

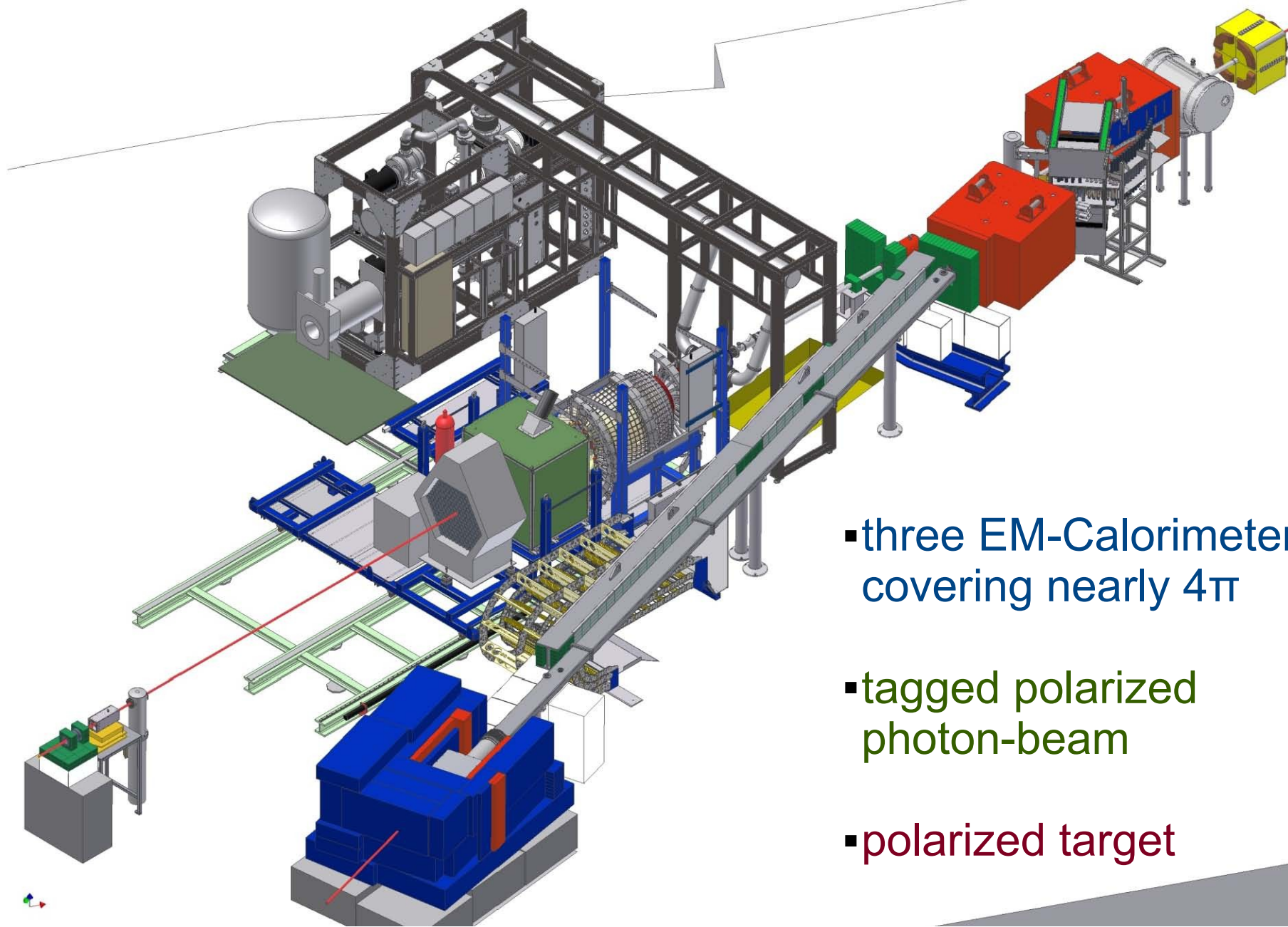
Prospects for SiPMs at the Crystal-Barrel Experiment

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The Crystal-Barrel-Experiment at ELSA

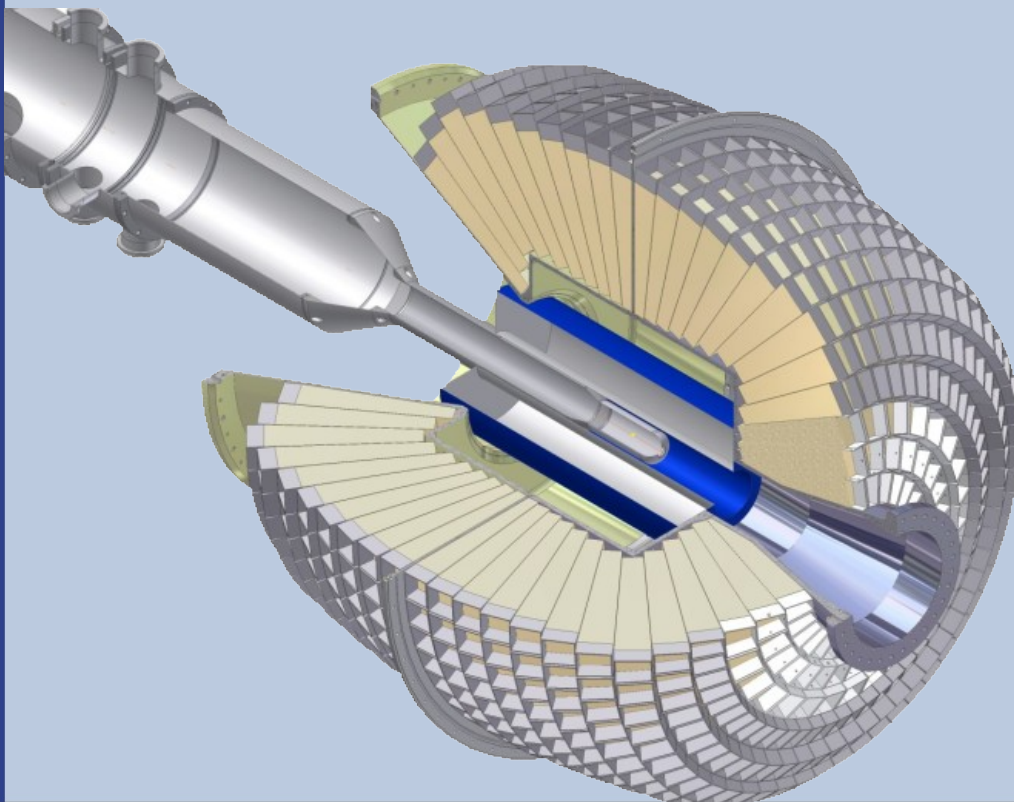
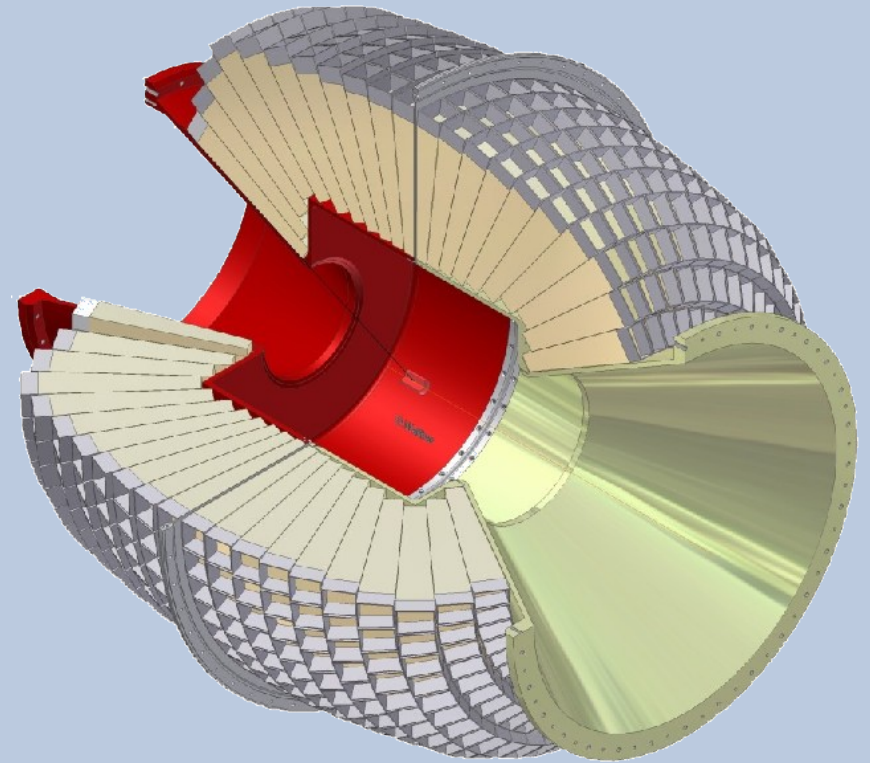
Baryon-Spectroscopy and Meson-Photoproduction



