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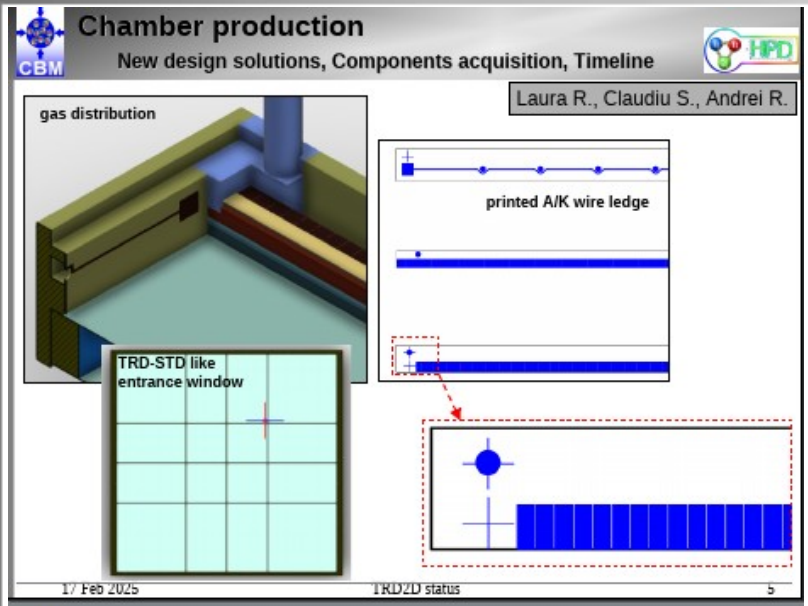
TRD2D

