

SciTil/BarrelTOF Status

Ken Suzuki, Stefan-Meyer-Institut, ÖAW

09.09.2014 PANDA L. Collaboration Meeting in Frascati

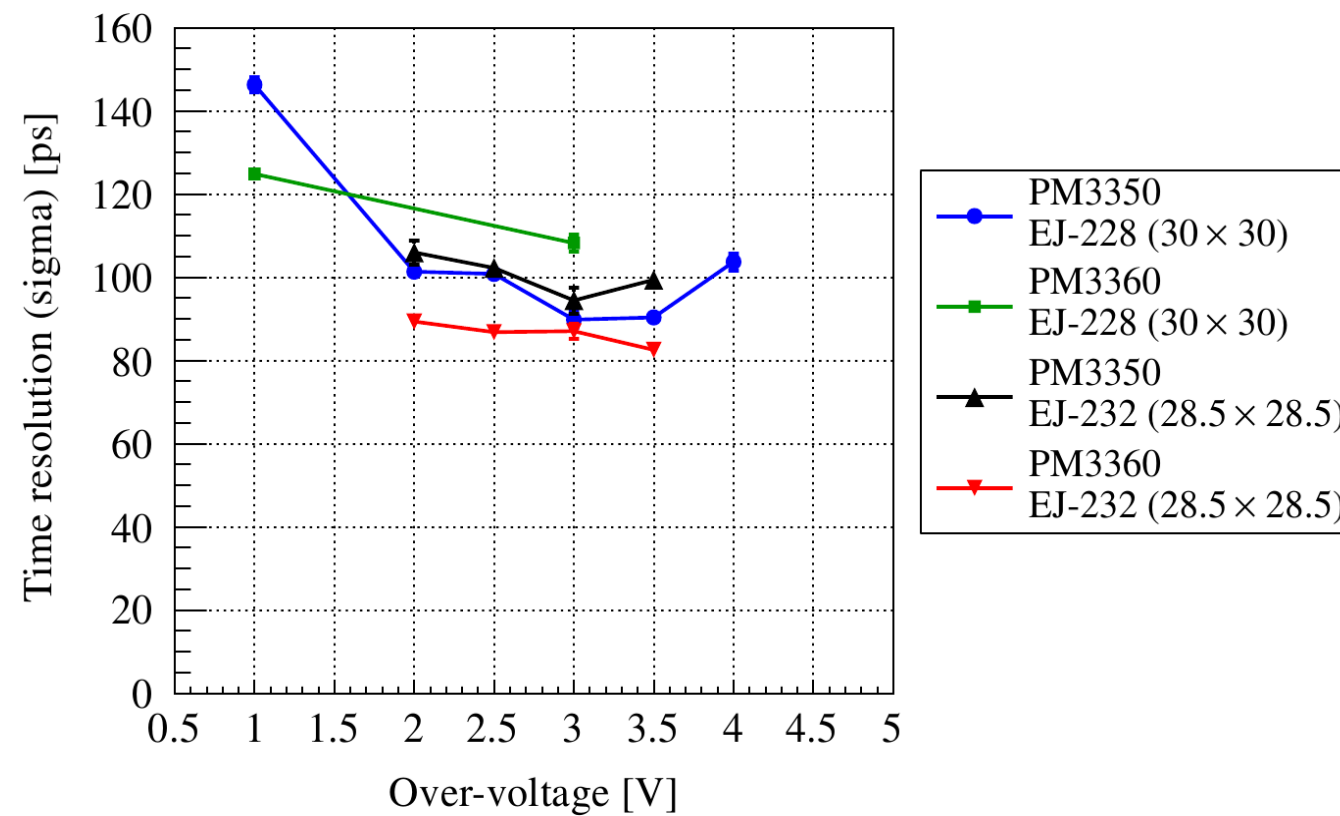
One day workshop on “Scintillation Tile Hodoscope Workshop” 24.7.2014, Vienna

- 09:30 *Greeting,* Hans Marton
- 09:45 *Introduction,* Herbert Orth
- 10:00 *R&D on time resolution studies at SMI,* Lukas Gruber
- 11:00 *News from Krakow on Sci-Rods,* Jerzy Smyrski
- 11:30 *Performance Comparison of SciRods and SciTils,* Albert Lehmann
- 12:00 *R&D on Readout solutions,* NNs

