

Studies of Wide SciRods

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- Motivation for wide "SciRods"
- Setups for Time Resolution Measurements
- First Results with ^{90}Sr source
- Setup with pion beam





Motivation for Wide “SciRods”

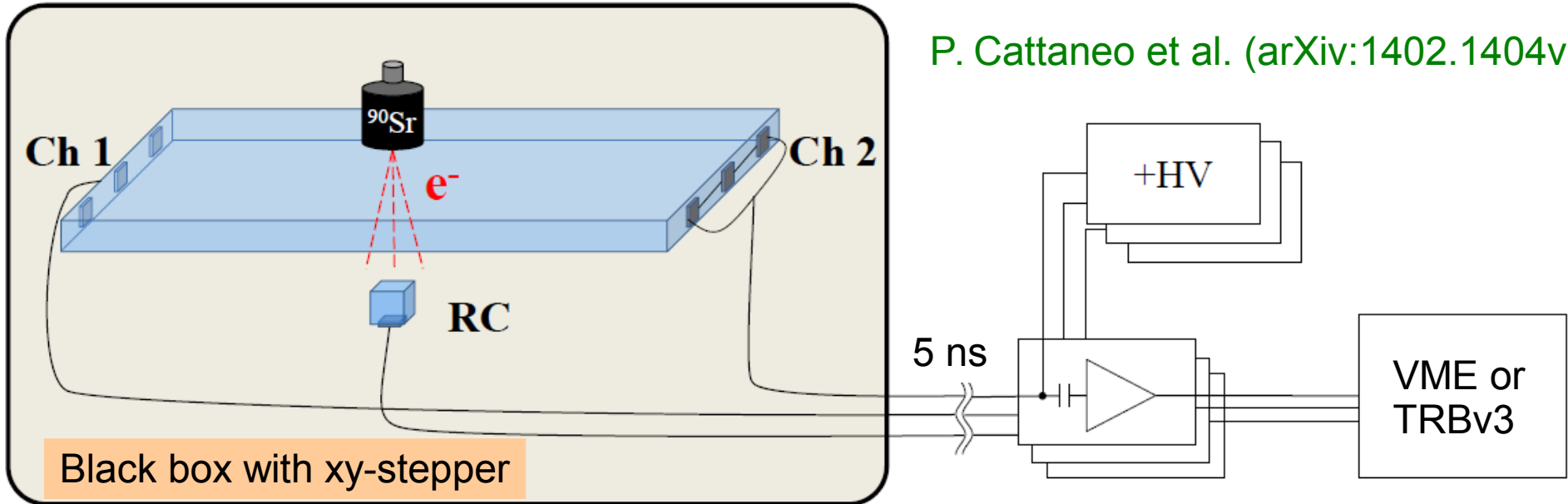
- Improve behaviour of SciTils with respect to
 - Light collection especially in corners
 - Homogeneity of time resolution across surface
- Wide SciRods read out by **four 3x3 mm² MPPCs at each side**
 - **120x30x5 mm³ ; 50x30x5 mm³ ; 30x30x5 mm³**
 - 4 MPPCs connected in series at each side
- Possible advantages of wide SciRods:
 - Collection of more scintillation photons
 - better time resolution
 - Better geometrical coverage with MPPCs
 - catch more photons from corners
 - more homogeneity in light collection and time resolution
 - Fewer “dead” regions (between scintillators) than with narrow SciRods



