

HADES group activities 2020-2022

A. Blanco

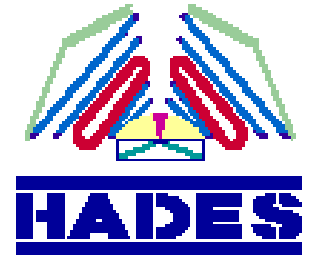
On behalf of the HADES group

FCT

Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR



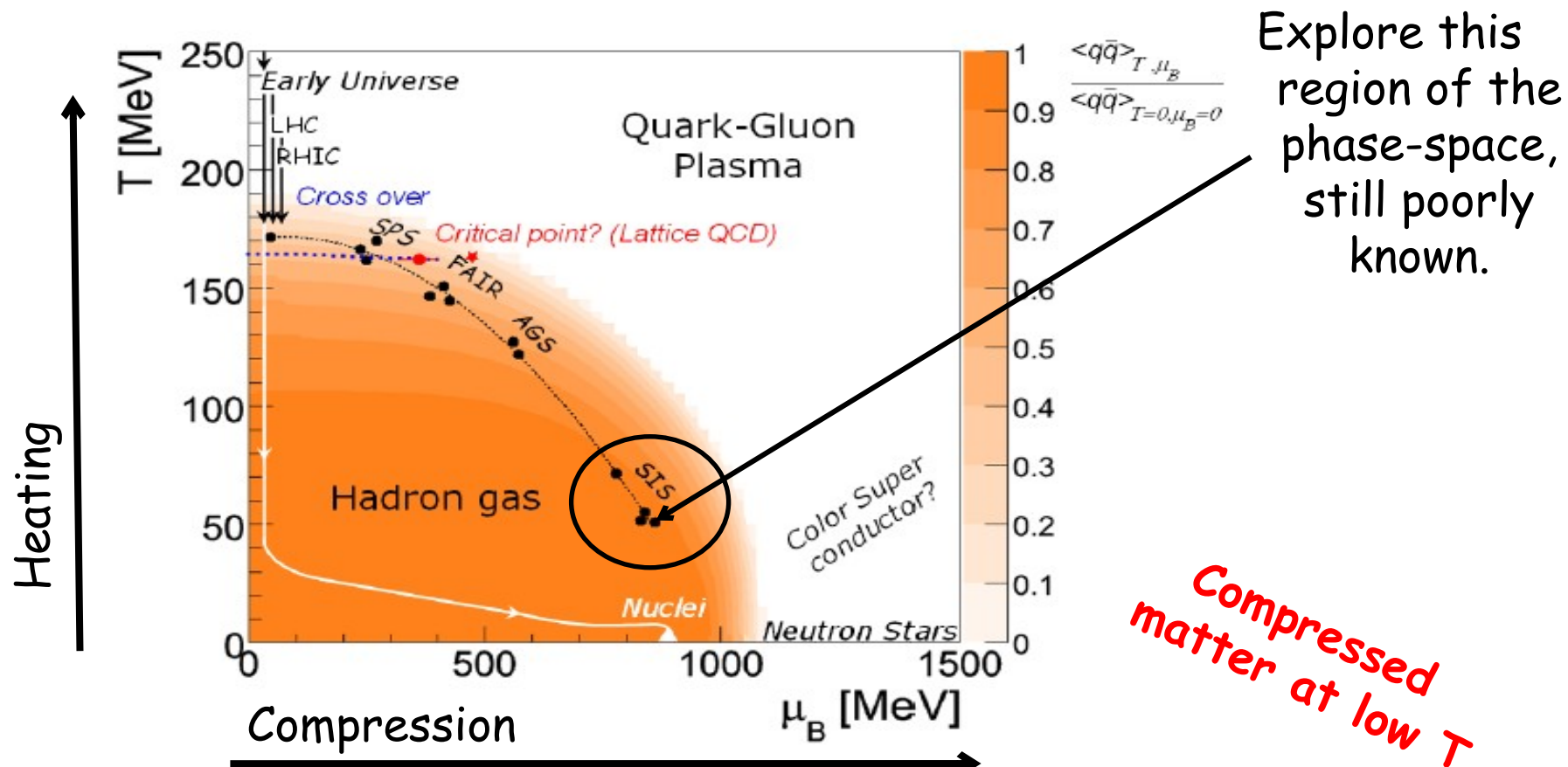
REPÚBLICA
PORTUGUESA



This work was supported by Fundação para a Ciência e Tecnologia, Portugal, in the framework of a MoU between FCT and HADES collaboration.

HADES experiment

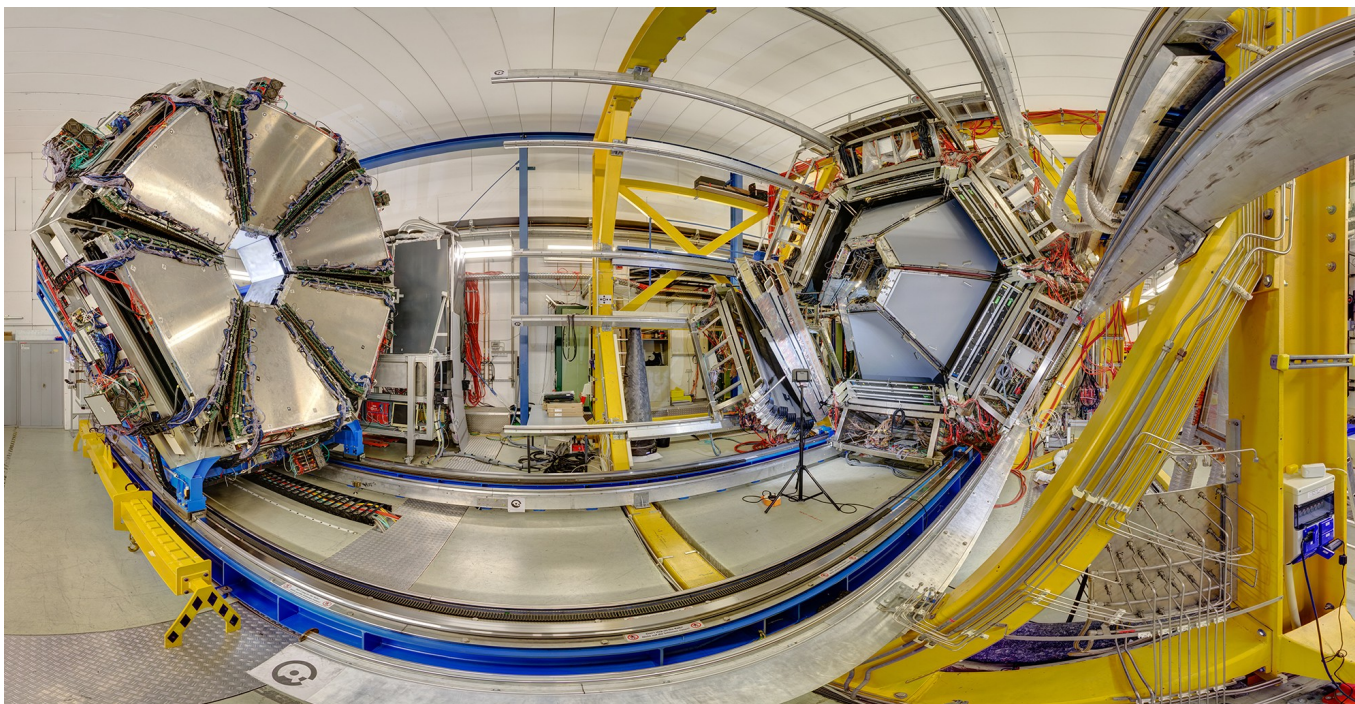
Study of "emissivity" and hadron properties in dense and cold nuclear matter, detected via $e^+ e^-$ pairs (dielectrons) and strange hadrons, produced in proton, pion and heavy ion induced reactions in a 1-4.5 GeV.



