

Studies of Wide SciRods

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- **Setups for Time Resolution Measurements**
- **Results with ^{90}Sr source**
- **Effects of wrapping the scintillator**





Motivation and outline for Wide “SciRods”

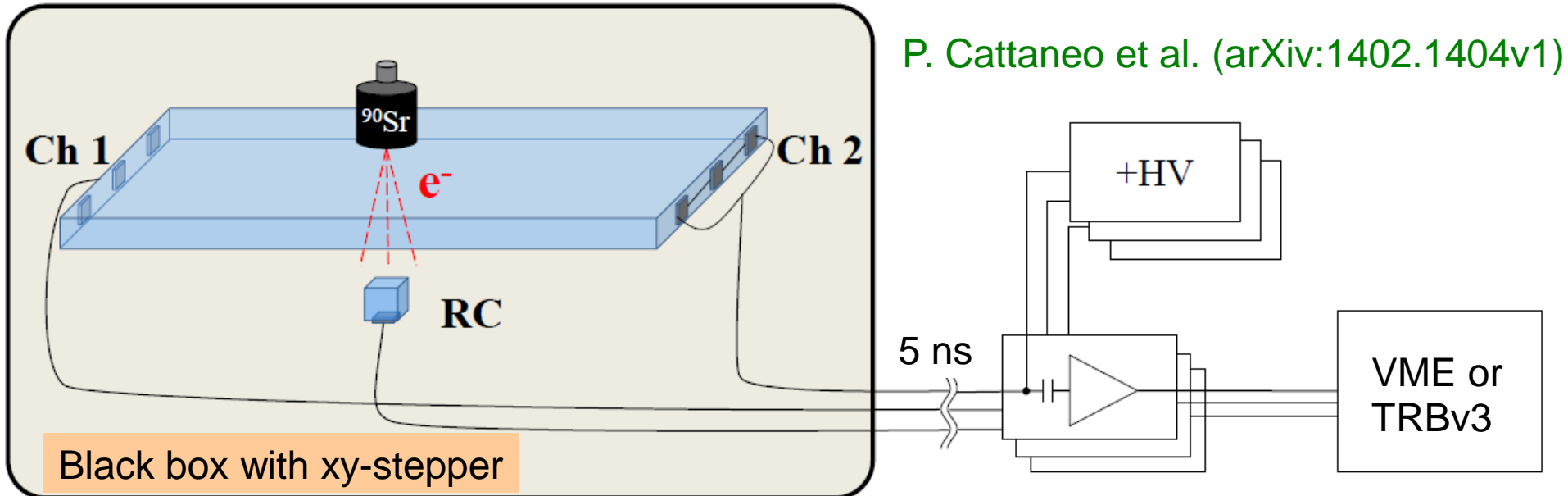
- Wide SciRods read out with $3 \times 3 \text{ mm}^2$ MPPCs
 - 4 MPPCs connected in series at each side
 - Fewer “dead” regions (between scintillators) than with narrow SciRods
 - $120 \times 30 \times 5 \text{ mm}^3$; $50 \times 30 \times 5 \text{ mm}^3$; $30 \times 30 \times 5 \text{ mm}^3$
 - Homogenous time resolution
- Comparison between BC420 and BC408
- Scintillator treatment
- Effects of wrapping the scintillator
- Effects of different Voltages and thresholds