Measurement Setup

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

Trigger Scintillator (RC): $5 \times 5 \times 5 \text{ mm}^3$

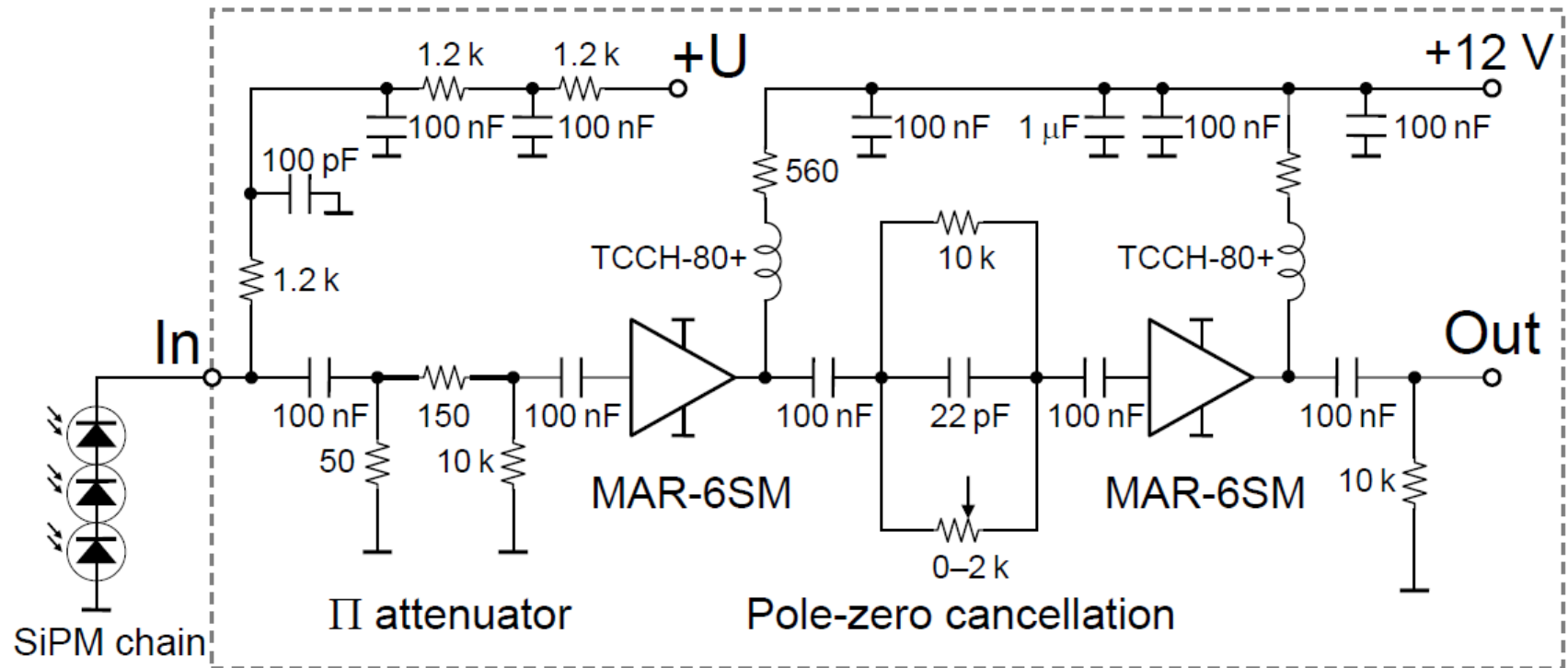


- Scintillator rods (BC420) read out at opposite sides with 4 MPPCs
 - Without wrapping and with white paper wrapping
 - Measure pulse heights (→ number of photons)
 - Measure time difference (→ time resolution)
- xy-Scans of scintillator surface in 1-2 mm steps



