PANDA SciTil Supermodule Prototype

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PANDA LVII Collaboration Meeting, GSI
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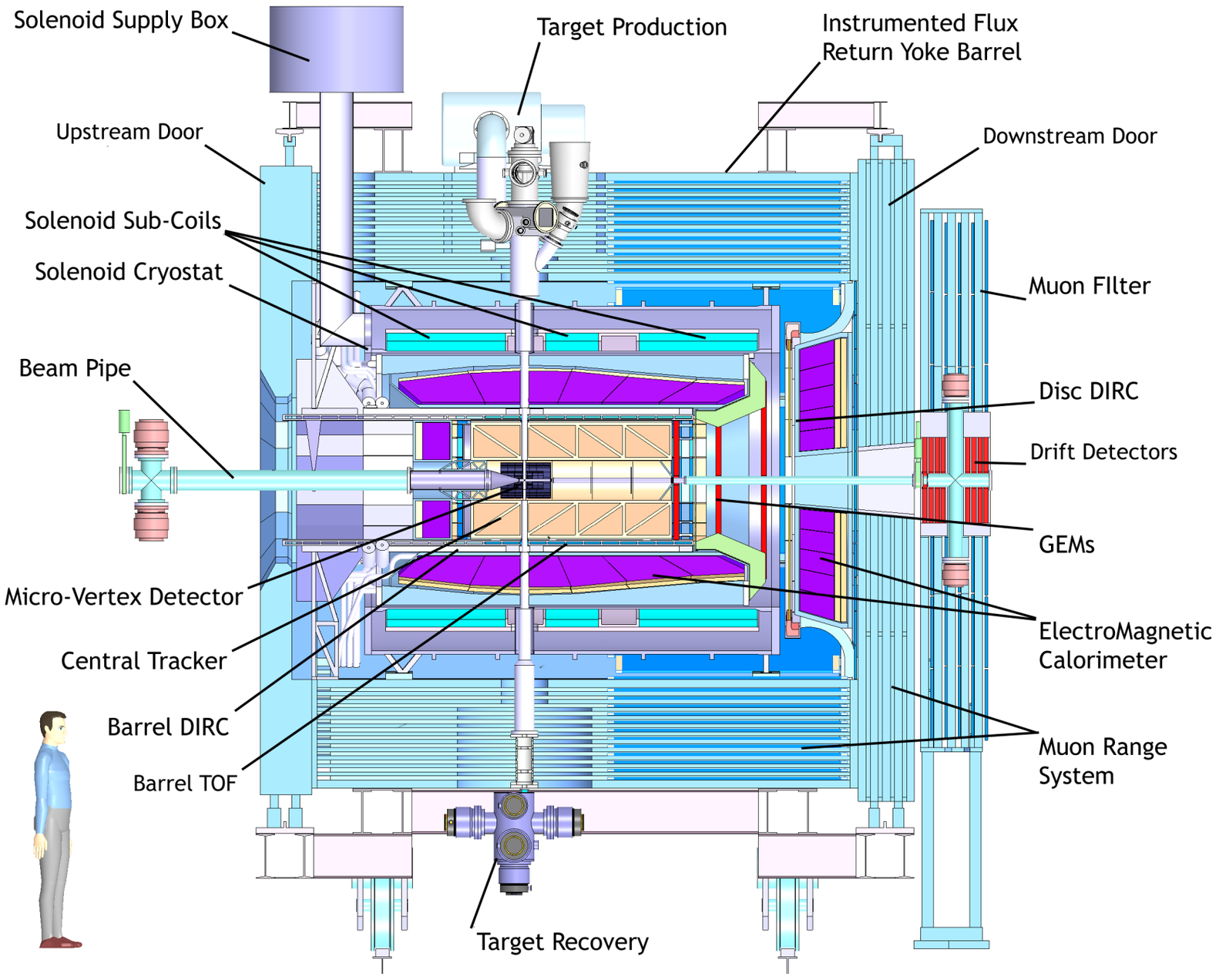
Background

- TDR delivery due at the next PANDA meeting

- First prototype to test several concepts, mostly mechanical stability and “rail board”*

