Scintillator detectors for ND280 TOF

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Workshop on Neutrino Near Detectors
based on gas TPCs
CERN, 8 November 2016

Requirements for TOF

scintillator detectors
total area ~200 m^2

- **Efficiency for MIP ~ 100%**
- **Timing, σ ~ 0.5 ns ?**
- **Both end WLS/SiPM readout**
- **Dimensions of detectors, length a few meters ?**
- **Spatial resolution?**

Possible option for TOF detectors

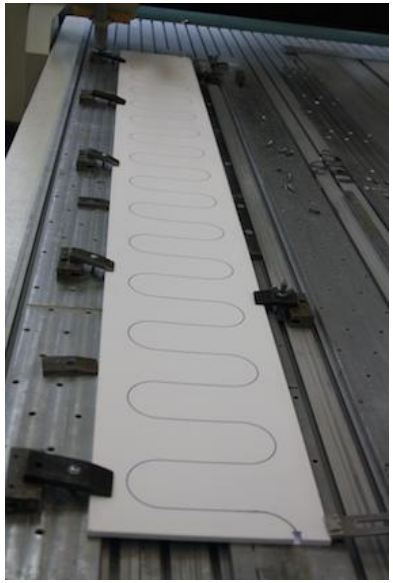
Extruded plastic scintillators

Wavelength shifting fibers: Y11… (decay time 10-12 ns)