- three EM-Calorimeter covering nearly 4π
- tagged polarized photon-beam
- polarized target

Places for SiPM Application

- New Tagging Hodoskop
- Calorimeter Trigger
- TPC Start Detector



CsI (TI) Calorimeter - Trigger

1230 crystals with photodiode readout via WLS

- no trigger capability

90 crystals with PMT readout

- do not work within 2 Tesla

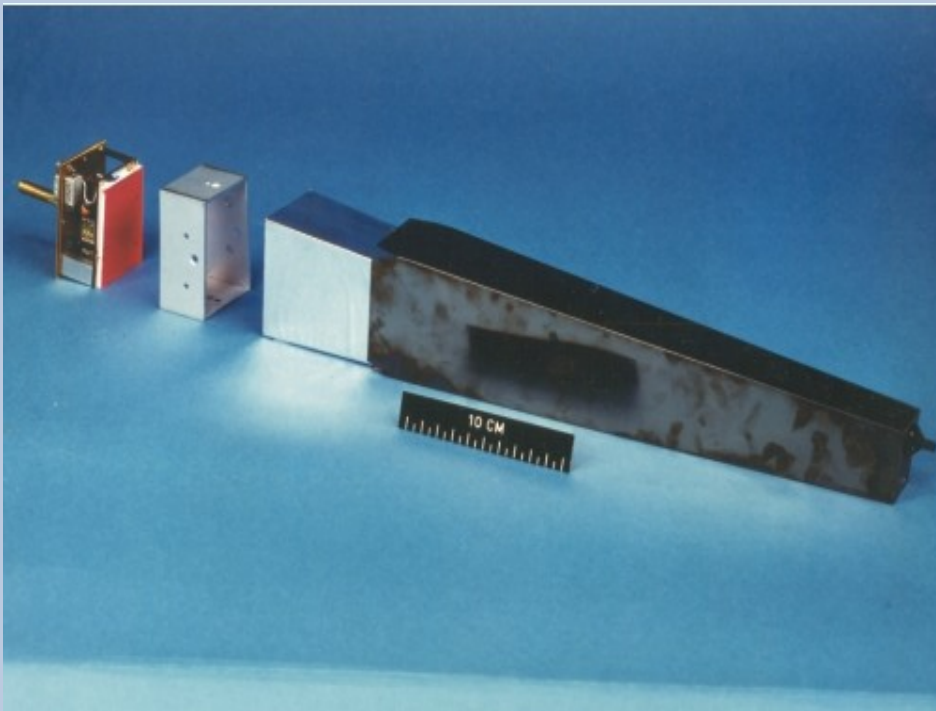
need for a fast trigger solution :

either

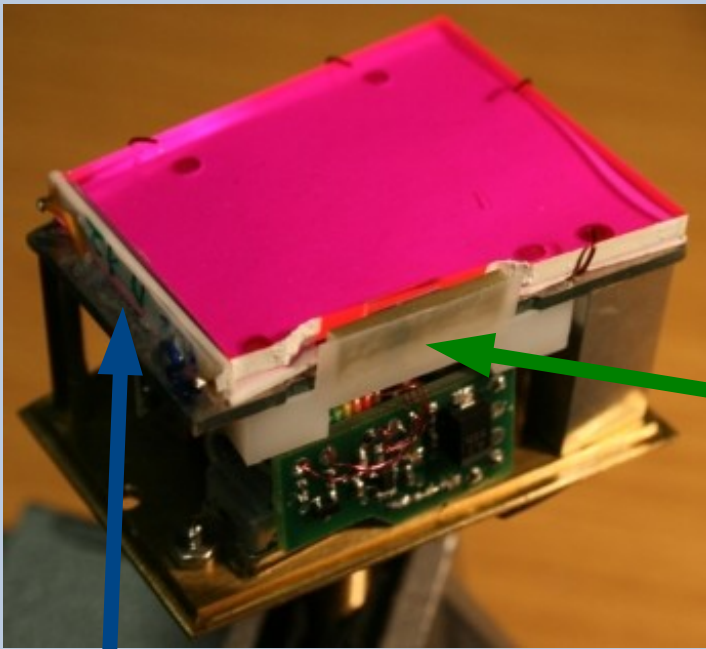
- adding SiPMs to the WLS

or

- replacing the PDs with APDs (with or without WLS)



