Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Nationales Metrologieinstitut

nTOF

Recoil Test: Results with PRT-PTB

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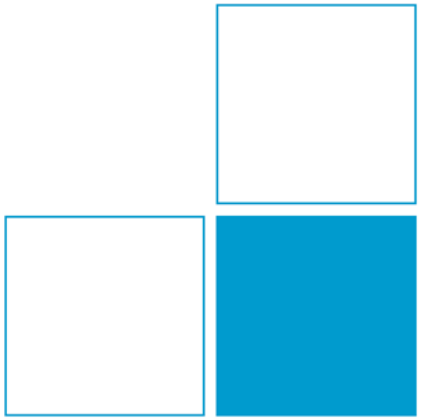
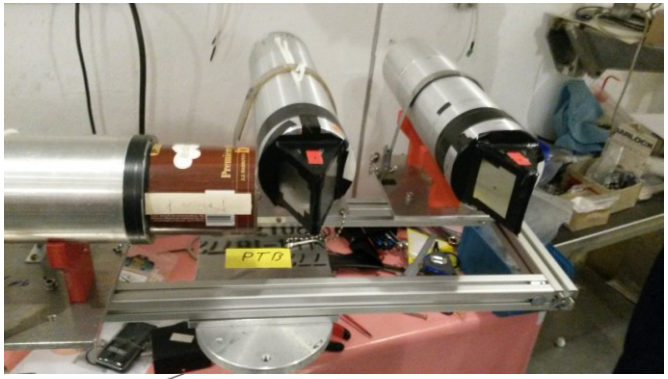


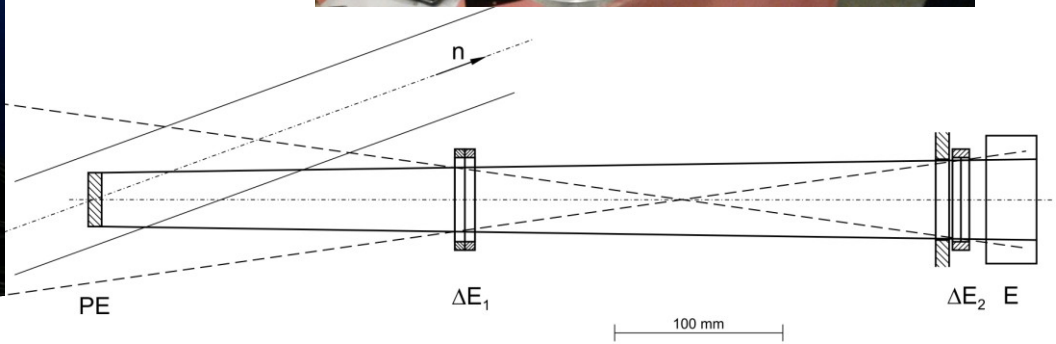
Goals of the Recoil Test (for PTB!)

First n_TOF beam time for the PTB team:

- Understand the procedures for data taking and analysis at n_TOF
- Get a 'feeling' for the background
- Test various detectors in a flexible set up

⇒… Lots of equipment!

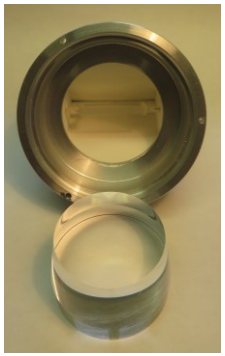


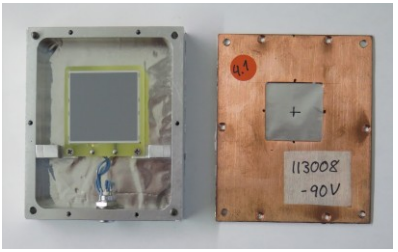


Detectors

ΔE detectors

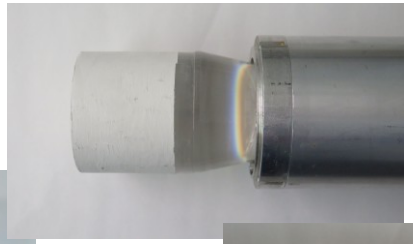
- 2 mm, 5 mm EJ228 (40 mm x 40 mm)
- 500 µm Si PIPS (30 mm x 30 mm)

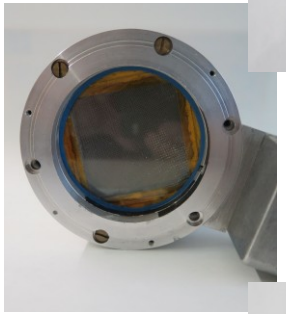




E detectors

- 40 mm NE102 (∅50 mm) E_p < 70 MeV
- 80 mm EJ204 (∅ 80 mm) E_p < 103 MeV
- 76 mm $LaBr_3$(Ce) (∅ 76 mm) E_p < 182 MeV