HADES experiment

Study of "emissivity" and hadron properties in dense and cold nuclear matter, detected via $e^+ e^-$ pairs (dielectrons) and strange hadrons, produced in proton, pion and heavy ion induced reactions in a 1-4.5 GeV.

Spectrometer with high invariant mass resolution and high rate capability.
Installed at SIS18, GSI, Darmstadt. <http://www-hades.gsi.de/>



Project launched in late 1994
6 years R&D and construction

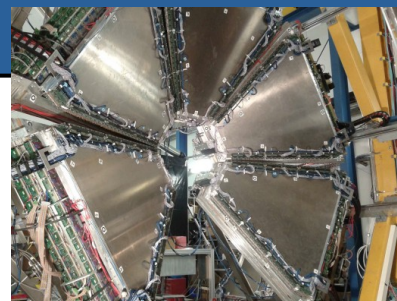
First production run in 2002

International collaboration of
27 institutions from 10
European countries.

Cyprus, Czech Rep., France,
Germany, Italy, Poland, Portugal,
Russia, Slovakia, Spain.

- RPC-TOF-W.

- Maintenance, operation and upgrades



RPC-TOF-W

- Design and construction of the new RPC-TOF-FD

- RPC-TOF Forward Detector



RPC-TOF-FD

- Collaboration with the HADES tracking group

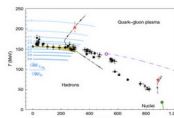
- Support the MDC group in preparing the HADES tracking system for High-Rate Experiments at SIS100 (FAIR) + Maintenance, operation and upgrades.



MDC prototype

- Analysis

- ~~- Investigation of hadron properties inside a baryonic rich medium.~~



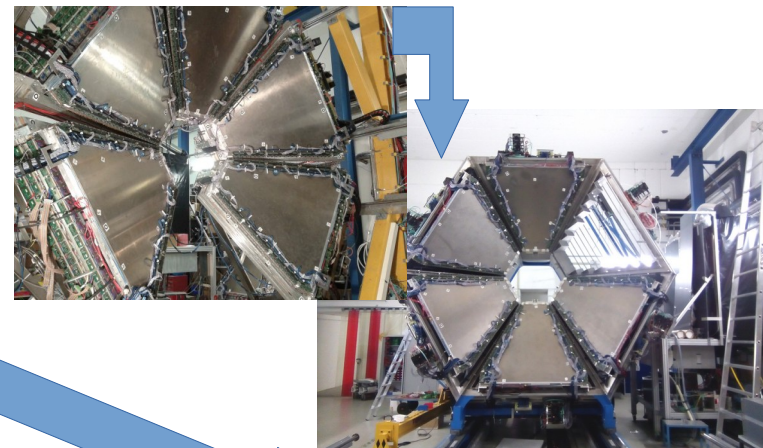
HADES na Nature Physics / 2019-08-12
Noticias LIP

Resultados da experiência HADES com contribuição directa do LIP publicados na revista Nature Physics apresentam a medição das propriedades de um estado de matéria similar ao que resulta da fusão de duas estrelas de neutrões

[LER MAIS >](#)



- Re-installation of the RPC-TOF-W** (together with all subsystems and cabling). This was done (partially) several times due to the phased installation of the ECAL detector (at the rear of RPC).
- Detector calibration.**
- Complete **upgrade of the DAQ system** (~2300 ch).
- Successfully data taking Feb 2022** with P+P @ 4.75 AGeV.



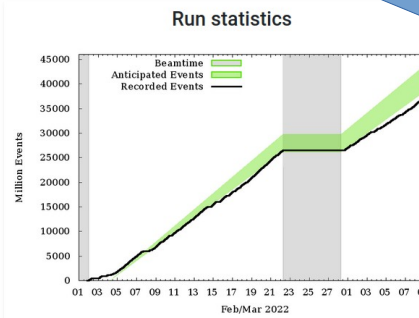
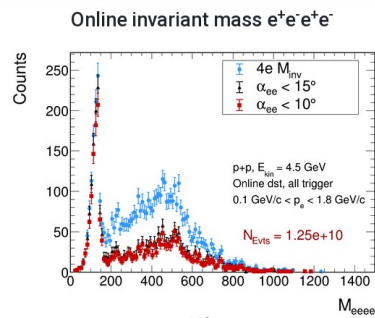
HADES monitoring LIVE

p+p 4.5 GeV

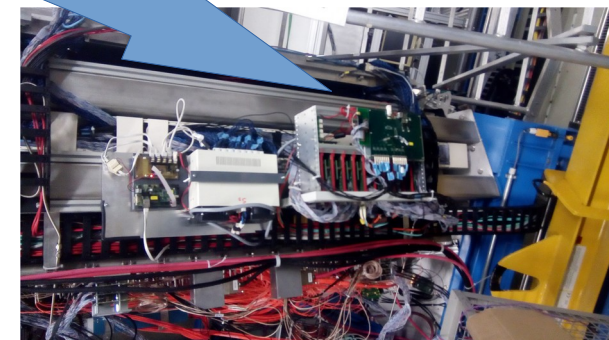
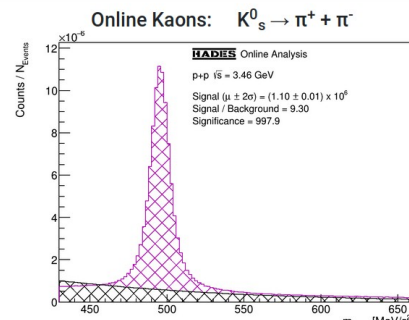
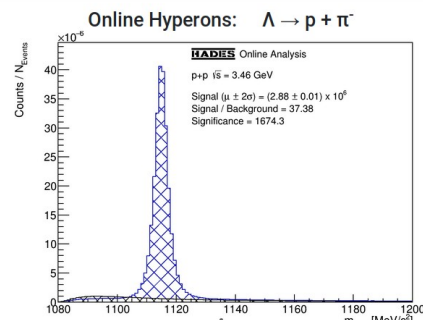
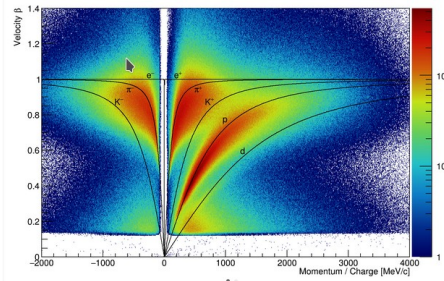
Date: 30/6/2022