SiPM CsI(Tl) Readout



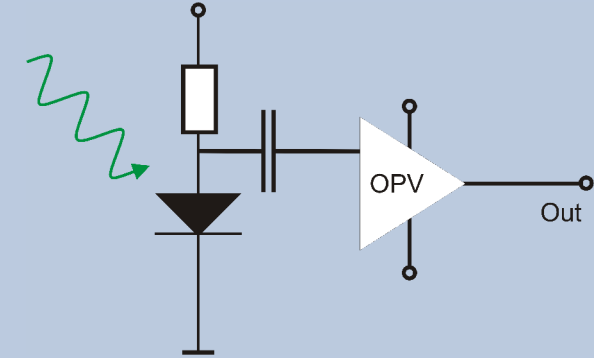
PhotoDiode

2 SiPMs

idea : adding two SiPMs in parallel mode to the WLS

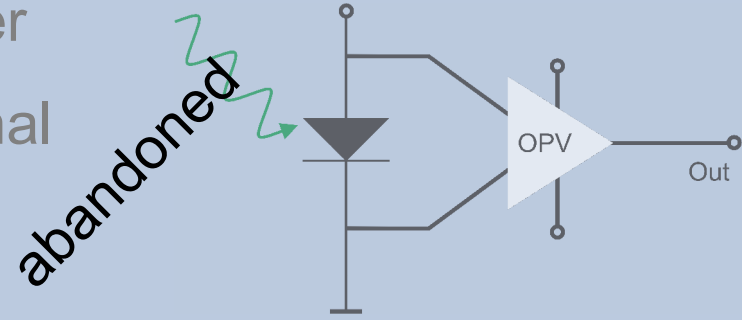
concept 1 : shaped amplification

- $\tau = 40 \text{ ns} : \sim 100 \text{ ns}$ risetime

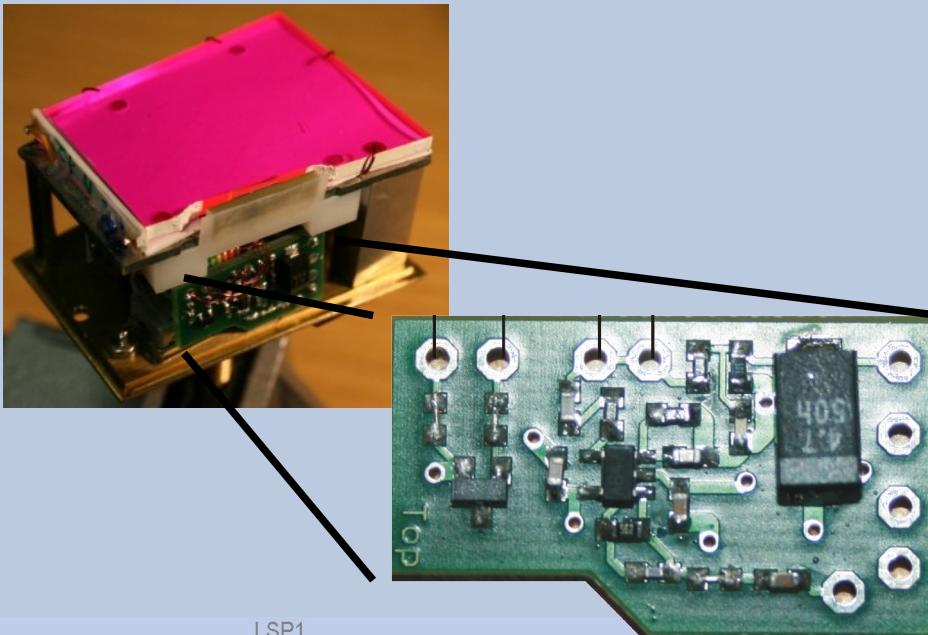


concept 2 : differential amplifier

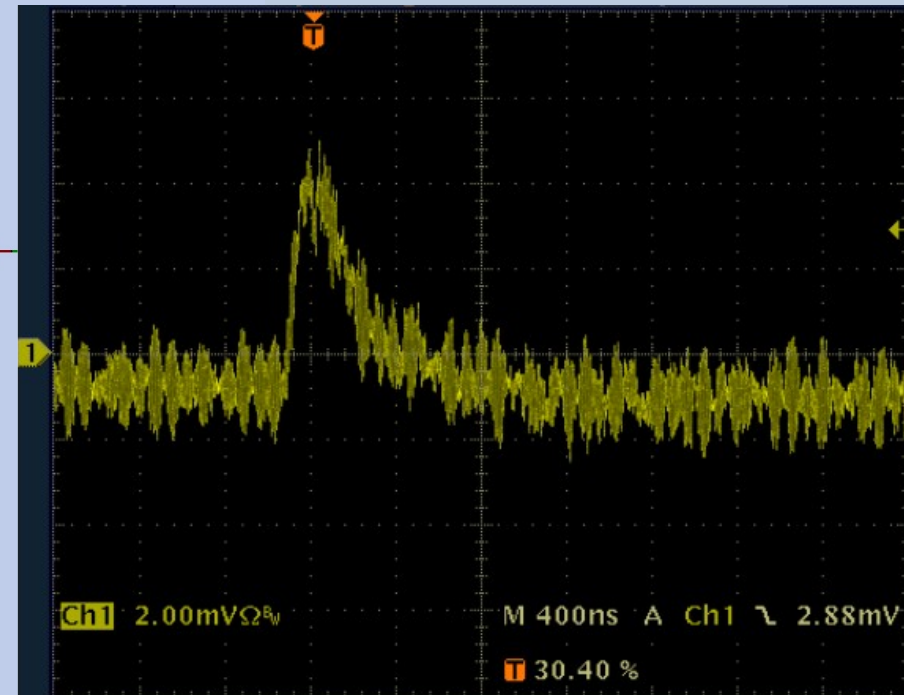
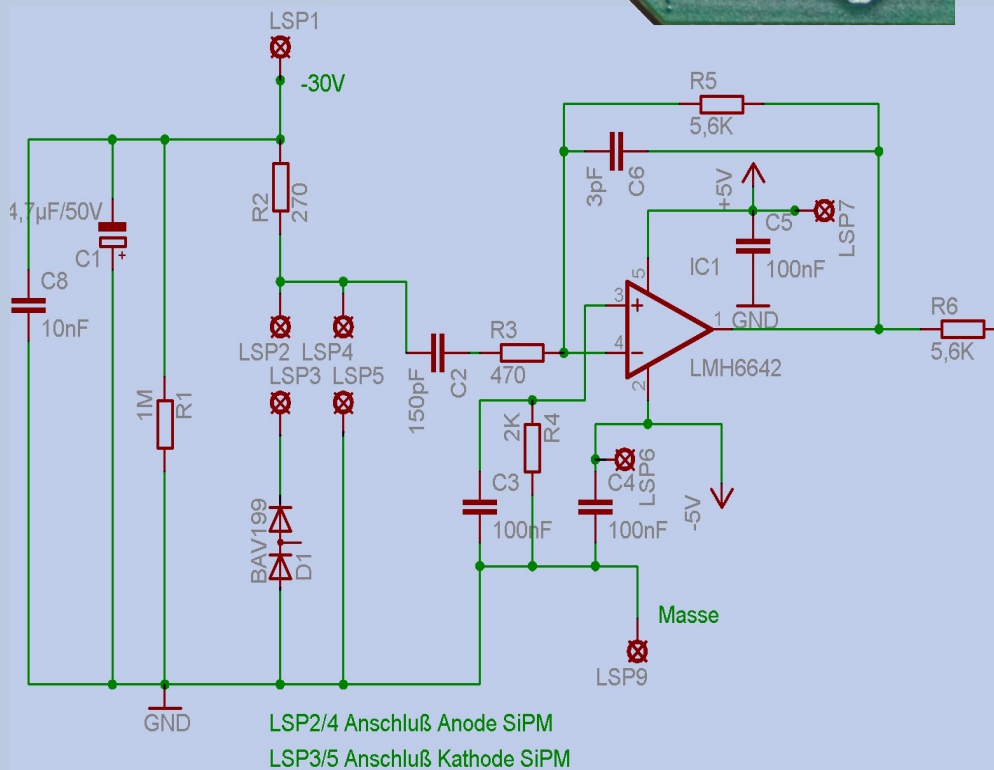
- no real improvement of signal to noise ratio
- most noise from the SiPM