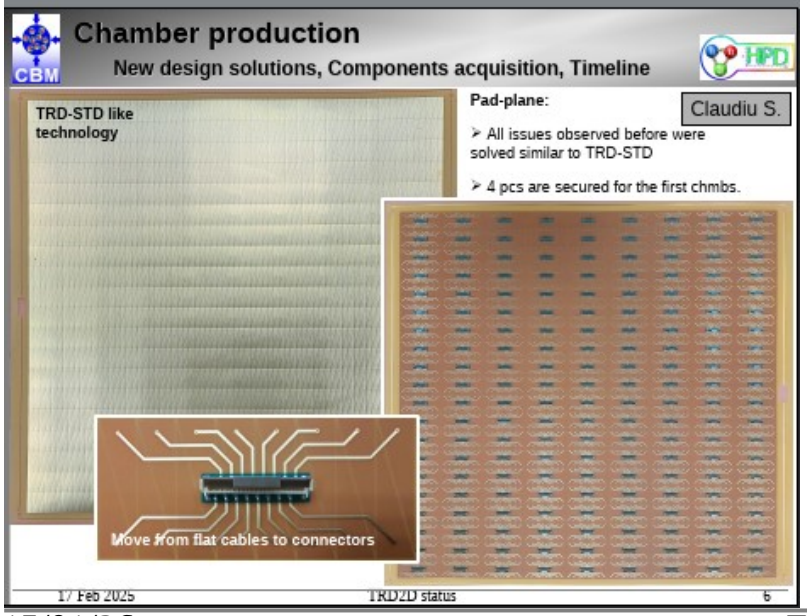
Activities 2025

FAIR-RO ISAB Meeting

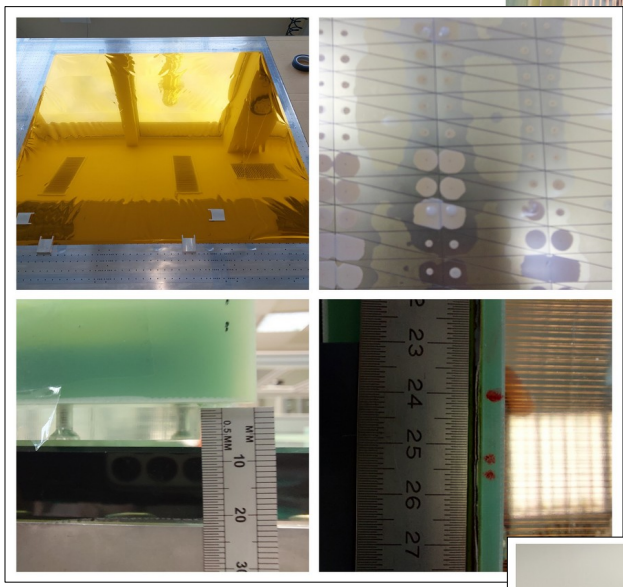
January 2026

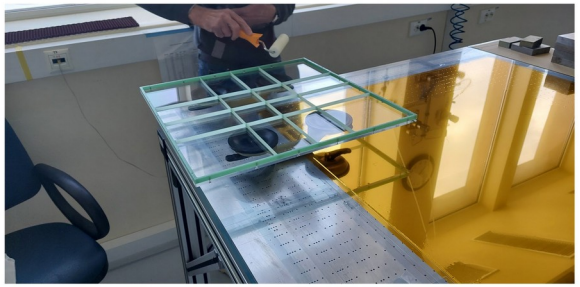
TRD2D chamber redesign – first try

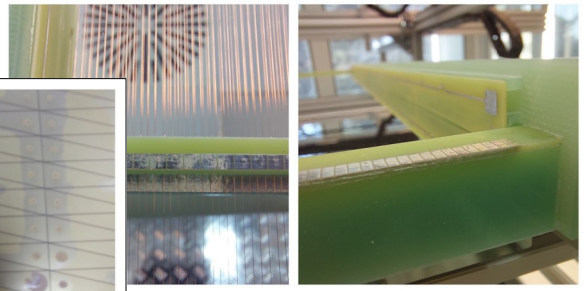




features →
… and







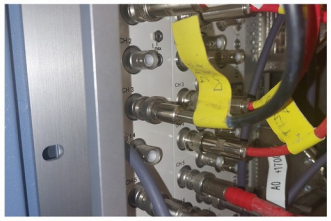
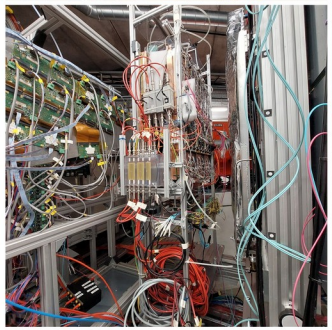
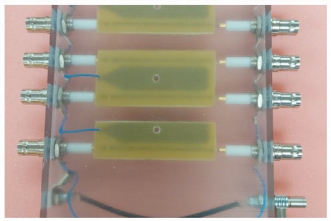
← problems

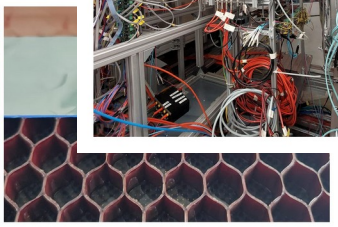
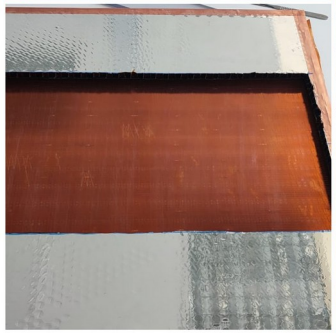
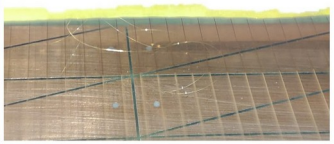
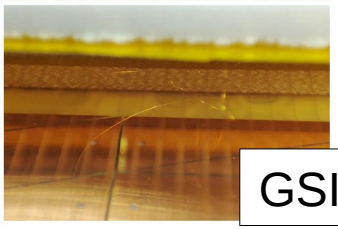
- not gas tight
- no control on the wire tension
- had to be disassembled

TRD2D chambers @ mCBM May 2025

Bucharest → GSI



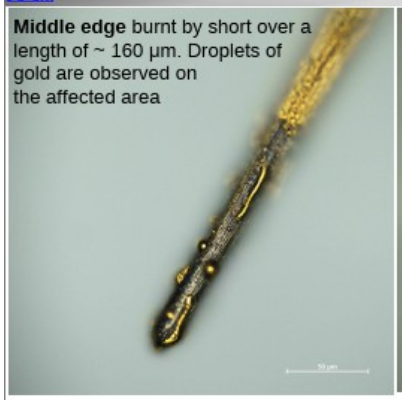




GSI → Bucharest

Anode wire optical inspection

Middle edge burnt by short over a length of ~ 160 µm. Droplets of gold are observed on the affected area



End edge connected to the chamber support. Mechanical deformation in the wire is visible

→ 4 anode wire samples were extracted from the 2 chambers
→ all 8 wire ends were optically inspected and they all show very similar features
→ the affected region was consistently measured around 160 µm.

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Energy released from the HV filter

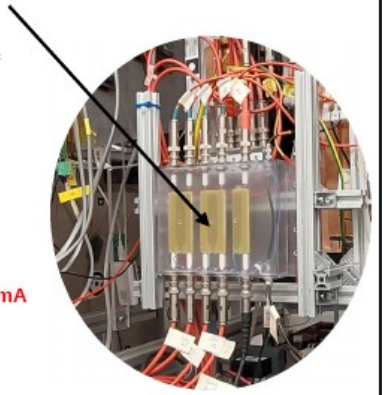
Conditions for the filter design :
→ cut frequencies on the HV line above f0 = 1 / 2π R C)
→ tension drop at high currents (R I_{max} / U)

R = 5.1kΩ C = 36nF

Q = 2 kV x 36 nF = 72 µC

I = 72 µC / 0.2 ms = 360 mA

Previous tests showed that a current of 20mA can destroy an anode



Thanks to Philipp Kehler for driving this discussion

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TRD2D chamber redesign – second try

From Alexandru Bercuci

To Claudiu Schiaua, Mihai Petrovici, Mariana Petris, Laura Radulescu, Alexandru Bercuci

7/15/25, 11:43

Subject **Re: Fwd: TRD2D strategy**

paper, but I really think the time was not wasted as they are now easy to refer to as POVs of out group members.