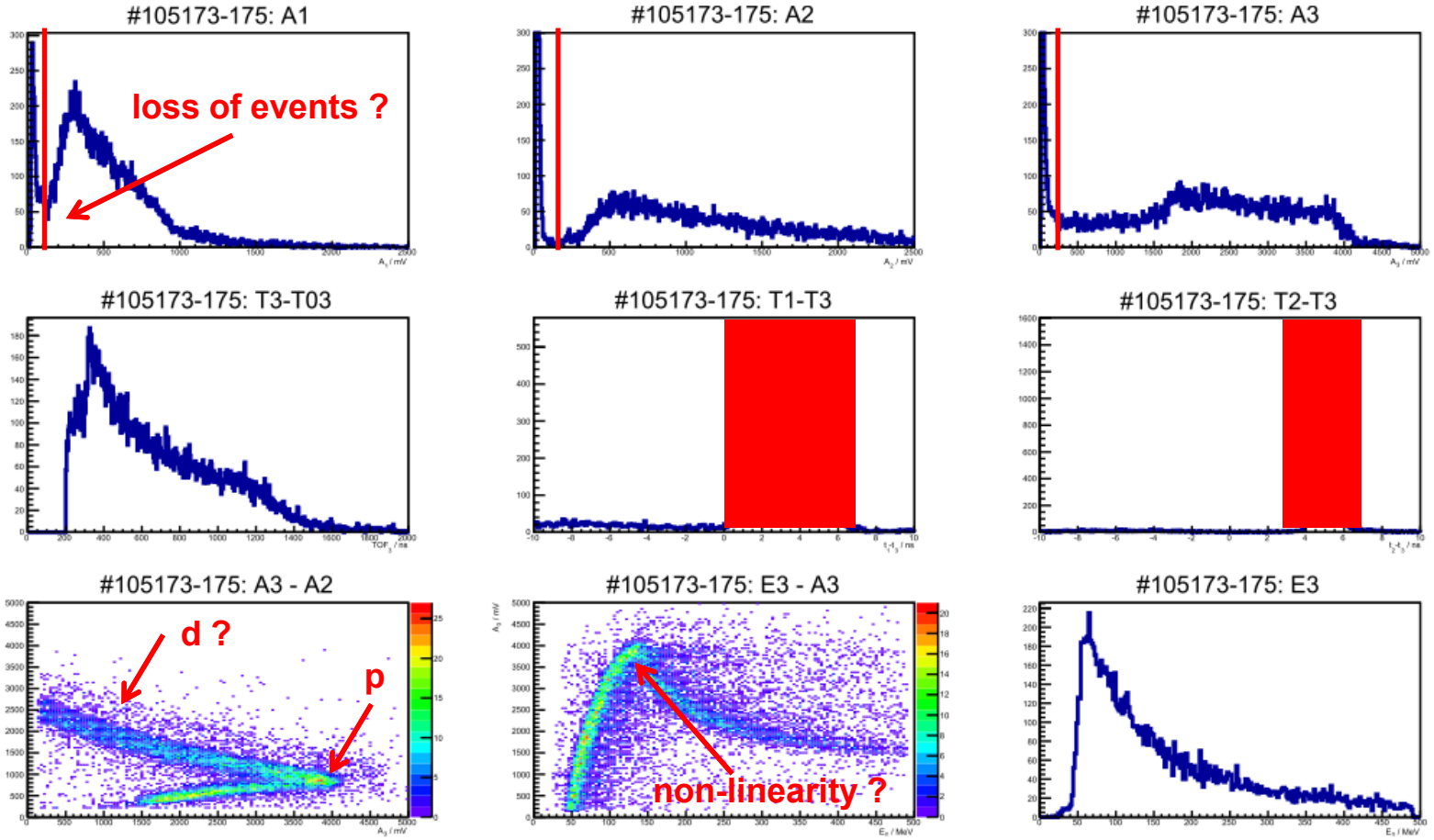


PMTs

- XP2020Q: EJ228
- XP2020: NE102, EJ204
- $LaBr_3$: R11937
- PLANACON MCP-PMT with ext. grid: EJ204

