 35 (October 1 - October 8)	WG1
8/25/2025 17:32:54	Gaetano Barone	gaetano.barone@cern.c	4D/AC-LGAD ML readout processing	Week 35 (October 1 - October 8)	WG3
8/26/2025 18:11:07	Brendan Regnery	Brendan Regnery	FBK RSD radiation hardness	Week 36 (October 8 - October 15)	WG3
9/4/2025 14:21:24	Alexander Oh	alexander.oh@cern.ch	DRD3 WG6 3D Diamond	Week 36 (October 8 - October 15)	WG6

1<sup>st</sup> TB

2<sup>nd</sup> TB

- The task of Working Group 5 (WG5) within DRD3 is centered on **characterization techniques, irradiation and test facilities** for solid-state detectors.
- Test beams are **unique testing infrastructures**. WG5 aims to coordinate and facilitate test beam access as DRD3 community.
- 2025 has been the first year where we requested DRD3 testbeam access. Large interest shown in terms of technologies and people involved
- In total, we benefited of more beam time than originally planned:
  - 2 test beam periods requested as DRD3 community:
    - June (**14d**): 3 institutions, 2 experiments
    - October (**14d+14d** extension): 11 institutions, 6 experiments
  - 5 extra periods as DRD3 diamond (WG6,  $\Sigma=16d$ )  
DRD3 Cassia (WG1,  $\Sigma=26d$ )

- From PS/SPS coordination:

*Reminder: Beam time (**main user**) exceeding the limits of **2 weeks PS** beam time and **1 week SPS beam time per year** need the approval of one of these CERN committees: SPSC, LHCC, **DRDC**, INTC, RB or IEFC. Endorsement of beam time by a scientific committee does not guarantee the beam time can be scheduled*

- Normally these conditions are more relaxed for parasitic users.  
In H6B, which should be “our beam area” we can host up to 2 parasitic users:

- one normally could go immediately after the telescope on a green DESY table
- second parasitic would go behind, either on a motorized table or concrete block.  
Note: Due to high demand, the sooner we request the tables, the better...

# 1<sup>st</sup> DRD3 test beam

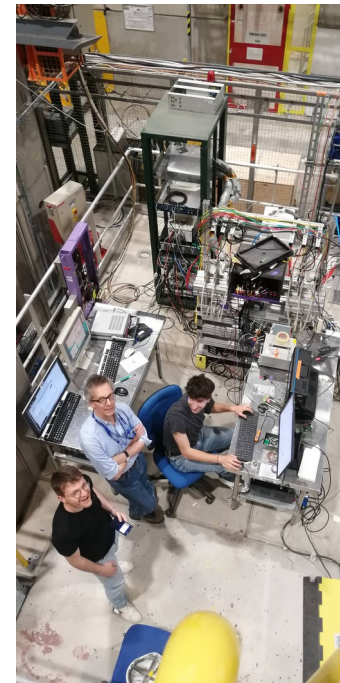
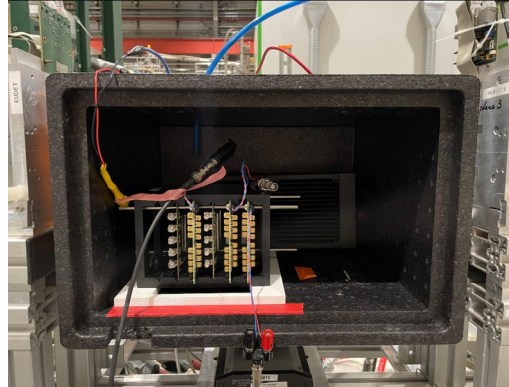
- 28 May-1 June:



Non-irradiated **DC coupled LGADs** with a **resistive layer** for signal sharing.

FBK sensors coming from FBK

Using own coldbox inside the telescope.



- 1-7 June:

Using LHCb coldbox

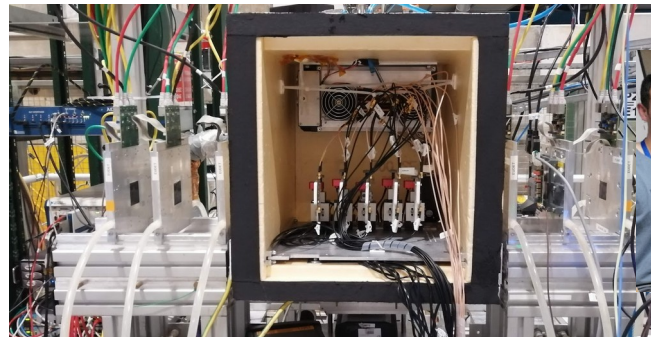


**IFCA-Spain:**

irr. **TI-LGADs** (FBK),  $\Phi \leq 2.5e15$  n<sub>eq</sub>/cm<sup>2</sup>

**Brown University:**

**AC coupled LGADs** to train machine learning methods to calculate the impact position of particles.



See I. Velkovska's summary in:

