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

HORIZON2020

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nTOF

# D2.10

# Report on the measurement of double-differential charged-particle emission cross sections at the CERN n_TOF facility in the neutron energy range from 20 MeV to 200 MeV

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# DDX experiment at CERN n_TOF

**Objective:** proof of principle experiment, measurement above 100 MeV of double differential cross section of (n,cp) reactions at CERN n_TOF

➤ **Task 1.4**: Detectors for non-energy application

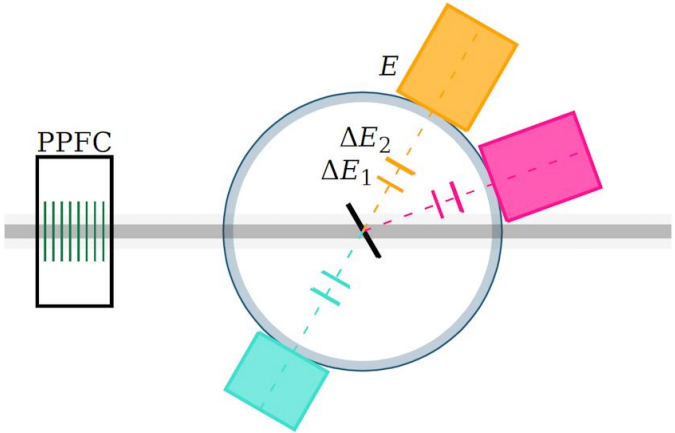
- D1.8: submitted 28-Feb-2022 (M24+6)
- Development of charged particle telescope for measurements at n_TOF with high energy neutrons

➤ **Subtask 2.6.2**: Measurement of cross sections relevant for hadron therapy

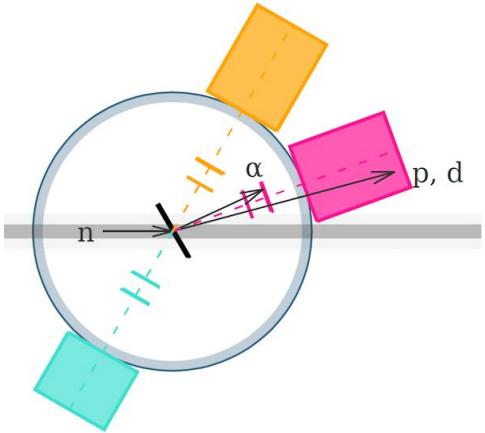
- D2.10: deadline 30-Apr-2024 (M48+8)
- Construction of dedicated setup and measurement of the double differential cross section of C(n,cp) between 20 and 200 MeV

# Proposed experimental setup

- Vacuum chamber with 3× particle telescopes at 20°, 60°, 120°
- Δ*E*-*E*-*E* technique for particle identification
  Transmission detectors: Si-diodes
  Stop detectors: plastic and $CeBr_3$ scintillators
- FC ($^{235}U$) as neutron monitor

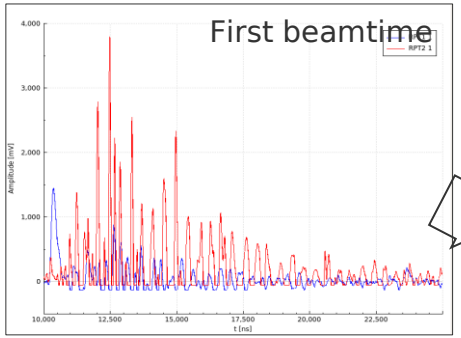


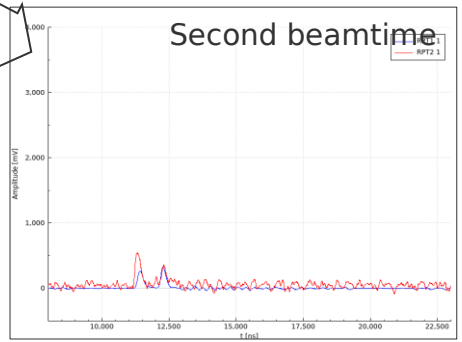

- n_TOF: only neutron source in Europe with $E_n$ >100 MeV
- In-beam tests are necessary for all new detectors; main concern: response to gamma-flash?
- FC was already used at n_TOF, but not the telescopes (task 1.4)
- Vacuum chamber had to be built from scratch (task 2.6.2)