First : The list of designs which are now supported by different members of our group are:

1. TRD2D-A : version from the TDR Addendum, with HC EW (Mihai) and light EW (Laura). Mounting from EW

2. TRD2D-B : new version, close to the TDR Addendum but with "improved" glueing technology for anode wires and mounting from PP. No constrains on the EW (Claudiu / Andrei)

3. TRD-STD with 2D PP : using the mechanical design and assembly technology of TRD-STD and the 2D read-out. Mounting from PP (Alex / Laura)

Conclusions from previous 3 prototypes and new guiding principles

1. Entrance window → rigid, high, non-uniform X-ray absorption;

2. Pad-plane → flat-cables soldered directly on the pad plane, costly, high error rate and prone to electrical shorts (after gluing). Deformation of pad surface due to soldering heat;

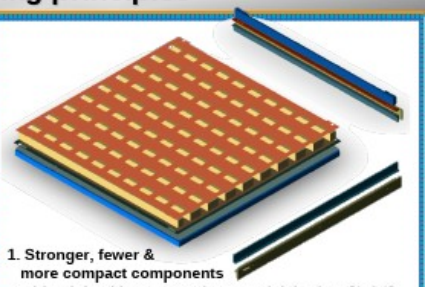
3. Gas inlets → Prone to large gas leakages, cumbersome design, fitted to 6mm pipes (8mm on TRD-STD);

4. Small material budget of the chamber → good for physics but too light to withstand the (cathode) wire pull during assembly;

5. Assembly procedure → improvised, no/erroneous alignment of components, no/erroneous gluing procedures (gas leaks);

6. Wire installation → susceptible to wire-misalignment, loss of tension, impossible to fix in case of error;

7. Wire QA (tension and position) → relying on a > 20 year old technology (legacy of ALICE TRD) used in new circumstances.



1. Stronger, fewer & more compact components with minimal impact on the material budget [3,4,6];

2. No critical modifications wrt. the TDR Addendum version [2,4];

3. Designed around the technology of assembly (devices, gluing, QA) for production [5,6,7];

4. Full integration with TRD-STD wrt. gas services (same flow resistivity) and TR detection [1,3];

5. New (wire, gas) QA [1,3,7].

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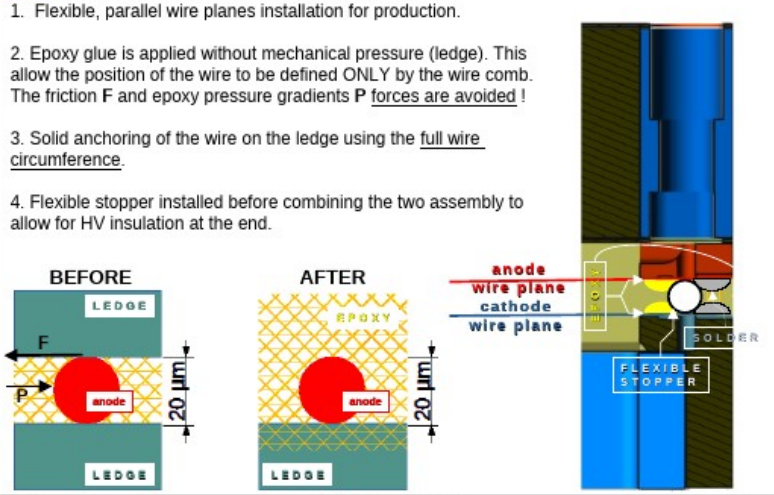
Chamber design updates

1. Flexible, parallel wire planes installation for production.

2. Epoxy glue is applied without mechanical pressure (ledge). This allow the position of the wire to be defined ONLY by the wire comb. The friction **F** and epoxy pressure gradients **P** forces are avoided !

3. Solid anchoring of the wire on the ledge using the full wire circumference.

4. Flexible stopper installed before combining the two assembly to allow for HV insulation at the end.



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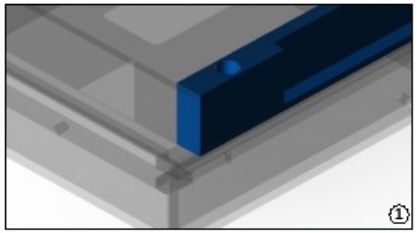
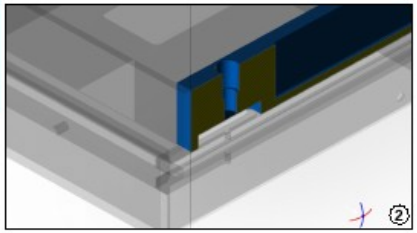
The entrance window (EW) and The gas inlet



1. The EW copies the solution of the TRD-STD to provide the same TR absorption/shadowing pattern and similar gas flow resistivity for integration in the same daisy chain gas system.
2. EW production will be done on the same device @ Muenster Uni.



3. Gas inlet is compatible with TRD-STD.
4. Gas inlet is used in the alignment of components (similar TRD-STD)
5. Improves on the TRD-STD solution as it is not puncturing the PP.

