Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin
National Metrology Institute

SANDA
Supplying Accurate Nuclear Data for energy and non-energy Applications

HORIZON2020

This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 847552 (SANDA).

Status of the DDX experiment in EAR1

(Double-Differential Cross Section of Neutron-Induced Charged-Particle Emission of Carbon from 20 MeV to 200 MeV)

R. Beyer, M. Dietz, A. Junghans, R. Nolte,
E. Pirovano, S. Pomp, D. Tarrío, P. Vaz
and the n_TOF collaboration

DDX experiment on carbon at high energies

DDX = double-differential cross section of neutron-induced charged-particle emission

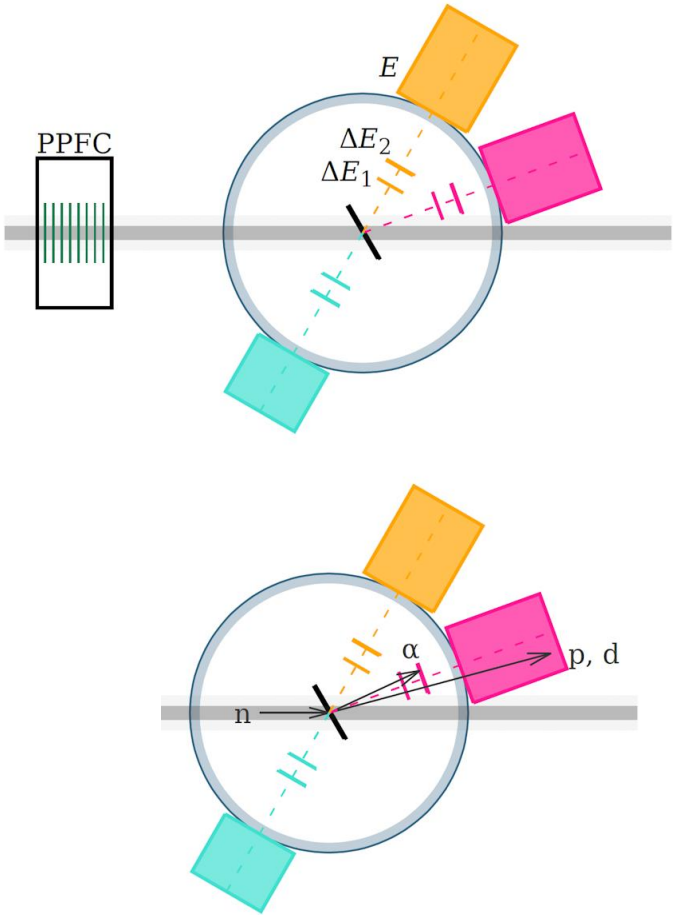
Experimental database / evaluations above 20 MeV for carbon:

- Emission p, d, t, ^{3}He, ^{4}He
- Few datasets, at selected neutron energies, only up to 100 MeV
- Evaluations not based on experimental data but model calculations
- Data are necessary for benchmarking, especially in the range 100-200 MeV and for the emission of compound ejecticles

Applications: dosimetry (hadron therapy), radiation damage calculations (space/air travel), neutron detector development

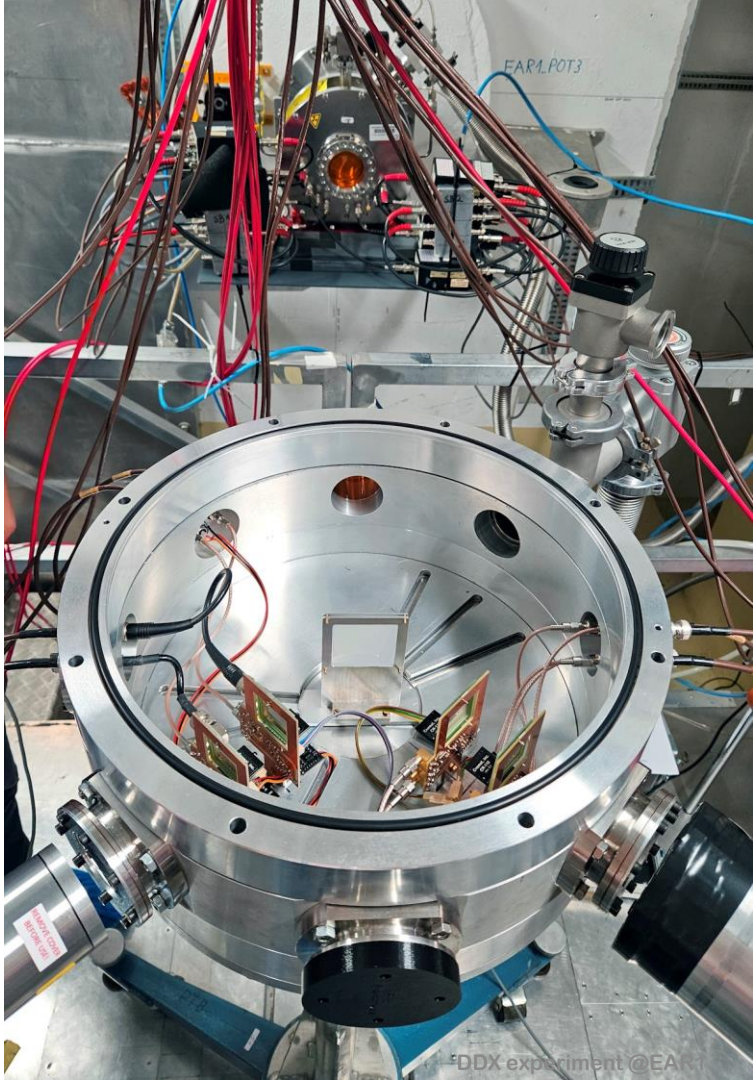
Concept

- Proof-of-principle experiment
- Target: carbon (graphite)
- Measurement of the energy distribution of the neutron-induced emission of p, d, t, α, ^{3}He
- *ΔE-ΔE-E* telescopes initially at 3 angles (20°, 60°, 120°)
- Particle identification: double/triple coincidences combined with the *ΔE-E* technique
- Focus on the energy range 100-200 MeV
- Goal: statistical uncertainties comparable to that of previous experiments, at least at forward angles