ΔE_1-ΔE_2-E: 2 mm, 5 mm EJ228, 80 mm EJ204

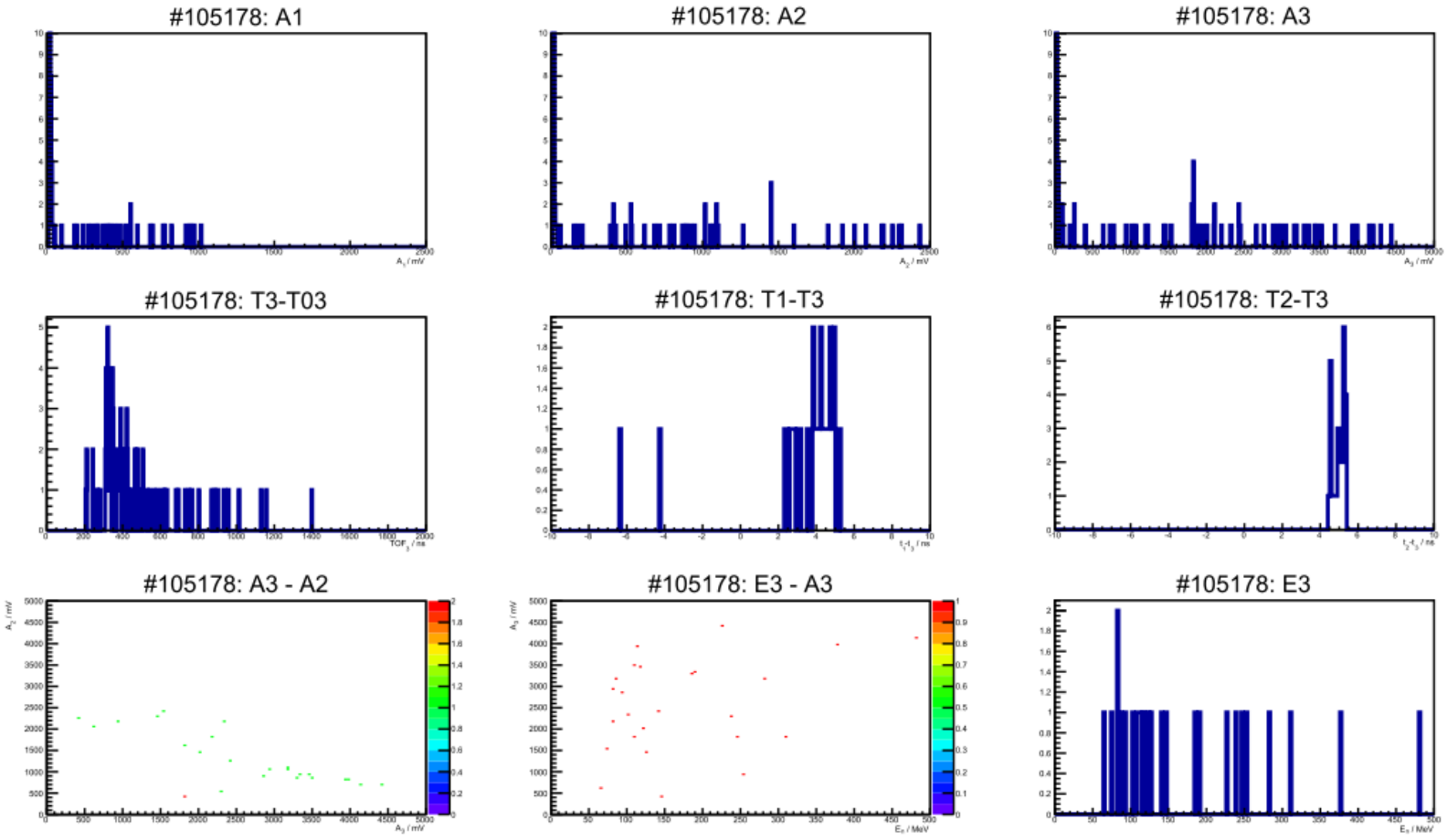
Angle: ≈ 23°, Radiator : 10 mm PE, Protons: 4.51×10^{16} (9.6 h)



- **Particle separation still incomplete**
- **Saturation effects in *E*-detector above $E_n \approx 80$ MeV ?**

ΔE_1-ΔE_2-E: 2 mm, 5 mm EJ228, 80 mm EJ204

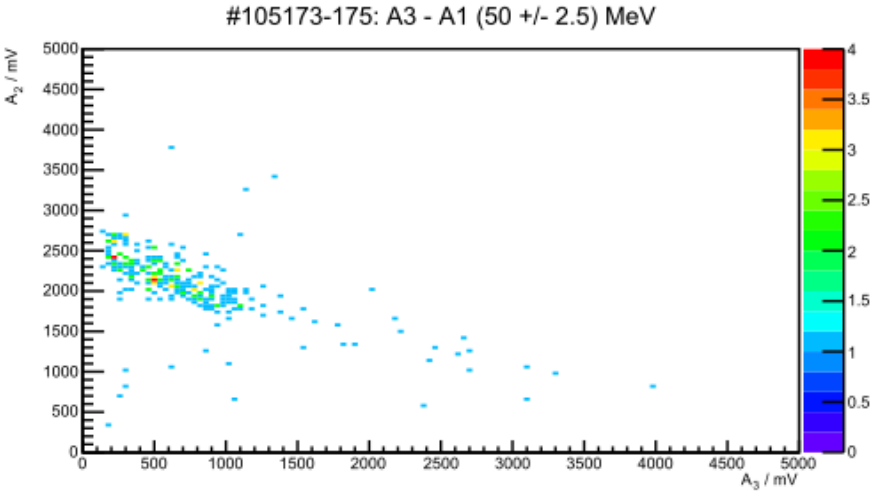
Angle: ≈23°, Radiator : empty, Protons: 9.81×10^{15} (22 % of foreground)