TRD2D
Tools and procedures

Assembly : Tools and procedures

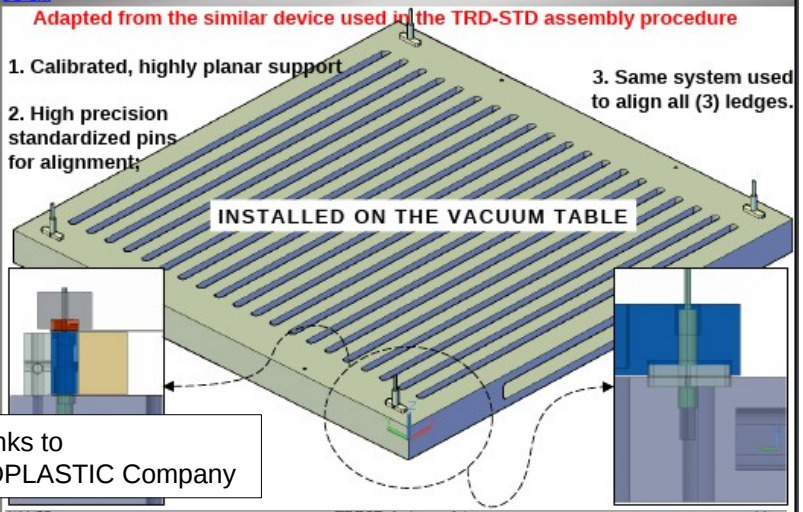
Adapted from the similar device used in the TRD-STD assembly procedure

1. Calibrated, highly planar support

2. High precision standardized pins for alignment;

3. Same system used to align all (3) ledges.

INSTALLED ON THE VACUUM TABLE



Thanks to PROPLASTIC Company

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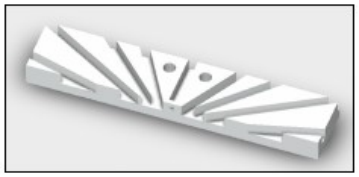
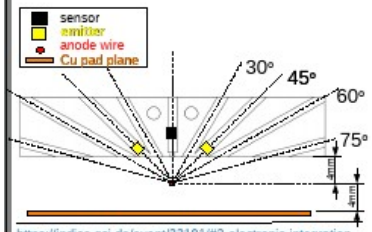
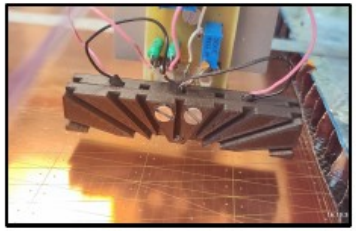
Wire QA : Tools and procedures

→ Assuring proper **wire tension and position is mandatory during chamber assembly**
→ The tool developed for **ALICE-TRD** construction needs major rework. Industry collaboration failed.

→ **Uni Muenster** efforts to build a new, reliable tool based on industry standards were joined by the Bucharest team.
→ **A prototype** for the **analog stage** was developed and successfully **tested in real conditions**.
→ **Positions and wire tensions** for both anode and cathode electrodes were measured.







https://indico.gsi.de/event/23101/#2-electronic-integration
https://indico.gsi.de/event/23391/#1-update

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Gluing : Tools and procedures

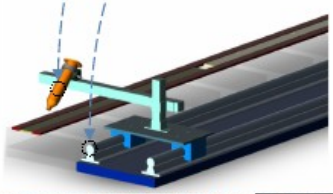
Principles of gluing

1. Gas tightness
   → continuity of the glue layer
   → air bubbles density
2. Mechanical strength
   → even distribution of glue
3. Thickness of the glue
   → alignment of various working parts of the chamber
   → material budget

Technology

1. Calibrate the amount
   - *define, at design level, the thickness of the gluing layer*
   - *implement by using calibrated spacers*
2. Application (on the object)
   - *By pressure dispenser*
   - *Using different dispensers heads !*
3. *Distribute (on the surface)*
   - *by linear drive*

→ The spacers are used in the **RPC** construction.
→ Diameter **2mm** x Height **170µm**
→ **Self adhesion** layer for easy installation on the support.



→ Calibration of **epoxy width** by probing traces left by different dispenser heads sandwiched at 170µm spacing.

https://indico.gsi.de/event/23152/#4-on-glueing-processes-in-cham

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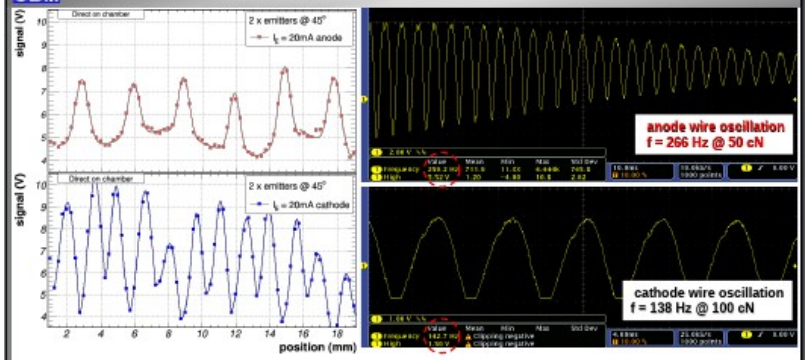
Wire QA : Tools and procedures



→ The Wire QA analog prototype **is operational**.