Event Rate: 40 - 55 kHz

Beam Intensity protons/s: 7.8×10^7



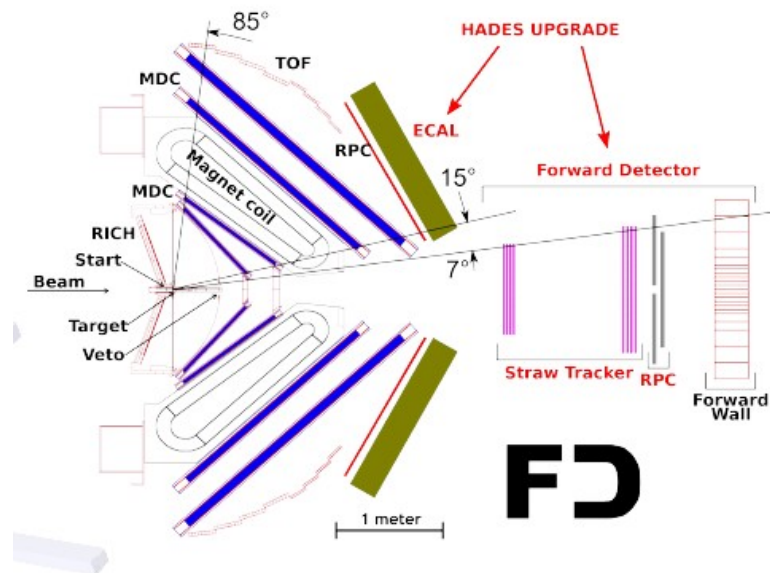
PID: Velocity vs Momentum



Overview of the new RPC-TOF-W
DAQ based on TRB3sc

HADES PHYSICS WITH FORWARD DETECTOR

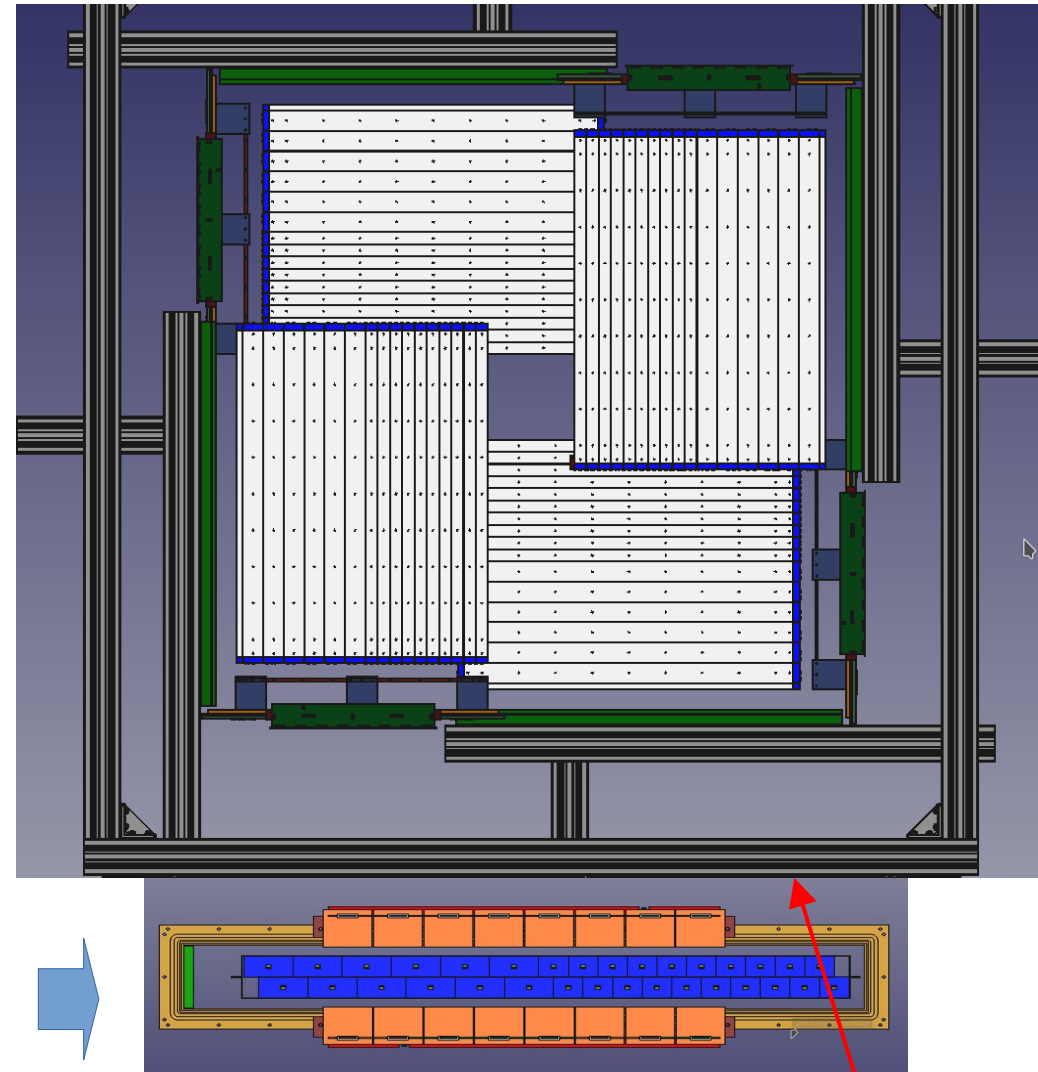
- Measurement of **double-strangeness production (Ξ)** in elementary p+p reactions at energies above the threshold. (G. Agakishiev et al. Phys.Rev.Lett.103:132301,2009.)
- **Electromagnetic decays of hyperons.** (Kaxiras, Moniz, and Soyeur. Phys.Rev.D32 (3 198508)



fRPC design

- **Four sectors with 32 individually shielded RPCs**, same technology used in RPC-TOF-W, but different geometry and thinner glass for high rate.
- **64 FEE channels/sector** (256 total) each readout by one TRB3.