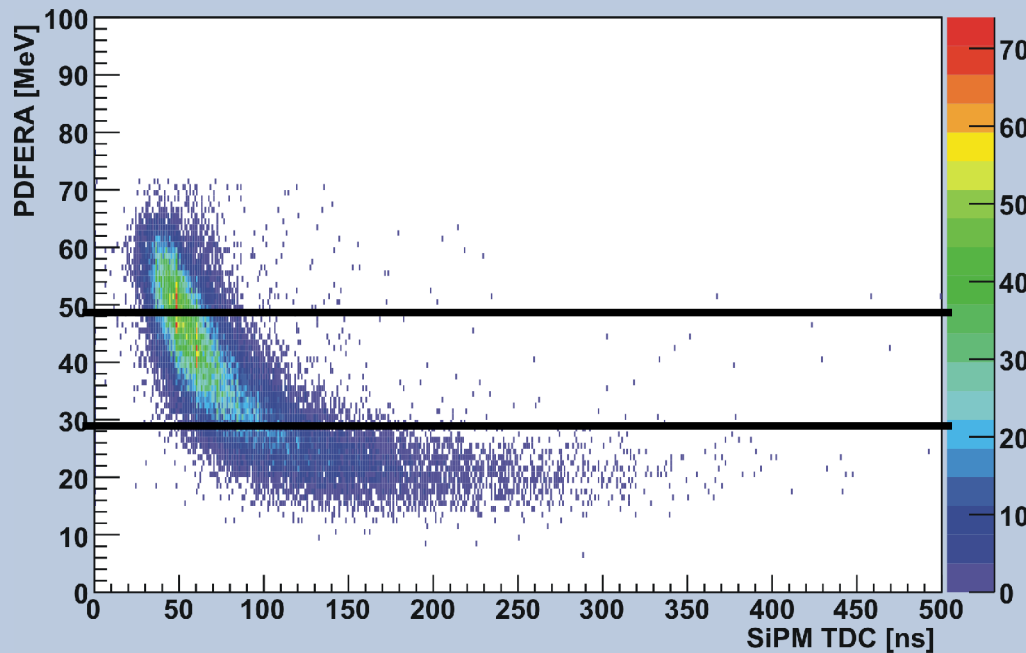
CsI(Tl) Readout with Pulsar SiPMs



- two 9 mm² / 5kPixel SiPMs (MEPhI / Pulsar) in parallel
- triggerthreshold of 25 MeV tested with nearly 100% efficiency; 20 MeV possible

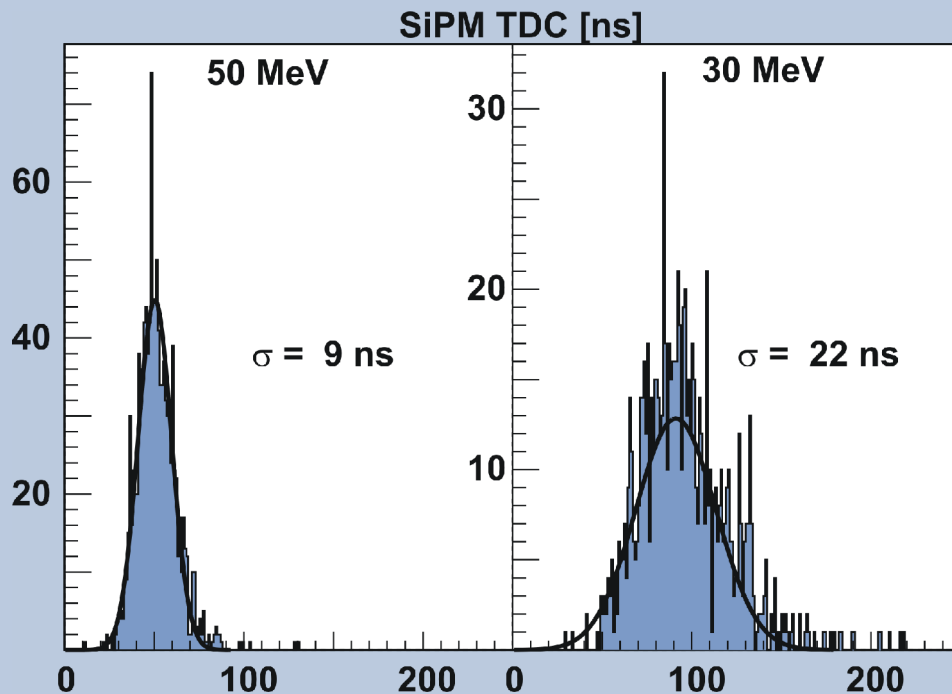


Time Resolution with Pulsar SiPMs



- measured timeresolution
 - $\sigma = 9 \text{ ns @ } 50 \text{ MeV}$
 - $\sigma = 22 \text{ ns @ } 30 \text{ MeV}$

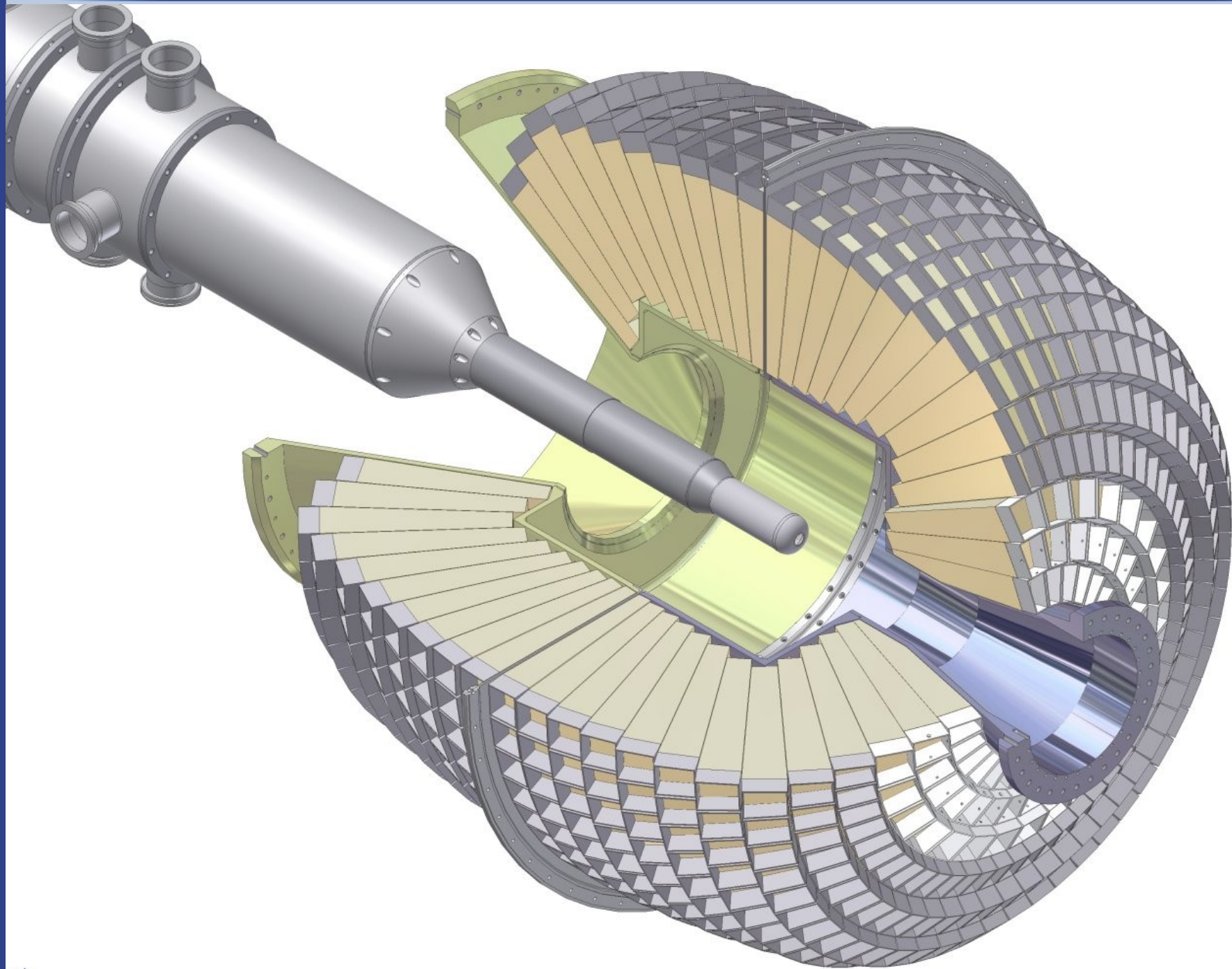
- SiPM readout fullfills our requirements