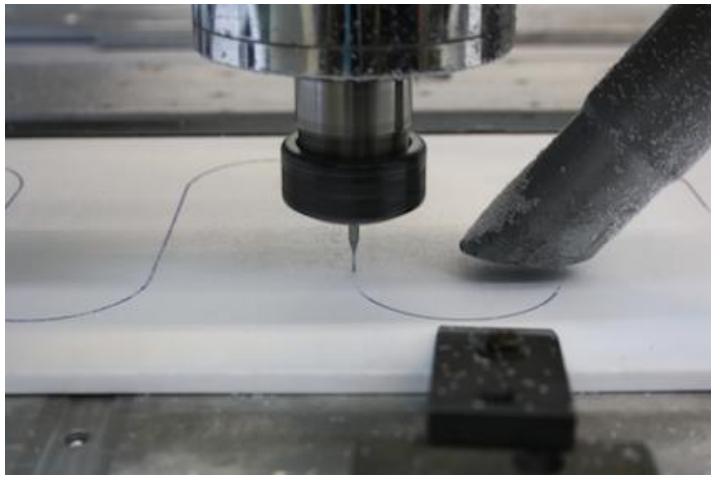
Silicon photomultipliers: MPPC, SenSL…

Extruded scintillator detectors

Baby-MIND detectors

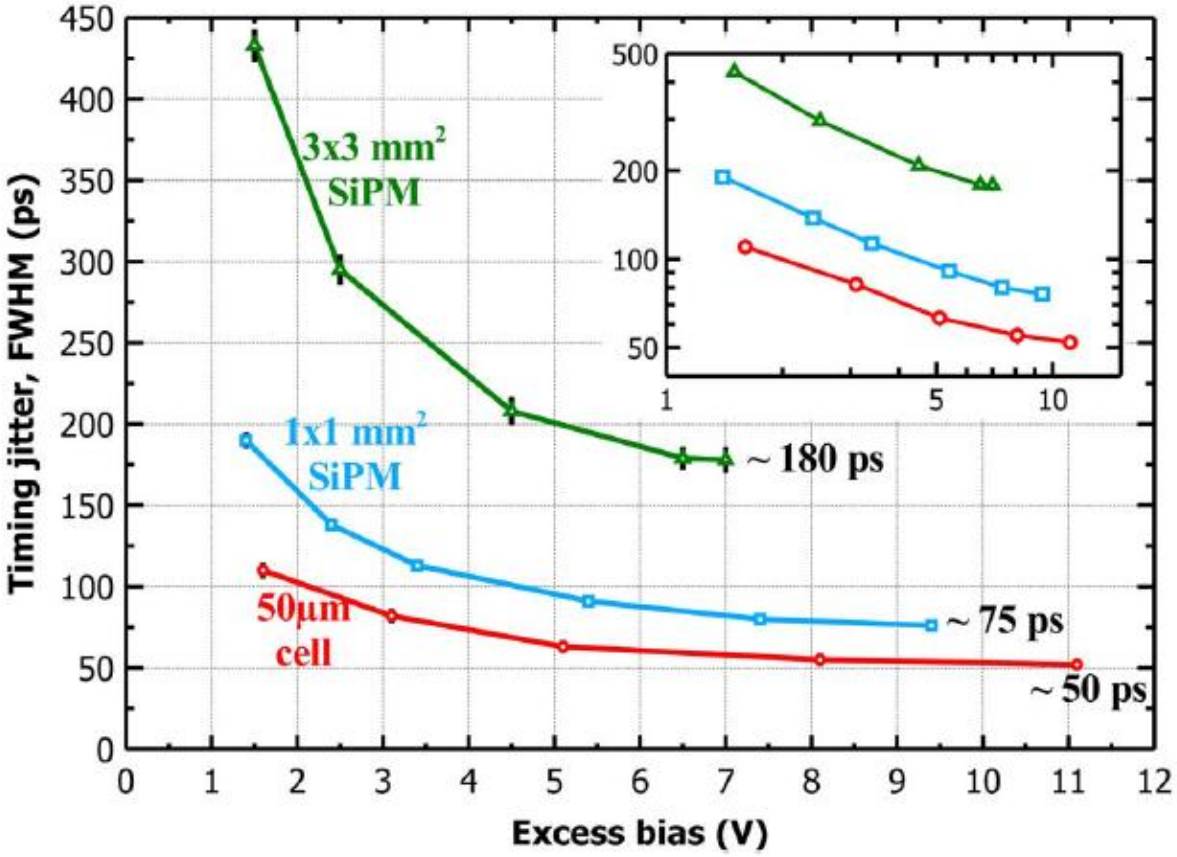


WAGASCI MRD detectors

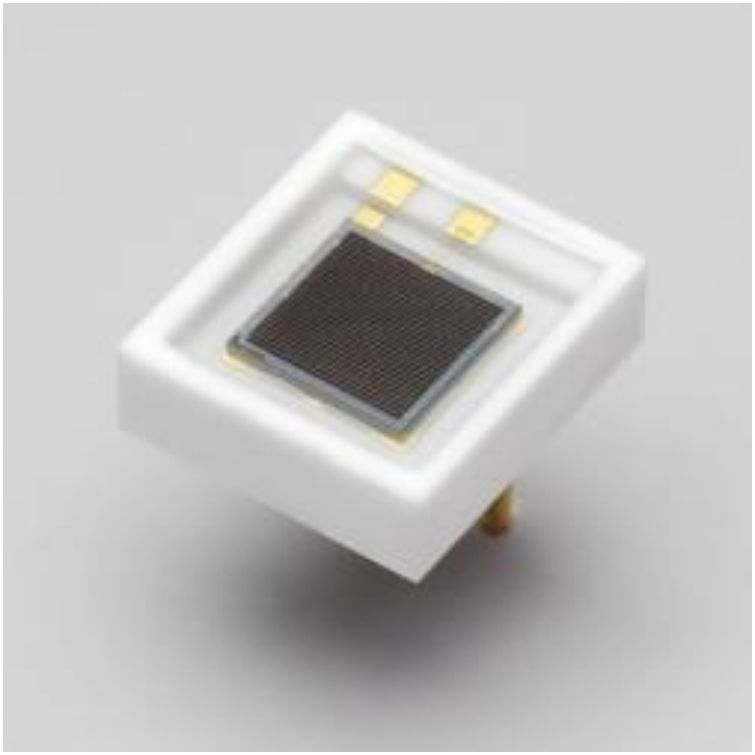


Photosensors: timing

Y.Musienko, talk at RICH2016