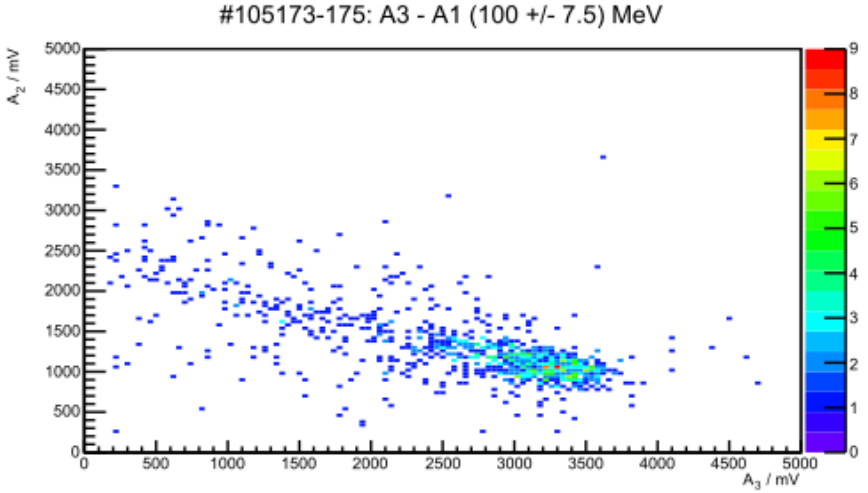


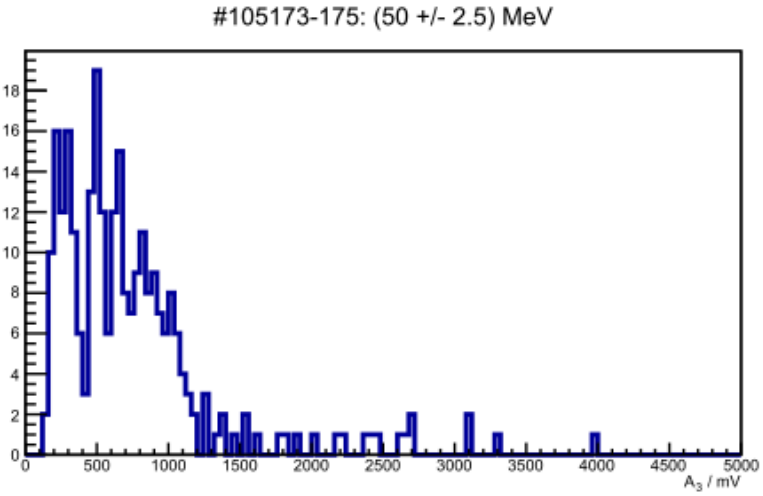
- **background suppression satisfactory: $N_{BG}/N_{FG} \approx 1$ % for 10 mm PE**

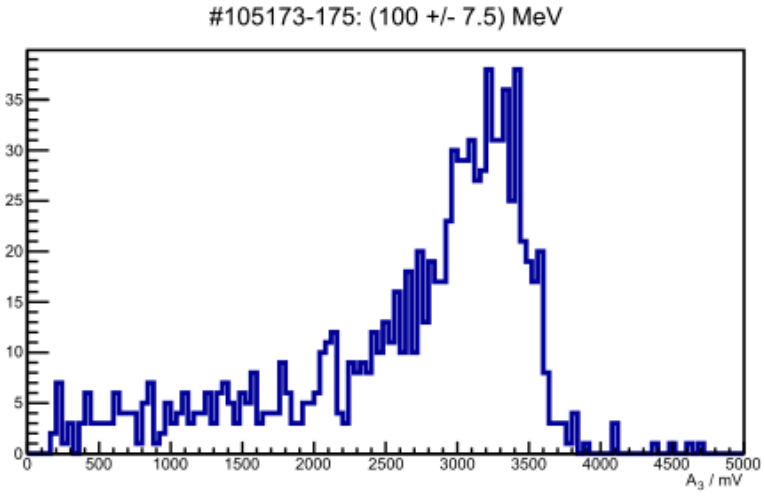
ΔE_1-ΔE_2-E: 2 mm, 5 mm EJ228, 80 mm EJ204