→ For the chamber prototype the **QA will be done manually**. The data processing and **the digital part exists (Uni Muenster)**, but they will be integrated in the future.

https://indico.gsi.de/event/23101/#2-electronic-integration
https://indico.gsi.de/event/23391/#1-update

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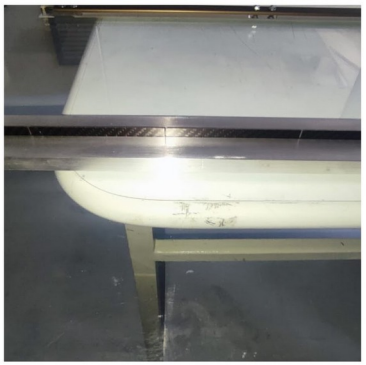
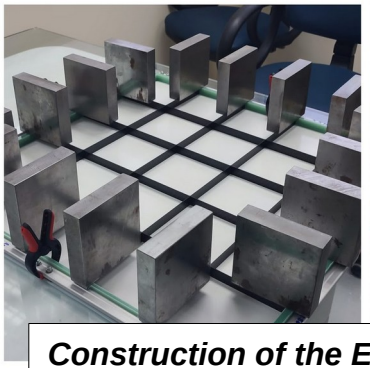
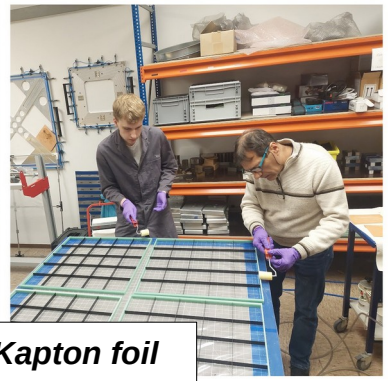
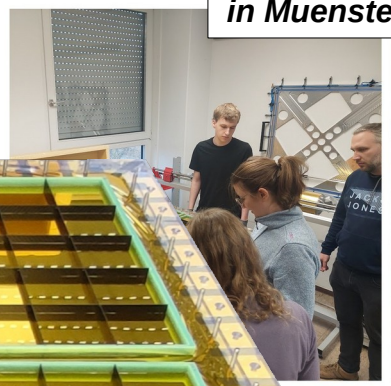
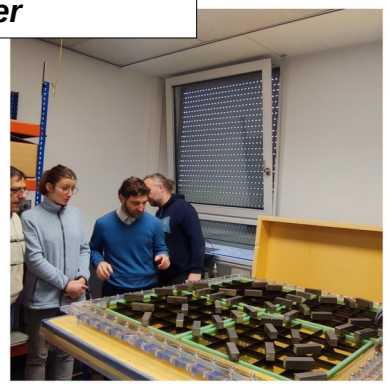
TRD2D Entrance Window (EW) tools, methods, procedures and production

Thanks to
Cosmic Rays group (IFIN-HH)






Construction of the EW frame in Bucharest

Installing Kapton foil in Muenster

4 EW produced in Muenster and personally transported to Bucharest

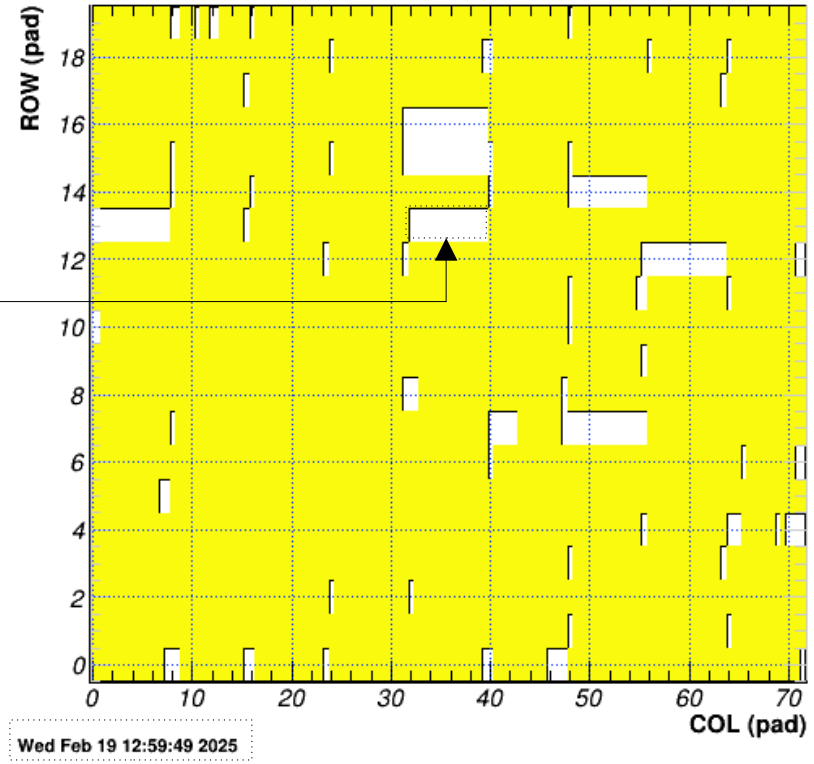
FASP based FEB

1. ASIC – FASP Production

→ Test production (0.2k) / *wire bonding* > 90% dice (+bonding) efficiency (mCBM 21-24)

→ Test production (0.5k) / *flip-chip bonding* (mCBM 25)

- → ~ 80% bonding efficiency (first batch)
- → ~ 50% bonding efficiency (second batch) !!
- → further problems when bonded to FEB