Measurement Setup

Source: 1 mCi ^{90}Sr with 1 mm aperture

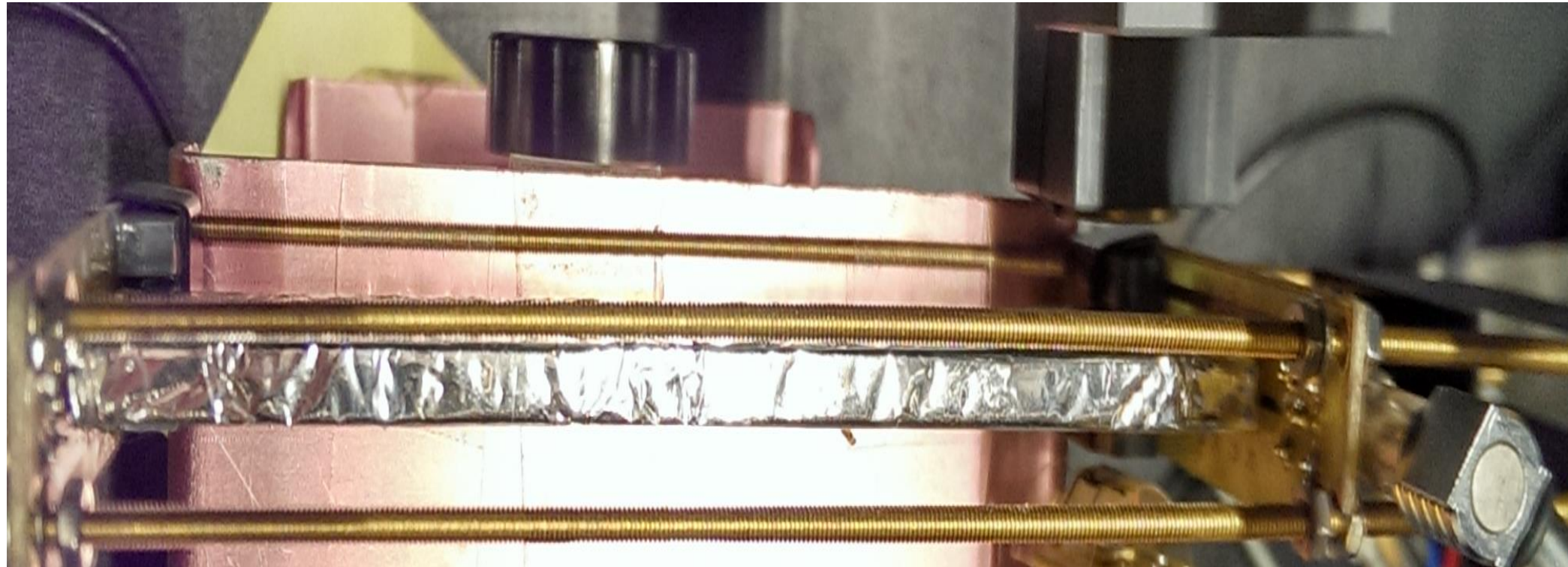
Trigger Scintillator (RC): 5x5x5 mm³



- Scintillator rods read out at opposite sides with 4 MPPCs
 - Without wrapping and with white paper wrapping
 - Measure pulse heights (→ number of photons)
 - Measure time difference (→ time resolution)
- xy-Scans of scintillator surface in 1-4 mm steps