Radiator: 10 mm PE



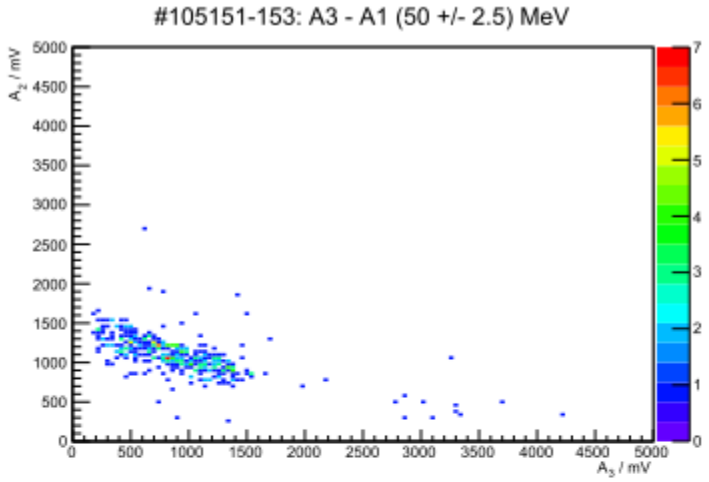


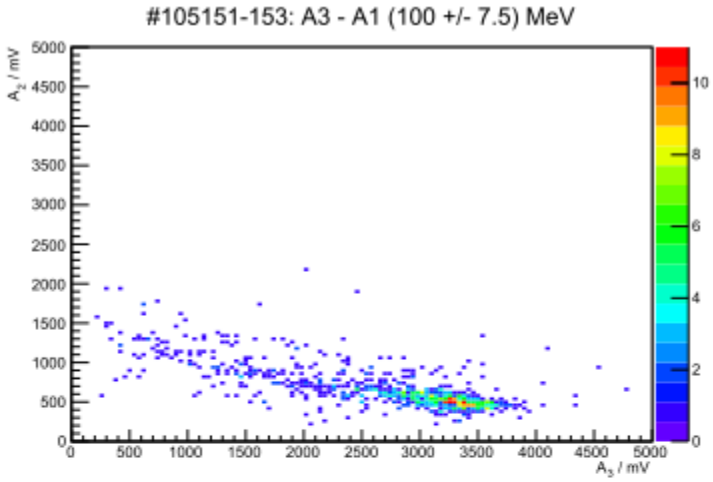


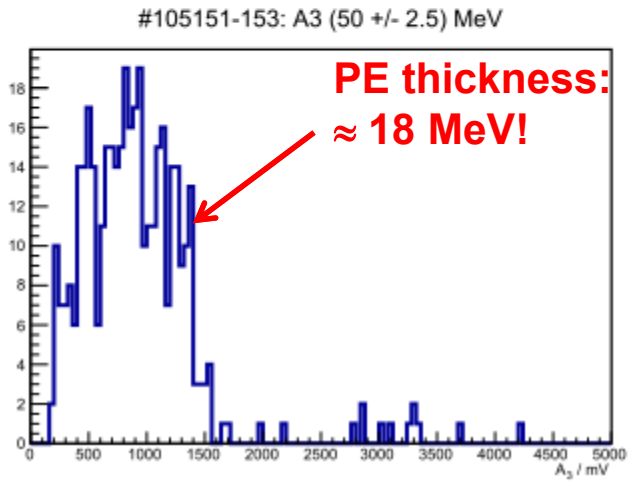


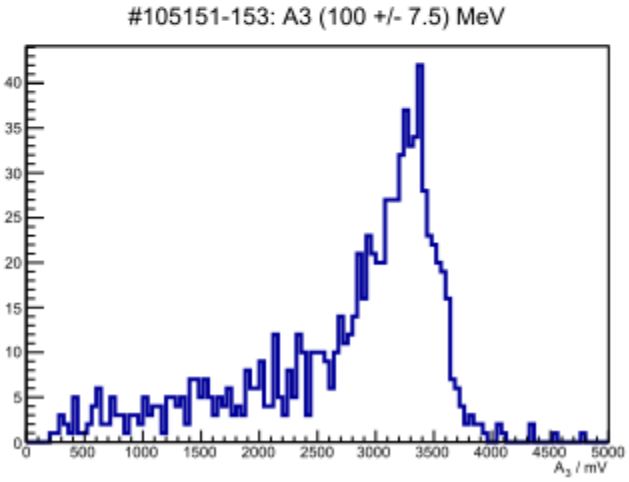
ΔE_1-ΔE_2-E: 2 mm, 2 mm EJ228, 80 mm EJ204