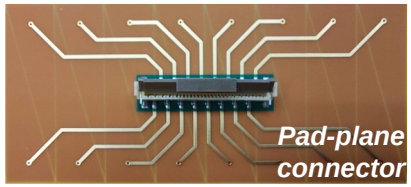


2. ASIC Engineering run

→ ~ 200% (17k) of the CBM demand

3. New concept ASIC bonding

→ New substrate + wire bonding (correlated with changes in the pad-plane)



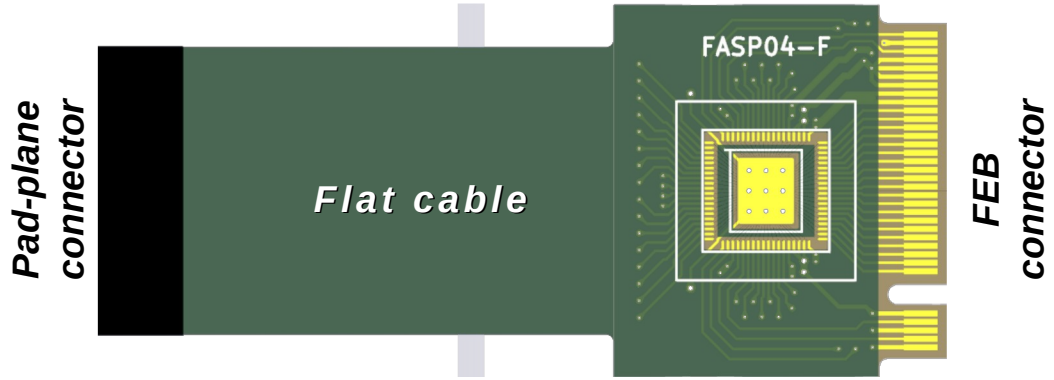
- → design ready
- → engineering in progress (Hybrid Swiss)
- → production and testing Q1/26