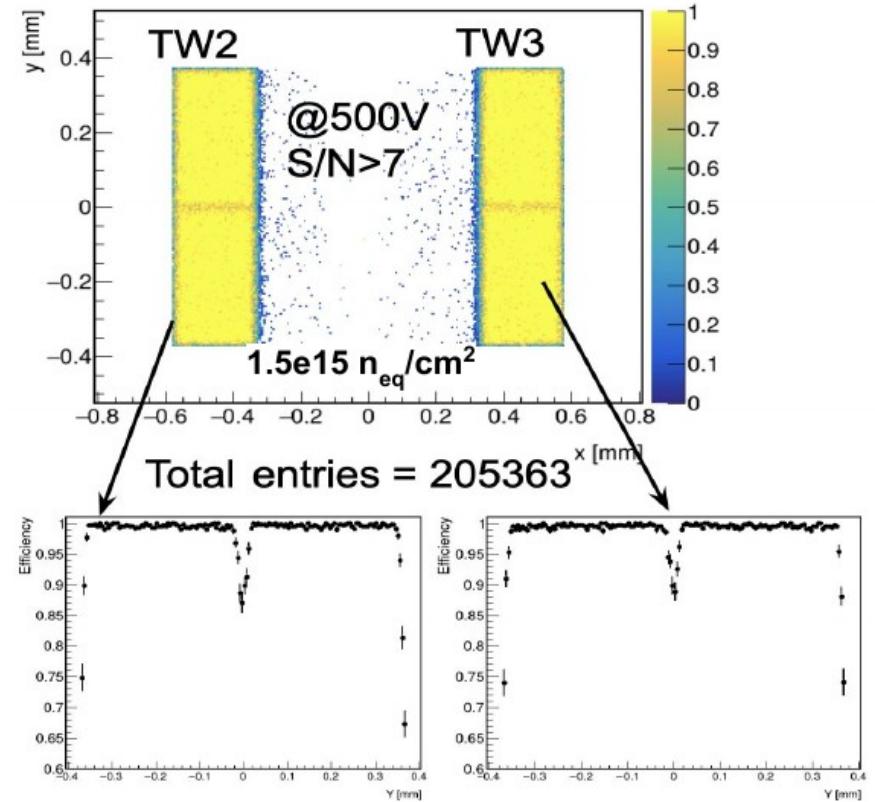
**Performance of irradiated TI-LGADs at 120 GeV SPS pion beams**

Iskra Velkovska<sup>1</sup>, A. Donald Gentry<sup>2</sup>, A. Macchiolo<sup>3</sup>, A. Gomez Carrera<sup>1</sup>, B. Hiti<sup>1</sup>, C. Torres Muñoz<sup>6</sup>, G. Kramberger<sup>1</sup>, I. Vila Alvarez<sup>4</sup>, J. Duarte Campderros<sup>4</sup>, L. Diehl<sup>3</sup>, M. Fernandez Garcia<sup>4</sup>, M. Puklavec<sup>4</sup>, M. Oliver Beghuin<sup>3,5</sup>, V. Gkougkousis<sup>5</sup>, Y. Padniuk<sup>3</sup>

<sup>1</sup>Jozef Stefan Institute (SI), <sup>2</sup>University of New Mexico (US), <sup>3</sup>University of Zurich (CH), <sup>4</sup>Instituto de Física de Cantabria (CSIC-UC), <sup>5</sup>Université Libre de Bruxelles (BE), <sup>6</sup>Universidad de Sevilla (ES)

(also containing info on 2<sup>nd</sup> TB Oct 2025)

## Tracking efficiency results for irradiated TI-LGADs from W2



**TW2 mean efficiency = (98.31 ± 0.08)% (stat only)**

**TW3 mean efficiency = (97.68 ± 0.08)% (stat only)**

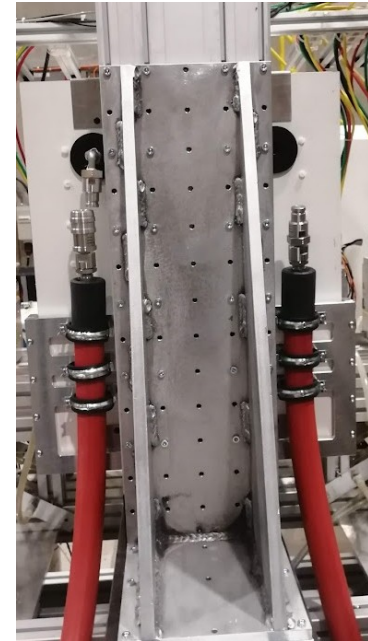
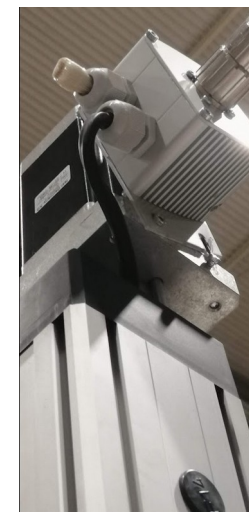


# First time as well for some new infrastructure

First group of users delayed by  
infraestructure commissioning  
... and mishaps