Radiator : 10 mm PE, red. thickness of the ΔE_2 detector



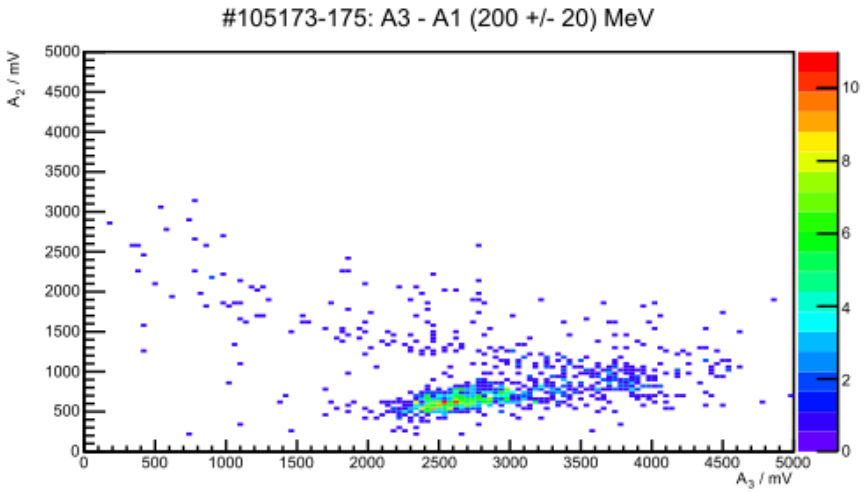


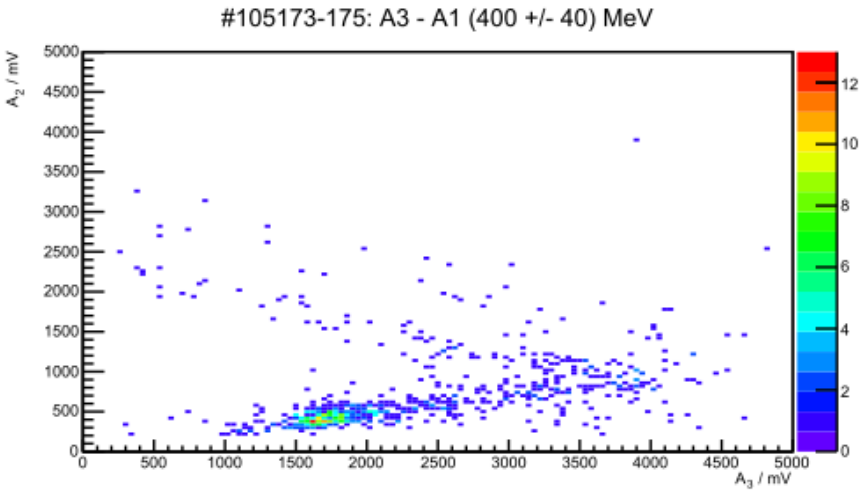


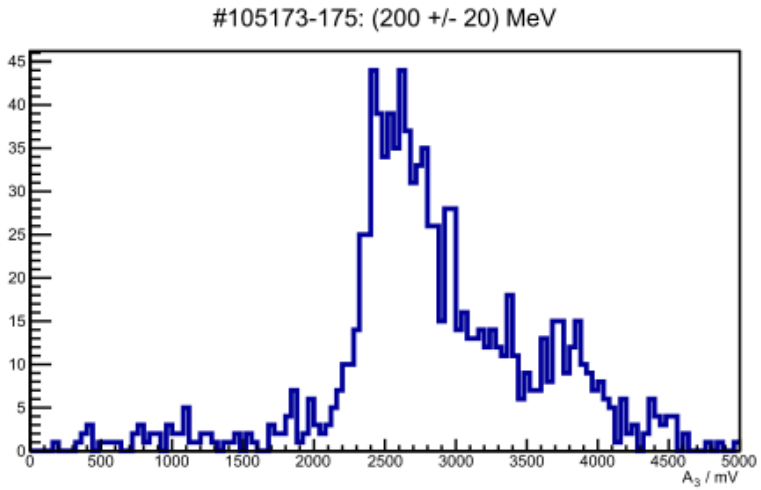


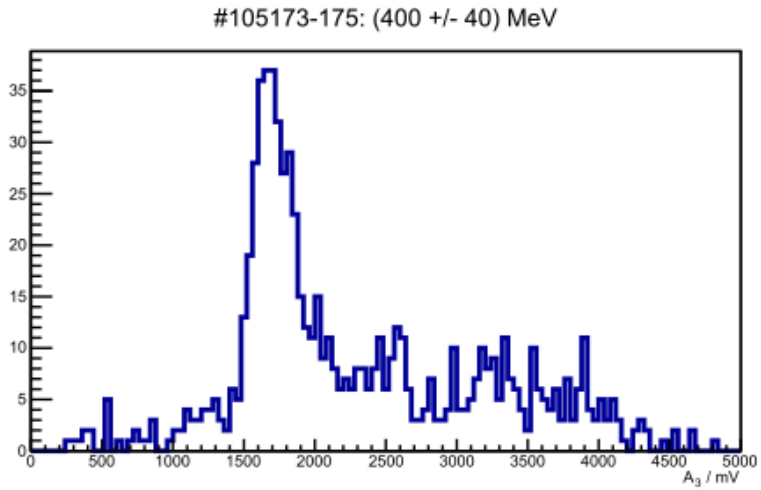
ΔE_1-ΔE_2-E: 2 mm, 5 mm EJ228, 80 mm EJ204