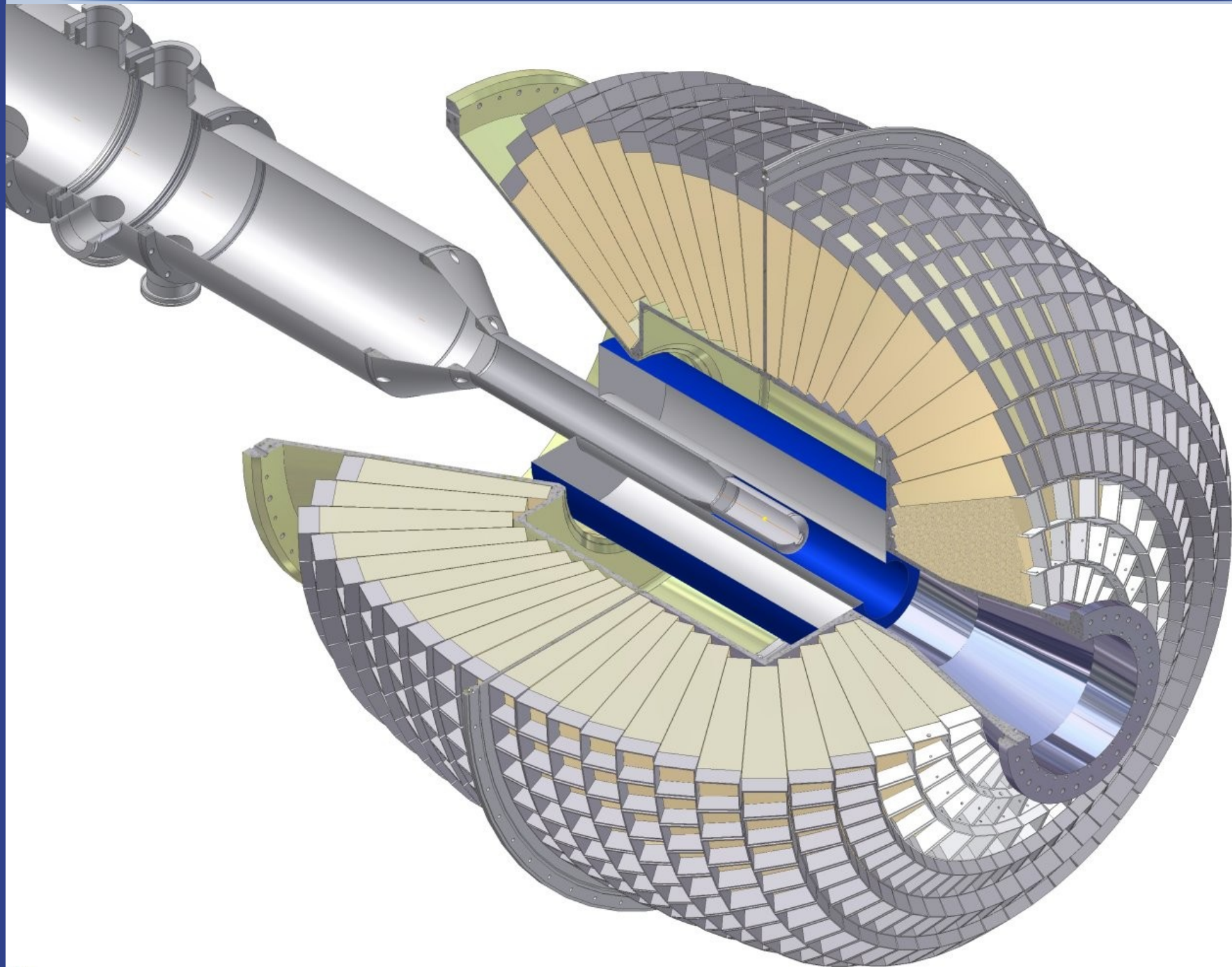
- tests with 3x3 mm Photonique SiPMs in progress
- show already a much better signal to noise ratio (compared to 2 year old Pulsar SiPMs)