Internal structure. Two layers with 16 cells each, readout in both sides



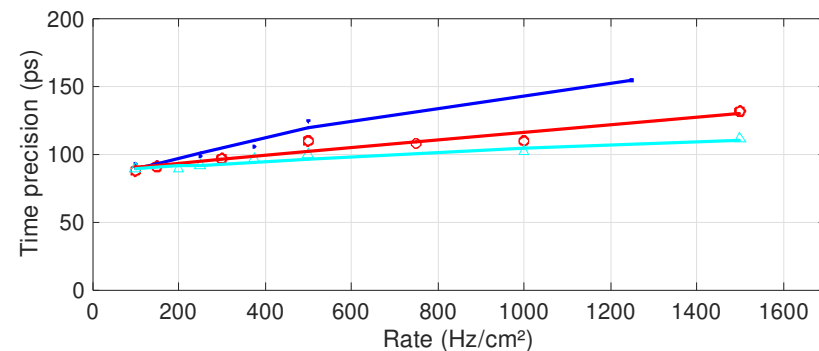
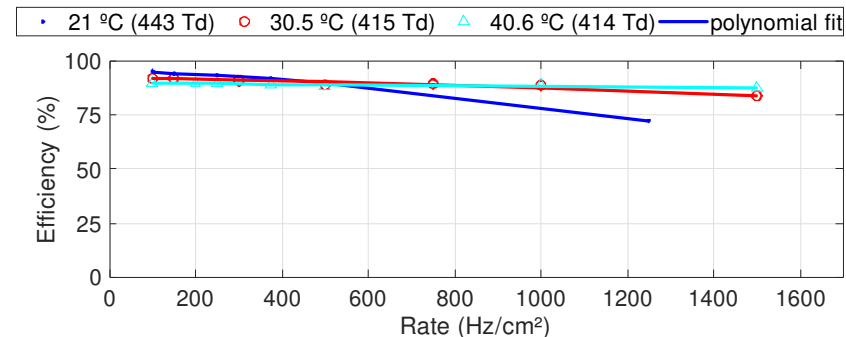
Design and construction of the new RPC-TOF-FD

Testing the first prototype in beam @ Julich. In particular the capability to recover the detector performance @ **high particle loads** ($>1\text{kHz}/\text{cm}^2$) when working temperature is increased

RPC + heating system for count rate improvement



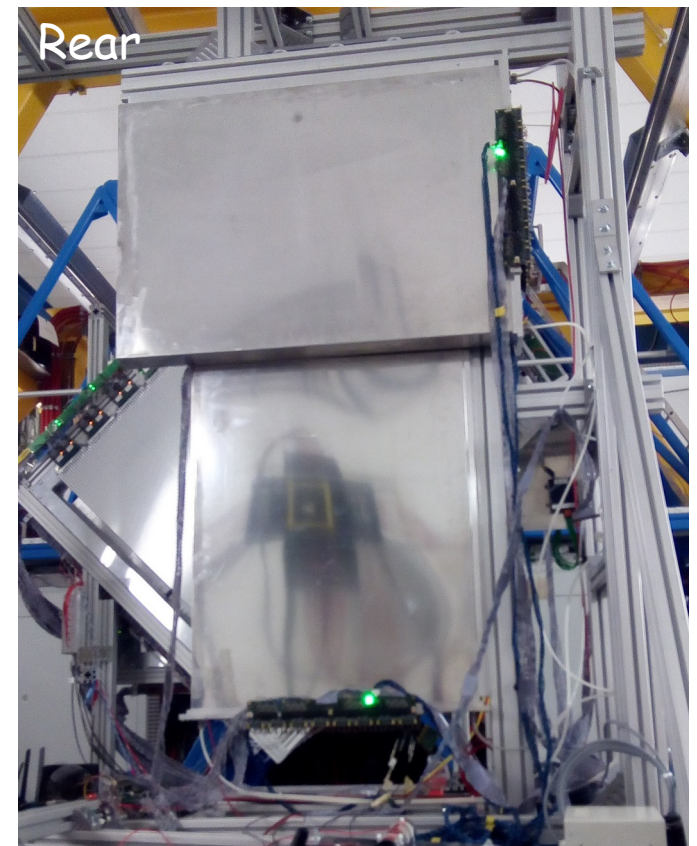
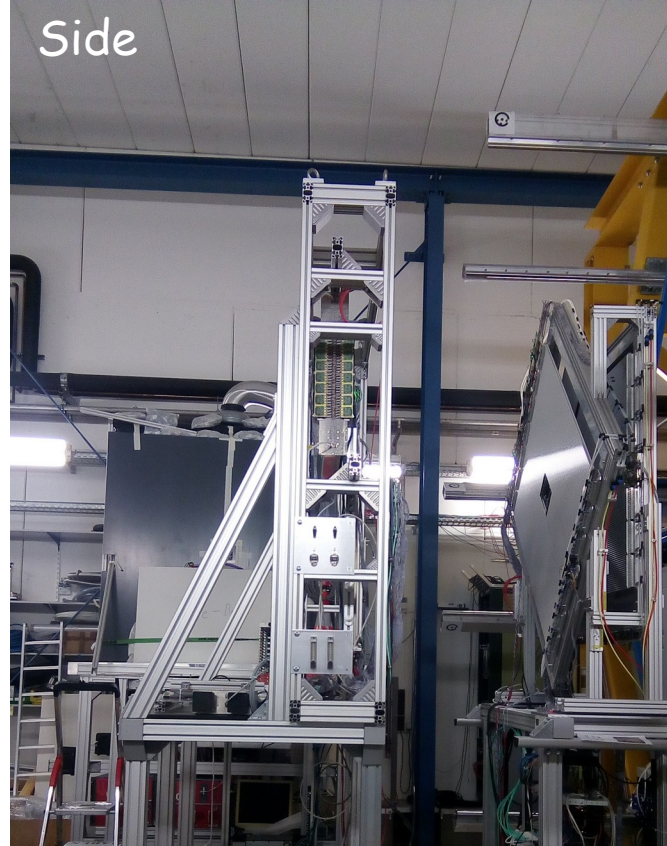
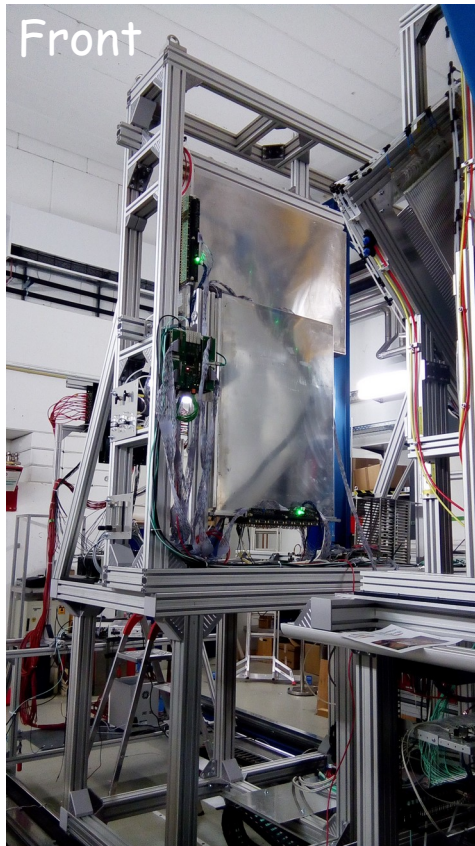
Reference scintillators



Design and construction of the new RPC-TOF-FD

Installation in two phases,

Two modules in Feb 21 (without heating system) followed by a engineering run.