Assembly



Fitting  
replacement  
needed



Reassembly



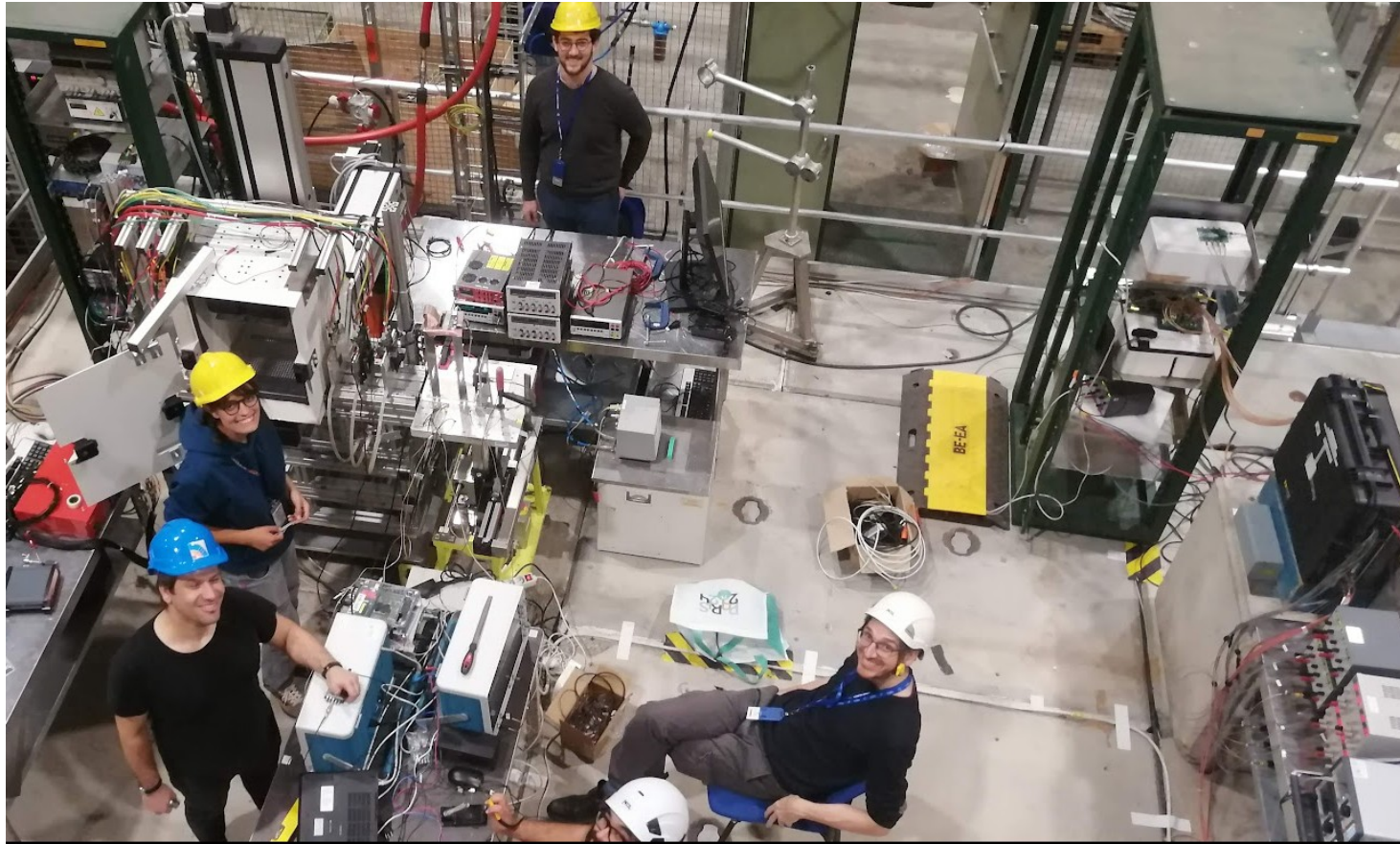
Circulation test

Spare piece sent from UZH!

But **commissioning** and **reparation** of the coldbox took **longer** than the time assigned to the user inside the coldbox (DC-RSD) so they had to switch to an **alternative plan** using non-irradiated detectors.

Once the coldbox was fixed we decided to run without switching-on **fans** (**condensation** due to air sucked in from outside).