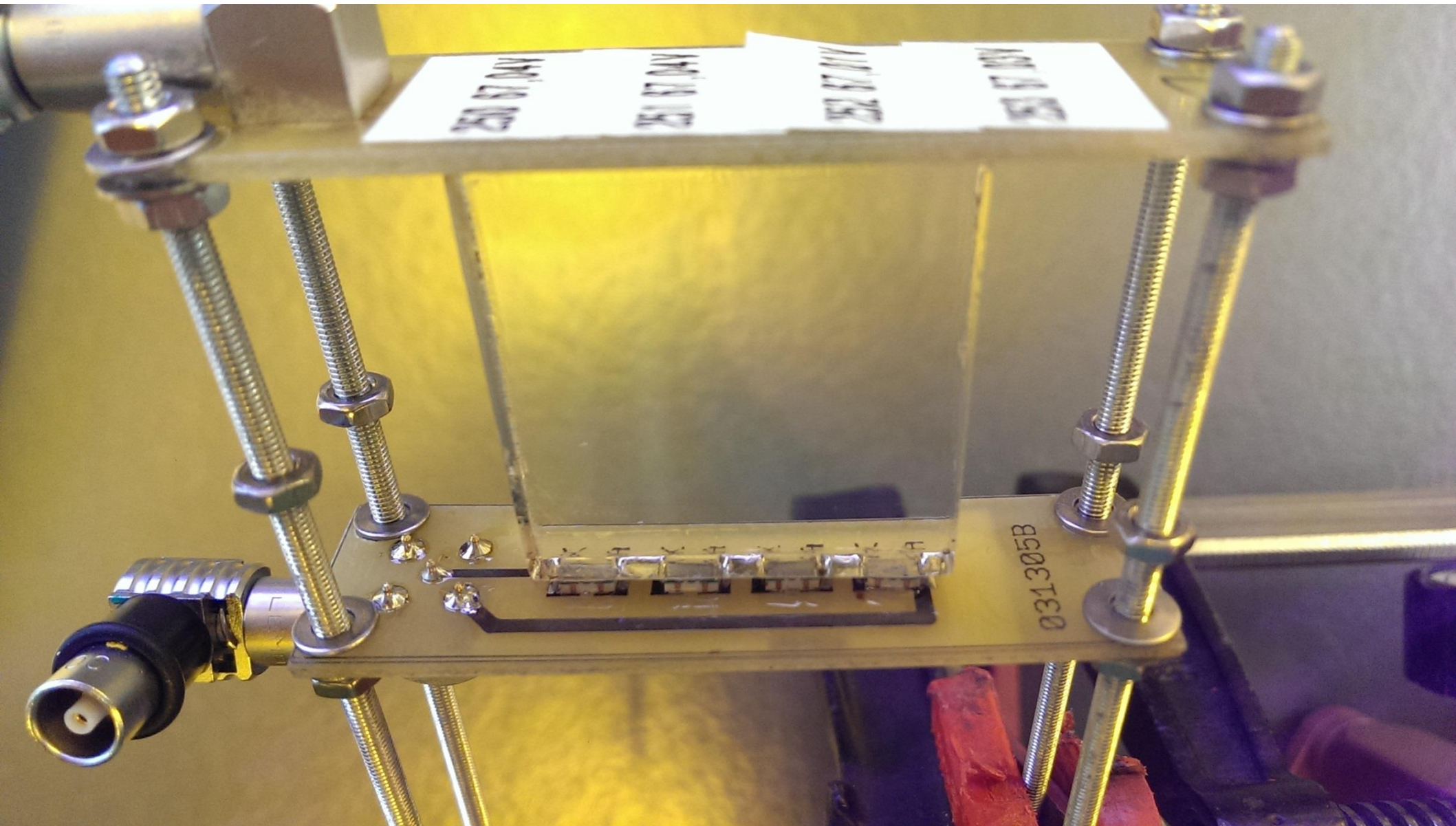
Measurement Setup



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Measurement Setup



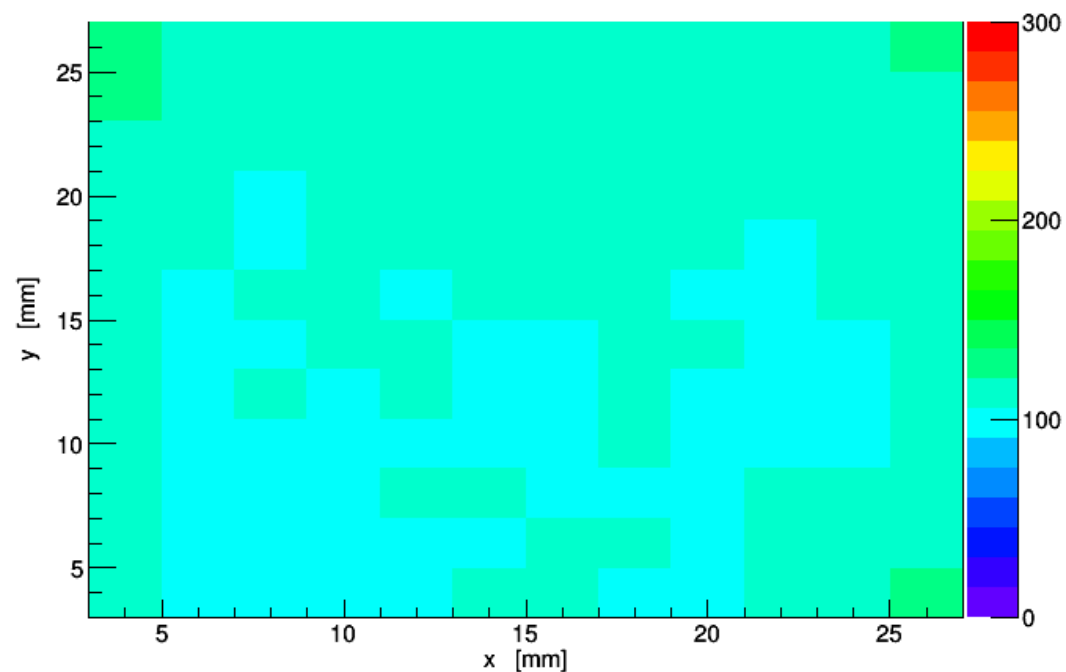
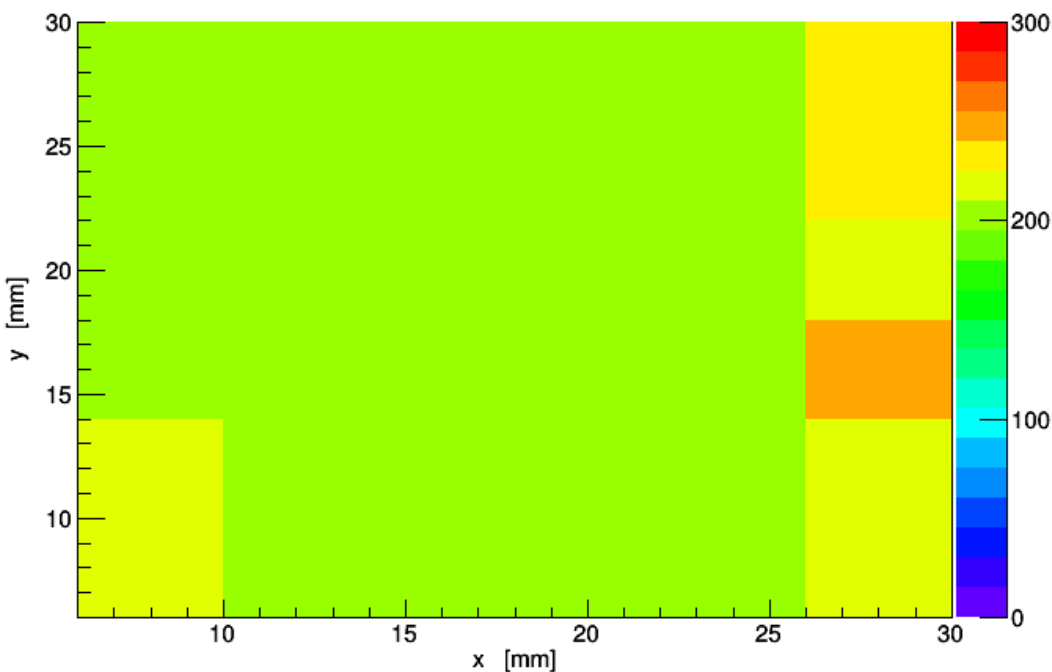
SciRod Scans (5x30x30 mm³), BC408 and BC420