- 13:30 *Status of detector geometry integration in PANDA root,* Herbert Orth
(for Andreas Gerhard)
- 14:00 *Radiation hardness,* Dominik Steinschaden and Ken Suzuki
- 14:30 *Mechanical integration,* Carsten Schwartz (Lars Schmitt)
- 15:00 *Organization of the SciTil group - discussion*
- 15:30 *Schedule towards the TDR -discussion-*
- 16:00 *Funding and personnel - discussion-*

<https://indico.gsi.de/conferenceDisplay.py?confId=2952>

Ketek time resolution



**Time resolution dependent on SiPM type, scintillator and over-voltage.
Time resolution of about 85 ps reached with PM3360TS!**



SciRod Time Resolutions

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

Scintillator $5 \times 5 \times 120 \text{ mm}^3$

MPPC	BC408		BC420	
	Time resol. (σ_t)	Best time resol.	Time resol. (σ_t)	Best time resol.
S10931-100P	83 ± 11	60	66 ± 9	49
S10931-050P	95 ± 8	85	71 ± 9	57
S12572-050P			62 ± 10	52
S12572-015P	101 ± 13	76	85 ± 11	66
S12652-050C	81 ± 12	63	68 ± 10	51

Scintillator $5 \times 5 \times 50 \text{ mm}^3$

MPPC	BC408		BC420	
	Time resol. (σ_t)	Best time resol.	Time resol. (σ_t)	Best time resol.
S10931-100P	87 ± 6	72	64 ± 4	56
S12652-050C	83 ± 6	72	62 ± 5	53

- Two groups independently proved that the desired time resolution can be achieved.
- Further optimisation can be done, nevertheless we know there's a solution.
- An important milestone is achieved.

Work packages (proposal)

- Detector R&D
- Physics Simulation
- Radiation Hardness Test
- Readout Electronics
- Mechanics
- TDR

Work packages (proposal)

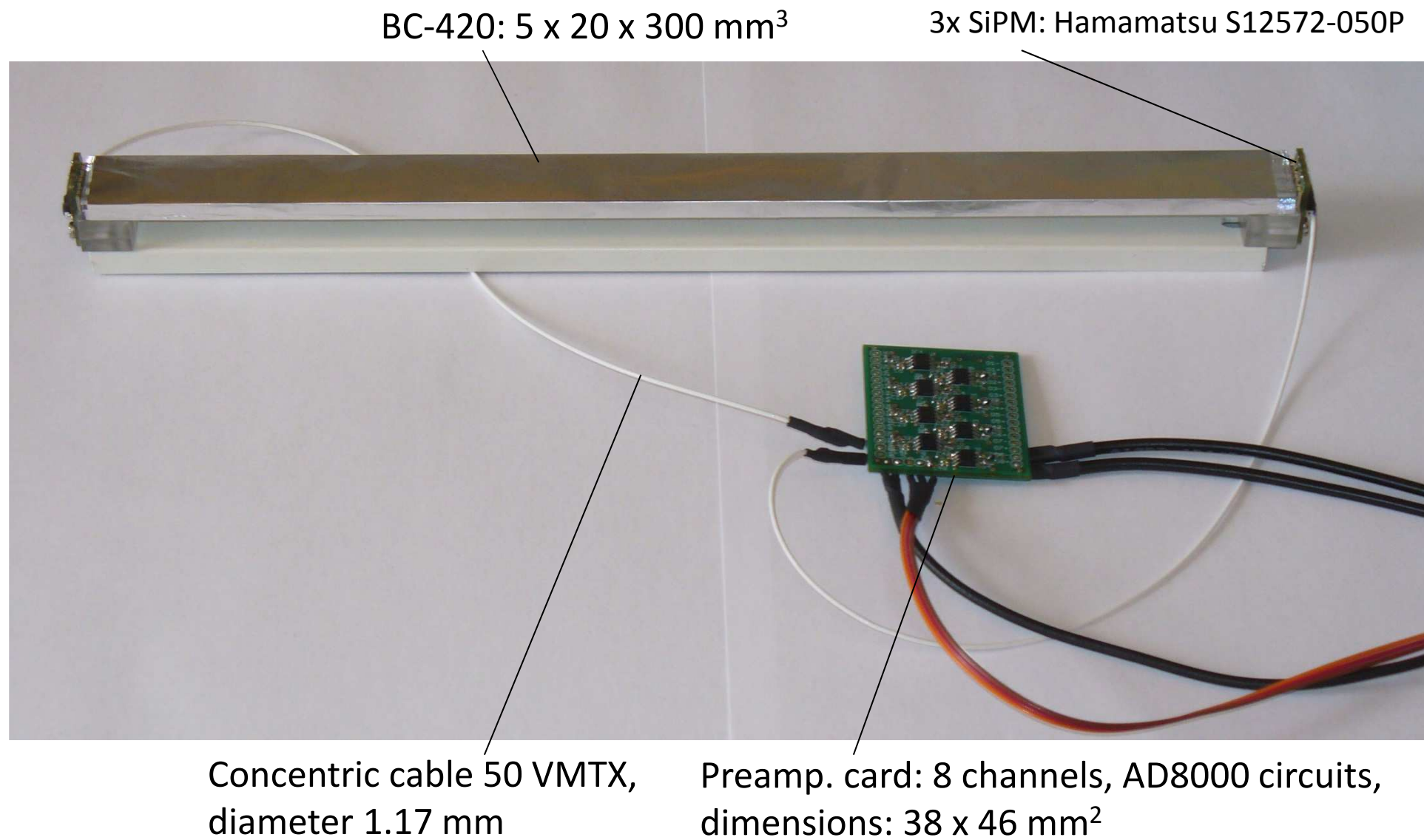
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Work package