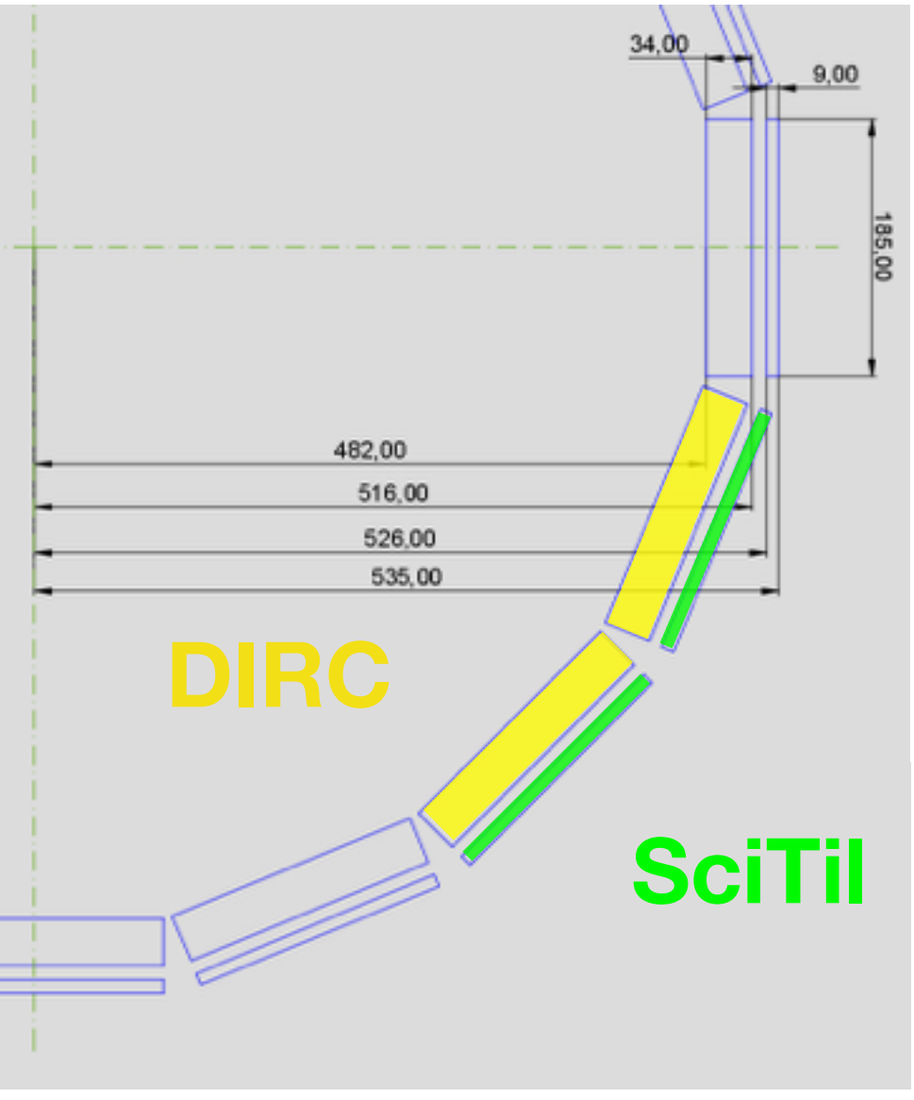
- W/ or w/o the ASIC(TOF-PET) chip

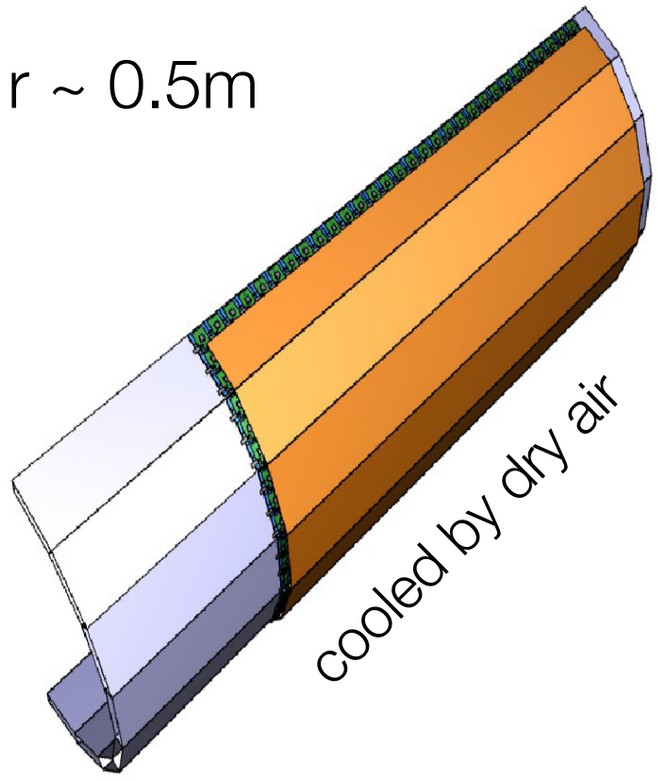
Barrel timing counter in TS = SciTil