# Result of detector tests

- No in-beam tests were possible until 2022
- D1.8 (Feb-2022) based on lab results + MC calculations

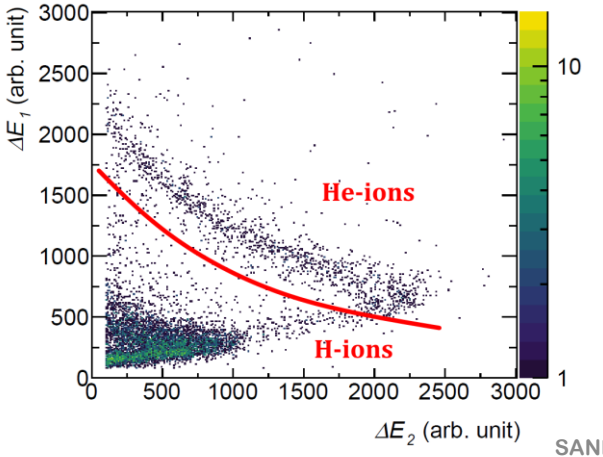



- Detector tests at n_TOF: May 2022, November 2022, using an old chamber for monoenergetic beams
- Gamma flash does not saturate the detectors, main problem: RF noise
- Solutions: improved grounding, cabling and shielding

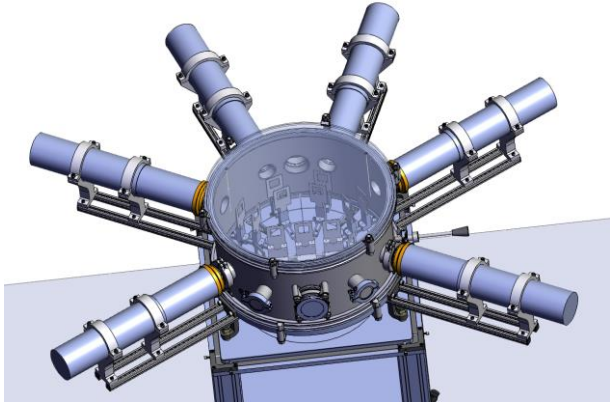
Results for D2.10:

- Separation of H/He ions is possible up ~200 MeV
- Determination of requirements for mechanical construction (e.g. RF tight vacuum chamber) and read-out chain (required energy resolution)



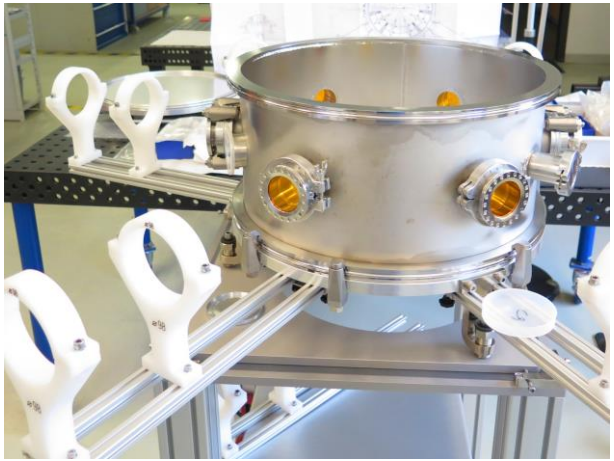
# Progress on C(n,cp) measurement

- Jan-2023: started design/construction of dedicated vacuum chamber at PTB, estimated ~8 months
- Feb-2023: successful INTC proposal, ~30 days of beamtime ($3\times10^{18}$ pot)
- Sep-2023: planned date for C(n,cp) measurement



However:

- Vacuum chamber delayed to December 2023
- Delays also in other preparations (e.g. optimization of read-out) due to end of postdoc contract
- Additional delay: 6 months at least