Readout Circuit

MPPC S12572-050P

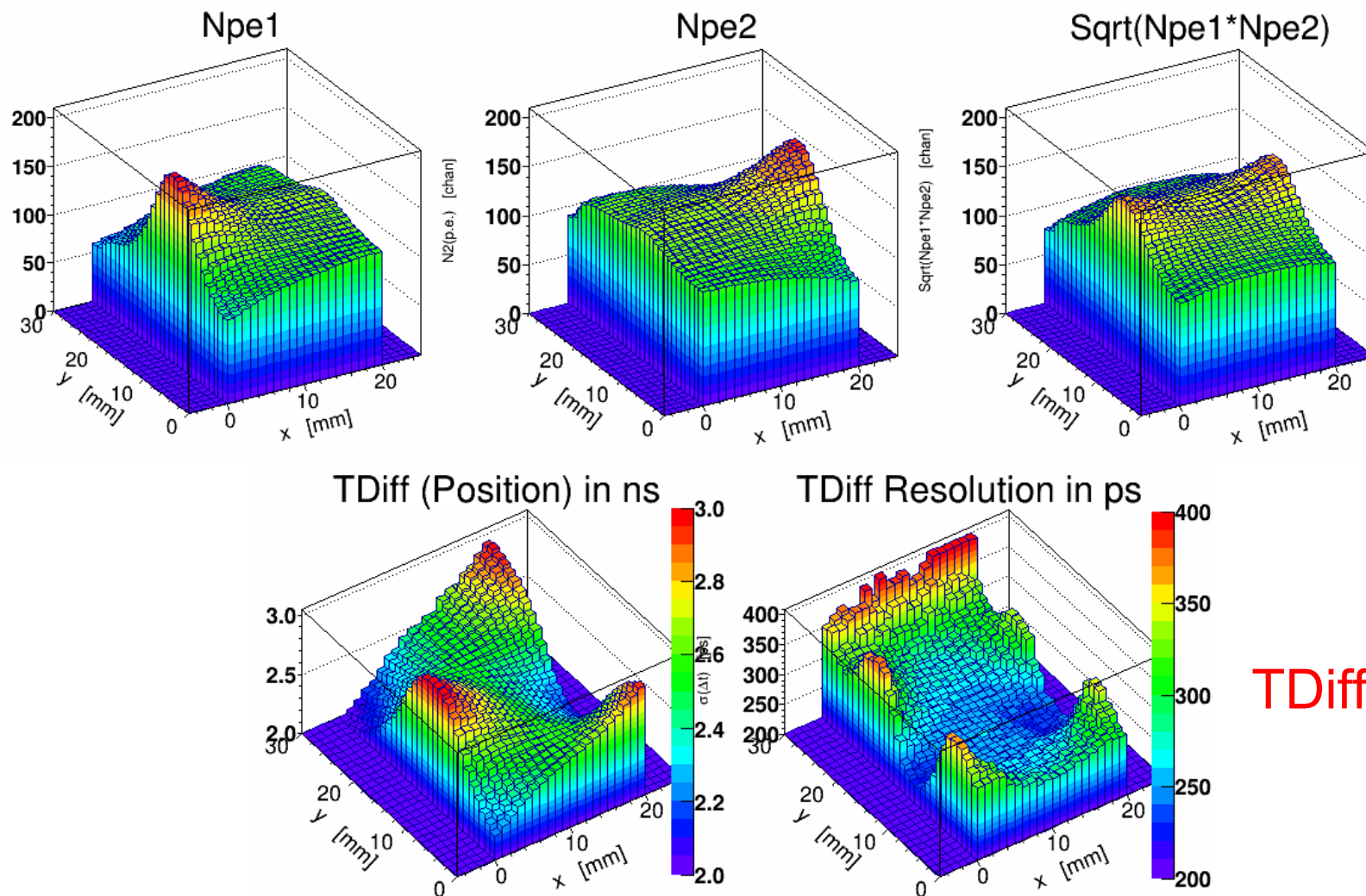


- Readout circuit taken from MEG Collab. [P. Cattaneo (arXiv:1402.1404v1)]
 - Several SiPMs connected in series
 - 2 MAR-6SM amplifiers
 - Analog shaping and pole-zero cancellation to shorten signal to <10 ns width



SciTil Scans (Npe and TDiff)