Left: DC-RSD being mounted. Center: Minicactus behind telescope. Right: ETROC2



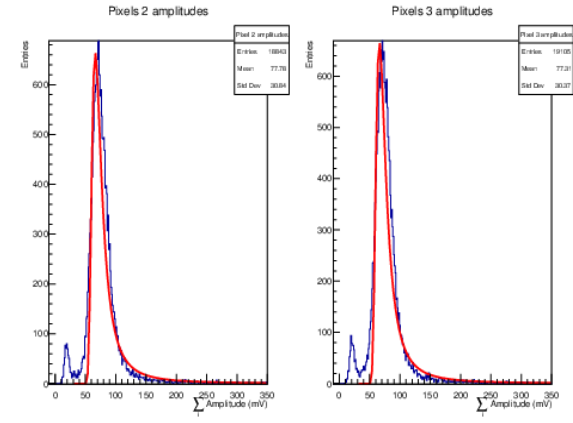
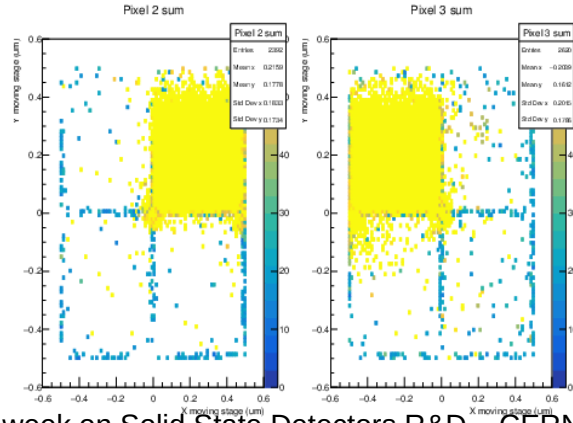
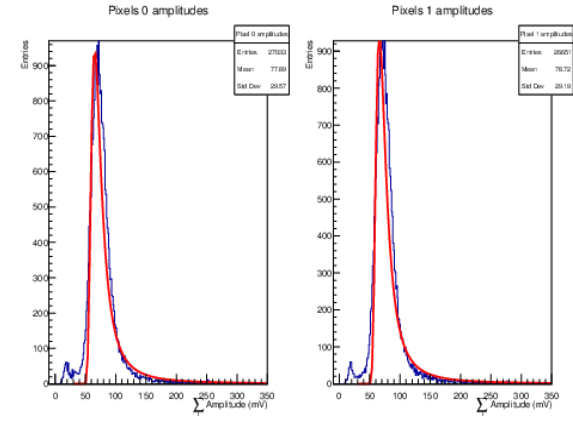
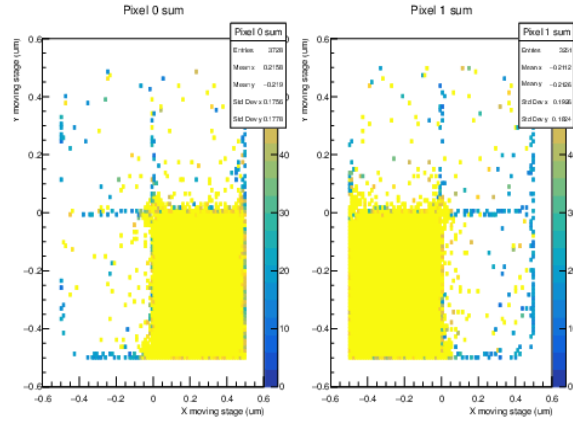
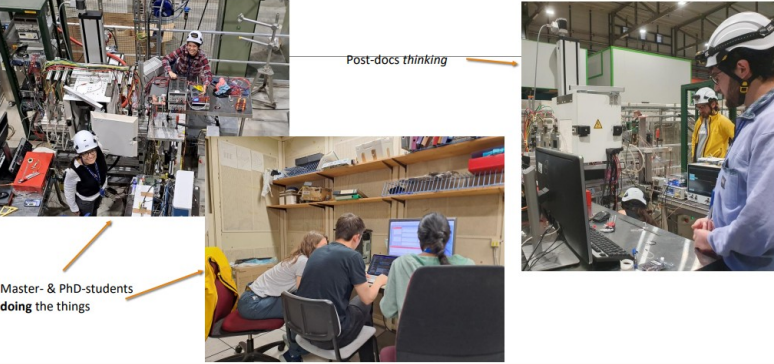
# 2<sup>nd</sup> TB, Oct 2025: first period

Devices produced by RSD group: KIT + CERN

Analysis ongoing (preliminary plots by Luca Menzio et al.)



THE Team



## Testbeam results of the MiniCACTUS\_v2

Joaquim Pinol on behalf of CACTUS

Stefano Terzo, Raimon Casanova Mohr, Joaquim Pinol Bel, Sebastian Grinstein  
IFAE

Yavuz Degerli, Fabrice Guilloux\*, Jean-Pierre Meyer\*, Prof. Philippe Schwemling\*  
CEA/Irfu  
\* also Université Paris Cité

Archie William Hanlon, Eva Vilella Figueras, Jan Hammerich  
University of Liverpool

Pablo Fernandez-Martinez, Dr. Giulio Pellegrini  
IMB-CNM, CSIC



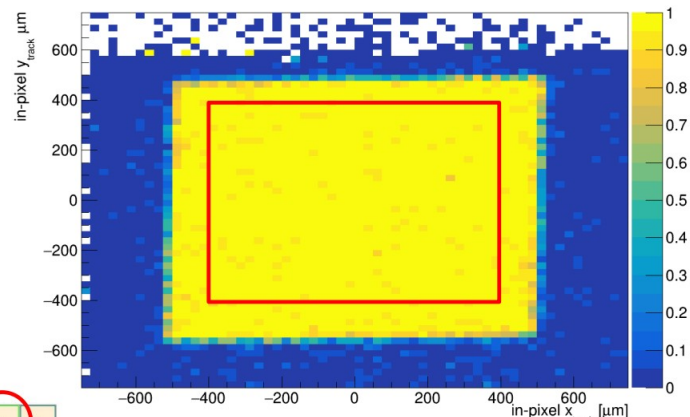
4th DRD3 week on Solid State Detectors R&D

10th November 2025

## October 2025 – Tracking efficiency 1x1 mm<sup>2</sup>

Tracking efficiency of  $99.0 \pm 0.1\%$  on the central part on the pixel (in red,  $0.8 \times 0.8 \text{ mm}^2$ ) @350 V