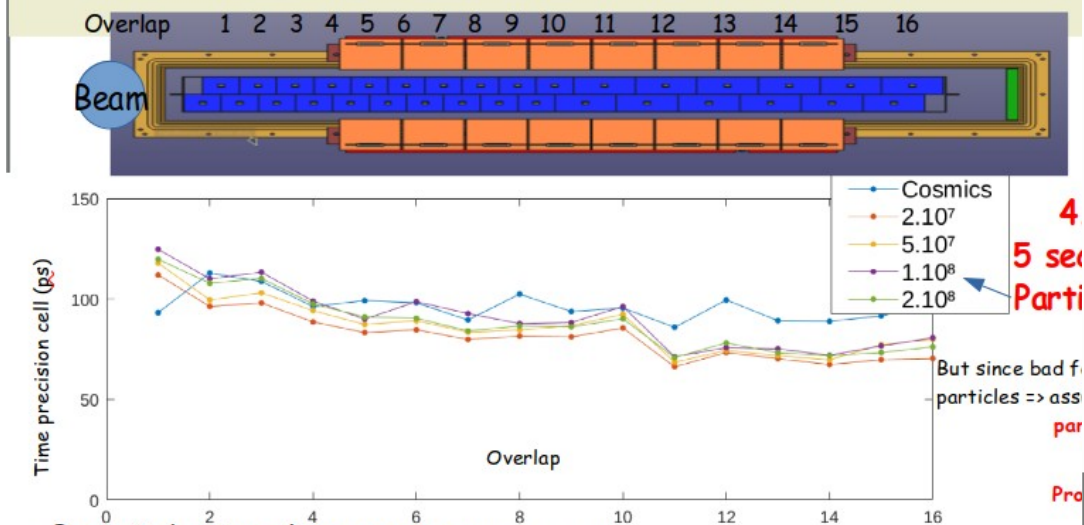


Design and construction of the new RPC-TOF-FD

Outcome of the **engineering run (Feb21)**.

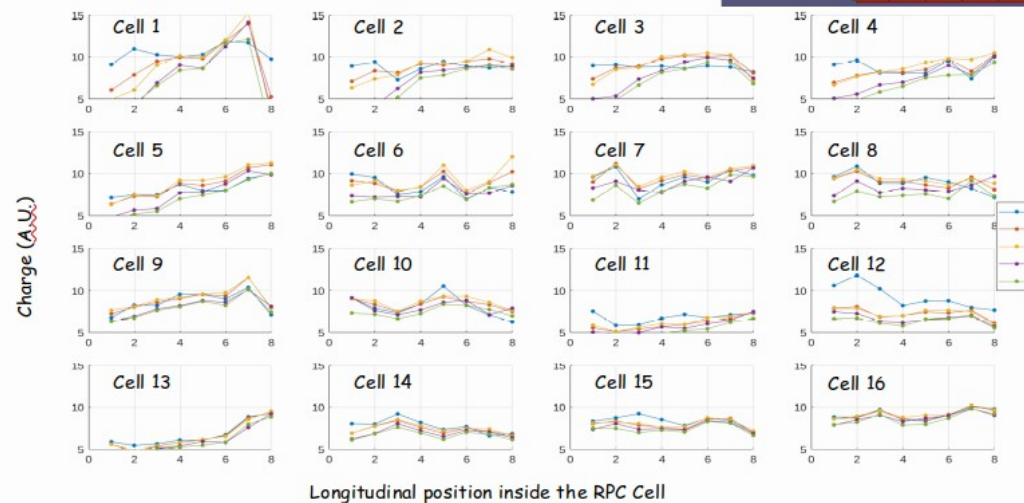
- The **system is well behaved**, but **near the beam axis the RPC is quite saturated**. Simulations discovered that direct protons from the beam line were impinging the RPC => reposition
- **Heating system will also help** (as we already know).

Intrinsic performance. Preliminary results. Timing precision in overlap



- Beam is better than **cosmics** (this is normal)
- General **slight degradation** as a function of rate and in cells closer to the beam
- **Time precision calculated in overlap mitigate the effect of rate.**

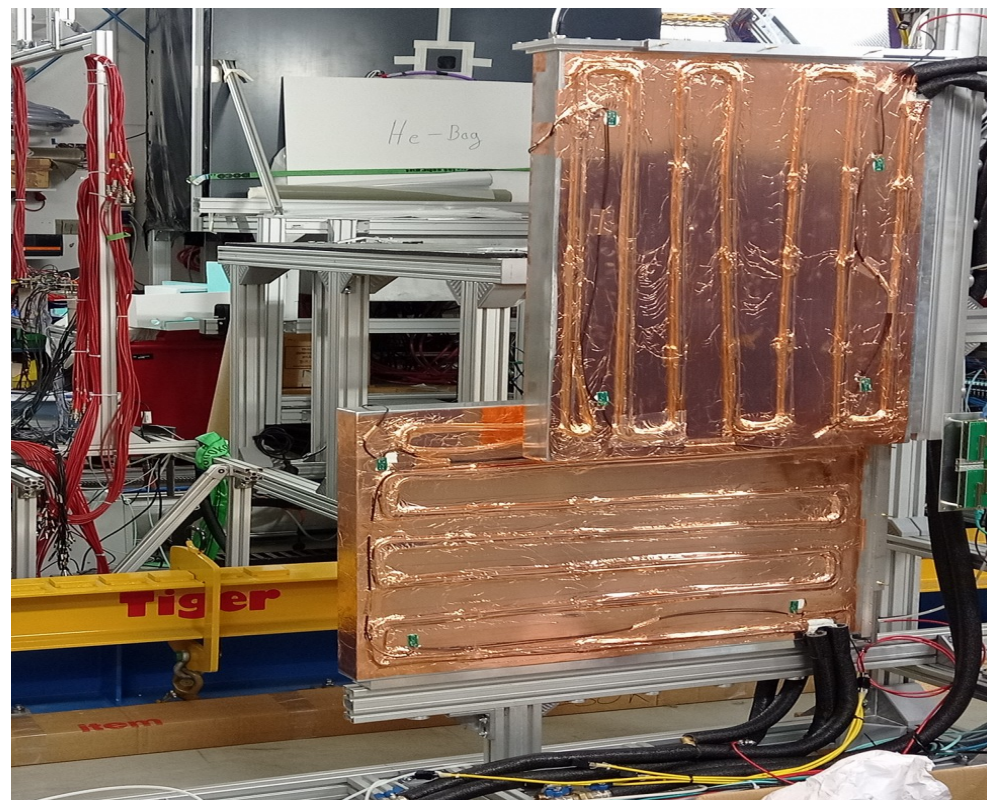
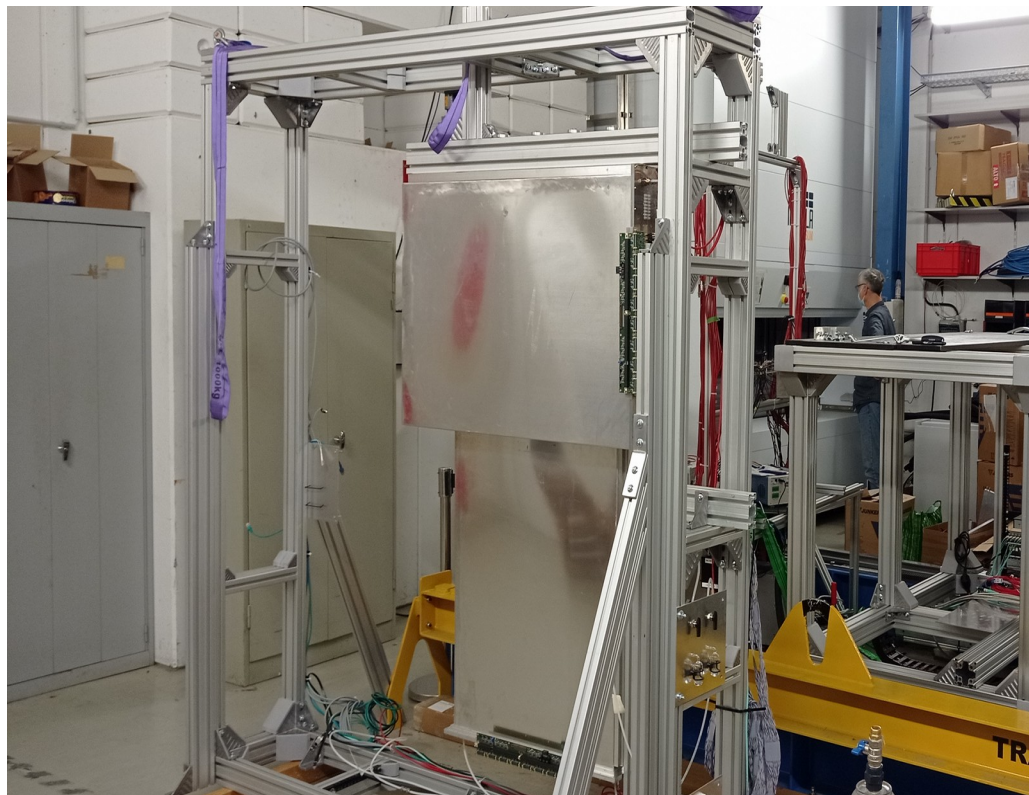
Intrinsic performance. Preliminary results. Charge