Timeline

- Nov 2020 INTC LOI (detector tests)
- May 2022 1st detector test
- Nov 2022 2nd detector test
- Feb 2023 INTC proposal for carbon measurement (3×10^{18} pot)
- Sep 2023 3rd test: short carbon run in (semi) final configuration
- Dec 2023 new vacuum chamber ready
- Early 2024 completion electronics / detector characterization
- Late 2024 carbon measurement



5DDX experiment @EAR1

Status as of November 2022

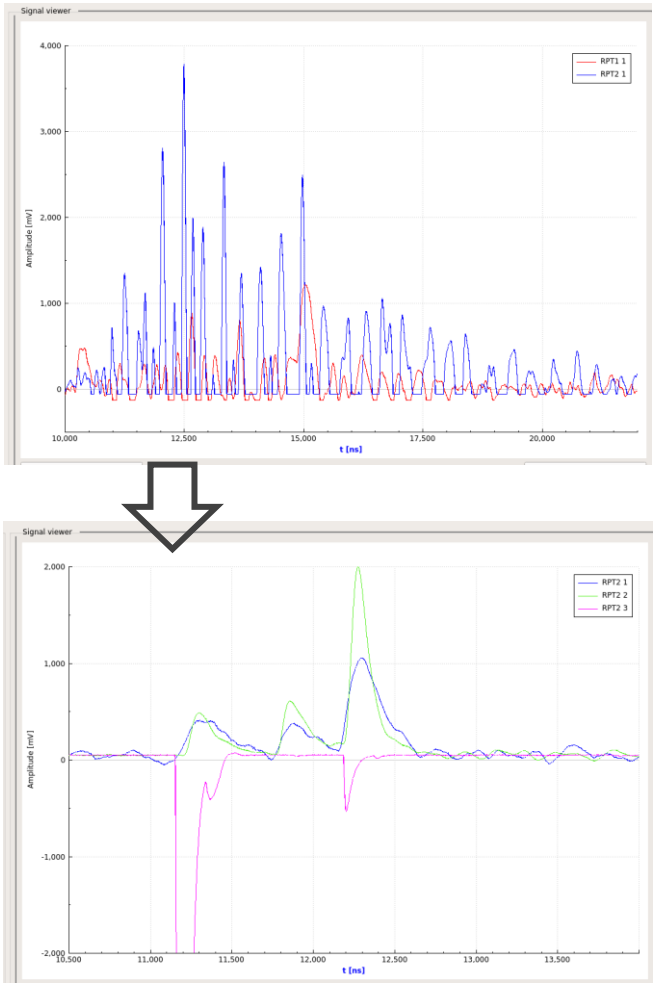
Main difficulty: γ-flash induced e.m. interferences

Solutions

- Improved grounding, short cables
- RF tight chamber (windows included)
- Preamps inside the chamber

Still to improve / or missing:

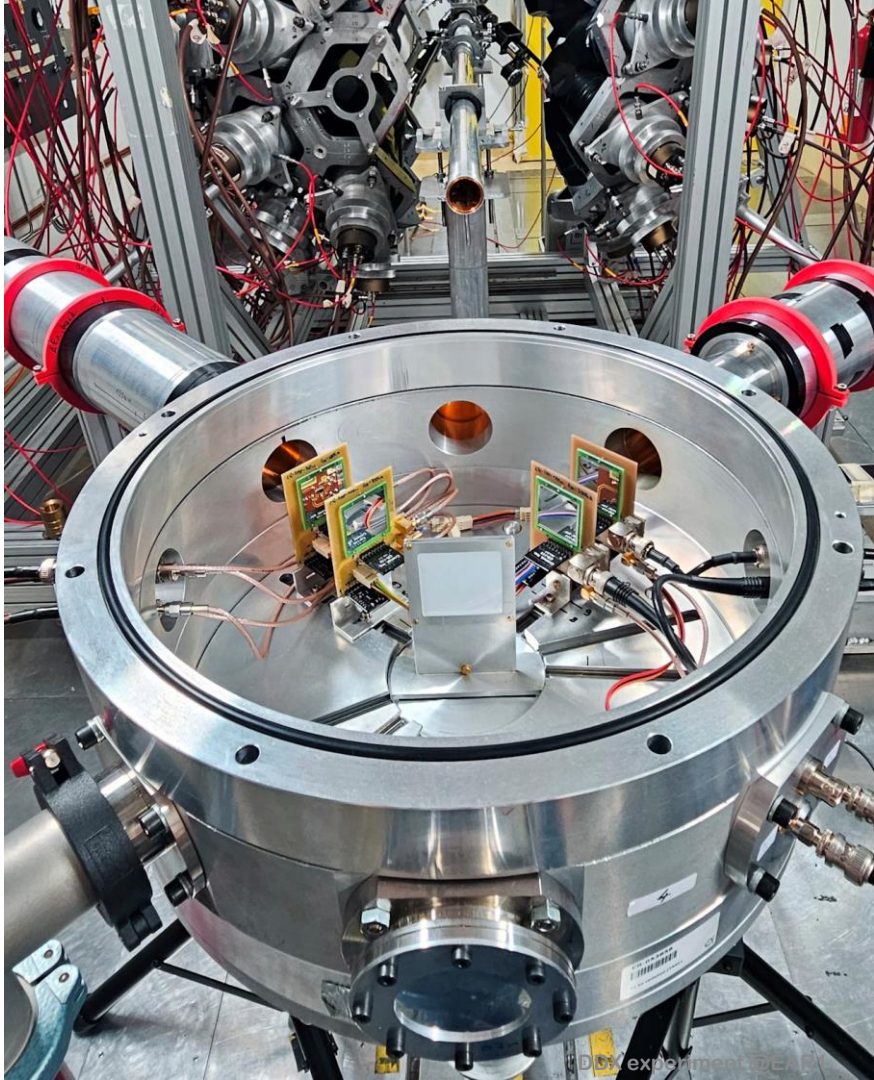
- Si-diode energy resolution / particle discrimination
- Carbon run with final configuration to test $^{3}He/^{4}He$ ions discrimination capabilities