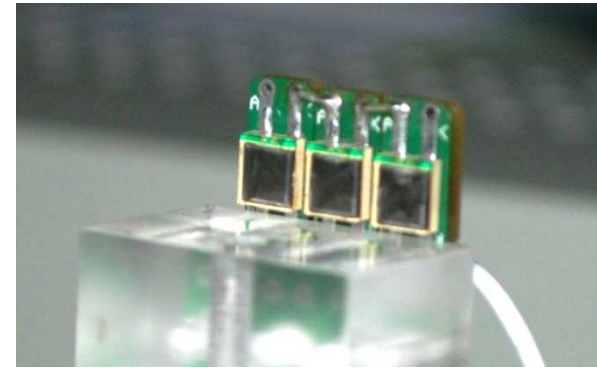
Detector R&D

- SciTil (Vienna) / SciRod (Erlangen / Cracow)
- Detector simulation for optimisation of geometry and other parameters
 - Lukas Gruber has setup a “full” simulation
 - Dominik Steinschaden is ready to do a systematic study
- Test with radioactive source and/or beam
- We know there’s a solution that satisfies the requirement. We should finalise the geometry “soon”. Should be tested with physics simulation as well in parallel.

New prototype



Read out



Active area: $3 \times 3 \text{ mm} \times 3 \text{ mm} = 27 \text{ mm}^2$
Sci-rod end face: $5 \text{ mm} \times 20 \text{ mm} = 100 \text{ mm}^2$

- Three SiPMs (Hamamatsu S12572-050P) connected in series,
 $V_{\text{op}} = 3 \times 67 \text{ V} = 201 \text{ V}$,
advantage: shorter pulses, faster rise time compared to
parallel connection or to single SiPM
- Preamps placed outside active area – connections from SiPMs
to preamps are done with long, thin concentric cables