Photosensor



Hamamatsu MPPC S12572-050

3x3 mm^2

3600 pixels

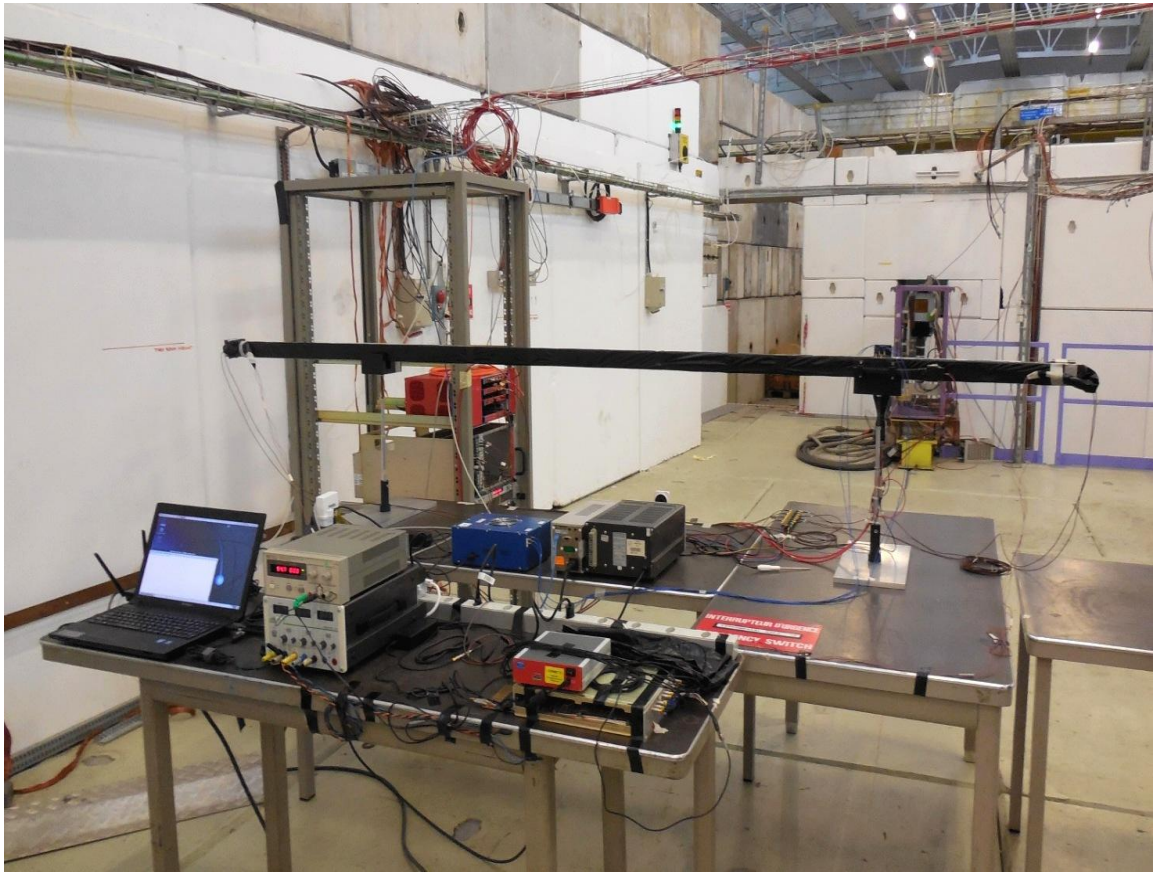
PDE ~36% at 500 nm

Dark rate (th =0.5 p.e.) <1MHz

Time resolution (1 photon) σ ~ 100 ps

Test of extruded scintillators

at PS T9 beam line



Beam: **10 GeV/c**

Composition:

mainly π

Beam size:
trigger counters
cut the beam spot
1(horiz.)x5(vert.) cm2

Scintillator/WLS/SiPM detectors

Slabs: length = 3 m; thickness = 7; width = 3 cm, 5 cm and 10 cm

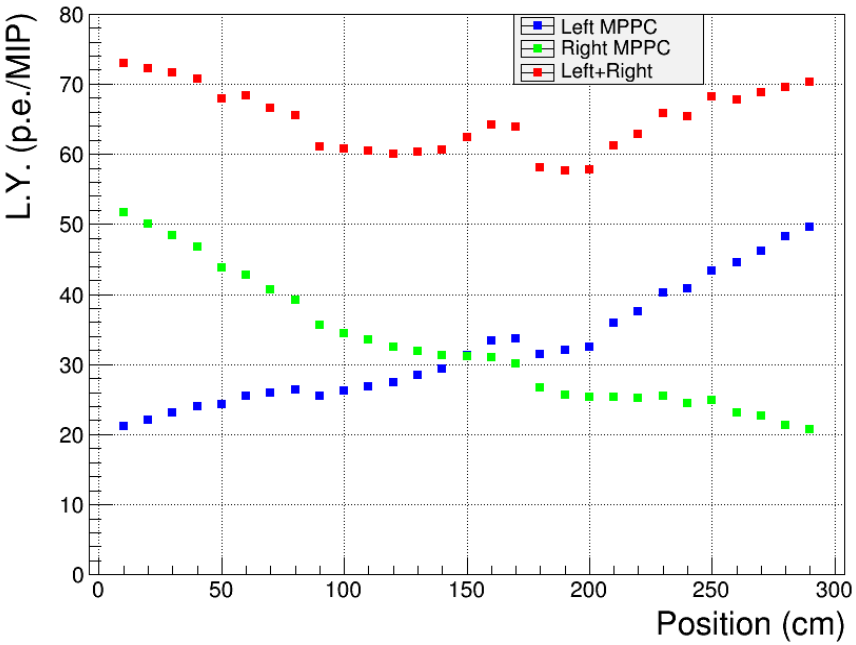
WLS fibers: Y11-MC Kuraray, diameter 1 мм

Photosensors: Hamamatsu MPPC S13081-050CS (1 mm^2)