In positions closer to the beam axis the effect in charge is > 30%

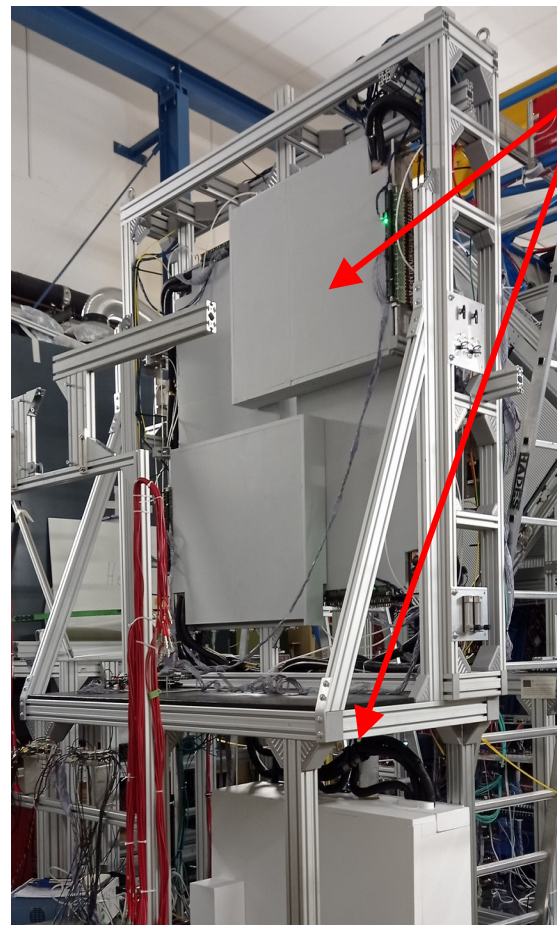
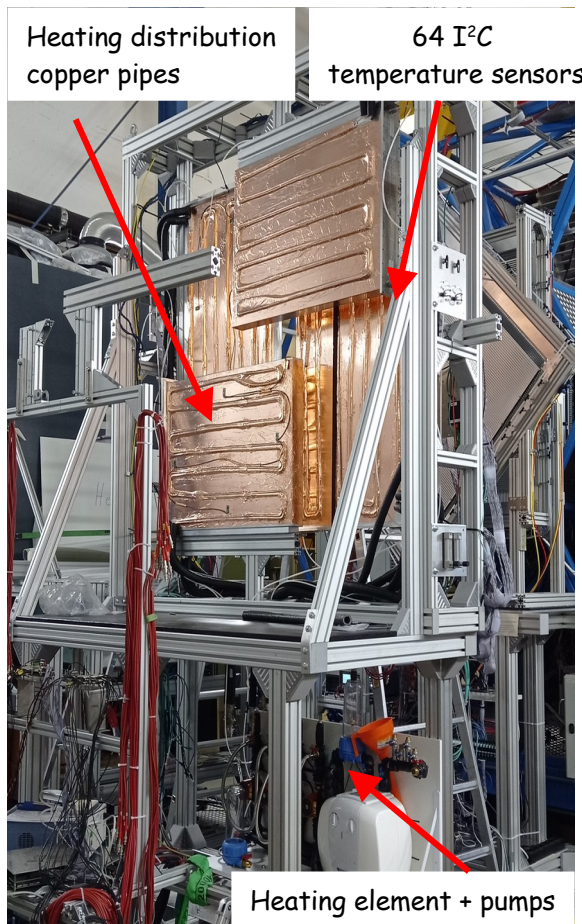
Design and construction of the new RPC-TOF-FD

Full TOF-FD constructed and **installed @ GSI (Dec 21)** followed by a production beam run.

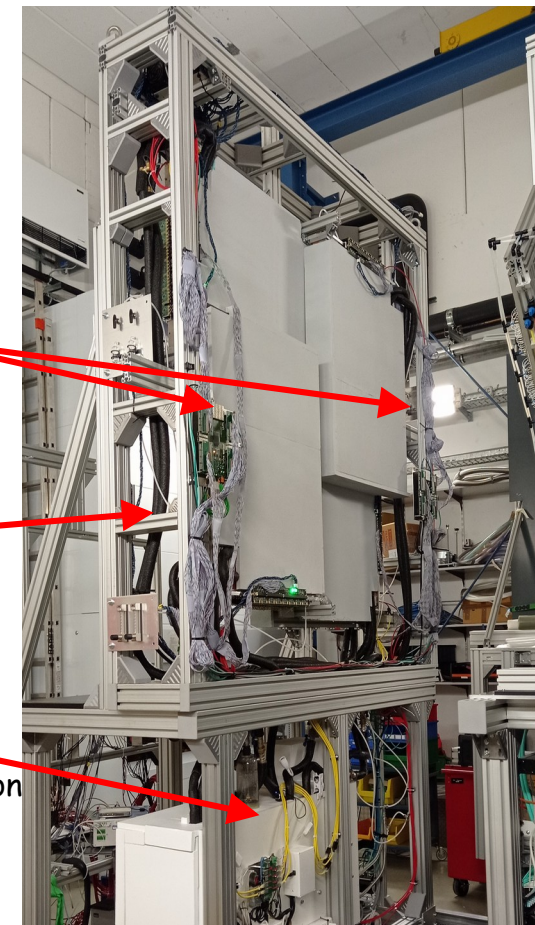


Design and construction of the new RPC-TOF-FD

REAR



FRONT



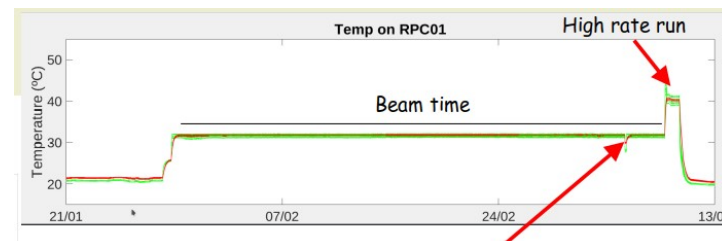
Design and construction of the new RPC-TOF-FD

Outcome of the **production beam run Feb22**.