4. FEB updates

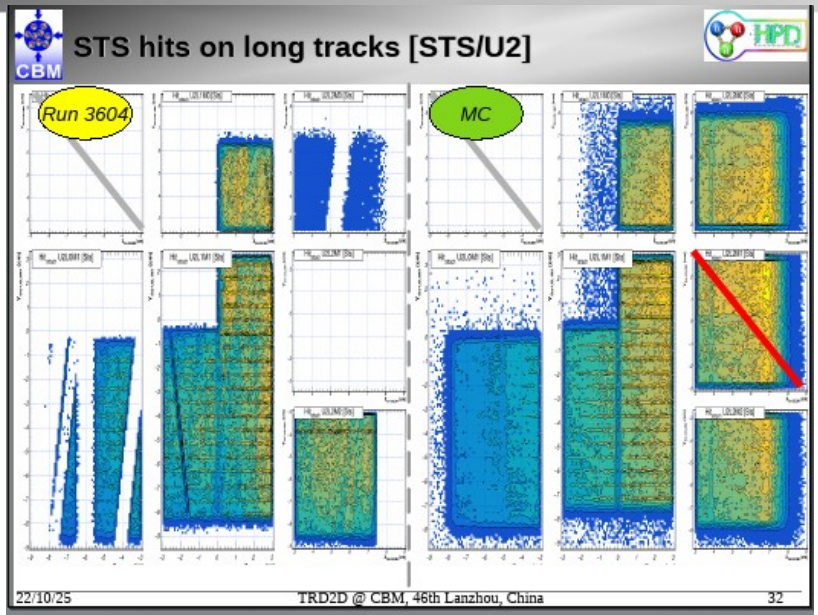
→ reduced component cluttering

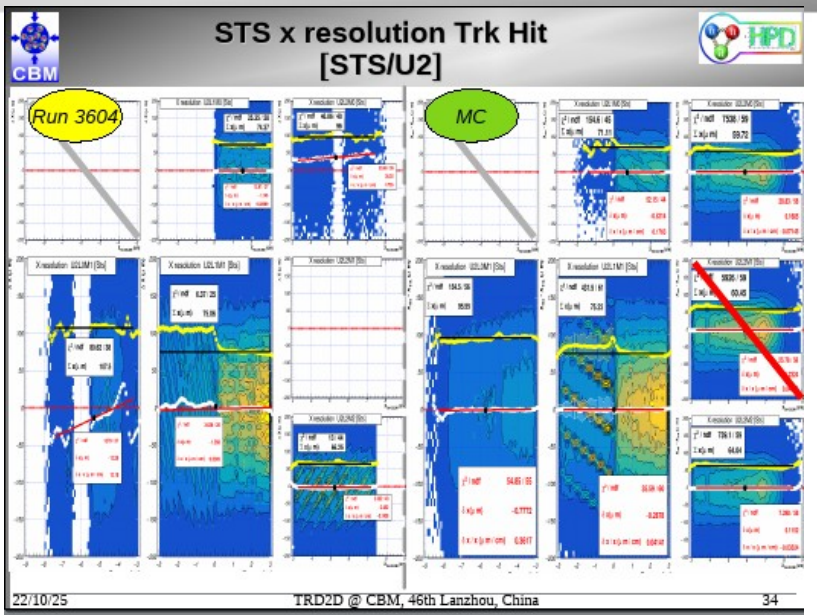
→ increased redundancy

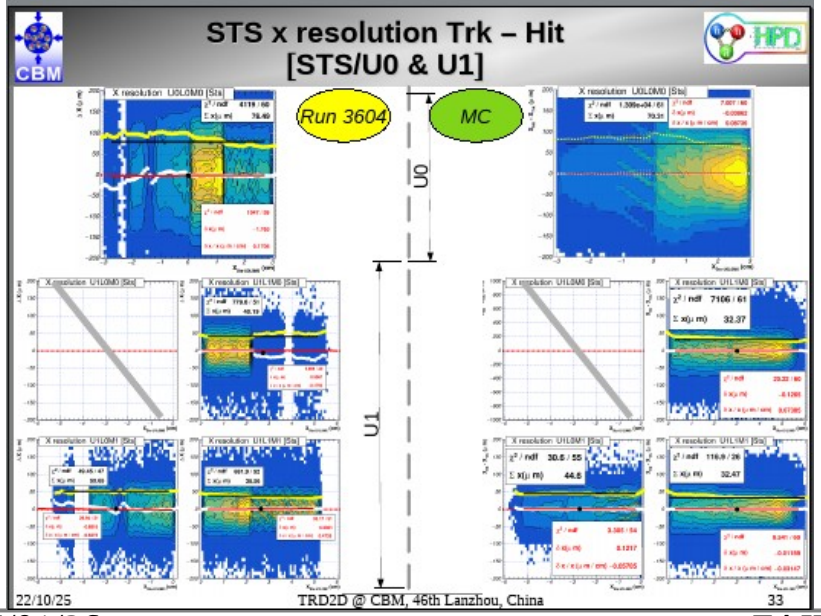
→ improvements in DAQ (CDR)