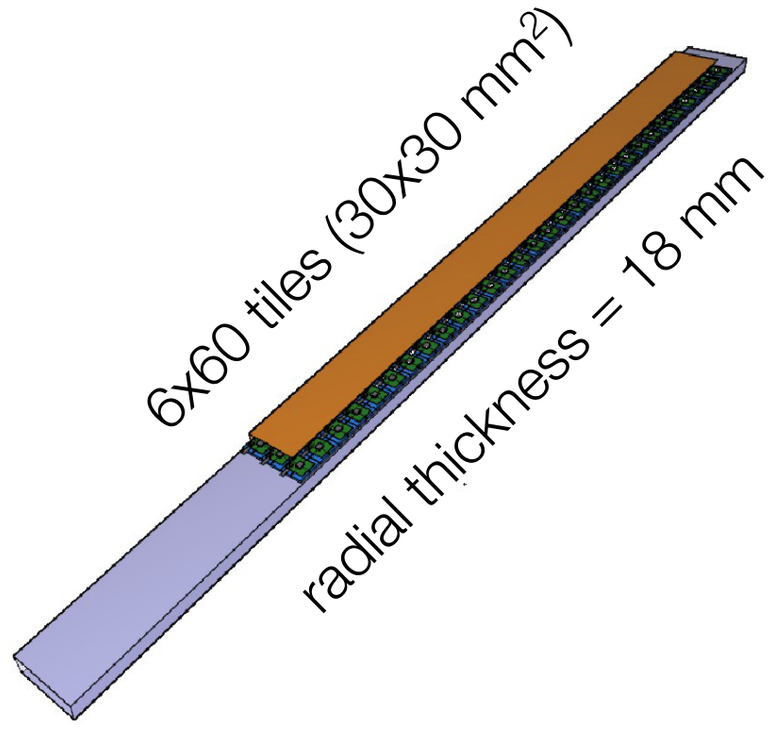
MVD<STT<DIRC<SciTil<EMC

Detector Layout





16 Super modules
outside of DIRC barrel