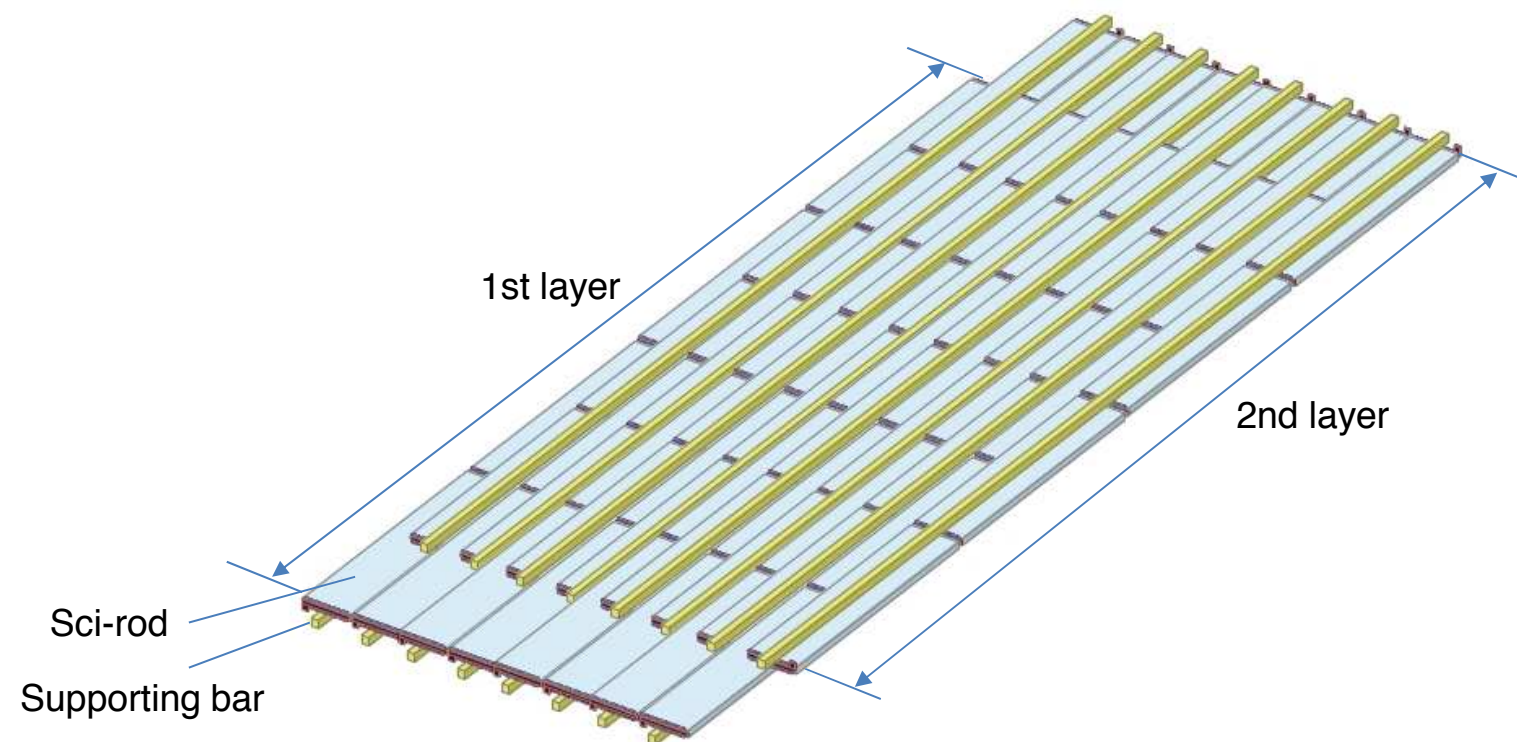
(solutions adopted from P. W. Cattaneo et al., arXiv:1402.1404v1)

MEG2 Experiment

Concept of TOF hodoscope

Two layers of Sci-Rods shifted by half of rod width and length:

- easy relative calibration of the rods
- better time resolution compared to single layer



Work package

Detector R&D, SciRod or other new design

- So far “SciTil” geometry is assumed in
 - Mechanics
 - Simulations in combination with other detector
 - $\Delta\theta$, $\Delta\Phi$ granularity
 - material budget
 - Number of channels and costs

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Work Package

Physics Simulation

... Das groessere Problem ist, dass es keine Studie gibt die belegen koennte, dass die gute Zeitaufloesung des SciTil fuer den DIRC hilfreich ist. Es ist plausibel, dass diese Information hilft, klar.

So gibt es Ideen, dass die Positionsinformation eines Tiles ueber eine Lookup-Table dafuer genutzt werden koennte, dass man schneller als durch das Tracking weiss in welchen Radiatormodul die Spur war und entsprechend im richtigen Sensormodul Photonen zaehlen koennte. Vielleicht hilft auch die gute Zeitmessung als Startwert fuer die DIRC Event Time.

Aber beides existiert wirklich nur als Idee ohne Beweise, nicht als Studie. Zum event timing und der Realisierbarkeit eines DIRC Timings a la BABAR sind wir noch nicht gekommen.