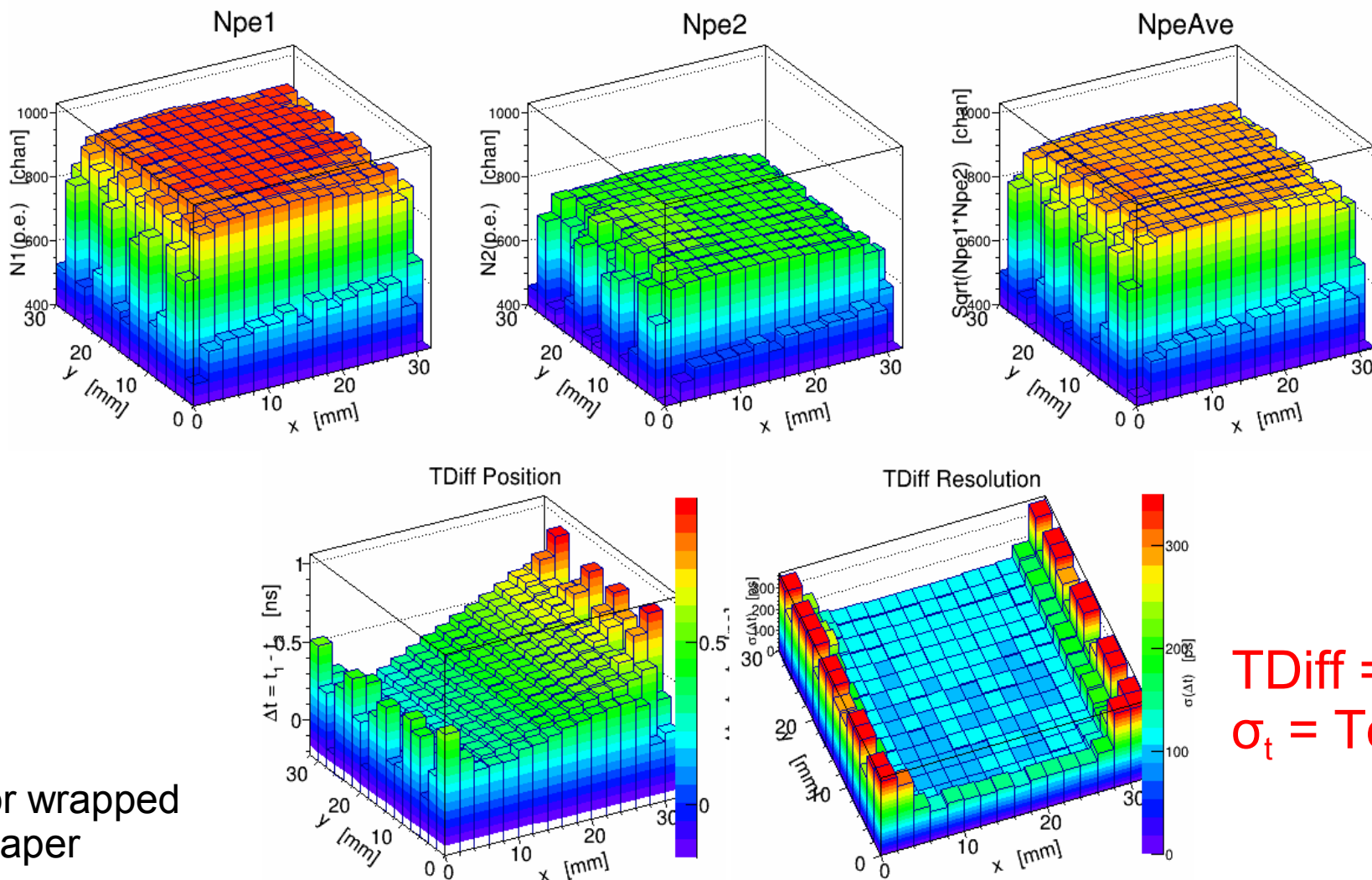
Scintillator BC408
MPPC S12652-050C



- Highest Npe close to MPPC and fewer far away from MPPC
- Best time resolution close to sensors

Wide SciRod Scans (5x30x30 mm³)