MCv2\_0 Pixel efficiency map

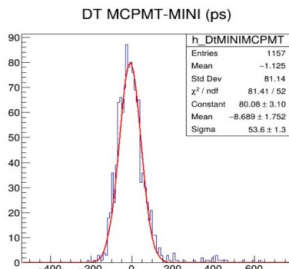


Efficiency calculated by tracks intercepting our detector over detected tracks on single track events

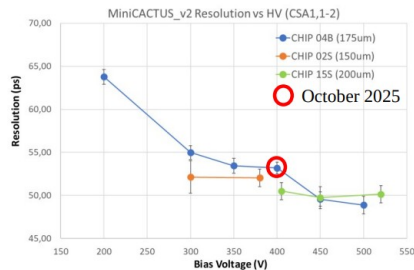
*Preliminary – Onoaina analysis*

## October 2025 – Timing results

- Result of  $\sim 53.6$  ps on  $0.5 \times 0.5 \text{ mm}^2$  pixel with  $175 \mu\text{m}$  thickness @ 400V (same conditions as previous slide)
- Few runs analysed show compatible with previously obtained resolution on CSA 1 of 54 ps:



CSA2  $0.5 \times 0.5 \text{ mm}^2$  @400V

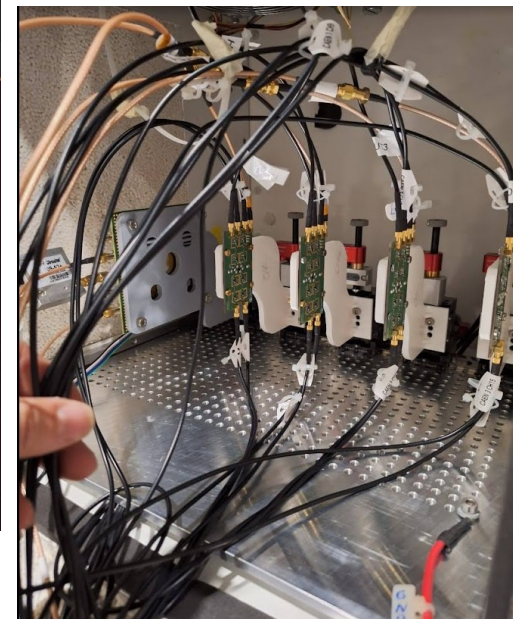
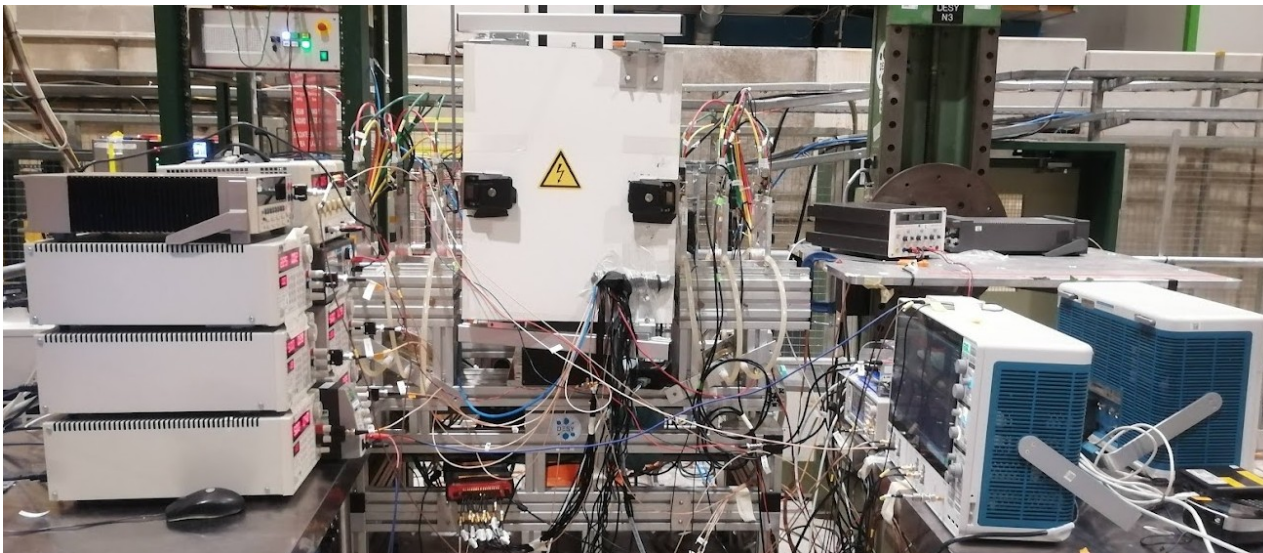