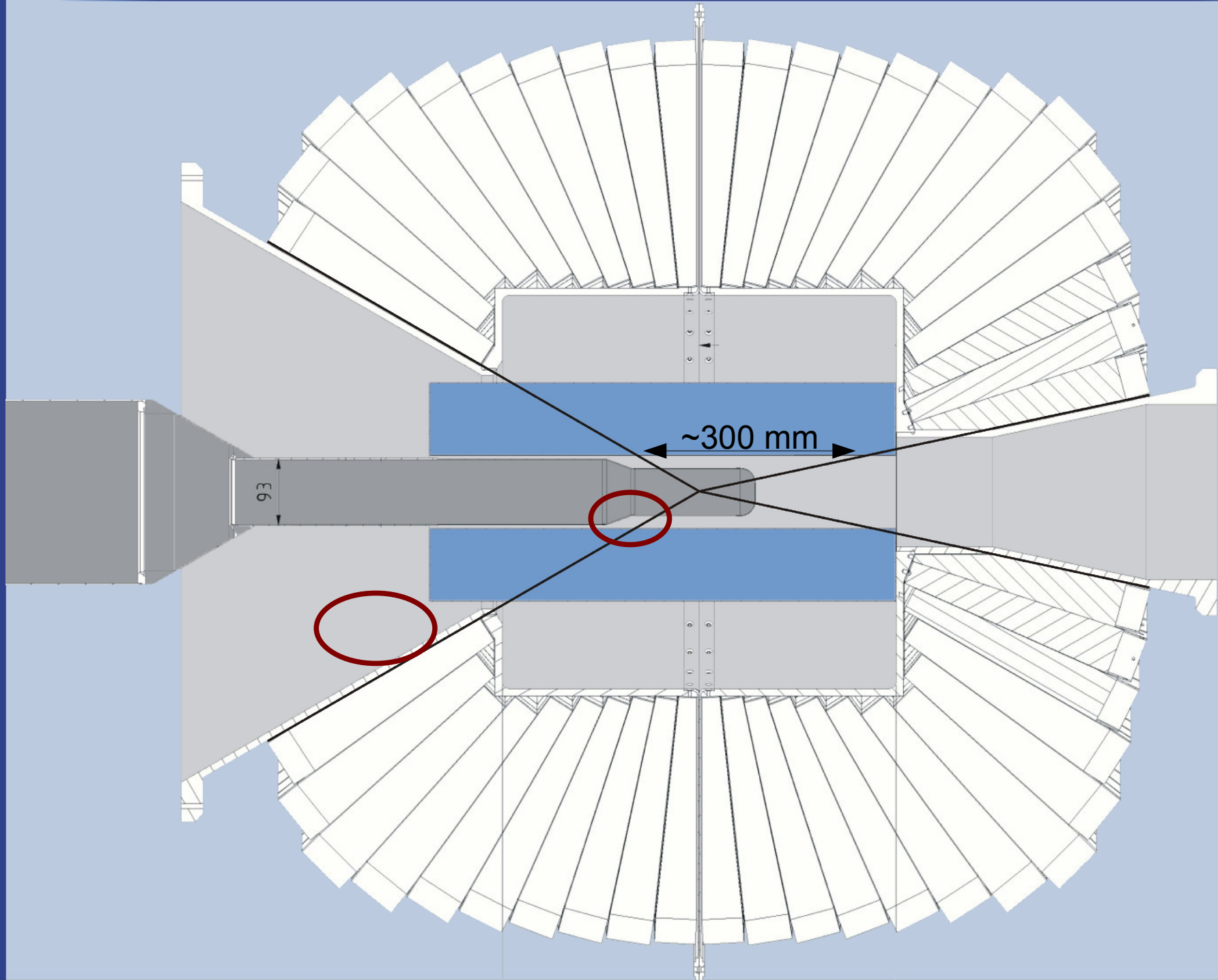
TPC Start Detector



TPC Start Detector



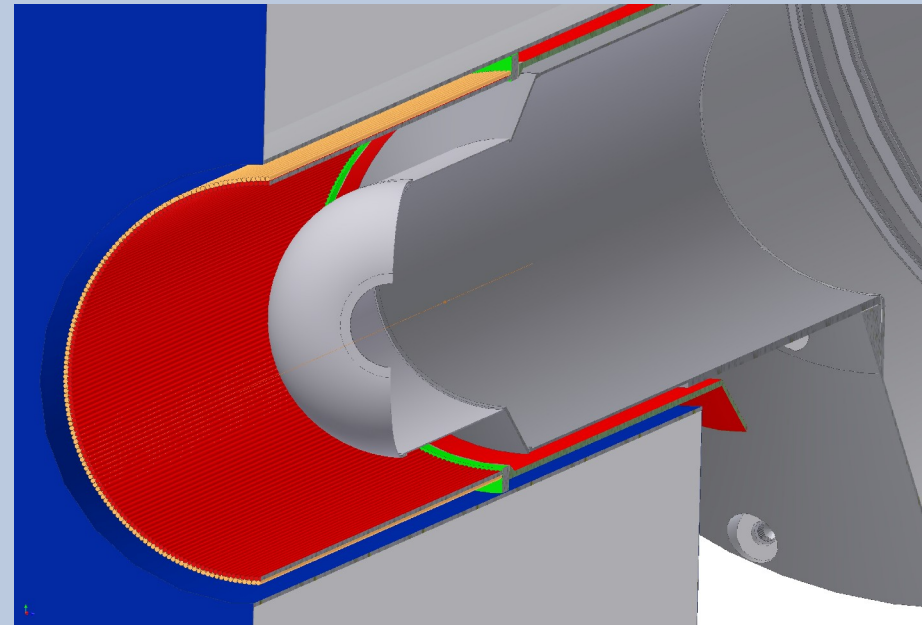
TPC Start Detector - Constraints



Detector Design Options

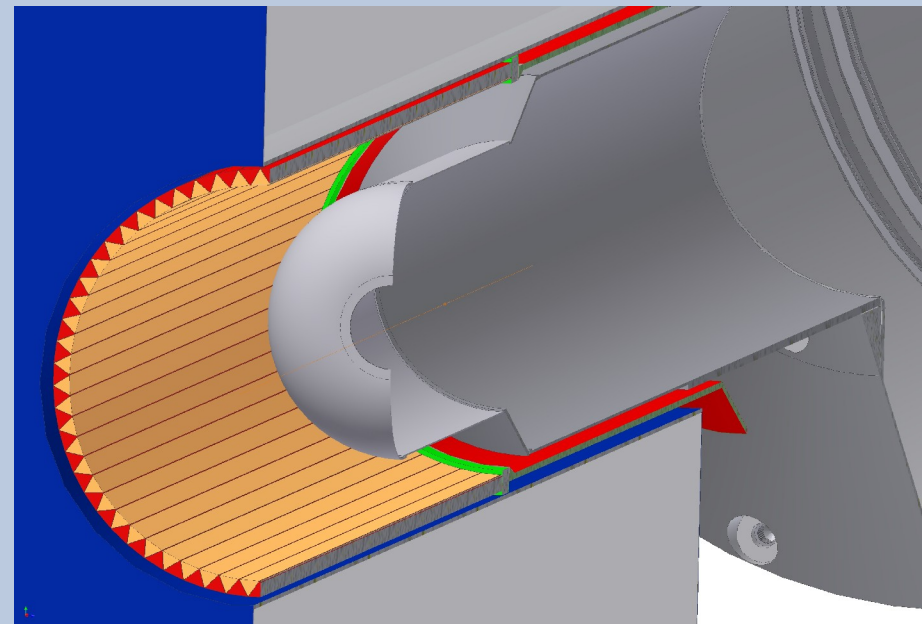
inorganic scintillating fibres

- bright, but... high Z
- high photon conversion probability
- proton scattering
- many (expensive) fibres = channels needed



plastic scintillators (triangular bars)

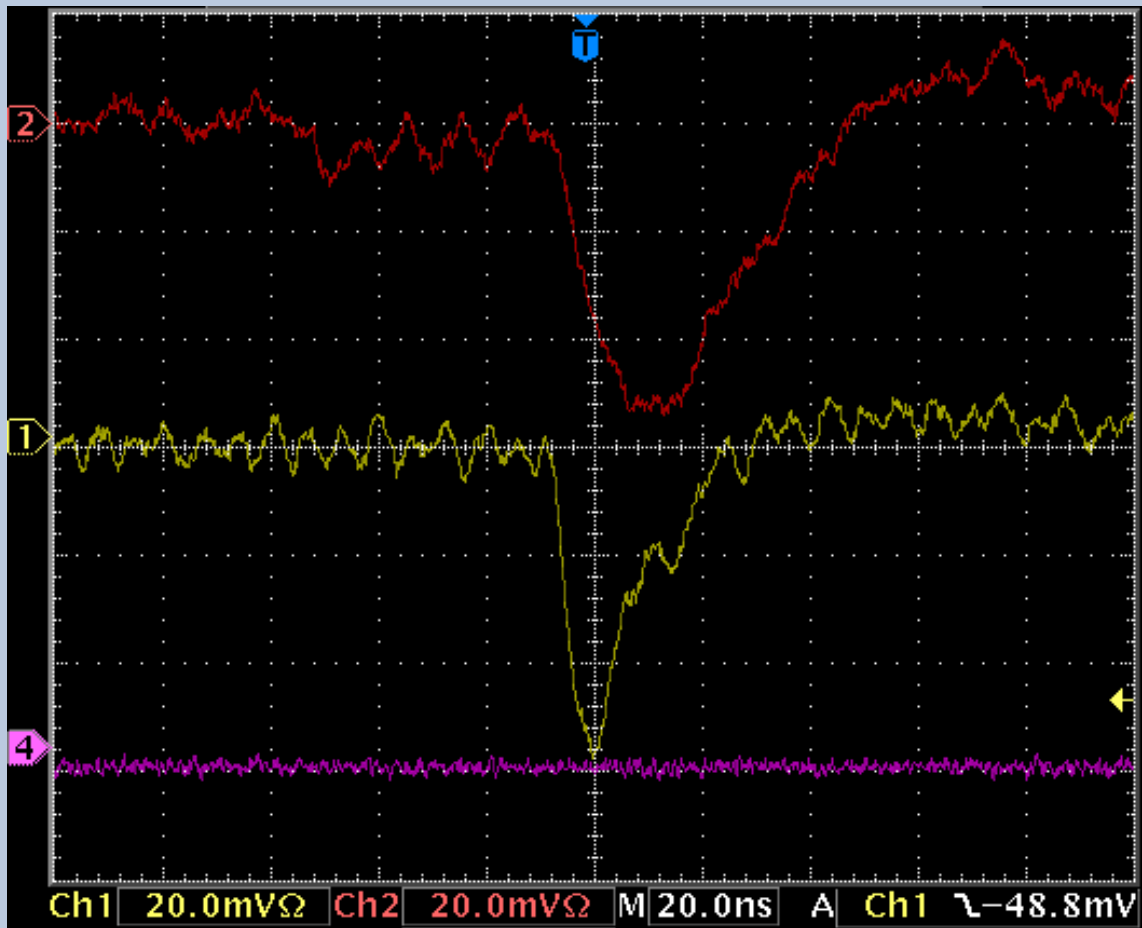
- few(er) channels
- dark (without cladding), < 5 photoelectrons with a PMT at middle of a bar