Scintillator BC420
MPPC S12572-050P



Scintillator wrapped
in white paper

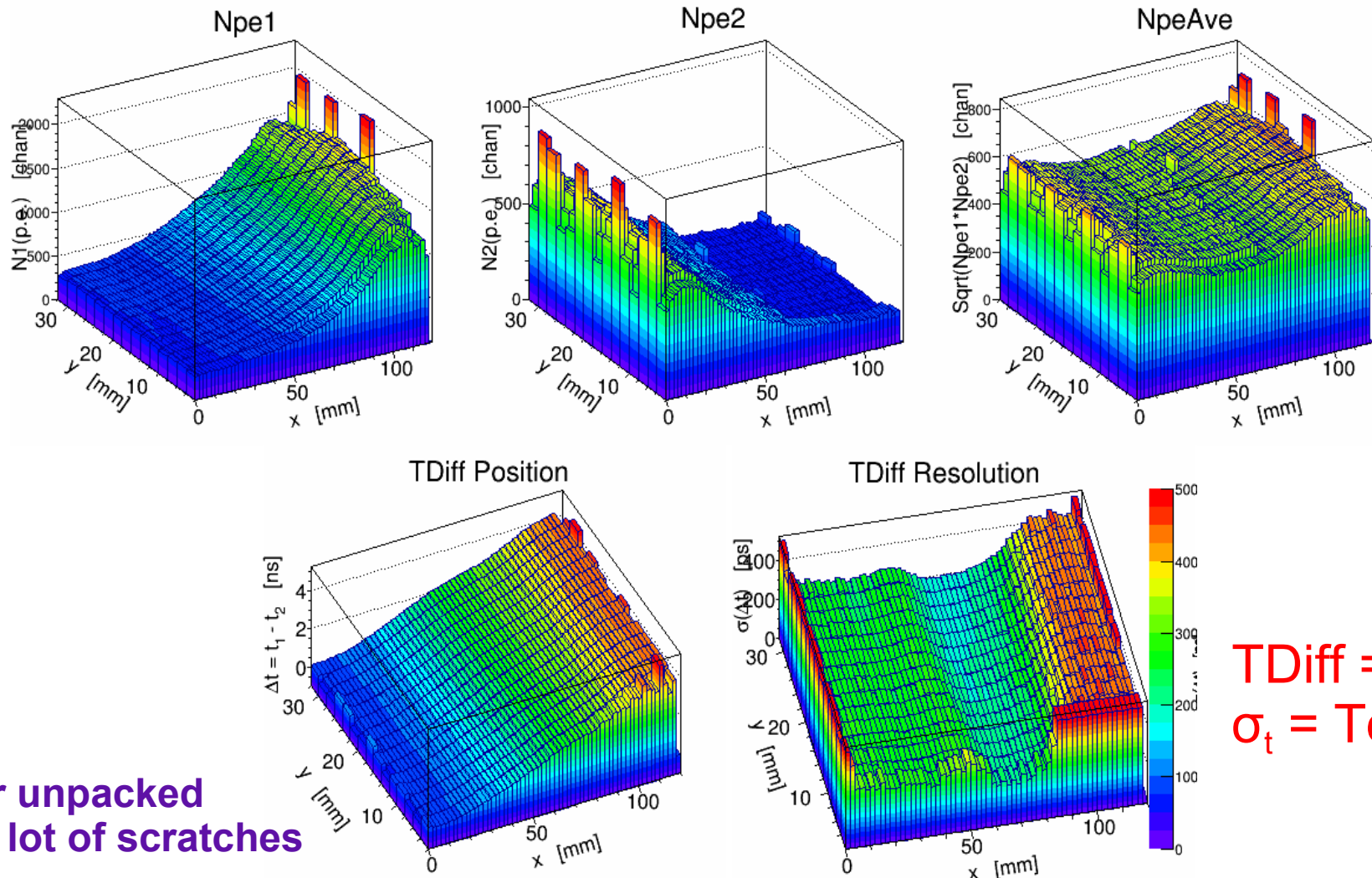
$$\text{TDiff} = t_1 - t_2$$

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

- Npe and Tdiff distributions are much smoother than with SciTils
- Best time resolution (σ_t) with white paper wrapped SciRod: **54 ps**

Wide SciRod Scans (5x30x120 mm³)