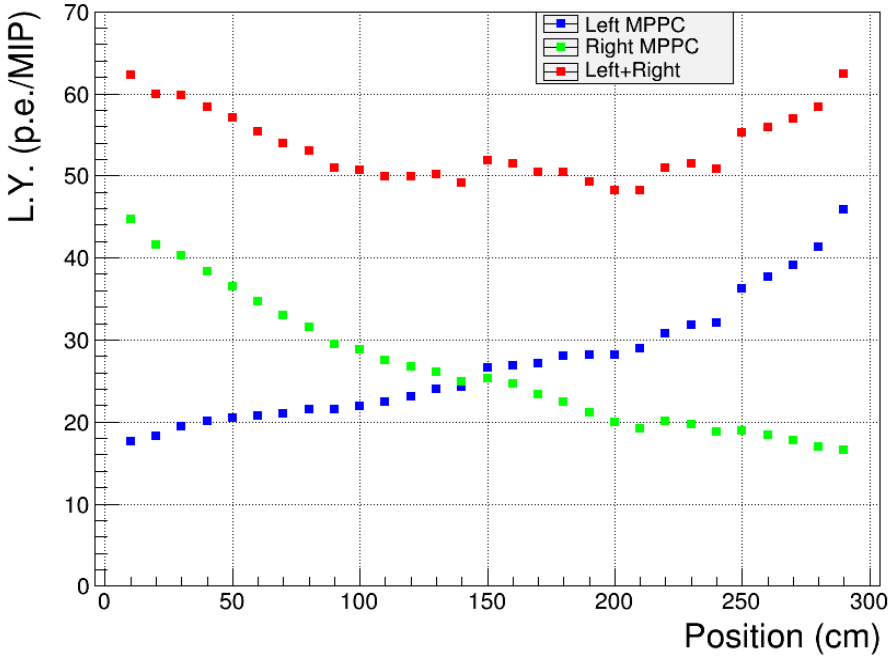
Light Yield

Light yield/MIP

3 cm



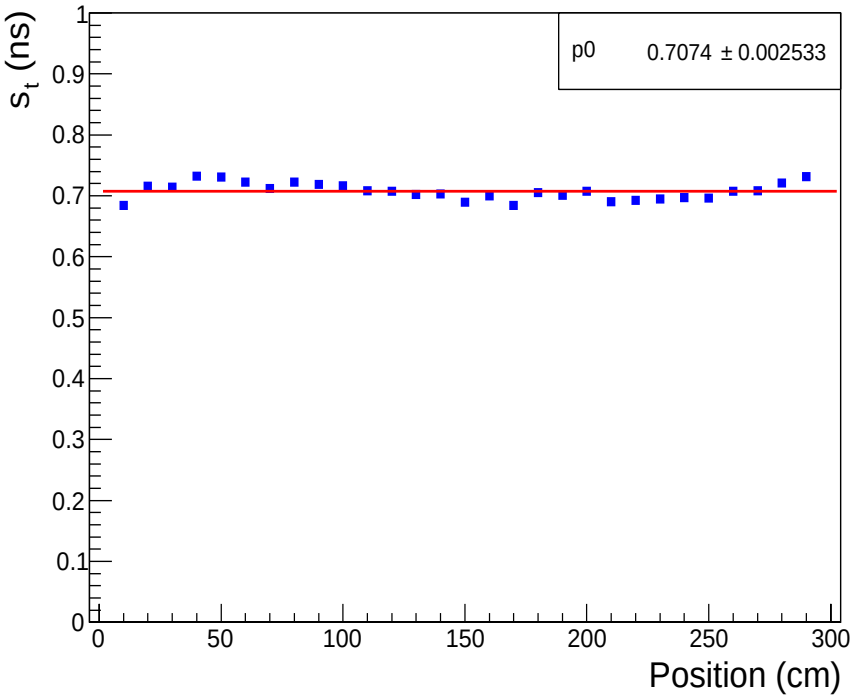
5 cm



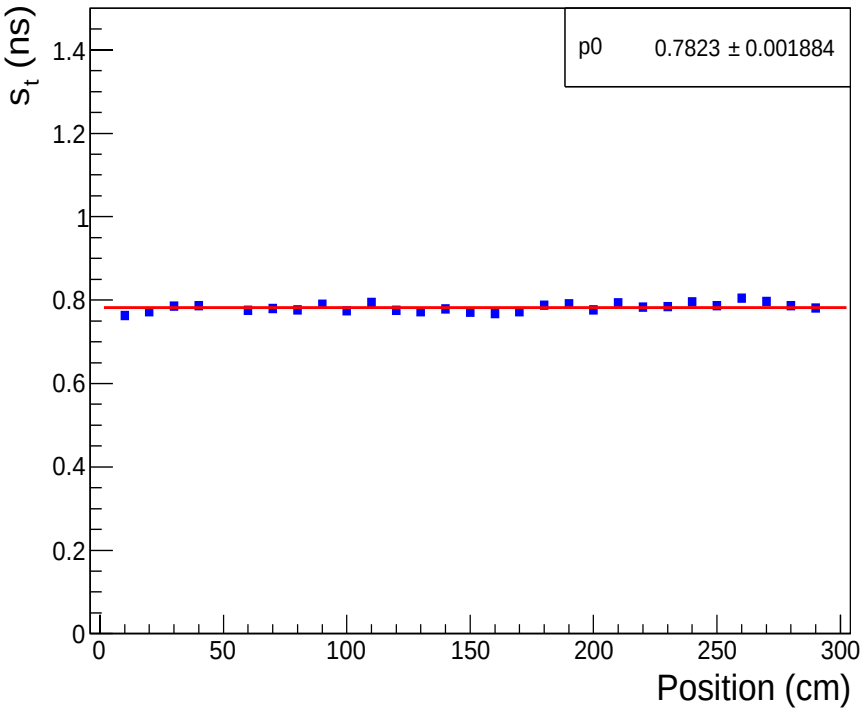
Time resolution

$(T1_{left}-T1_{right})/2$

3-cm slab 707 ps



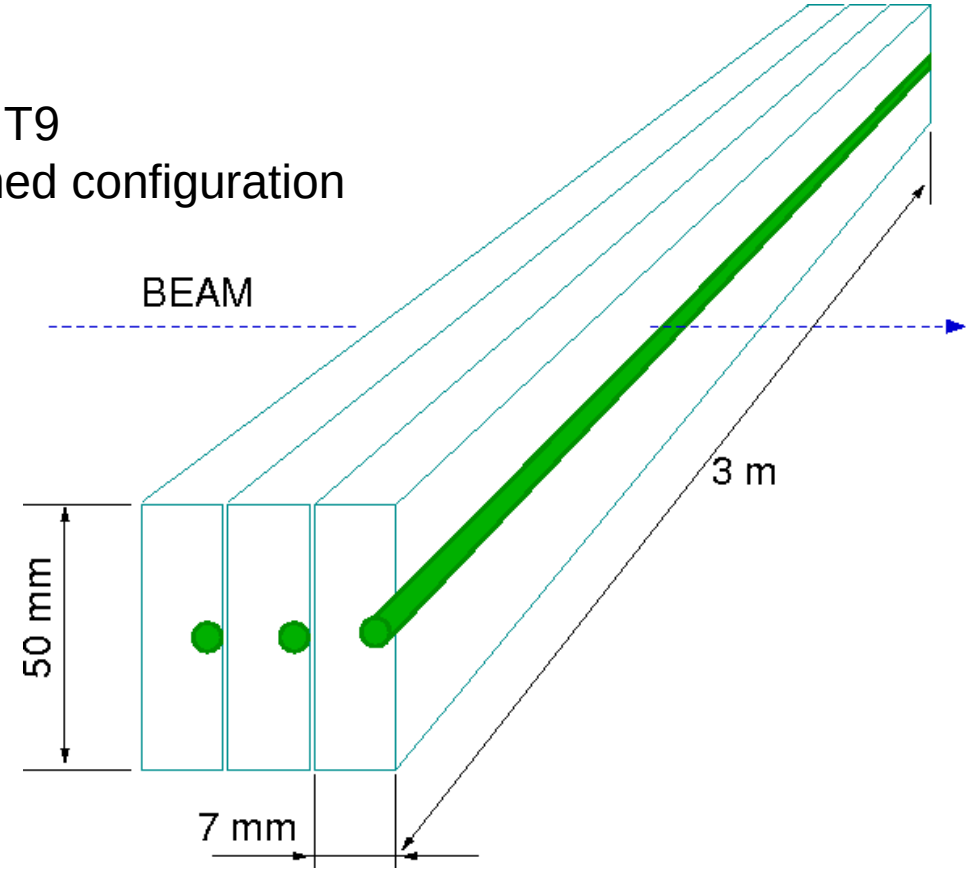
5-cm slab – 782 ps



LY and timing

width	3 cm 1 MPPC	5 cm 1 MPPC	10 cm, 4 MPPCs	10 cm, 2 MPPCs
LY (sum of both ends), p.e./MIP	60	50	45	27
Time resolution, σ ns	0.72	0.82	0.97	1.35

Test at T9
combined configuration



3 bars of the same width were tested simultaneously in the beam.

Average l.y.