Radiator: 10 mm PE



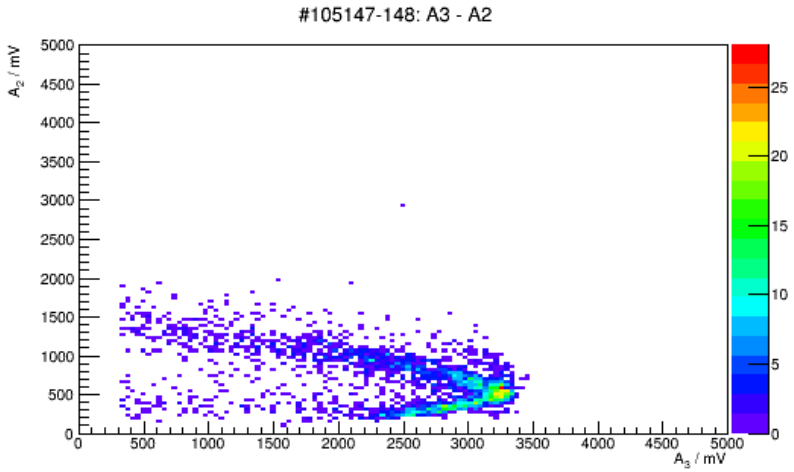


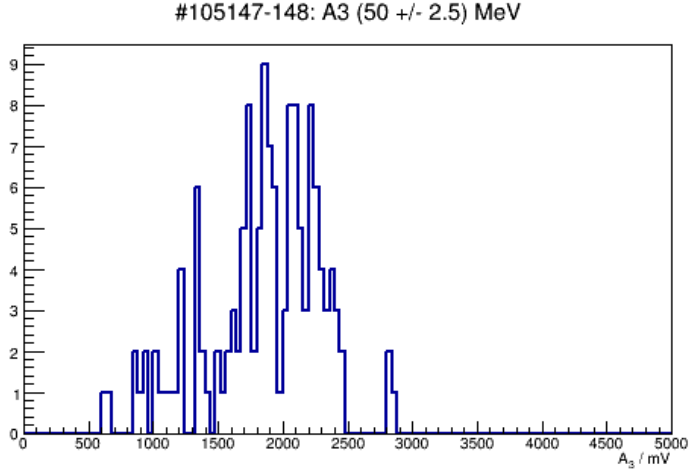


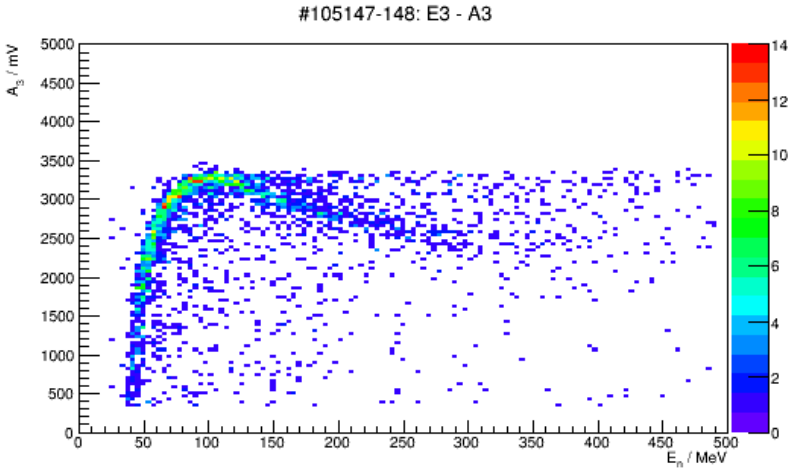


ΔE_1-ΔE_2-E: 2 mm, 2 mm EJ228, 40 mm NE102

Angle: ≈ 23°, Radiator : 4 mm PE, Protons: 4.51×10^{16}

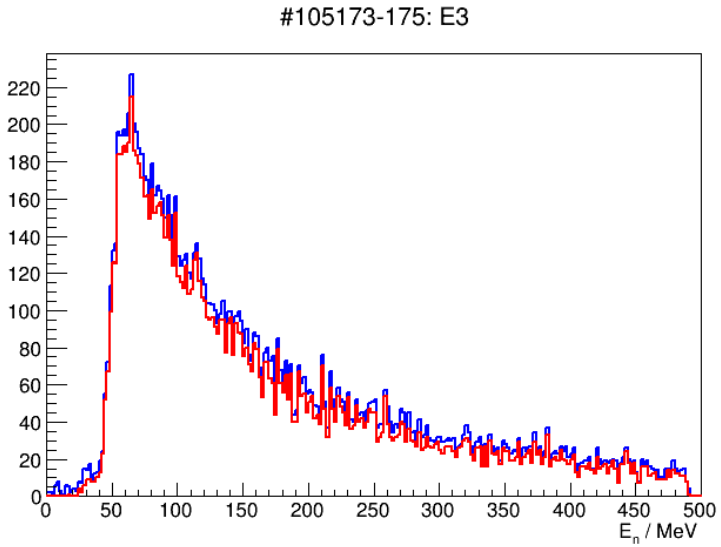


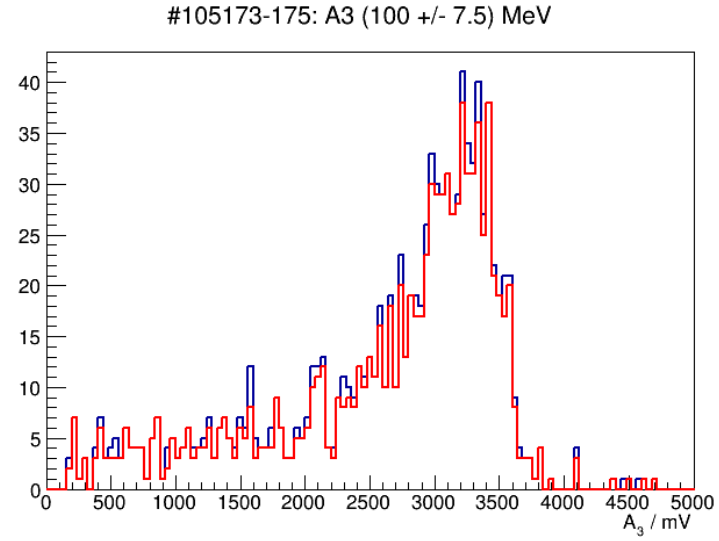




- E_n = 50 MeV possible with this design
- Less massive RPT for lower energies:
  - 300 µm Si Diodes as ΔE detectors

ΔE_1-ΔE_2-E: 2 mm, 5 mm EJ228, 80 mm EJ204





Coin. pattern: 1-2-3: 12229 events

2-3: 13518 events

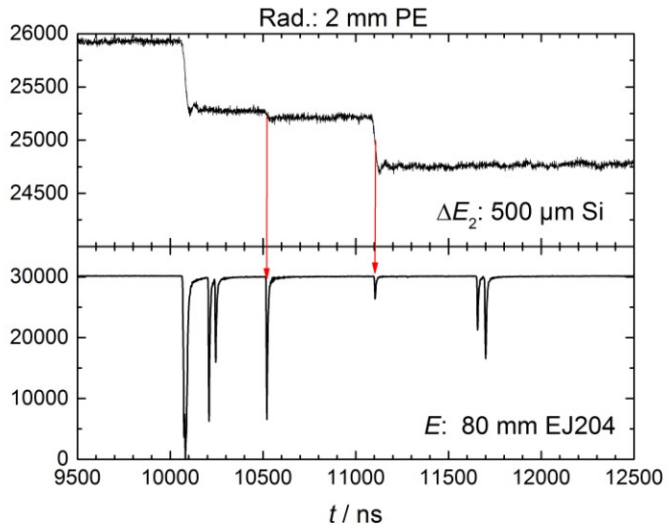
Relative diff.: ≈ 10 %

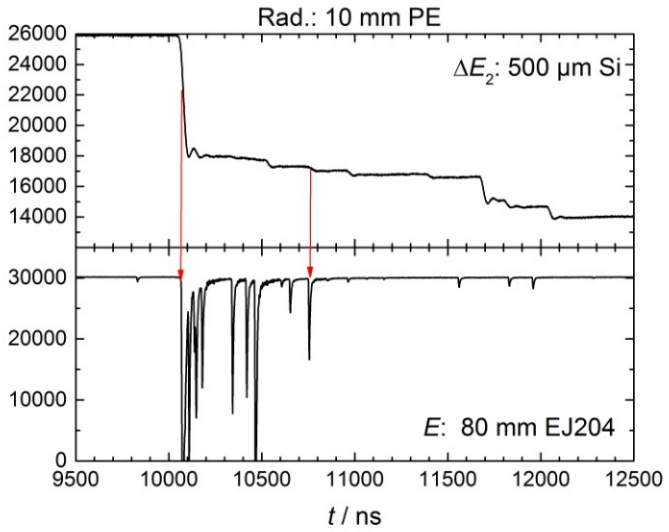
⇒ Triple-coincidence RPT necessary!