Scintillator BC420
MPPC S12572-050P



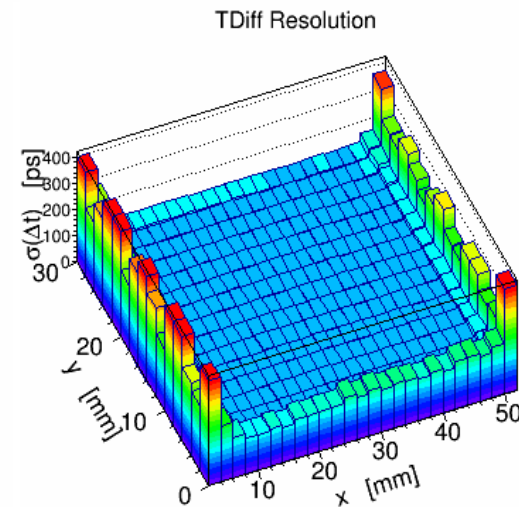
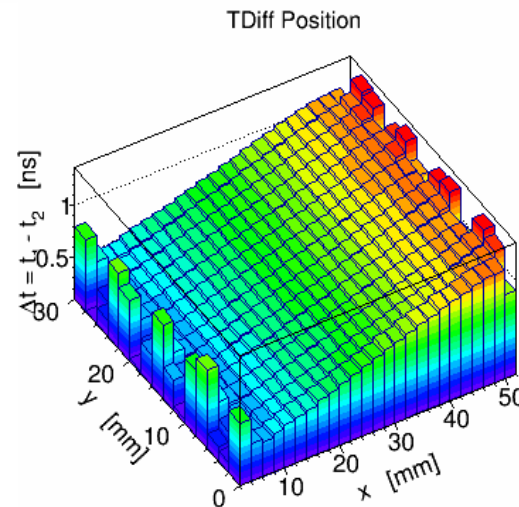
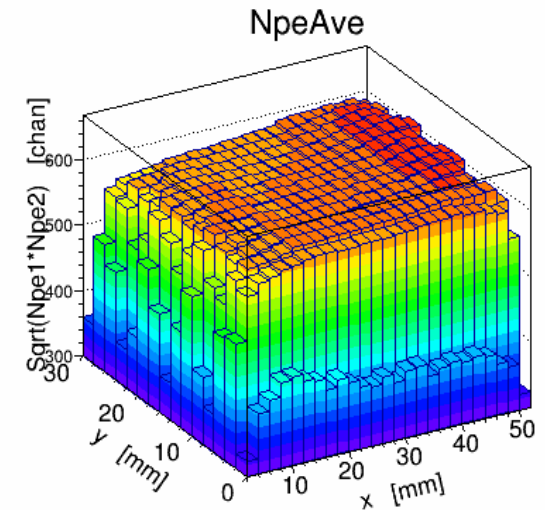
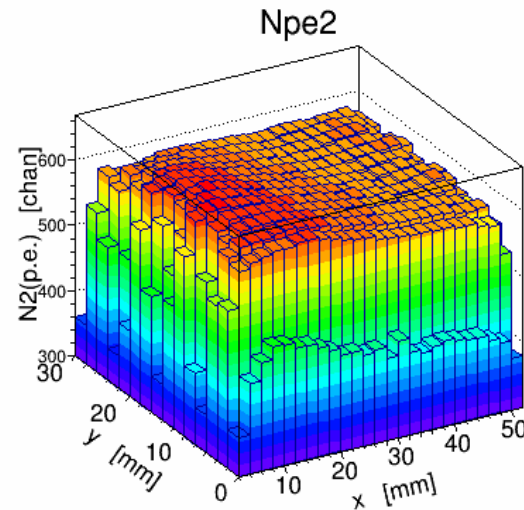
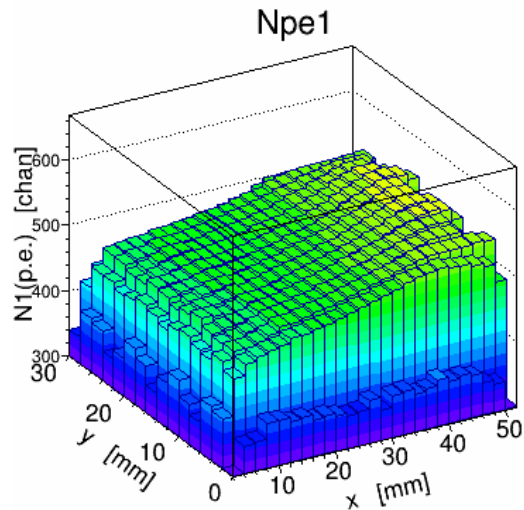
$T_{Diff} = t_1 - t_2$
 $\sigma_t = T_{diff} / 2$

Scintillator unpacked
and with a lot of scratches

- Npe and Tdiff distributions are smoother than with SciTils
- Best time resolution (σ_t) with white paper wrapped SciRod: ~ 95 ps

Wide SciRod Scans (5x30x50 mm³)