Zudem haben Marko's Simulationen fuer das Time Imaging der Plattengeometrie gezeigt, dass fuer den DIRC wenig Unterschied zwischen 100ps und 500ps Zeitaufloesung besteht was die PID Qualitaet angeht. Diese Studie beruecksichtigt den Untergrund nicht, ist nur event- und nicht time-based, usw, also nicht trivial zu interpretieren. ...

Work Package

Physics Simulation

... leider kann ich nicht an dem Workshop teilnehmen. Es tut mir leid aber it is impossible for me on such a short time notice to go to Vienna first of all (I have obligations here in Pavia) and also to prepare the material necessary to support the statement (in which I STRONGLY believe) the PANDA NEEDS the SciTil system both for Particle ID by means of the time of flight AND for the determination of the T0 of the physical events.

To be totally honest I am not aware that anyone in Panda has done simulations without the SciTil in a realistic situation (== with pileup background events) to demonstrate that. ...

(Gianluigi Boca)

I have written a 'Cleanup' procedure since a very long time, which eliminates tracks with missing hits along the trajectory.

However this procedure has never been refined as it could be.

Consequently the present version overeliminates the tracks leading to a loss in efficiency in the PR when the cleanup procedure must be turned on in the presence of event mixing.

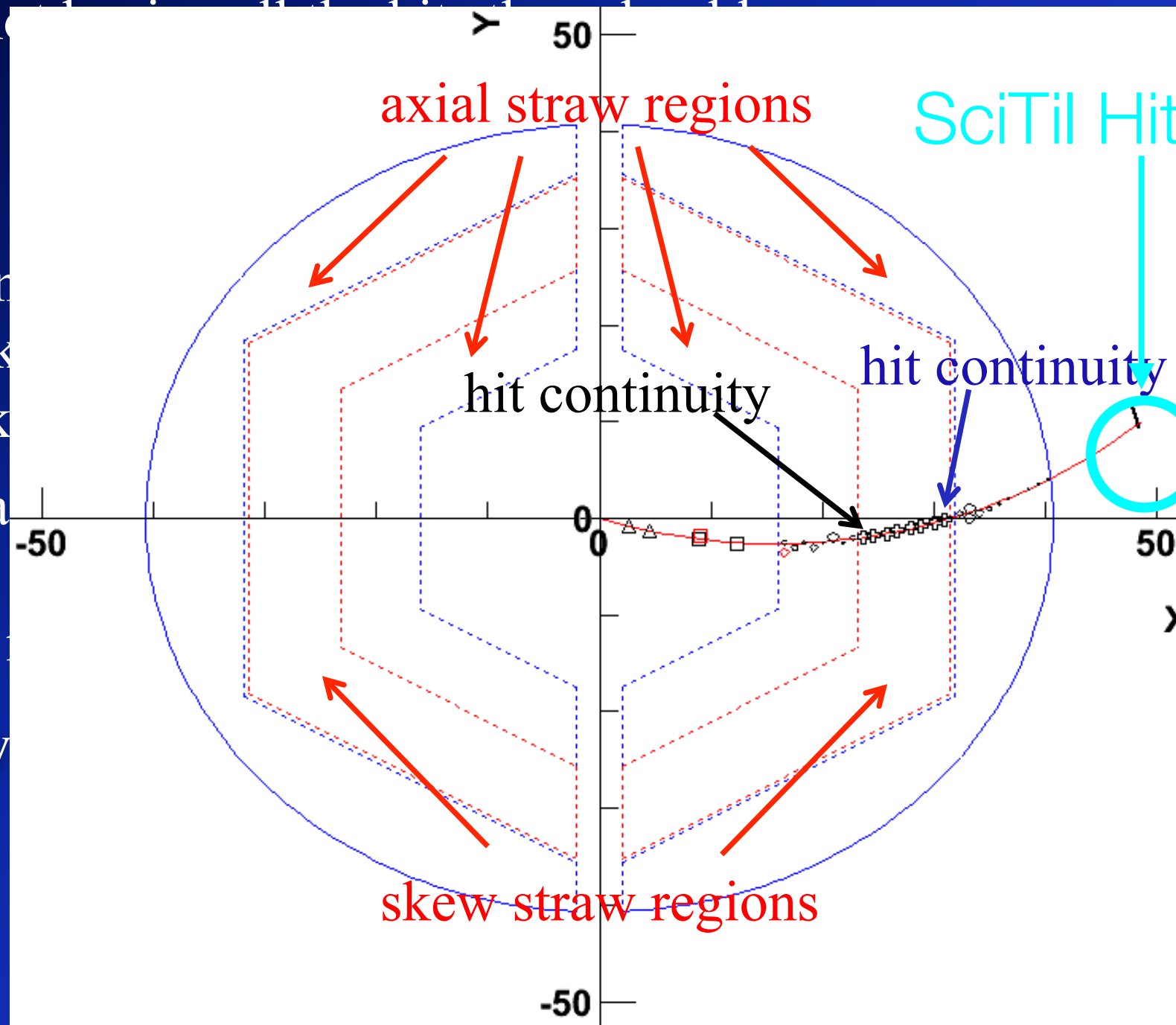
Presently I am rewriting the procedure in a systematic way, trying to exploit all the possibilities intrinsic to the STT, MVD and SciTil subsystems.