Summary for this configuration:

- **Neutron energy range: 40 MeV – 100 MeV**
- **Optimization required:**
  - **Particle separation**
  - **Linearity of the light output**
- **Comparison with MC simulations still to come**

ΔE_1-ΔE_2-E: 2 mm EJ228, 500 µm Si, 80 mm EJ204



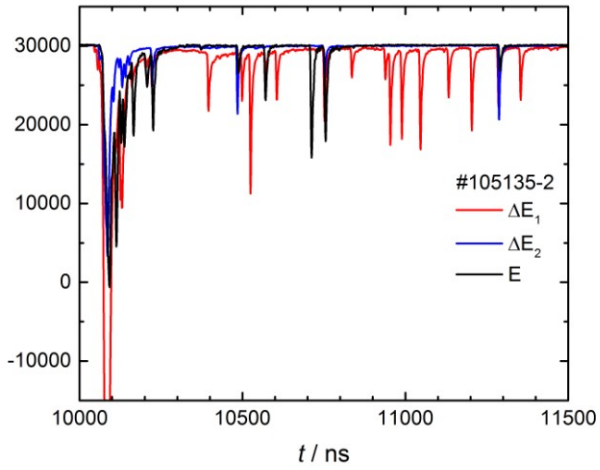


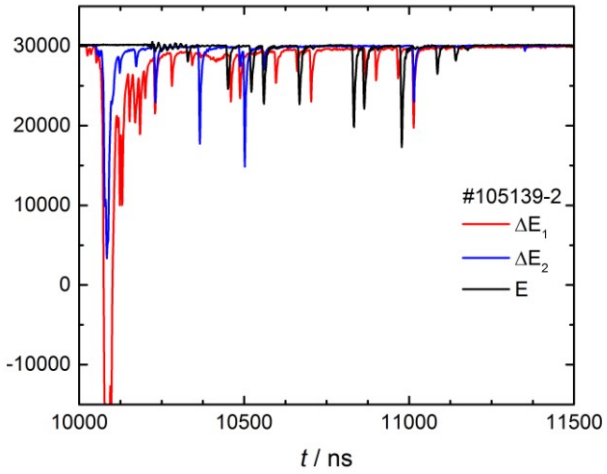
Use of Canberra RF 30 x 30 500 µm PIPS diodes investigated:

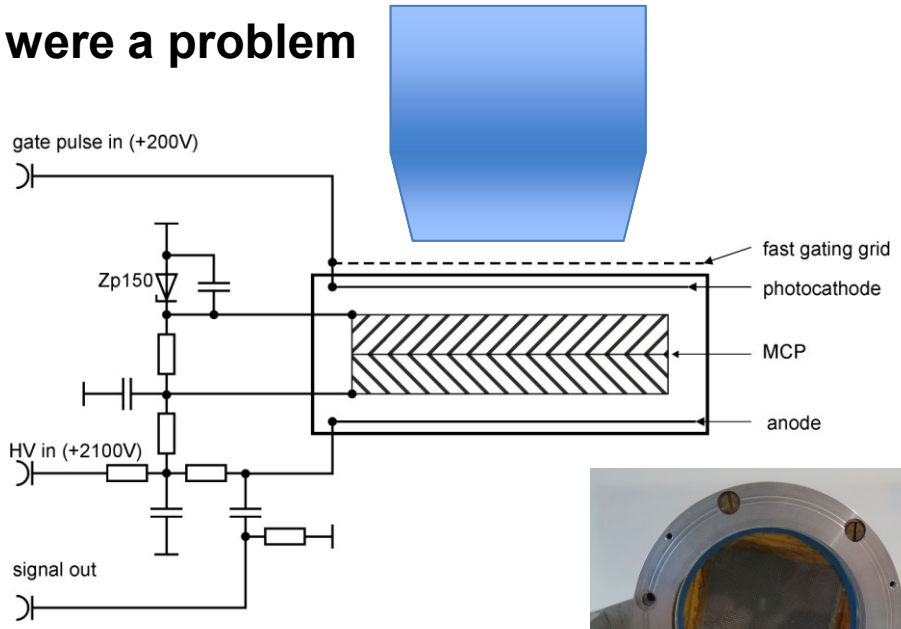
- **Fast preamps were unstable**
  - **Small signals too close to noise**
  - **Ringing induced by γ-flash**
- **Standard Canberra 2006 charge integration preamps work:**
  - **Even with thick radiators and close to radiator**
  - **Suitable analysis available in the SignalAnalyser?**

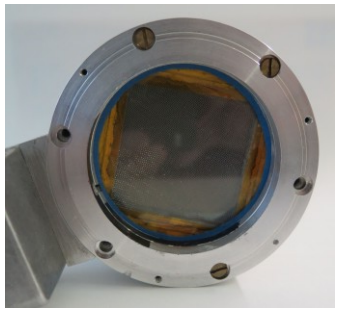
Gated PLANACON MCP PMT

… if the γ-flash were a problem









- **Gate-on period ≤ 2 µs**
- **Only small switching spikes!**

⇒ **Use of high-*Z* scintillators close to γ-flash**

- **$LaBr_3$(Ce)**
- **BaF_2 (with edge filter?)**

Conclusions

- **Recoil proton measurements at n_TOF are possible**
- **The present ΔE_1-ΔE_2-E RPT design can be used from about 40 MeV to 100 MeV (after optimization!)**
- **Extendable to 200 MeV using larger stop detectors (plastic or inorganic scintillators) and degraders**
- **A design for the energy range 20 MeV to 50 MeV has still to be developed**

$\Rightarrow$ It is time to think about the fission arm: ^{235}U(n,f) / np

Thank you for your attention and for all the support for the novices!

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