● BC408

● Tdiff ~200 ps

● BC420

● Tdiff ~100 ps



Scintillator unpacked

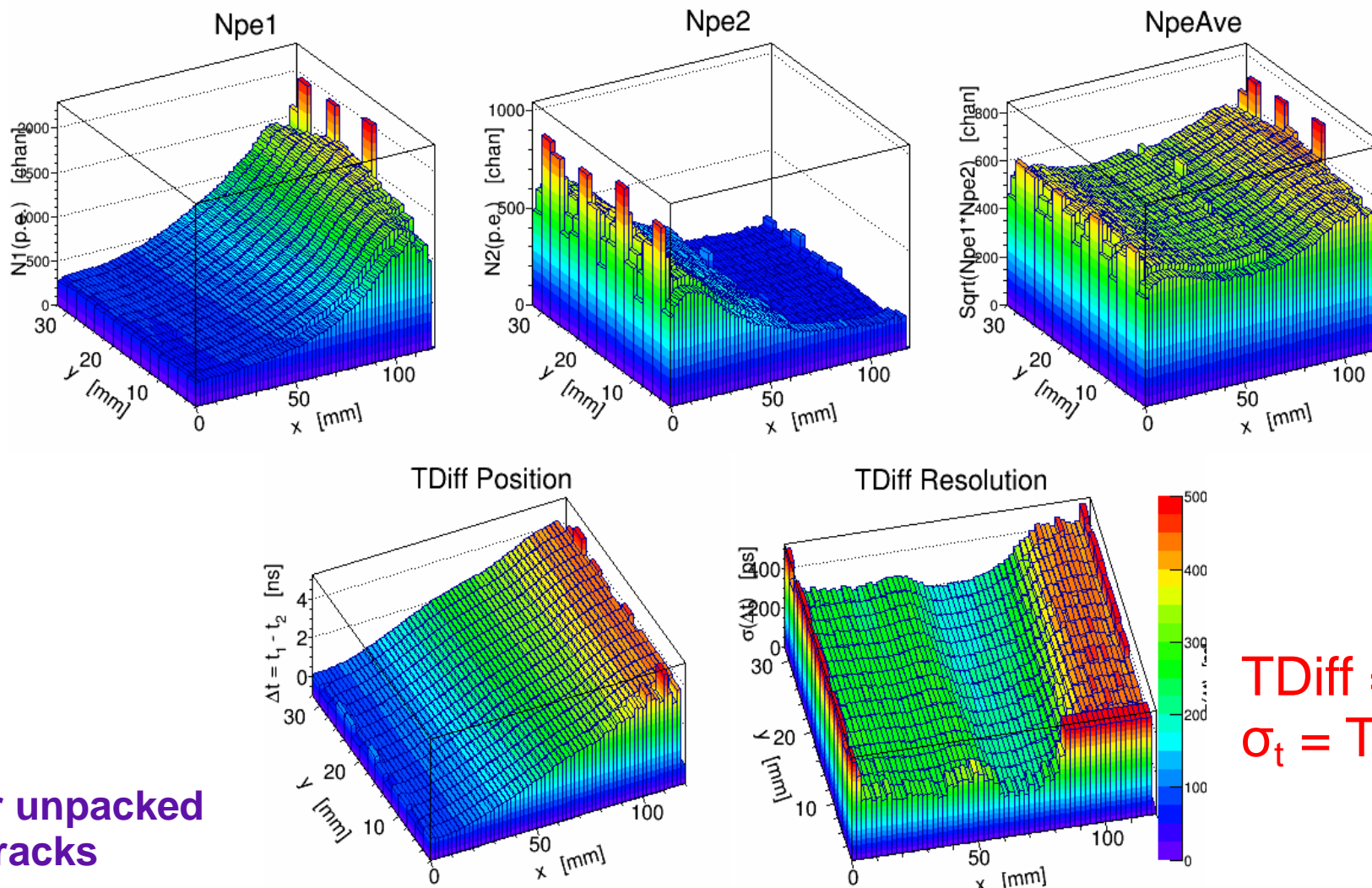
MPPC S12572-050P

● Time resolution with BC420 much better than with BC408

$$\begin{aligned} \text{TDiff} &= t_1 - t_2 \\ \sigma_t &= \text{Tdiff}/2 \end{aligned}$$

Wide SciRod Scans (5x30x120 mm³)

Scintillator BC420
MPPC S12572-050P



$$\text{TDiff} = t_1 - t_2$$

$$\sigma_t = \text{TDiff}/2$$

Scintillator unpacked
and with cracks

- Time resolution not homogeneous
- Big loss of photons

Wide SciRod Scans (5x30x120 mm³)