The work is still in progress, today I'd like to report the method I am following and the status of the work.

This procedure is contained in a class that can be used as a black box in case other Pattern Recognition needed it.

2 Use the $Z \phi$ positions of the skew hits to eliminate spurious tracks

- there is one hit (track) axial + skew
- first and last exception boundary
- continuity



new

raws.

Work Package

Physics Simulation

- This is to me a very high priority task that should be accomplished.
- Who? Ideally there's someone from the TOF group who dedicates him/herself to that task though...
- We need anyway a help from computing group people who has done a lot physics simulations.
- Contacting Stefano or Gianluigi would be a good starting point?

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Work Package

Radiation Hardness Test

- “Literature” study on-going
- HPH2020 just submitted, including a WP for a study of SiPM radiation hardness (coordinator: Herbert)
 - comprehensive and systematic study with n/p/e/ γ
 - but the timescale may **not** fit for us
- We should organise a test soon?
 - PIF@PSI
- Communicate with manufacturer
 - as they’ve been working on that and rather likely what we employ for the PANDA is a next generation product

Darkcount rate increase after irradiation

- Not very quantitative. Accidental observation during beamtime
 - JESSICA@FZ-Jülich
 - 2.7 GeV/c proton, $I=10^6$ Hz, defocused over a few cm^2
 - significant increase of darkcount
- 1% of 10^6 for 20 hours $\rightarrow 7 \times 10^8$ MIPs

Time needed to reach that dose in PANDA environment

- Assumption
 - 100 Hz/cm^2 (full intensity)
 - 100% duty factor
 - No recovery
 - 7×10^8 to start to see an effect
 - 7×10^{10} to start to lose a single *p.e.* detection capability
- $7 \times 10^8 / 100 / 3600/24 \sim 80$ days
- $7 \times 10^{10} / 100 / 3600/24 \sim 8000$ days