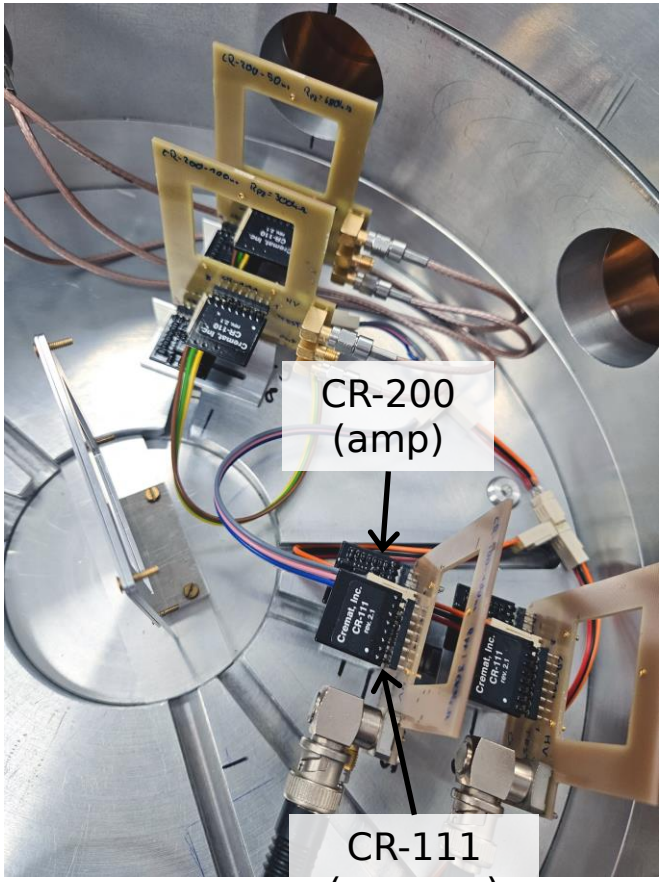


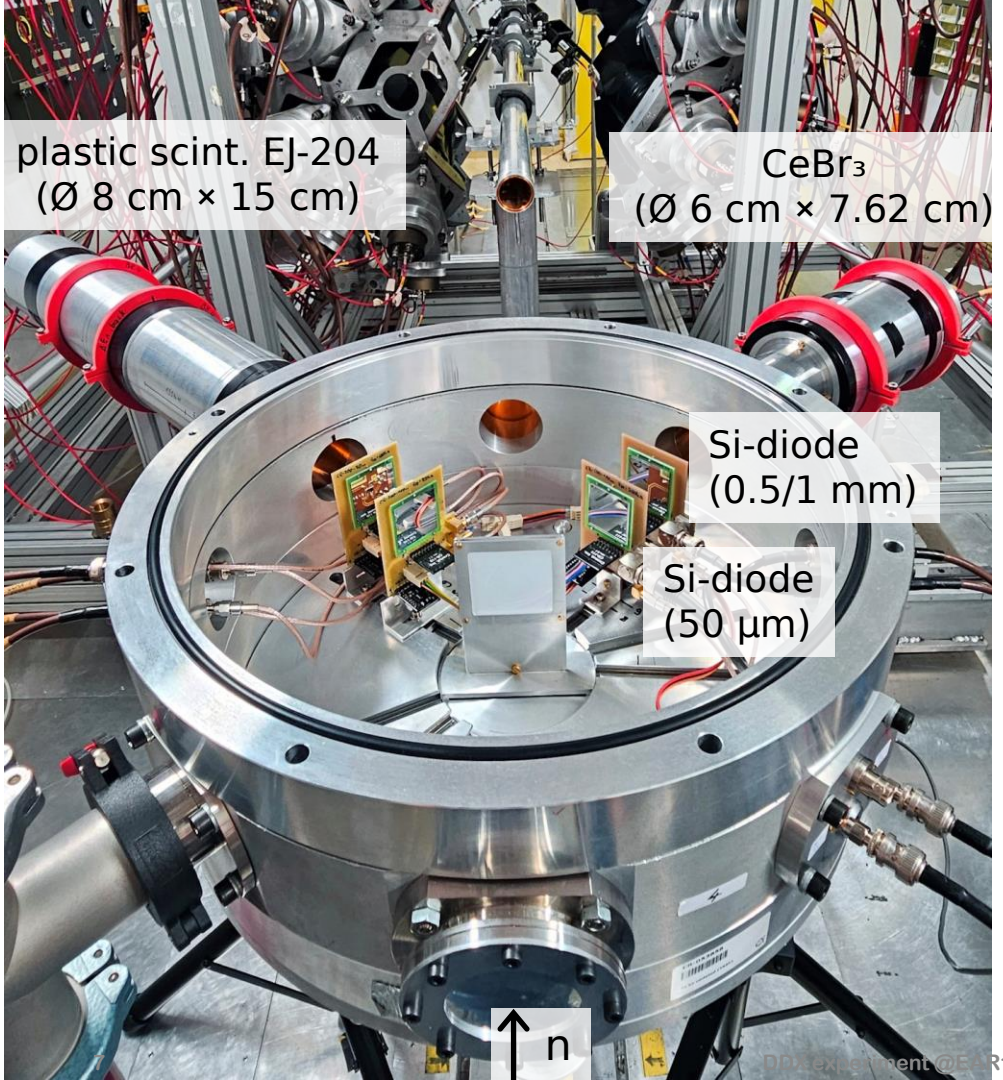
Test of September 2023

2 days beamtime, objectives:

- test new chamber + segmented Si-diode → did not work out (late deliveries) 😔
- collect statistics with preferred configuration: preamp and main amp inside the chamber (Cremat CR 110/111, CR 200-50ns/100ns)