July 2025 Summary plot on  $0.5 \times 0.5 \text{ mm}^2$



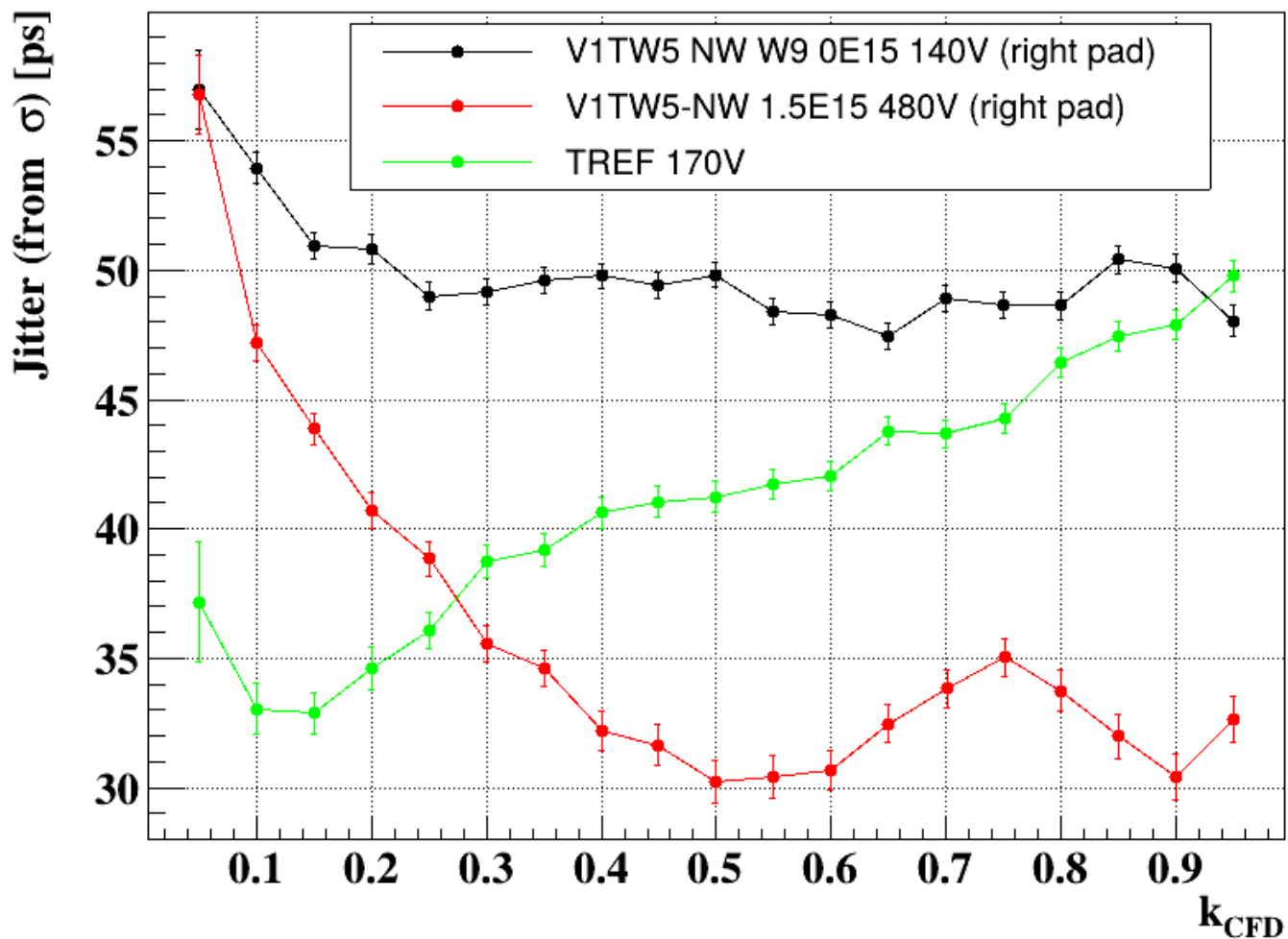
*Preliminary – Ongoing analysis*

Time reference employed: MCP~10 ps

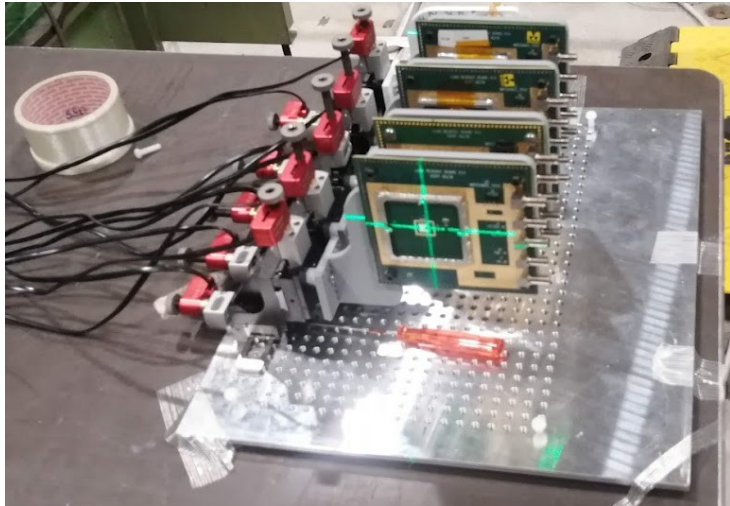
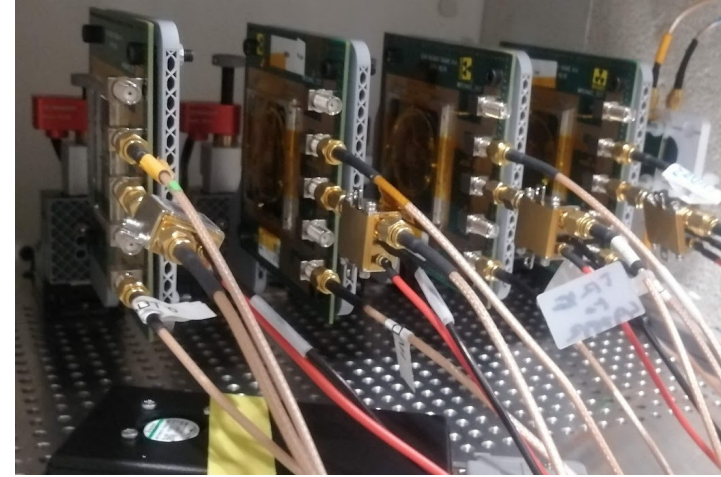