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Status

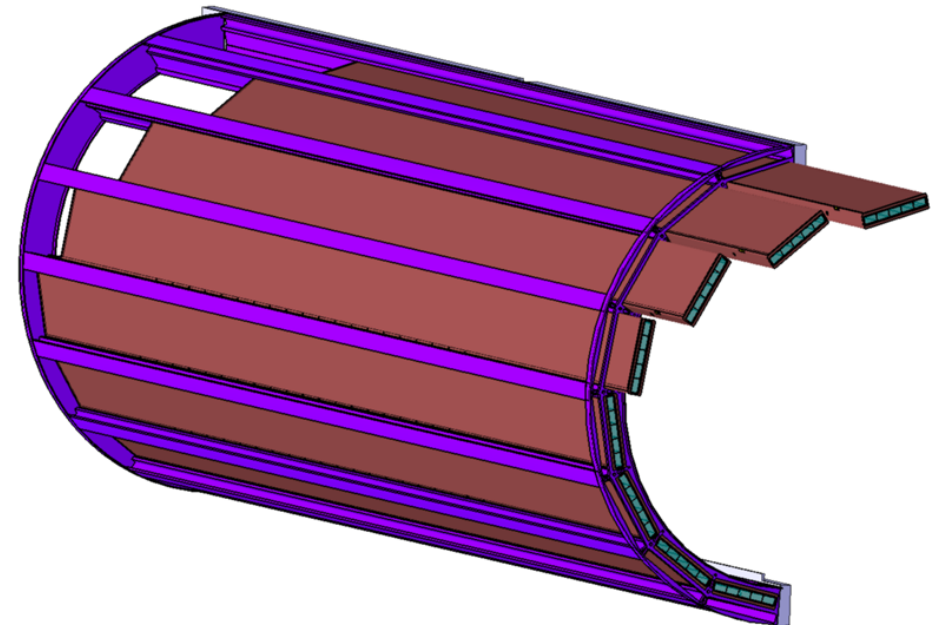
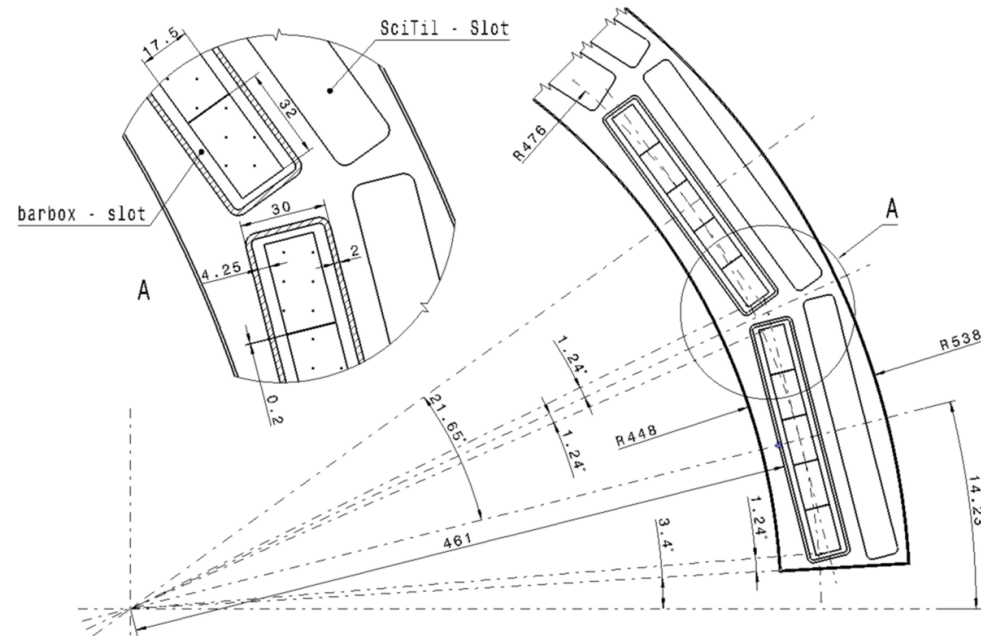
- Conceptual design is the proposal
- Carsten got an evaluation kit of TOF-PET chip
- Very high priority to get started
 - WG, TF
 - Avoid a full R&D from scratch. Any nearby group inside/outside PANDA who does a similar thing?

Work packages (proposal)

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Workpackage Mechanics

- Support frame shared with DIRC
- CAD drawing exists, but relying on the DIRC group