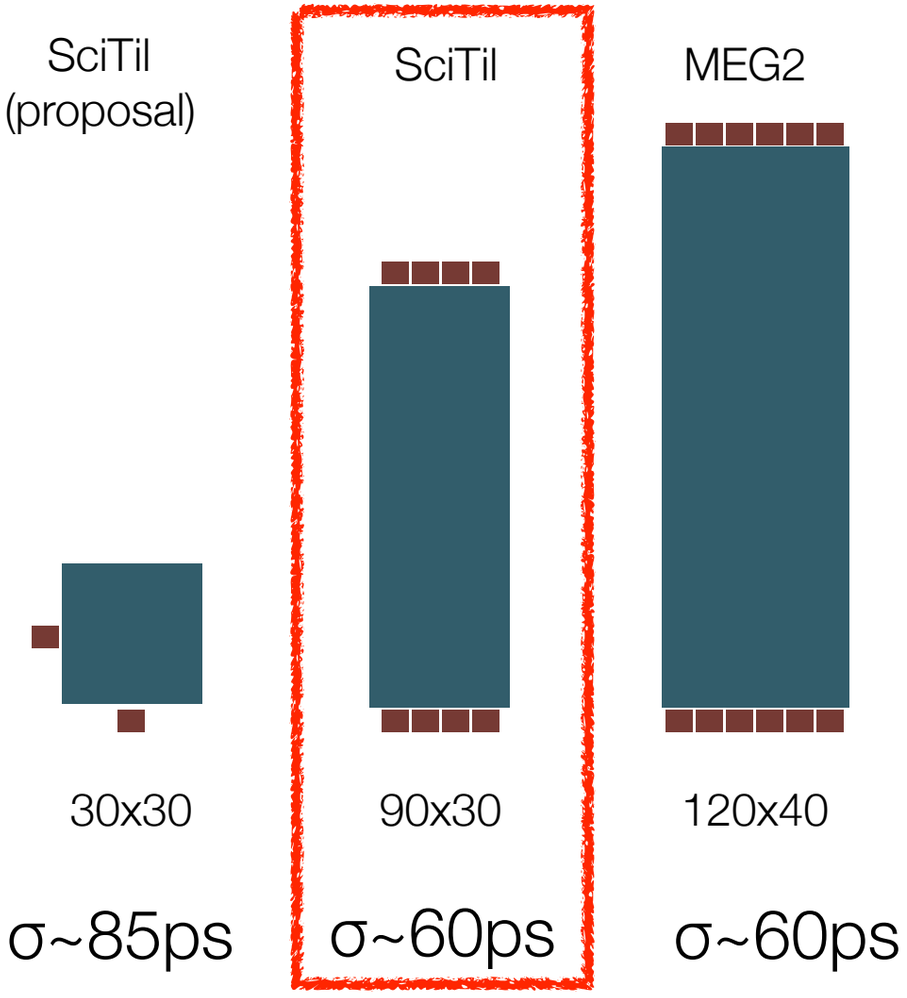


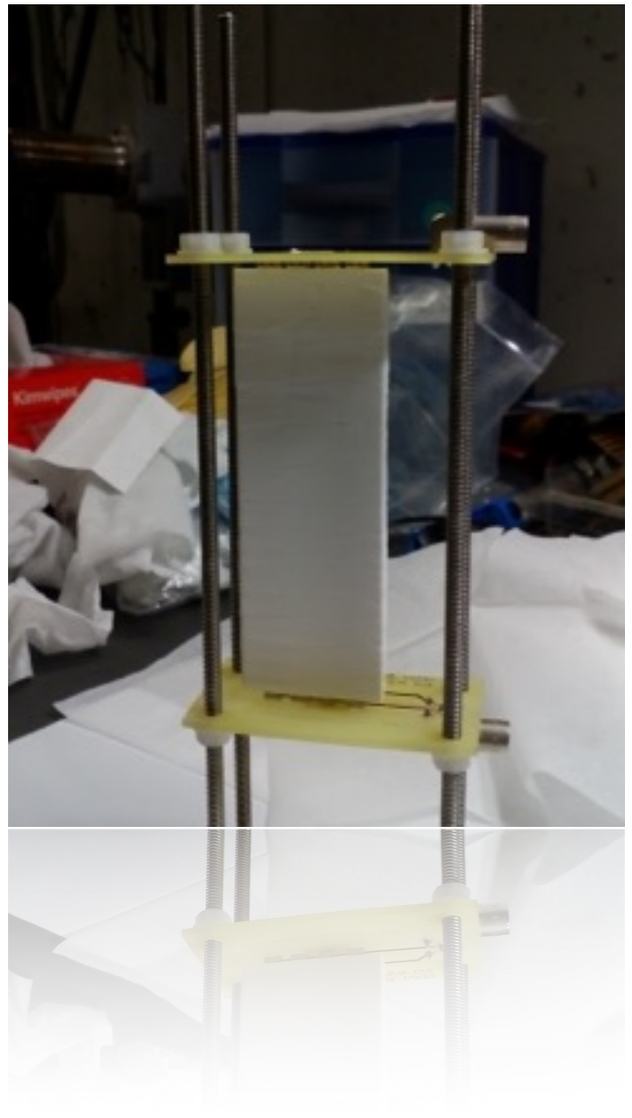
Super module
= 1800x180

Total 5760 SciTil module = 11420 SiPM channels

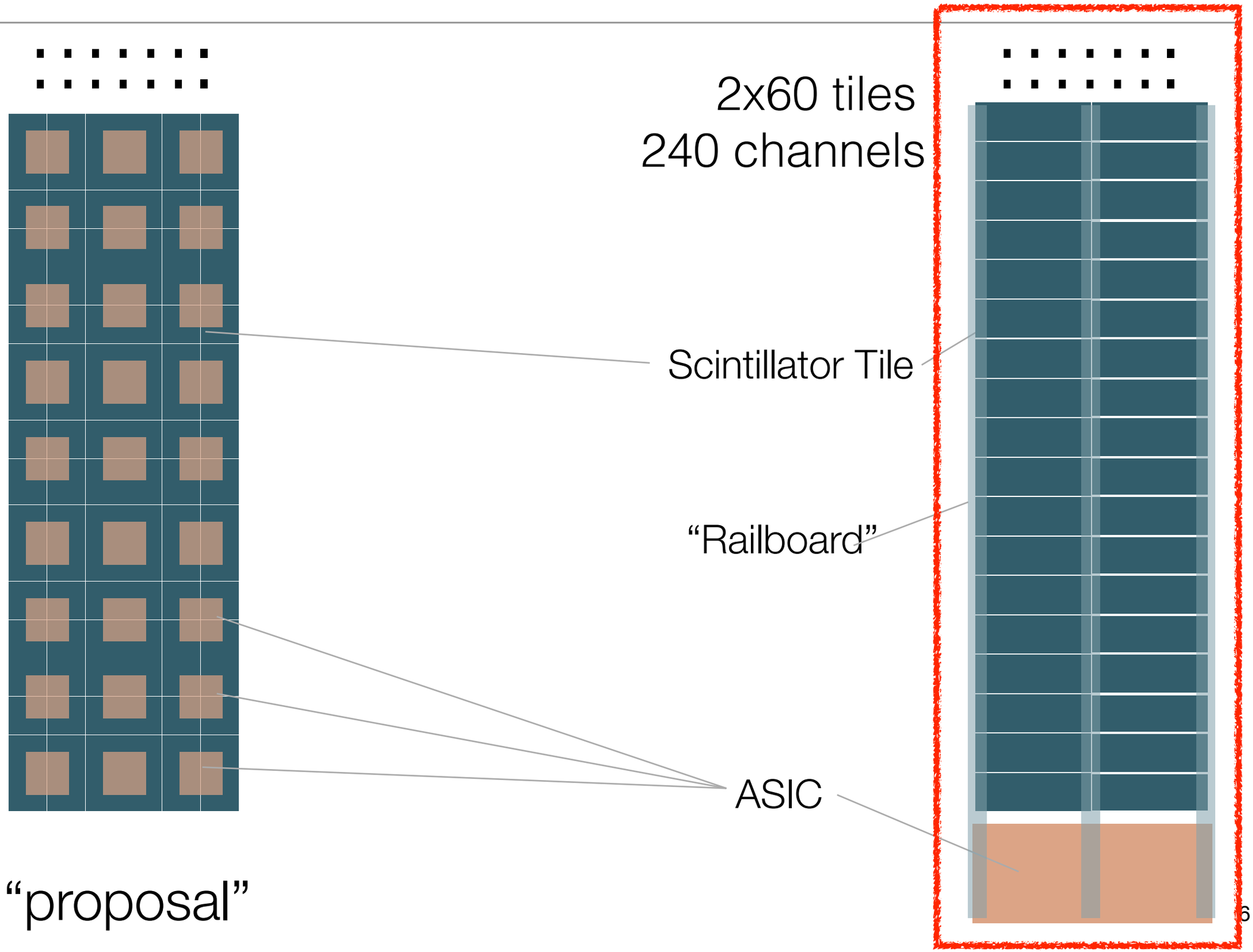
K. Goetzen et al., Proposal for a scintillator barrel hodoscope for P̄ANDA