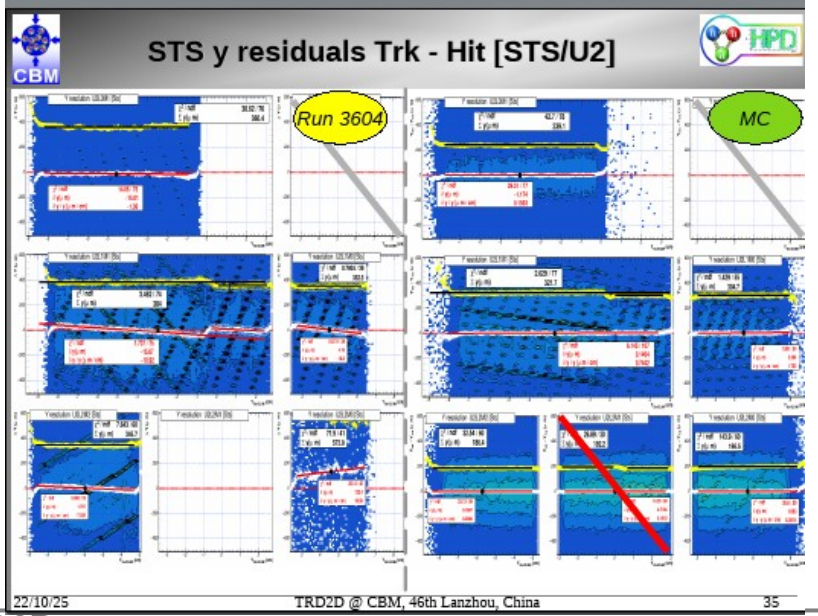


mSTS @ mCBM 24/25 alignment reference for TRD performance



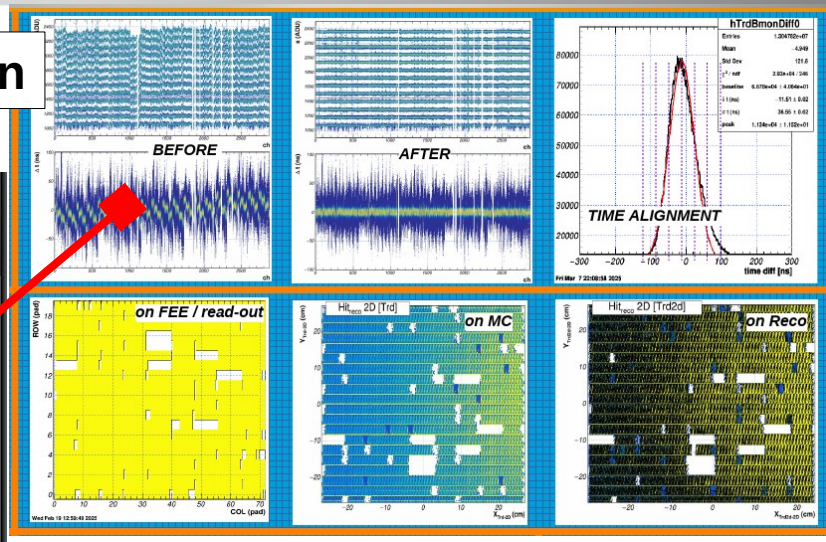






TRD2D demonstrator chamber @ mCBM Feb-March 2025

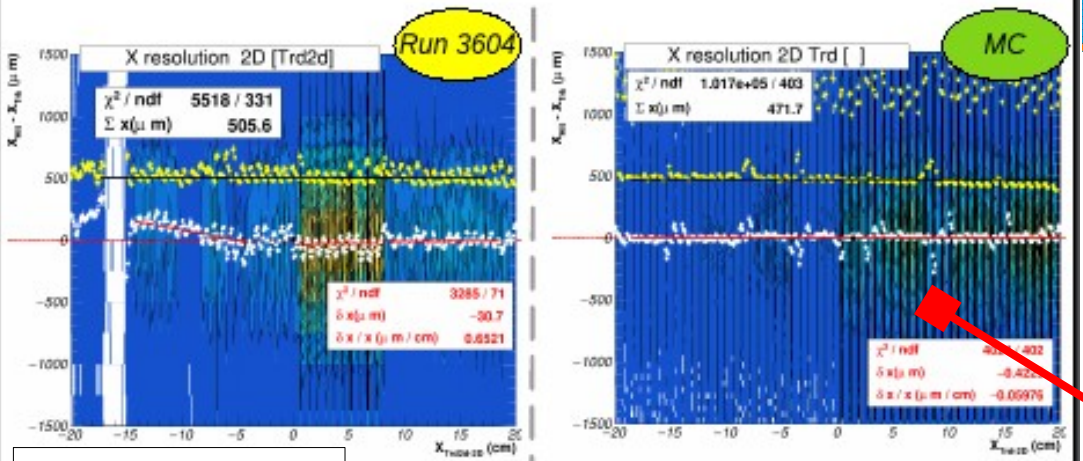
calibration



TRD2D residuals

$X_{Hit} - X_{Trk}$

- Use 3 STS hit tracks to generate references
- Study Hit → Trk residuals for measurements and MC
  - → residual mis-alignment **δx = - 30.7 µm**
  - → [3604]Σx = 505.6 µm; [MC]Σx = 471.7 µm; **+7% difference !!**
  - → systematic effects in the mCBM data reco **visible** !



performance

TRD2D @ CBM, 46th Lanzhou, China 18

TRD2D systematic

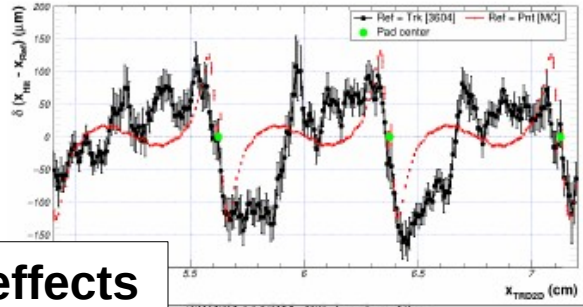
X_{Hit}

- The system is ready to place side-by-side the model world of MC points with the #real_data driven, reconstructed tracks world.

STS extrapolated mCBM[3604] tracks → TRD2D hit ← MC points

- For clarity, only one type of TRD2D hits are shown (nRC,sz4)

✔ Observed TRD2D systematic effects **range** is described by MC.
✗ The data is richer in "features" !



Systematic effects

TRD2D @ CBM, 46th Lanzhou, China 19

TRD2D
Contributions and Outreach

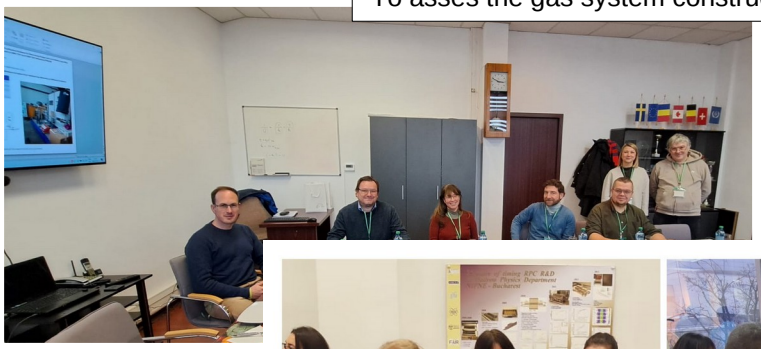
CBM Collaboration Meeting

- TRD2D status – parallel meeting, 45th CBM CM
  https://indico.gsi.de/event/21761/

- TRD2D status – Technical Board, 45th CBM CM
  https://indico.gsi.de/event/19975/contributions/86898/

- TRD2D status – plenary meeting, 46th CBM CM
  https://indico.gsi.de/event/20881/contributions/92720/

Visit to the ICSI
To asses the gas system construction for RPC and TRD



Students

- *Lucian Simion* (Uni Politehnic
  Summer student
  Jul – Sep 2025
  https://indico.nipne.ro/event/4

- *Livia Ilie* (Physics Faculty)
  Master student
  Oct. 2025 →

Visit to the Uni Muenster
To asses the synergies of the
TRD-2D and TRD-STD projects

Visit to the IFIN-HH of the CBM management team
To asses the status of RPC and TRD projects run in IFIN-HH
https://indico.nipne.ro/event/432/

CBM Technical Board

- TRD2D @ mCBM25 investigations of the May campaign accident.
  16th Sept 2025 https://indico.gsi.de/event/23109/

- TRD2D design updates, production preparation.
  4th November 2025 https://indico.gsi.de/event/23368/