3-cm bar 60 p.e./MIP

5-cm bar 50 p.e./MIP

Combination of bars

Time resolution, σ, was calculated for combinations of the bars in the central point:

Two bars: $[(T1_{left}-T1_{right})/2 + (T2_{left}-T2_{right})/2]/2$

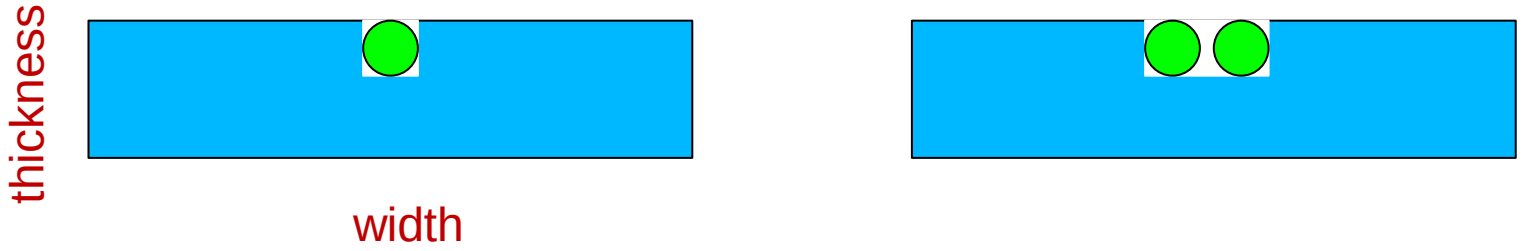
Three bars: $[(T1_{left}-T1_{right})/2 + (T2_{left}-T2_{right})/2 + (T3_{left}-T3_{right})/2]/3$

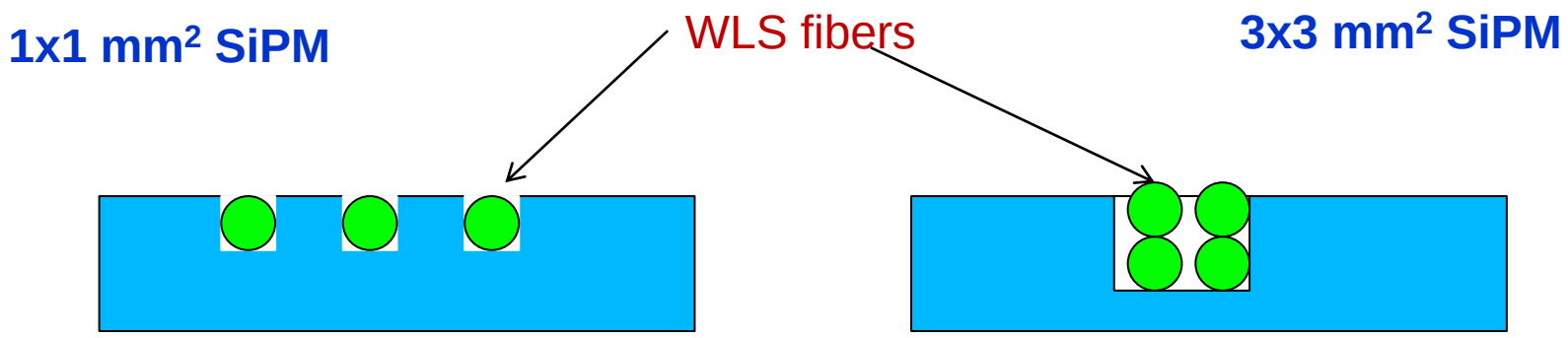
Central point

Bar width	Bar 1	Bar 2	Bar 3	Bar1&2	Bar1&3	Bar2&3	Bar 1&2&3
3 cm	745	682	698	508	530	494	422
5 cm	815	796	780	586	594	574	487

WLS readout options

Length	1 – 3 meters or longer
Width	3 – 20 cm
Thickness	7-10 mm
Reflector	Chemical thickness 50-100 μm
WLS fibers	Kuraray, Y11
Photosensors	SiPM: 1 mm^2 – 9 mm^2 MPPC, SenSL…





Next steps

- Monte Carlo → requirements for TOF detectors
  - needed timing
  - separation of ingoing/outgoing tracks
- Further improvement of scintillator quality
- Optimization of WLS/SiPM readout