Testing devices from new FBK run plus AC-LGAD

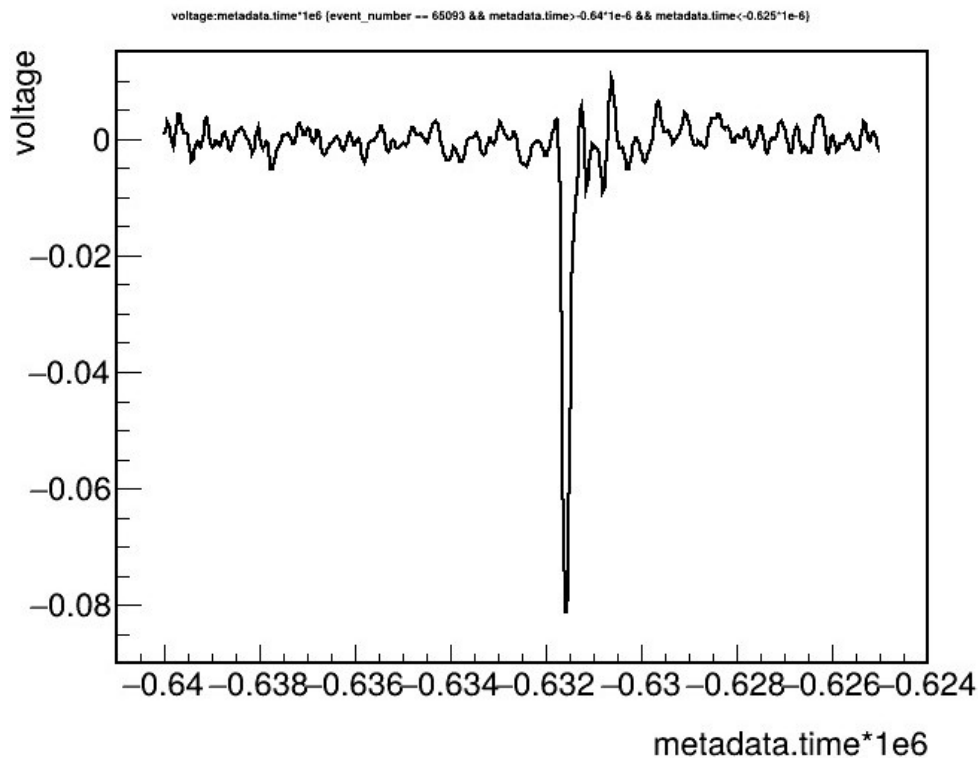
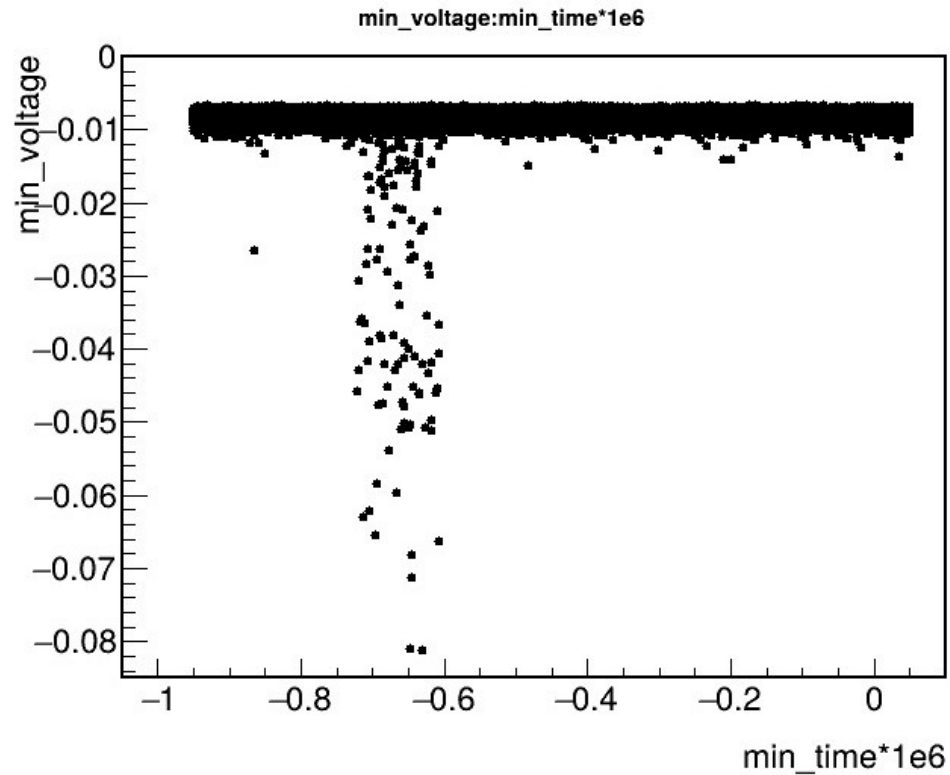