# Progress on C(n,cp) measurement

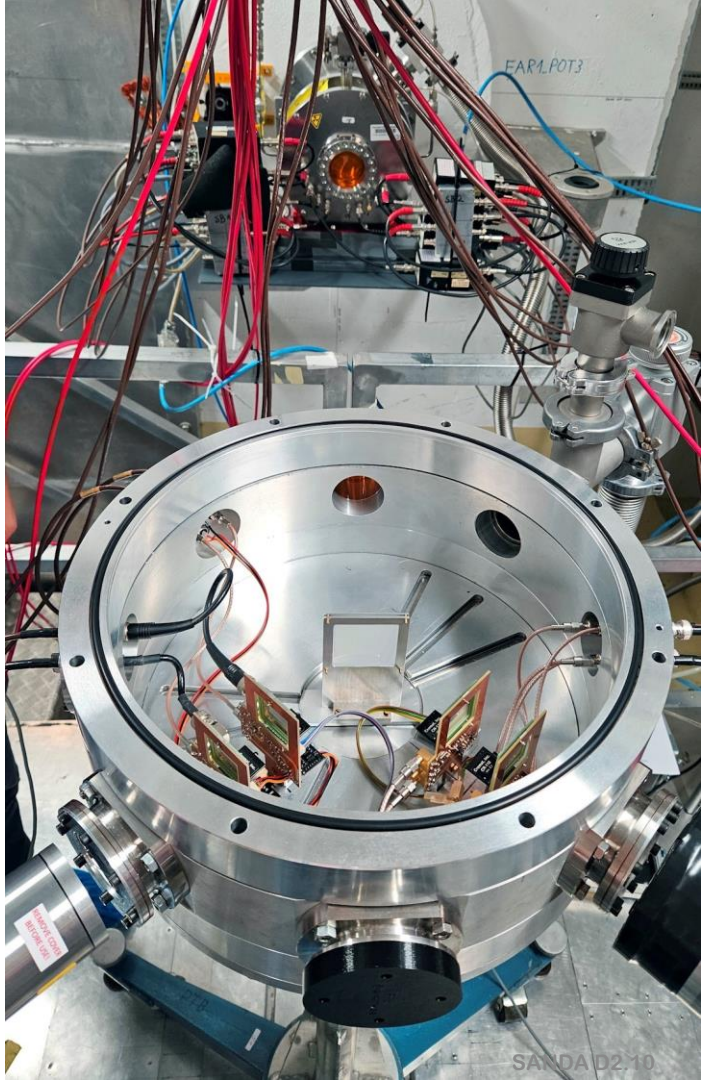
- Original plan (Sep-2023) not feasible
- New date: start date of new postdoc contract (~spring) + some months to get acquainted with the project
- Beamtime moved to Sep-2024

Mitigation:

- Beamtime in Sep-2023 was shorted but not cancelled
- Run with graphite target, new electronics and old vacuum chamber

Expected results for D2.10:

- Test of current choice of read-out electronics / final tech. specification of detector setup
- Possibly: first estimate of achievable energy ranges



# Timeline

| | Planned | Actual |
|---|---|---|
| **Detector development** | | |
| • Lab tests | 2020 | 2021 |
| • In-beam tests at n_TOF | 2021-2022 | May 2022, Nov 2022 |
| **DDX measurement** | | |
| • Construction final setup | 2022-2023 | Mar-Apr 2024: final design<br>Jul 2024: construction ready |
| • Final beamtime | 2023 | Sep 2023: short carbon run<br>Sep-Oct 2024: final carbon run |
| | | |
| **Deliverables** | | |
| → D1.8 | Aug 2021 (M24) | Feb 2022 (M30) |
| → D2.10 | Aug 2023 (M48) | Apr 2024 (M56): on time |

# Summary

## Available

- Detectors (Si-diodes, scintillators, FC)
- Vacuum chamber is ready but empty
- Part of the read-out electronics
- Data from 3× test beamtimes

## Missing

- Part of the electronics
- Human resources (slow preparations)

## Ongoing actions

- Assembly of the DDX chamber / final tests
- Analysis of test measurement of Sep-2023
- New postdoc contract will start in spring

## For the deliverable

- By M56: finished detector design / by M60: finished construction
- Report on detector setup: technical description, commissioning, MC simulations
- Report on test beamtimes: proof of feasibility + first results on carbon
- Successful application for beamtime, fixed date for final measurement