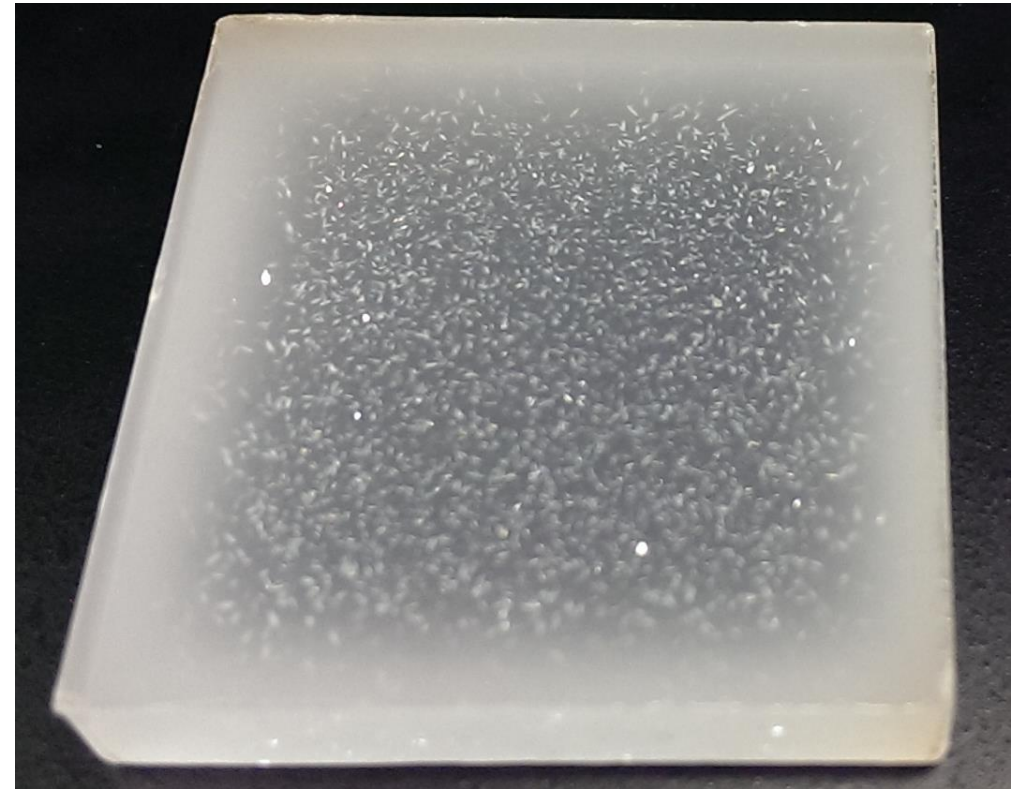
Scintillator treatment

- Problem: too much pressure
- → Solution: Flame polishing?
 - Need tempering:
 - Tempered in water
 - 20°C to 80°C: 2h
 - At 80°C: 4h
 - 80°C to 20°C: 4h



Scintillator treatment

- Problem: too much pressure
- → Solution: Flame polishing?
 - Need tempering:
 - Tempered in water
 - 20°C to 80°C: 2h
 - At 80°C: 4h
 - 80°C to 20°C: 5h
- Maybe 80°C is too hot?