plastic fibres

- „classic“ solution, > 50 photoelectrons at 15 cm

SiPM Readout of a Scintillating Fibre



SensL 3x3 mm

- SPMScint3035X13
- 3640 Cells

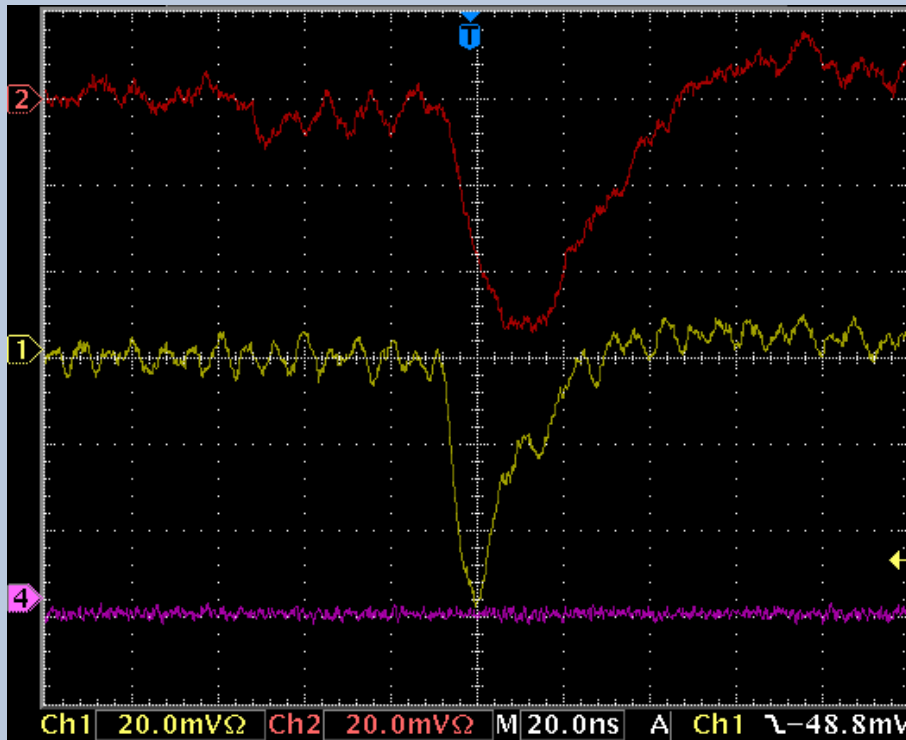
Photonique 2x2 mm

- SSPM_0611B4mm_PCB
- 1700 Cells

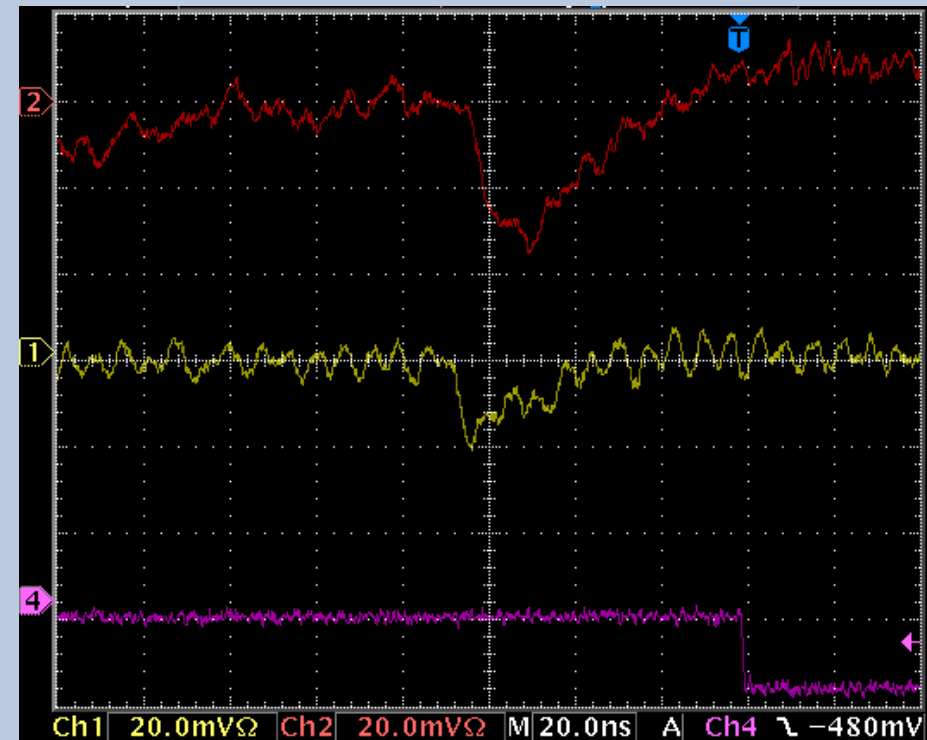
SiPMs read out with
Photonique AMP-0611
Preamp at 9V (Battery)

- 30 cm of 2 mm green BCF20 fibre
- Sr^{90} source at 15 cm, simultaneous readout of both ends (SensL & Photonique)
- external coincidence