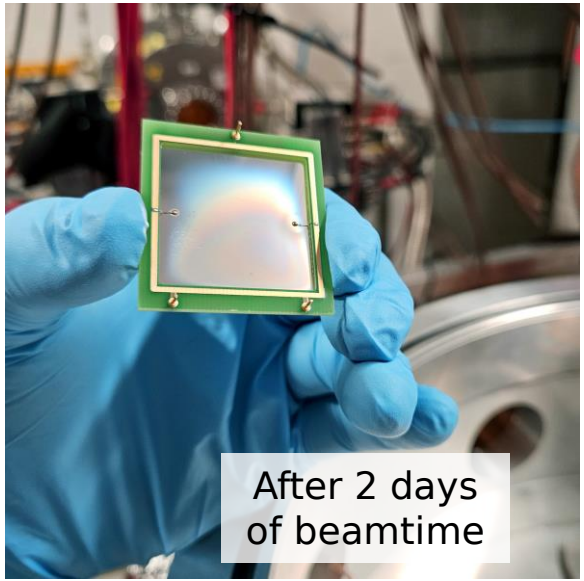



CR-200
(amp)
CR-111
(preamp)

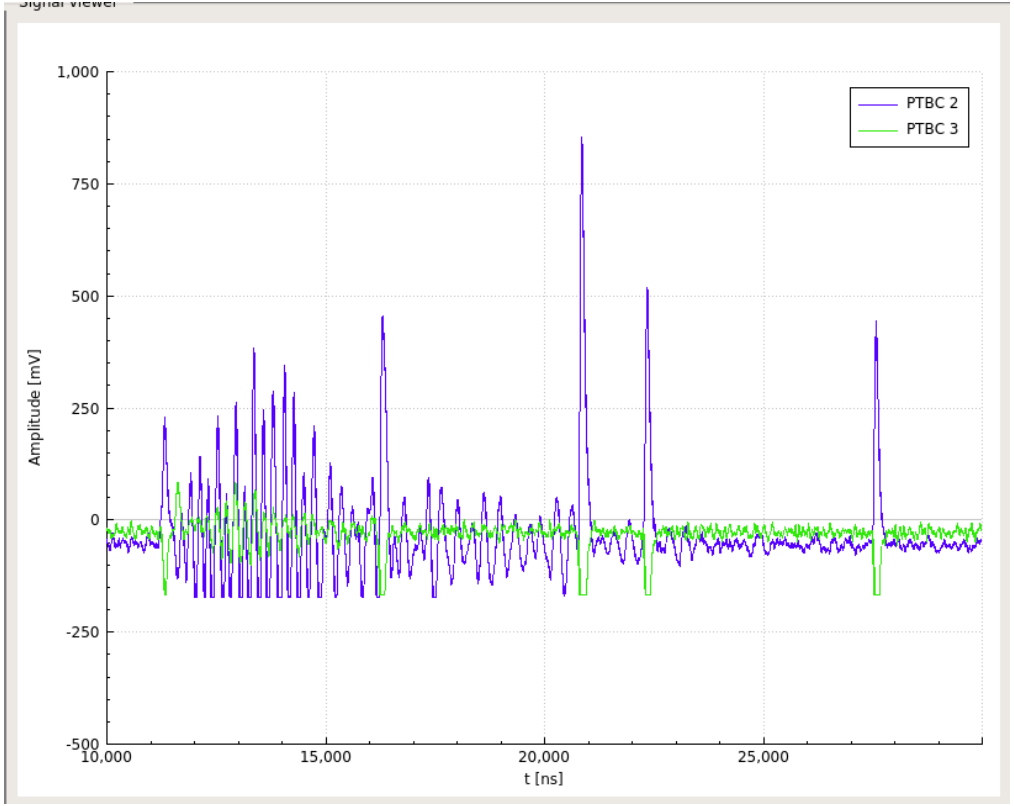

plastic scint. EJ-204
(Ø 8 cm × 15 cm)
CeBr3
(Ø 6 cm × 7.62 cm)
Si-diode
(0.5/1 mm)
Si-diode
(50 µm)
n

Hardware problems

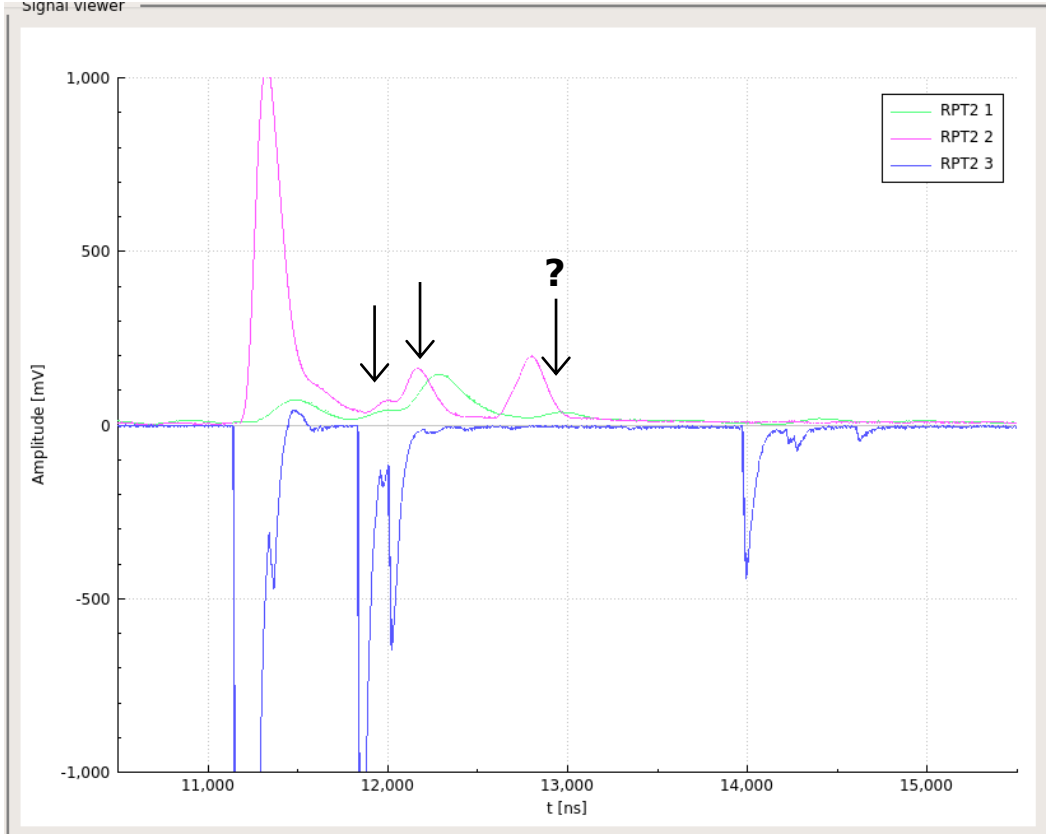
Deformed Si diode..?