6 weeks of operation at a higher working temperature to improve the counting rate capability of the system.

No saturation observed

@ around 600 Hz/cm^2 @ 8.10^7 p/s @ 31.4°

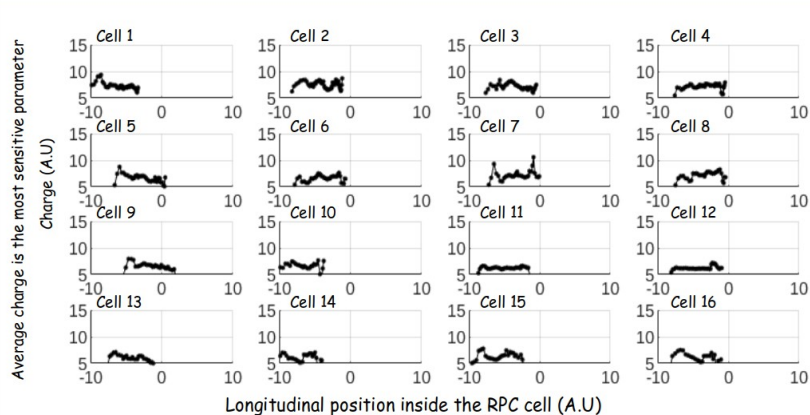


- $\Delta \text{Temp} < 0.5^\circ$ over $\sim 4 \text{ m}^2$
- Just one crash of the system to be improved.
- Tip: never use mechanics relays !!!!!

210 W @ $\Delta T = 14^\circ$ 450 W @ $\Delta T = 22^\circ$

Rate issues. fRPC is saturated?

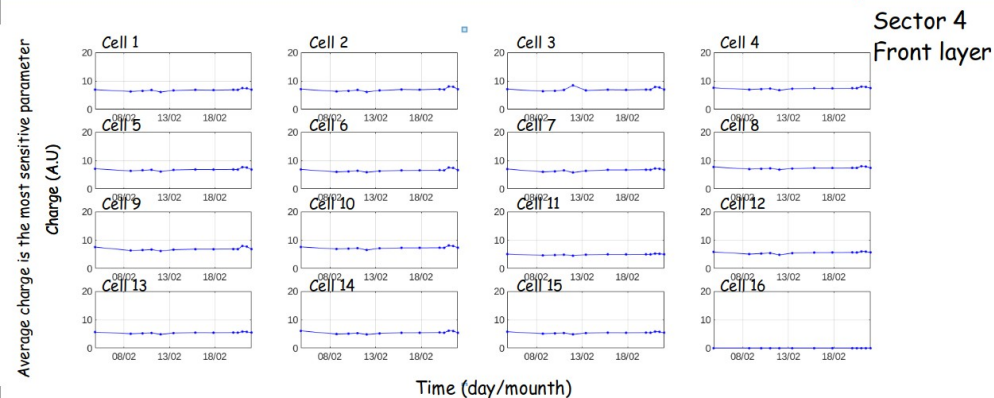
Maximum rate $\sim 600 \text{ hz/cm}^2$ @ 8.10^7 p/s @ 31.5°C



No noticeable dependence with rate

Rate issues. fRPC is saturated?

Maximum rate $\sim 600 \text{ hz/cm}^2$ @ 8.10^7 p/s @ 31.5°C



No noticeable dependence with time

Design and construction of the new RPC-TOF-FD

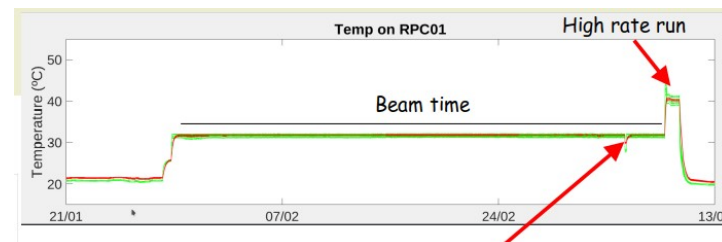
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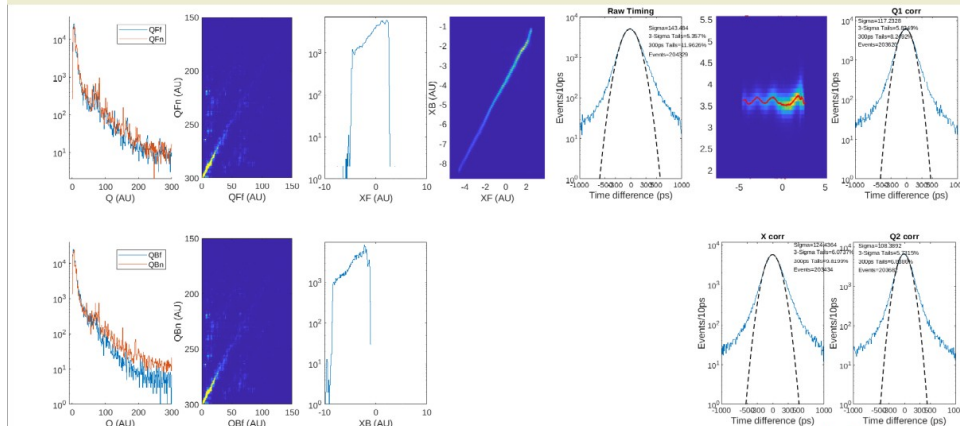
Timing precision around 80 ps



- $\Delta \text{temp} < 0.5^\circ$ over $\sim 4 \text{ m}^2$
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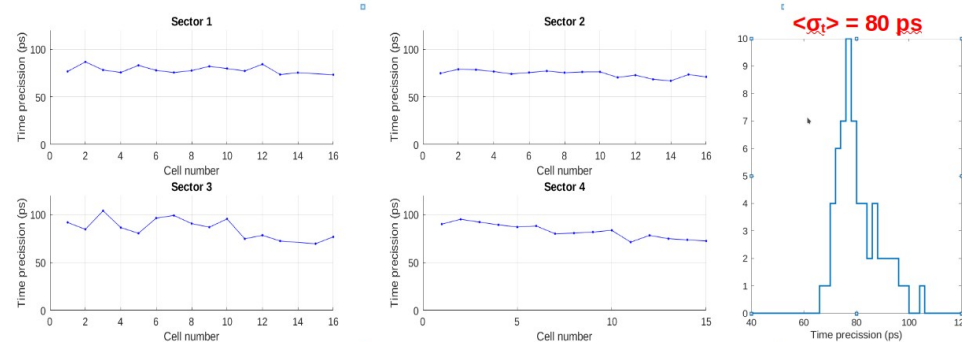
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Monitoring of each cell. Performance (σ_t) through overlap.