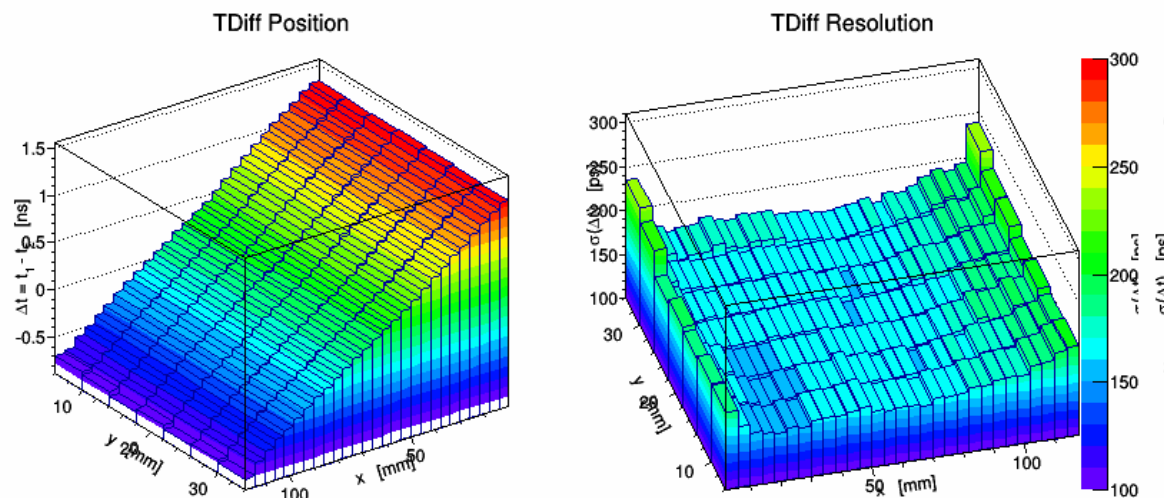
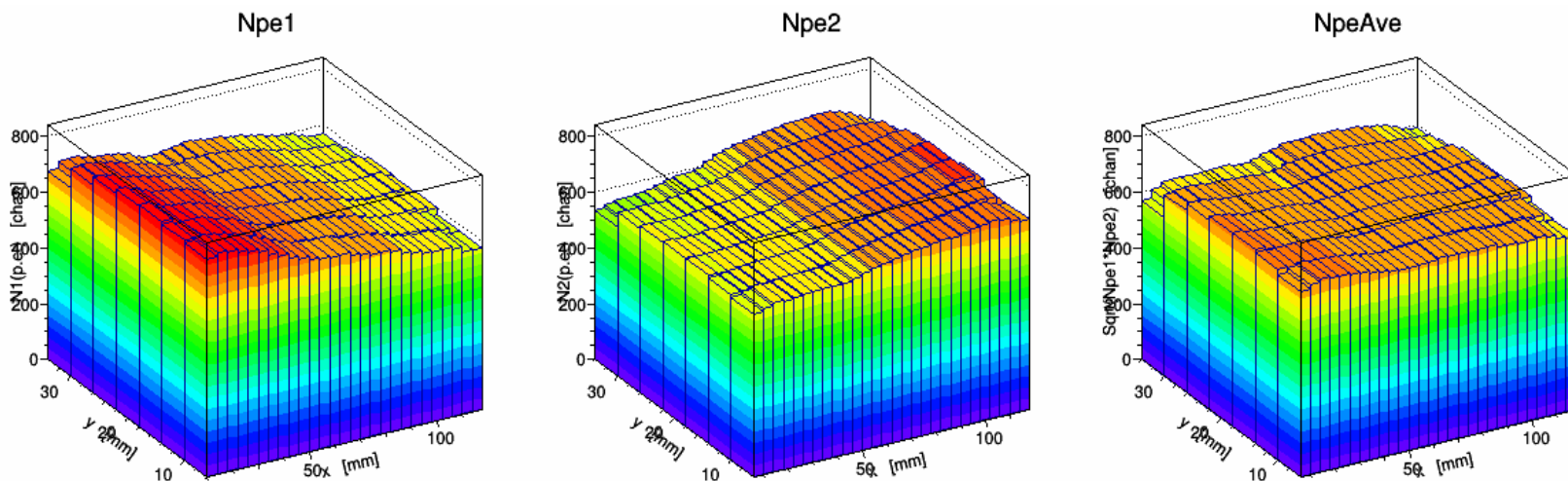
Scintillator treatment

- Now: Polishing with 4000 grain water silicon carbide paper
 - Needs some pressure
- After this polishing with acrylic glass repair paste
- → Again a few cracks