PPFC: cross-talk between electrodes



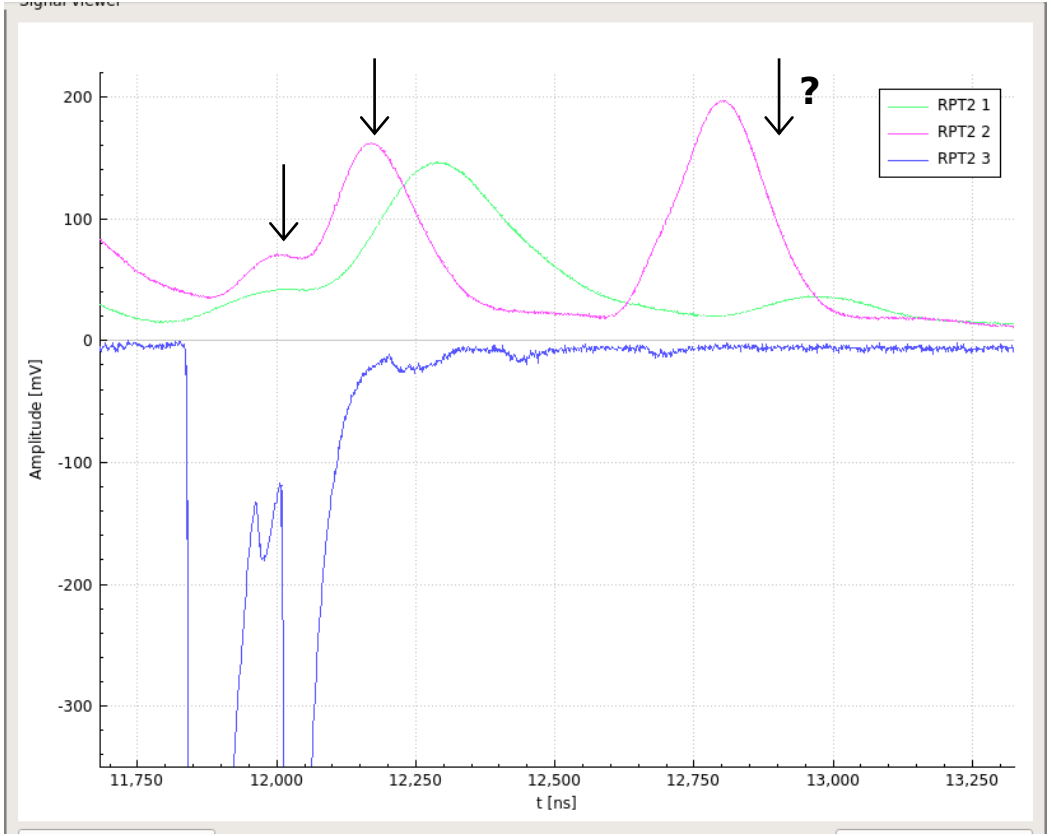
Waveforms – RPT2



DE1 49µm Si
DE2 1043µm Si
E 76.2mm $CeBr_3$

DE1 & DE2: CR111 preamp
→ lower gain

Waveforms – RPT2

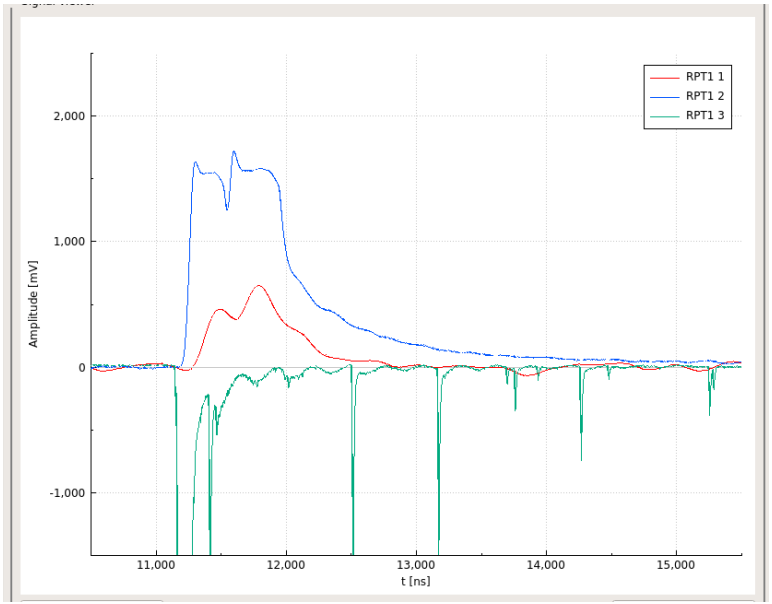


DE1 49µm Si
DE2 1043µm Si
E 76.2mm $CeBr_3$

DE1 & DE2: CR111 preamp
→ lower gain

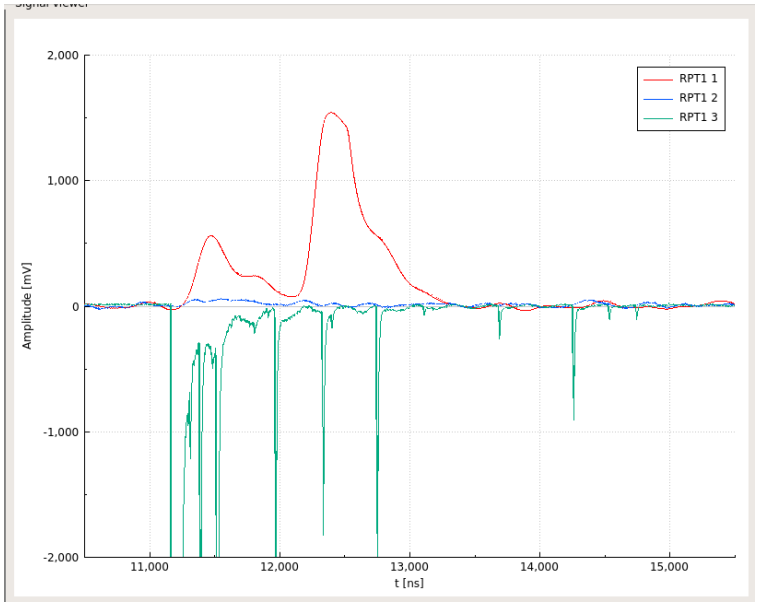
Tricky coincidence selection

Waveforms – RPT1



DE1 51µm Si
DE2 507µm Si
E 150mm Plastic

DE1 & DE2: CR110 preamp → higher gain
Saturation..? Or malfunction

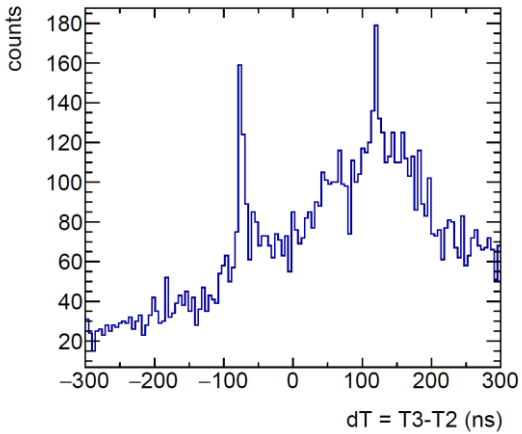


Coincidence filter

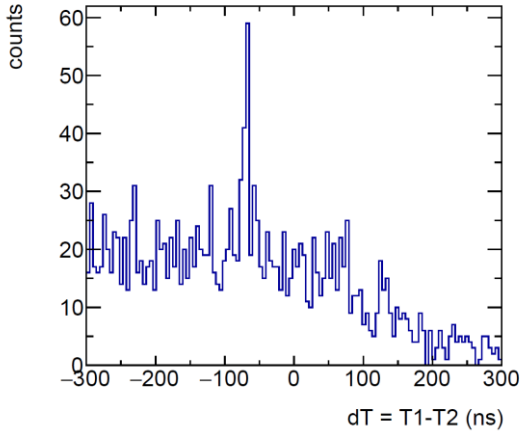
- Problem: slow detectors vs fast detector
- ➤ Optimization PSA / time resolution
- ➤ Coincidence selection based on fixed delay