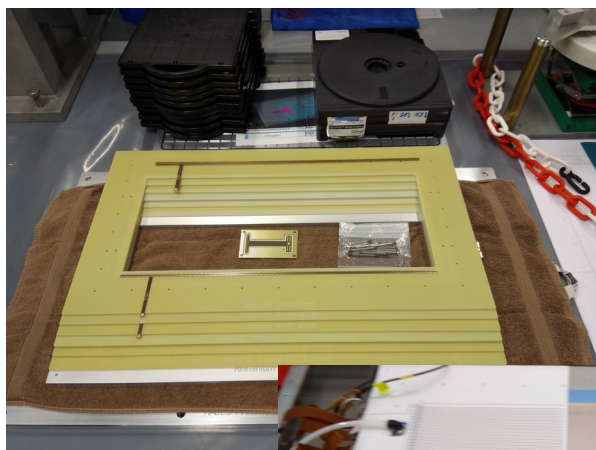


Timing precision: raw, position and walk corrected

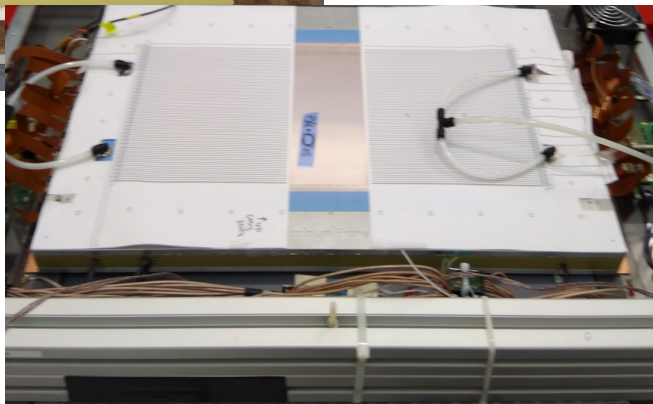
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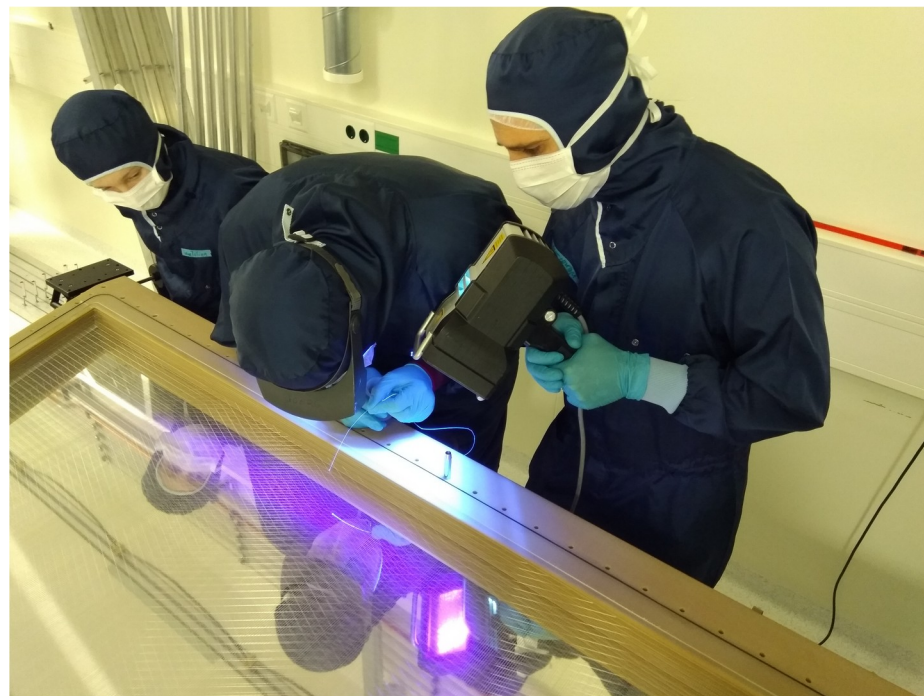
Prototyping new MDC chambers, which explore new configurations for the future upgrade of the tracking system.

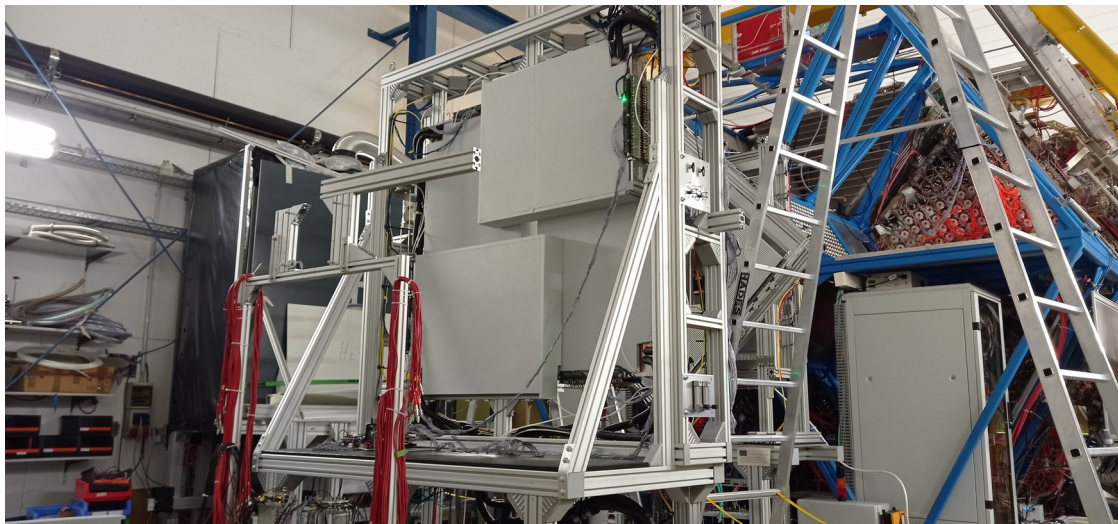


Heavily affected by the pandemic
No new developments



Maintenance and optimization of the current tracking system





- **RPC-TOF-W and RPC-TOF-FD operation**
 - **Data taking** with new systems already in FAIR PHASE-0.
- **Design and construction of the RPC-TOF-FD**
 - Finalize **implementation** of **FD** (small details missing): **Gas system, LV monitoring**
- **Collaboration with HADES tracking group**
 - Continuation of the **tests** carried out with the **MDC prototype** . **Maintenance of the gas systems.**