Wide SciRod Scans (5x30x120 mm³)

Scintillator BC420
MPPC S12572-050P



$$TDiff = t1 - t2$$

$$\sigma_t = Tdiff/2$$

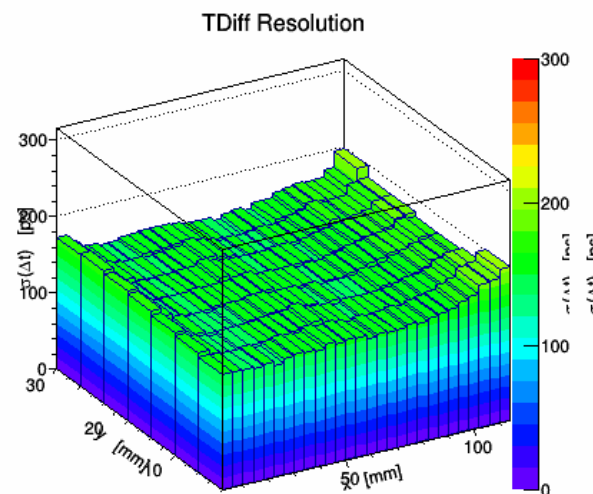
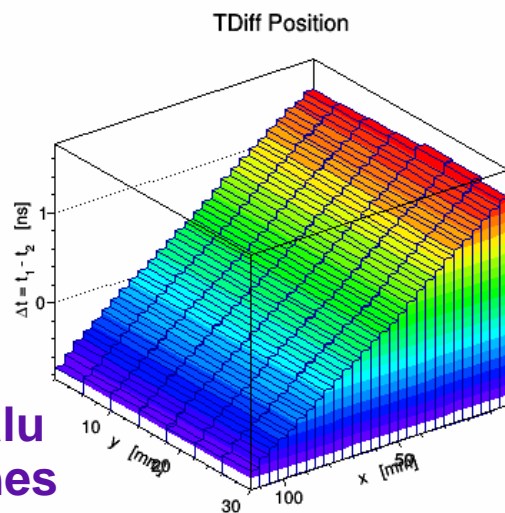
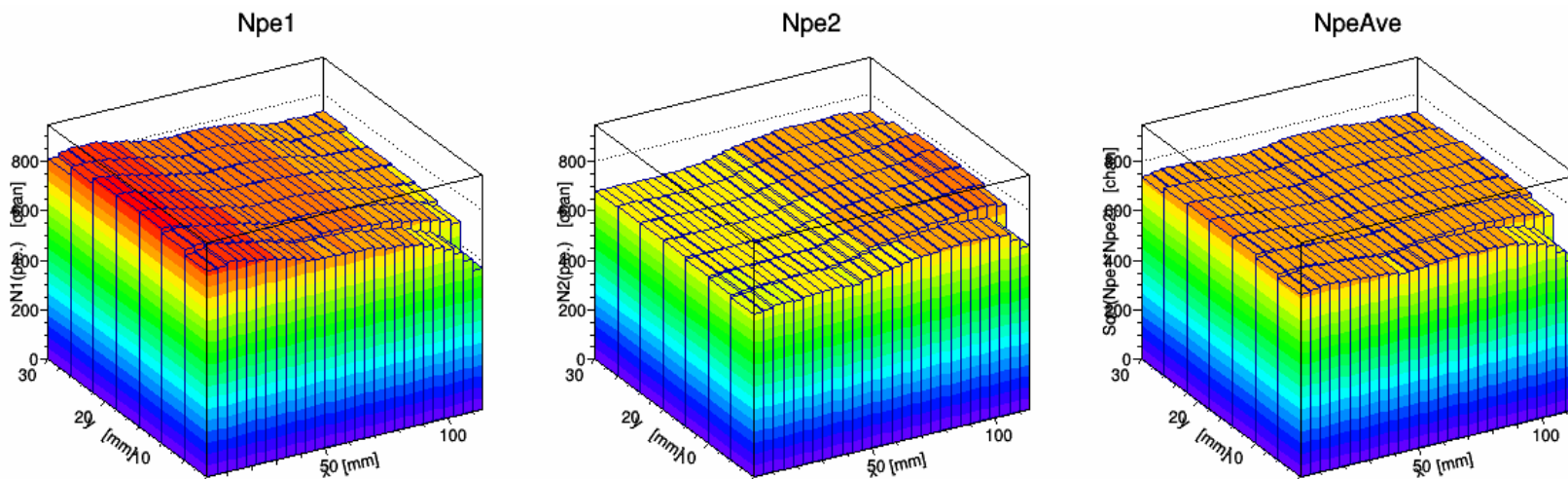
Scintillator unpacked
and with few scratches