Preliminary

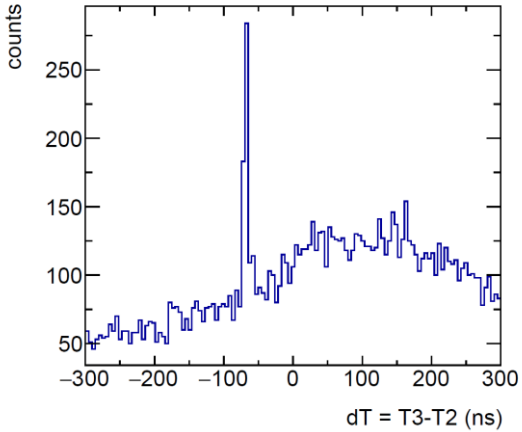
RPT2 : Plastic vs 500µm Si



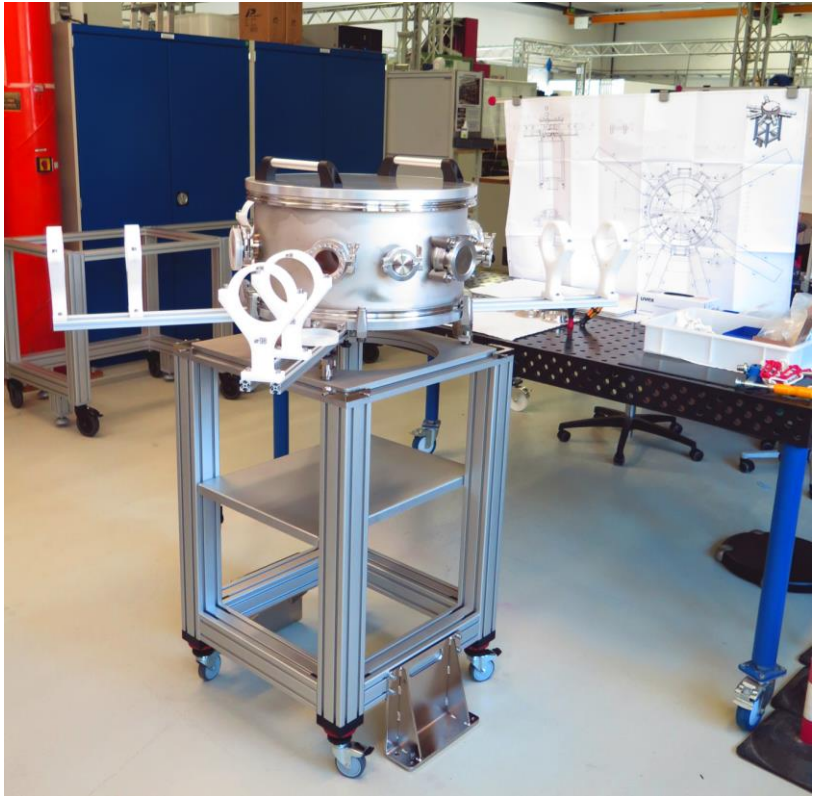
RPT1 : 50µm Si vs 1000µm Si

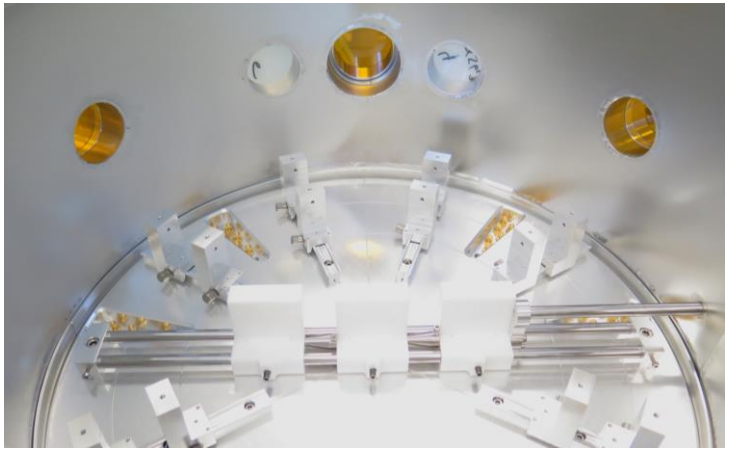


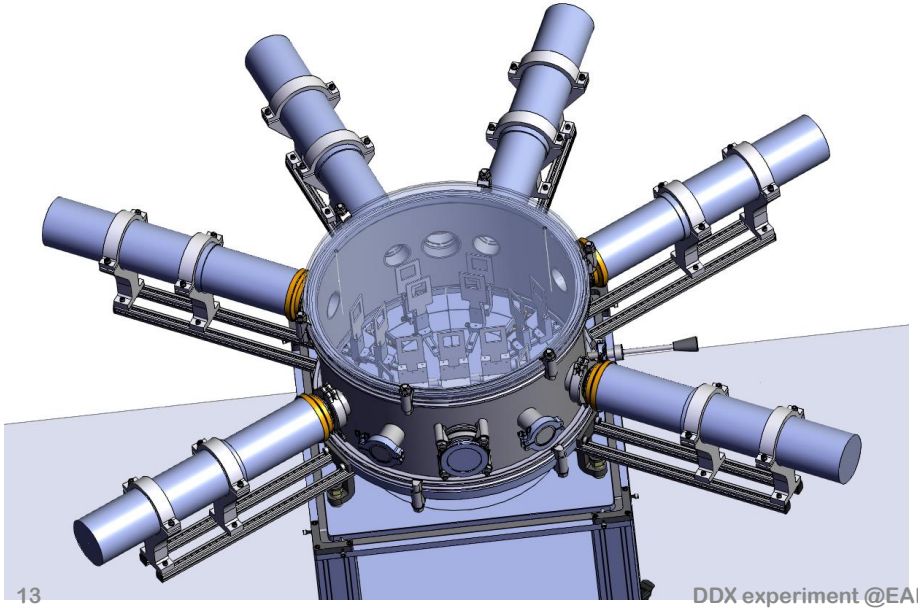
RPT1 : $CeBr_3$ vs 1000µm Si