Scintillator BC420
MPPC S12572-050P



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

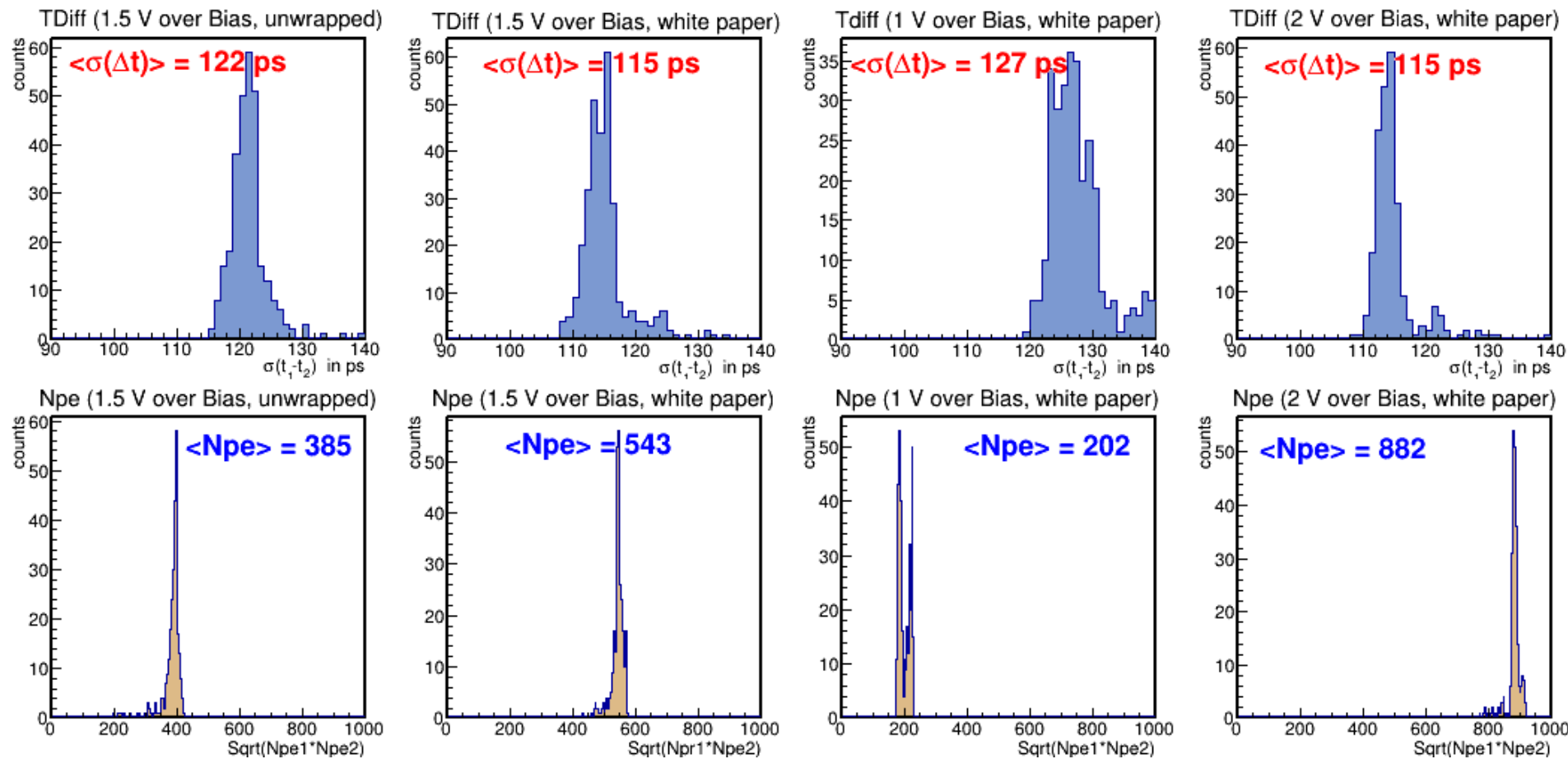
Scintillator wrapped
in white paper

- Npe and Tdiff distributions are much smoother than with SciTils
- Best time resolution (σ_t) with white paper wrapped SciRod: **<60 ps**



Different Setups (5x30x50 mm³)

Scintillator BC420; MPPC S12572-050P



$$TDiff = t_1 - t_2; \quad \sigma_t = Tdiff/2$$

- More Npe and better Tdiff with white paper wrapping and more bias
- Best time resolution: $\sigma_t = 58$ ps (very homogenous across surface)