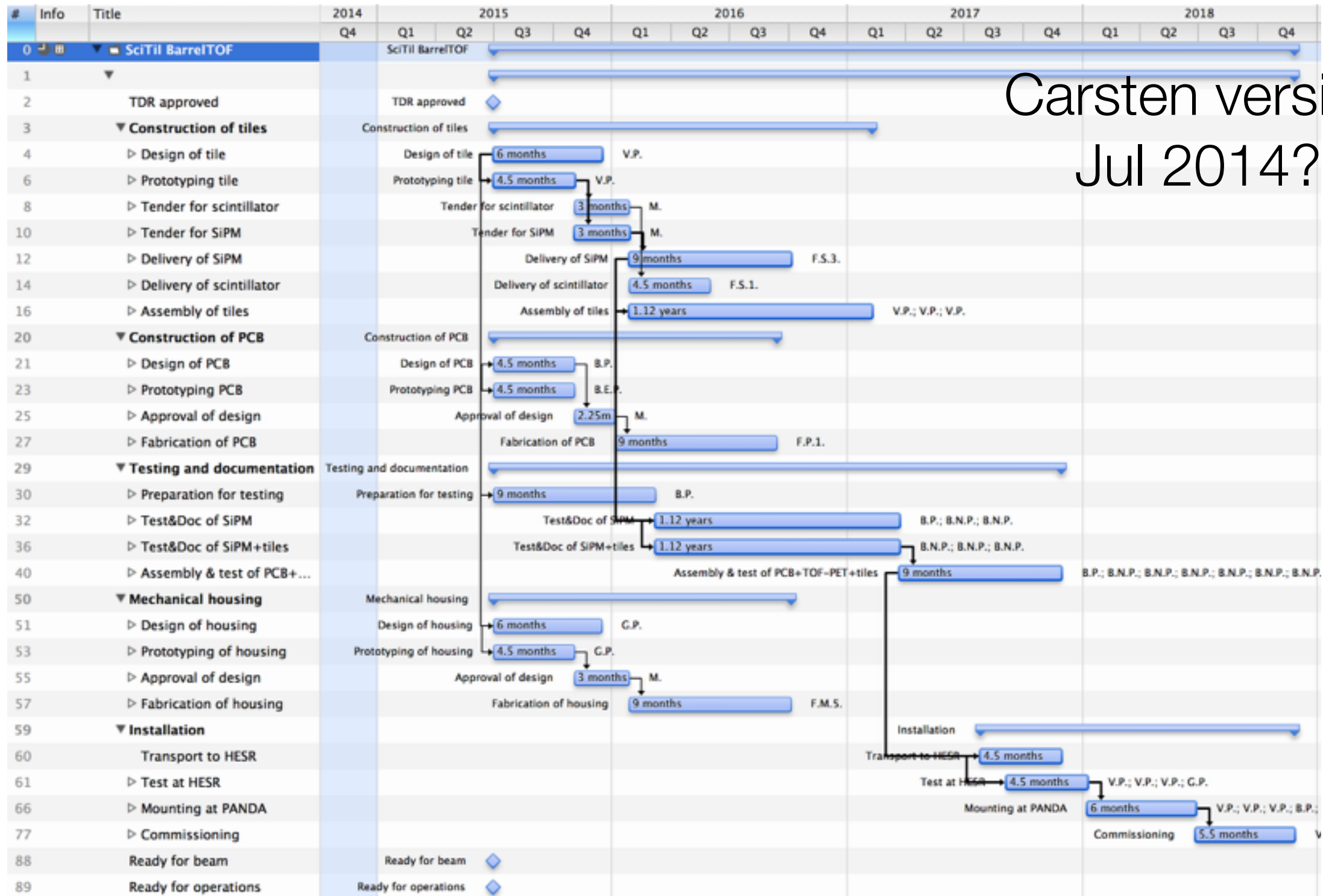


- Vienna will start our own design study, communicating with DIRC group, to implement possible a new design
- Alignment

Work packages (proposal)

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- Mechanics
- **TDR**

Timeline



Carsten version
Jul 2014?

Miscellaneous / Organisational detail

Communication Platform

- GSI Forum: PANDA>PANDA Detector>PANDA TOF
 - https://forum.gsi.de/index.php?t=thread&frm_id=165&
- Mailing list on GSI ListServ
 - PANDA-SCITIL
- Webpage
 - <https://www.smi.oeaw.ac.at/scitil/>

News from Vienna

- Lukas Gruber
 - finishing his thesis soon. next post unknown
- Stefan Brunner
 - just finished his thesis. likely to leave Vienna though unclear
- Dominik Steinschaden
 - started PhD recently

Spare slides

Cost Estimate

Element	Unit cost (€)	Barrel (kEUR)	Endcap (kEUR)	Total (kEUR)
Scintillator Tiles	25	140	50	190
SiPM	30	330	120	450
Readout	20	220	80	300
Mechanics		50	20	70
Sum		740	270	1010

Cost Estimate

Found a company making a scintillator tile, polish, glueing SiPM and wrapping for ~12€ per unit, 6-8 month delivery time for 6000 pieces

Element	Unit cost (€)	Barrel (kEUR)	Endcap (kEUR)	Total (kEUR)
Scintillator Tiles	<i>12.5</i>	<i>70</i>	<i>25</i>	<i>95</i>
SiPM	30	330	120	450
Readout	20	220	80	300
Mechanics		50	20	70
Sum		<i>670</i>	<i>245</i>	<i>915</i>