- Npe and Tdiff distributions are smooth
- time resolution (σ_t): $\sim 83 \pm 3$ ps



Wide SciRod Scans (5x30x120 mm³)

Scintillator BC420
MPPC S12572-050P



$$\begin{aligned} \text{TDiff} &= t_1 - t_2 \\ \sigma_t &= \text{TDiff}/2 \end{aligned}$$

Scintillator wrapped in alu foil and with few scratches

- Npe and Tdiff distributions are smooth
- time resolution (σ_t): $\sim 76 \pm 2$ ps

Different Setups (5x30x120 mm³)

6 V, not wrapped

7 V, not wrapped

8 V, not wrapped

TDiff: 176 ± 5 ps

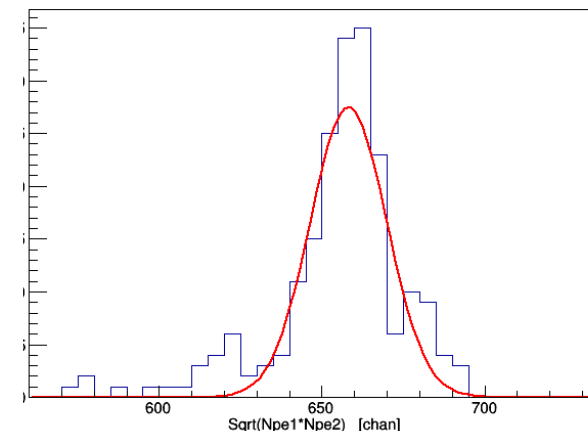
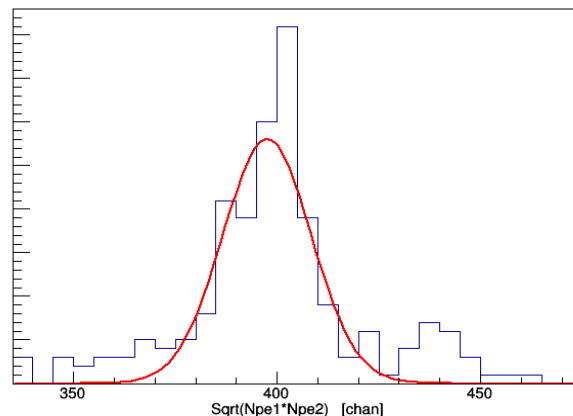
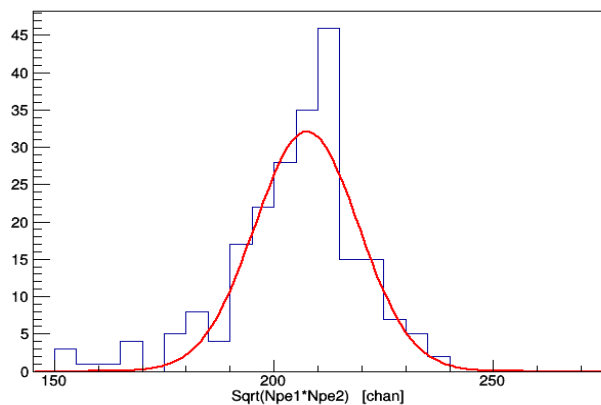
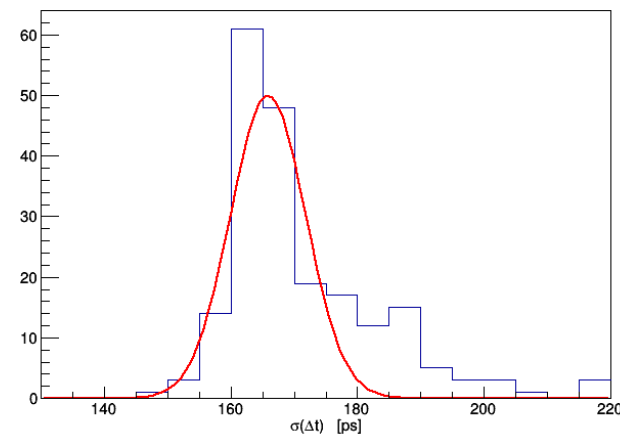
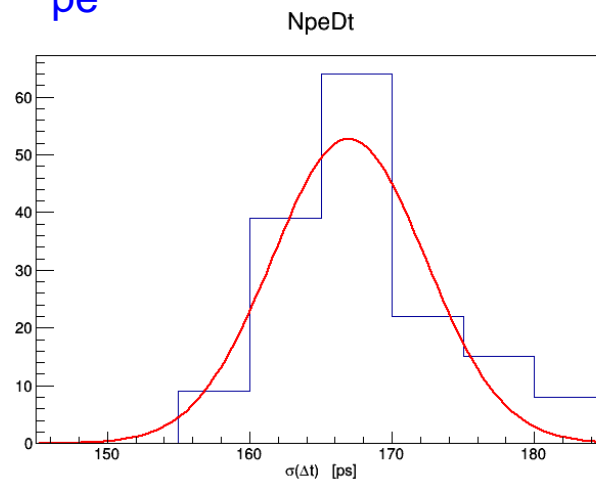
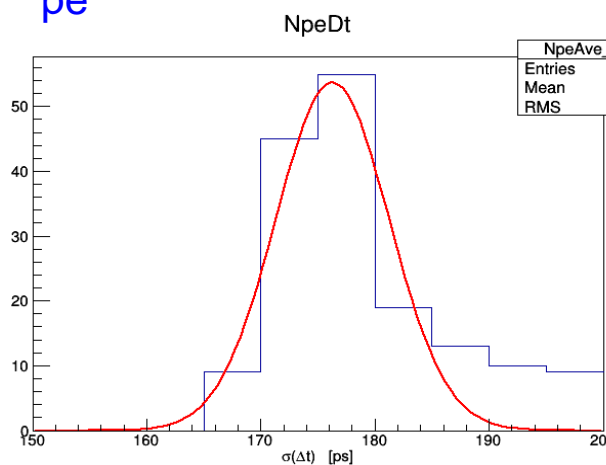
TDiff: 167 ± 5 ps

TDiff: 166 ± 6 ps

N_{pe}: 207 ± 12

N_{pe}: 398 ± 11

N_{pe}: 658 ± 12



More Npe and better Tdiff with more bias

$$\text{TDiff} = t_1 - t_2; \quad \sigma_t = \text{TDiff}/2$$



Time resolution with wrapped SciRod

- BC420
- MPPC S12572-050P
- 8V over Bias

| | Unwrapped | Paper | Aluminum foil |
|-----------------|--------------|--------------|---------------|
| σ_t [ns] | 83 ± 3 | 80 ± 2 | 76 ± 2 |
| N_{pe} [chan] | 658 ± 12 | 700 ± 15 | 743 ± 10 |

- Increase in N_{pe} because more photons captured
 - N_{pe} and time resolution benefits from wrapping



Threshold scan with (5x30x50 mm³)

- BC420, wrapped in paper
- MPPC S12572-050P
- 7 V over Bias
- Measured at 9 points homogenous distributed

| | 10 mV | 15 mV | 20 mV | 25 mV | 30 mV | 50 mV |
|-----------------|---------|---------|---------|---------|---------|---------|
| σ_t [ns] | 57 ± 5 | 57 ± 6 | 55 ± 1 | 56 ± 1 | 57 ± 1 | 61 ± 2 |
| N_{pe} [chan] | 736 ± 9 | 736 ± 3 | 737 ± 3 | 732 ± 5 | 733 ± 4 | 727 ± 5 |

- Optimum for this voltage is 20 mV?



Summary and Outlook

- Continue to use BC420 instead of BC408
- Improve SciRods time resolution with
 - Wrapping in aluminum foil
 - Increasing PMT Voltage
- Immediate and future plans:
 - Find better values for threshold and Voltage
 - Use Padiwa-Boards for readout
 - Tests with very high rate proton beam
 - Test configurations with 2 and 3 MPPCs connected in series
 - Use KETEK SiPMs
 - Studies with BC418 scintillators (5 and 3 mm thick)