# 3Ds and diamond



# Re-using Minicactus Tek oscilloscope producer (thanks Quim @ IFAE ) Developed online DQM



## DRD3 funding and storage space

- For the second testbeam we have benefited from DRD3's common funding for electronics pool rental. Please remember to return material as soon as TB is finished
- DRD3 eos space provided:  
`/eos/experiment/drd3/TB-data` (please ask me if you need access)

## DRD3 safety form and RP measurements

- We send 1 safety form per period and organized RP measurement at the end of the beamtime
- **Temporary** storage of irradiated material possible, as well as transport to/from testbeam area

## Summary

- DRD3 large interest in testbeam access has been shown in terms of experiments and people involved during this first year of access.
- Looking forward for a requested 6 weeks of 2026: Cactus, COFFEE series, Diamond, 3D trenched, TI-LGADs, 4D tracking.

## Acknowledgements

- Thank you to all people involved organizing and participating during this testbeam period
- Considering the lack of sleep and harsh working environment inherent to testbeams, we witnessed a very constructive team spirit despite throughout these weeks.

## And thank you as well for key support to this project:

- **PS/SPS coordination** for their flexibility allocating extra time for us.
- **H6 beam physicists** (Laurence James Nevay & Maarten Van Dijk) for immediate feedback & support
- **CERN SSD** lab for infrastructure, material, tools, access to lab, office space, storage...
- **CERN bond lab** for taking care of our last minute requests

# Extra info

# 2026 requests

## Requested 2 (WP1) +3 (WP2) +1(WP3) week

Category	Details			
Project reference	Cactus			
Test beam goals	Characterization of CMOS chips with and without gain layer and irradiated (if available)			
Basic requirements	Telescope, power supplies, TLU, Oscilloscopes, cold box (only in case of availability of irradiated devices)			
Preferred period and duration	SPS (11.03 - 03.08.2026), ~1-2 weeks (ideally one at the beginning, one at the end of the SPS period)			
Participating institutes and contact persons	IFAE, CEA-IRFU; Contact: Stefano Terzo			
Category	Details			
Project reference	TI-LGAD (approved within DRD3 WP2)			
Test beam goals	Systematic comparison of the performance after irradiation of TI-LGADs from the RD50 and AIDAInnova batch with different parameters			
Basic requirements	AIDA telescope, cold box, one HV and LV line per sensor, oscilloscope for triggering. DAQ (CAEN digitizers) provided by users.			
Preferred period and duration	One week in March and one week in June			
Participating institutes and contact persons	UZH, Santander, Ljubljana (open to others in TI-LGAD project); Contact: Anna Macchiolo			
Category	Details			
Project reference	Approved DRD3 WP2 project: LGAD-based timing tracker development for future collider			
Test beam goals	1) Sensor characterization: pixel and strip AC-LGAD timing and spatial resolution study. 2) Sensor and ASIC system performance evaluation.			
Basic requirements	Telescope, cold box, power supplies, oscilloscope, trigger system, TDAQ			
Preferred period and duration	PS, mid-2026, approx. 2 weeks			
Participating institutes and contact persons	IHEP (CAS), Zhengzhou University, Shandong University; Contact: Mei Zhao (mei.zhao@cern.ch, zhaomei@ihep.ac.cn)			
Category	Details			
Project reference	DRD3 WG6 3DD (Diamond detectors for future collider experiments)			
Test beam goals	Study of 3D diamond test structures with vertical and twisted electrode geometries to evaluate charge collection, internal resistivity effects			
Basic requirements	High-speed oscilloscope readout (6GHz or 2.5GHz, 25GS/s, 4 channels), LV and HV power supplies (up to 100V, sub-nA precision), ROI-based			
Preferred period and duration	Two separate weeks (e.g., January or April) to allow intermediate analysis			
Participating institutes and contact persons	University of Manchester, CERN; Contact: Alexander Oh			
Category	Details			
Project reference	DRD3 WG1 project: COFFEE series HVCMOS chips (CERN-DRD3-PROJECT-2025-007)			
Test beam goals	Characterization of COFFEE3 chips (spatial resolution, charge collection efficiency, etc.)			
Basic requirements	Most equipment provided by team; moving stage with remote control (e.g., DESY table) requested.			
Preferred period and duration	One week at SPS around April (negotiable)			
Participating institutes and contact persons	IHEP (CAS, lead institute); Contacts: Li Yiming (liyiming@ihep.ac.cn), XU Zijun (xuzj@ihep.ac.cn)			
Category	Detail			
Project reference	Novel silicon 3D-trench pixel detectors based on 8-inch CMOS process (approved within DRD3 WP2)			
Test beam goals	First test beam studies of small cell 3D pixel detectors with intrinsic gain			
Basic requirements	AIDA telescope, cold box, one HV and LV line per sensor, oscilloscope for triggering. DAQ (CAEN digitizers) provided by users.			
Preferred period and duration	One week in March and one week in June			
Participating institutes and contact persons	IHEP, Ljubljana, NIKHEF (open to others within the DRD3 WG2 project); Contact: Gregor Kramberger, Manwen Liu			