Fibre Response to Electrons



Typical signal in self trigger

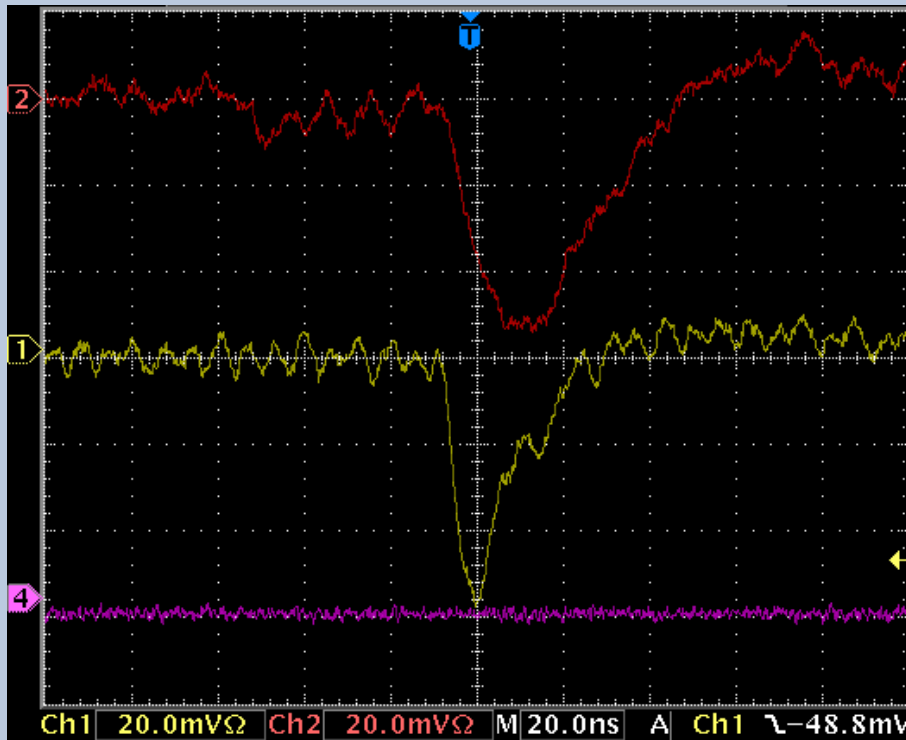


MIP signal triggered by the external coincidence

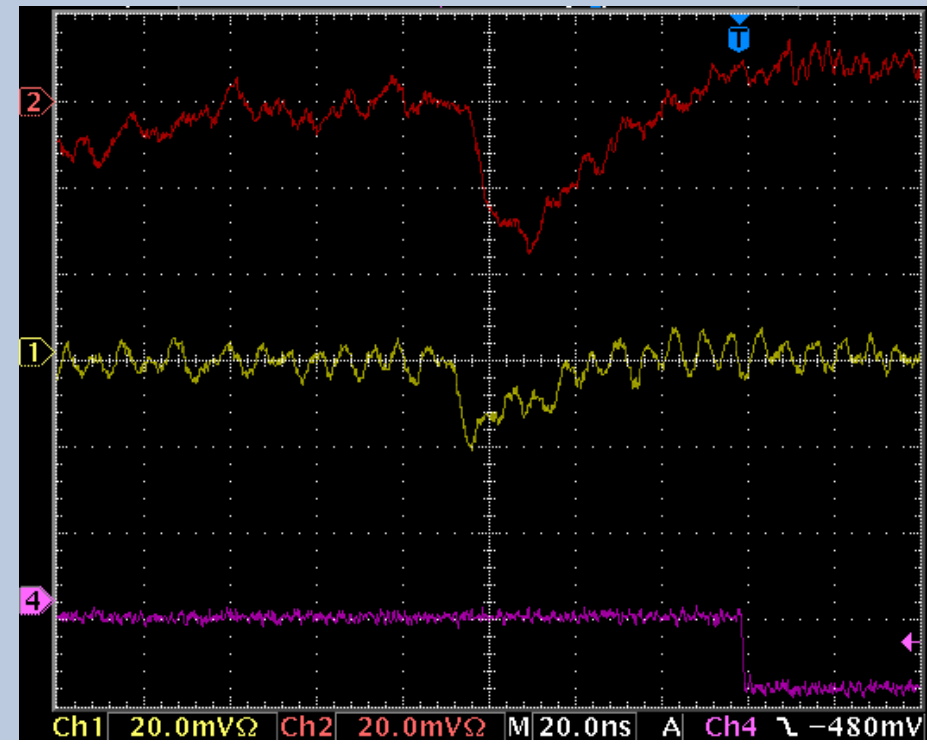
SiPM - 10 cm cable - PreAmp - 30 cm cable -
testbox feedthrough - 1 m cable

Bias supply - 2 m cable - feedthrough -
30 cm cable - PreAmp

Fibre Response to Electrons



Typical signal in self trigger

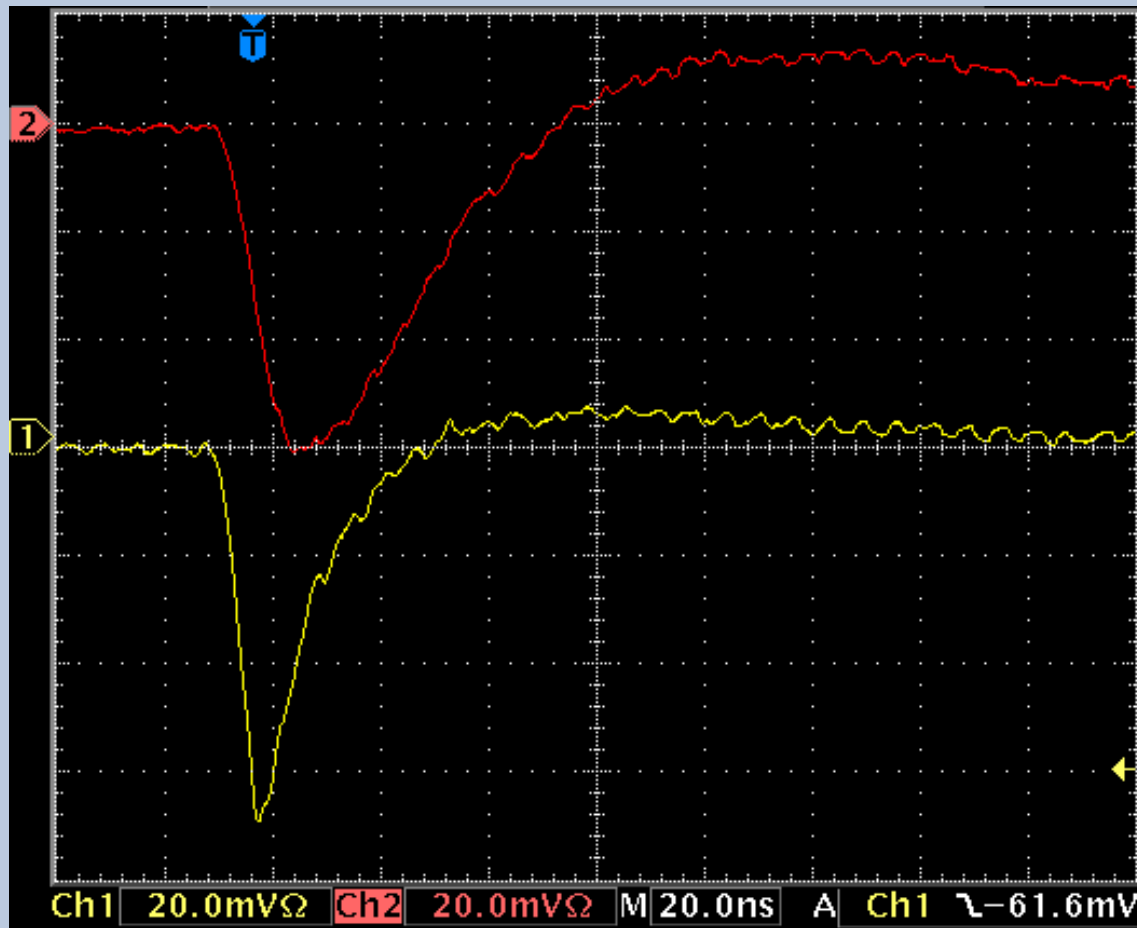


MIP signal triggered by the external coincidence

SiPM - 50 cm cable (or no cable) - PreAmp -
no cable (or 50 cm cable) - patchpanel - 8 m cable

Bias supply - 8 m cable - patchpanel -
no cable (or 50 cm cable) - PreAmp

Fibre Response to Electrons



SensL
3x3 mm

Photonique
2x2 mm

average pulshape of 512 samples

Summary

- three (possible) applications for SiPMs at the Crystal Barrel Experiment
- noise still the biggest problem under „real“ experimental conditions
(room temperature, running experiment / accelerator nearby, larger distances between SiPM and electronic)
- ongoing tests for all three applications ...