Wide SciRod Time Resolutions

- Time resolution $\sigma_t == \sigma(t1-t2) / 2$

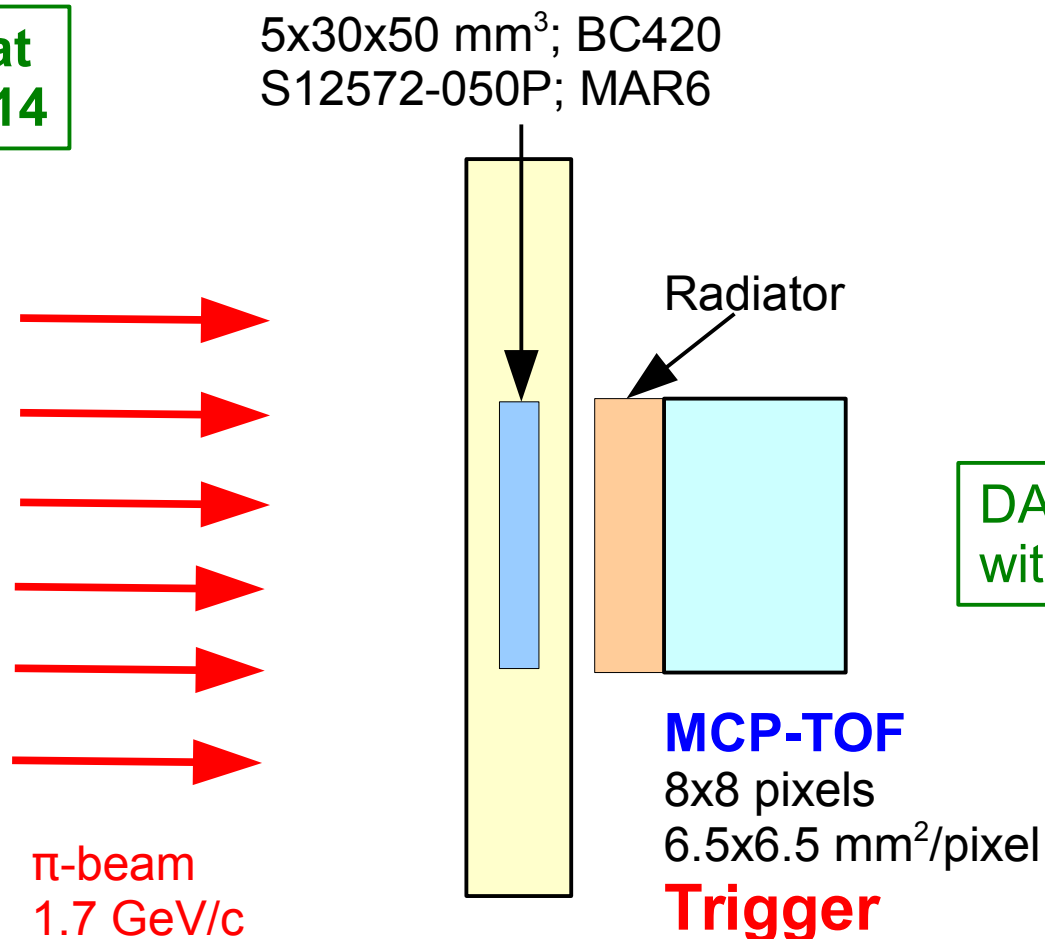
	Time Difference Resolution		Time Resolution	
	Mean $\sigma(t1-t2)$	RMS $\sigma(t1-t2)$	Time resol. (σ_t)	RMS σ_t
MPPC + Scintillator				
S12572-050P + BC420 5x30x120 mm ³	290 (190-460)	78	145 (85-230)	39
S12572-050P + BC420 5x30x50 mm ³	115	4	58	2
S12572-050P + BC420 5x30x30 mm ³	107	5	54	3

- Main problem with 5x30x120 scintillator: surface scratch and cracks
- Very good **time resolution of <60 ps** for other sizes
- Time resolution **very homogeneous across surface** (see low RMS)
- Looks very promising !!



Setup at GSI Pion Beam

A few hours data at
27 – 29 August 2014



DAQ using TRBv3
with PADIWA boards

- Analysis still pending
- First glimpse at time resolution: <100 ps



Summary and Outlook

- Wide SciRods with seriell readout of 4 MPPCs look very promising
 - Less dead region between counters than with narrow SciRods
 - **Very good time resolution**
 - **Very homogenous response across surface**
 - Seem to be preferable compared to SciTils:
to use less SiPMs → make scintillators longer
- Immediate and future plans:
 - test better 5x30x120 mm³ BC420 scintillator
 - Test configurations with 2 and 3 MPPCs connected in series
 - Use KETEK SiPMs
 - Studies with BC418 scintillators (5 and 3 mm thick)