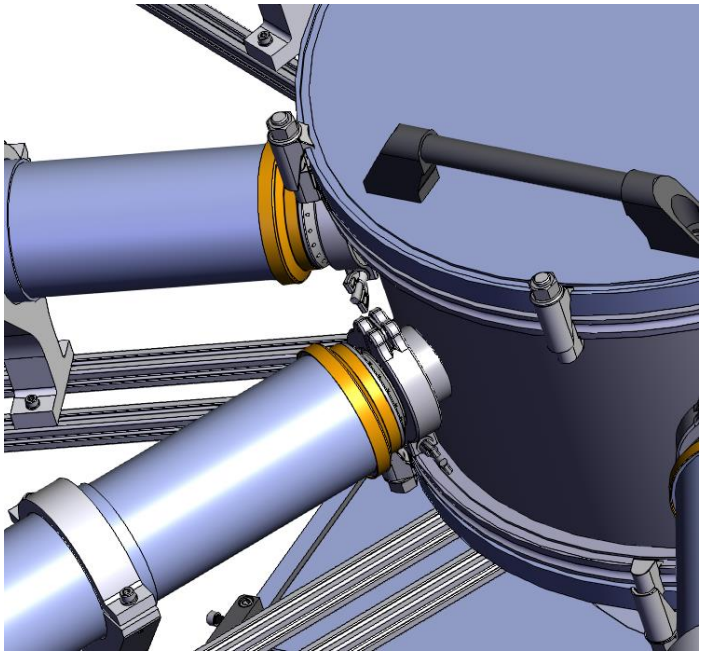
New DDX chamber

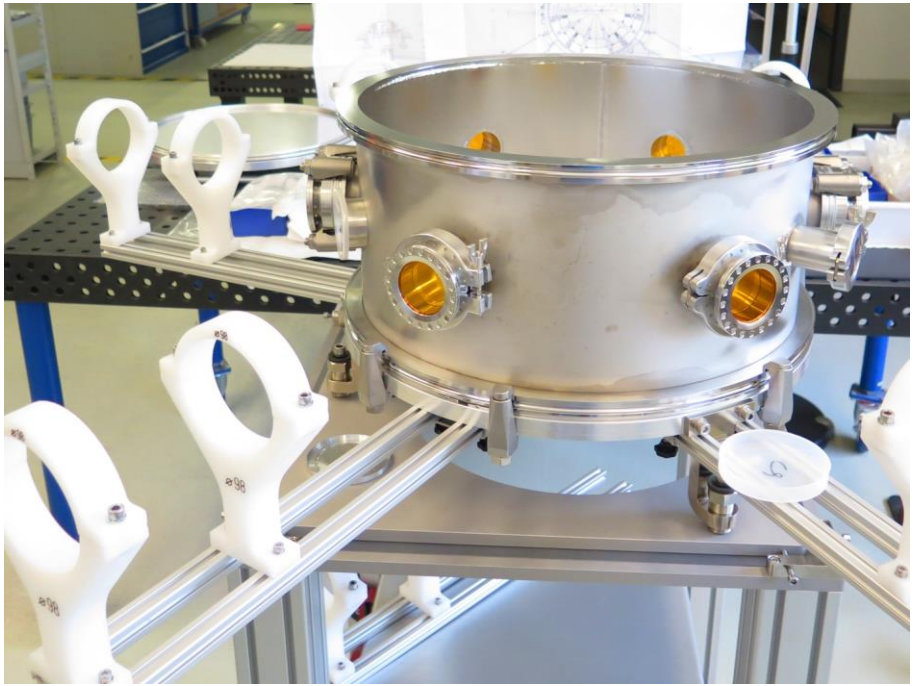


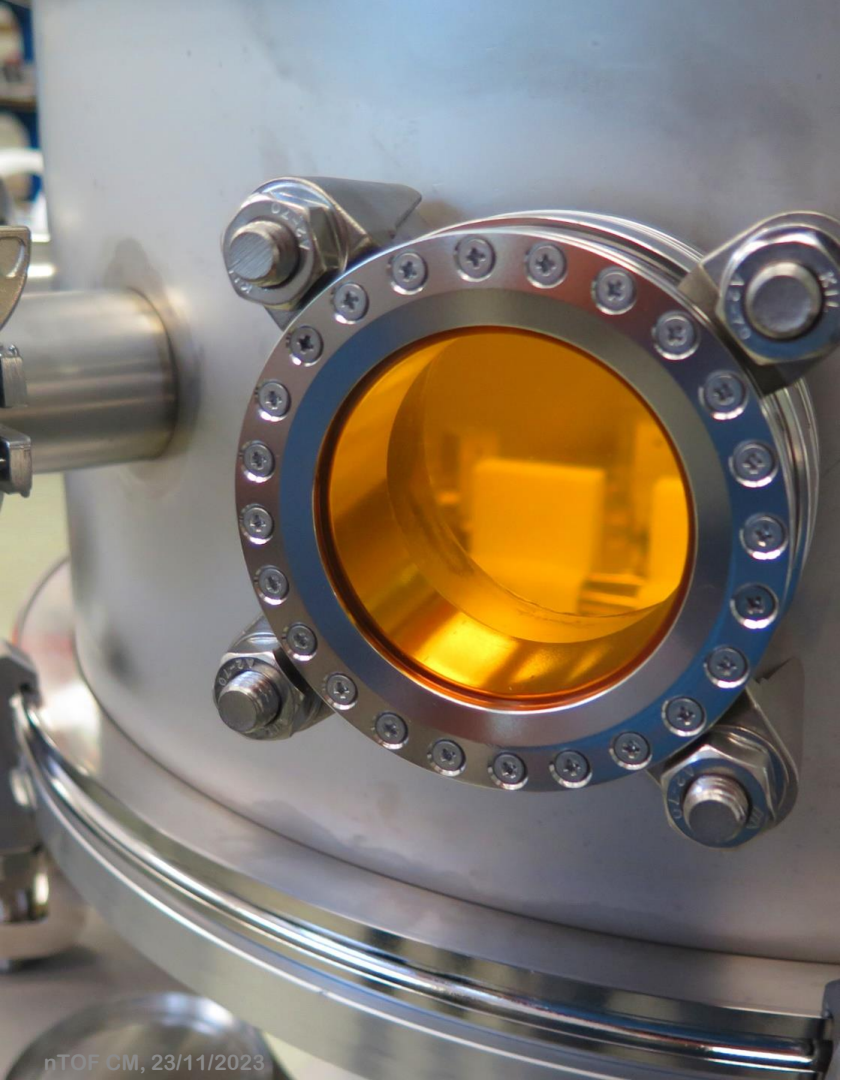




New DDX chamber



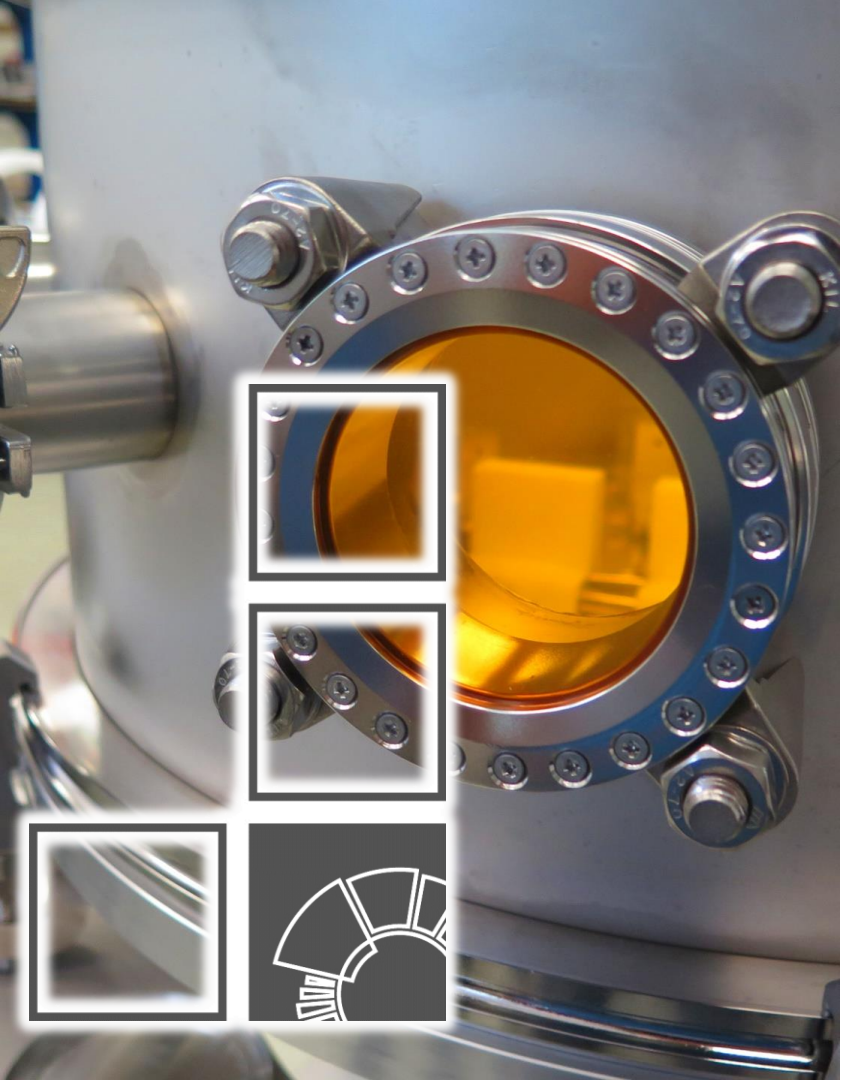




Outlook

- Deep dive on the data analysis
- Lab test of segmented Si detector
- Tests on heat dissipation of electronics
- Characterization of E-detectors (light collection)
- Alternatives to Cremat preamplifiers…?
- Plastic scintillators with light guides..?

➤ Beamtime in October 2024!



Thank you!