SciTil single tile design



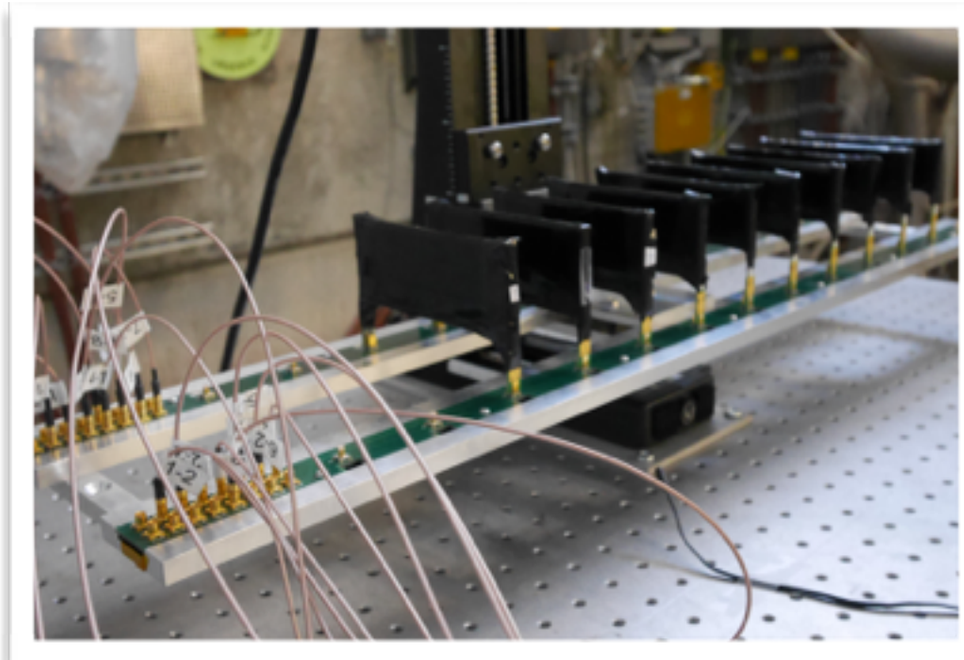


SM conceptual design



Rail Board

- multi-layered (>60 layers), long and narrow PCB board, that works as
  - multichannel signal cable
  - noise resistant = coax. cable equiv.
  - function as a support structure
- What we (PANDA SciTil) need
  - length = 180 cm, width = 25 mm?, thick < 4 mm?
  - 60(120) channel = 30 x2(x4) = 240(x) layers
- What MEG2 had
  - length = 94 cm, width = 25 mm, thick = 5mm
  - 16 channel = 8 x 2 = 48 layers?



Example of MEG2 TOF

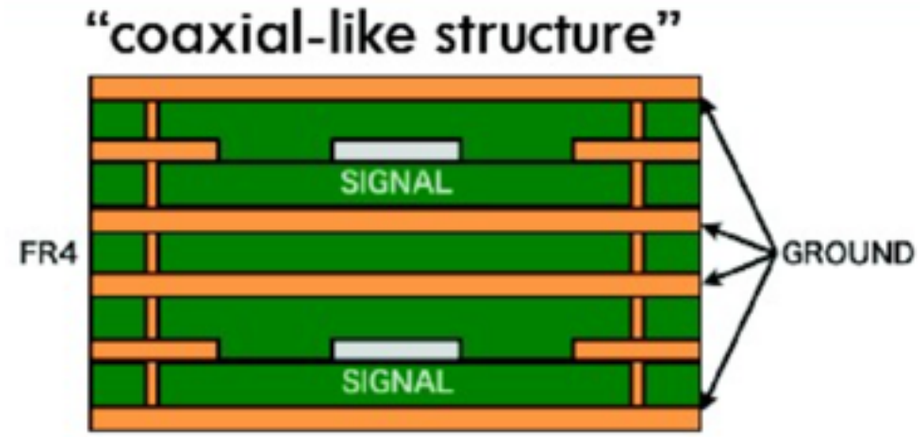
Contact at MEG2

Matteo De Gerone <matteo.degerone@ge.infn.it>

Wataru Ohtani <waratu@icepp.s.u-tokyo.ac.jp>

Multilayer PCB

- Coaxial-like structure to transmit signals over a PCB board, that features
  - High density(?)
  - Good shielding from external noise
  - High bandwidth
  - Low crosstalk
  - Mechanical strength
- 3 (cupper) layers per signal



Designed by INFN-Genova

Matteo De Gerone <matteo.degerone@ge.infn.it>

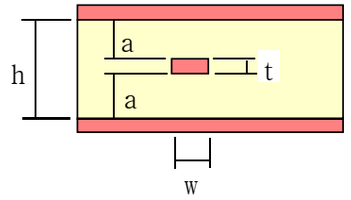
Q:

- How many channels/layers are the maximum?
- Two rails in parallel on one board possible?
- Is 180 cm long (multilayer) PCB possible?

Q: Two rails in parallel?
A: Yes

Theoretisch kann die Leiterbahnbreite ca. 0,16mm sein (Berechnung im Anhang). Das ergibt mit 2x0,16mm Abstand zu ground und 0,16mm ground 0,64mm je Kanal. Bei den Steckern werden aber Durchkontaktierungen notwendig sein, sodaß die Gesamtbreite um einiges größer wird. Es können also mehrere Kanäle nebeneinander untergebracht werden.

STRIPLINE



$$Zo = \frac{60}{\sqrt{(Er)}} \ln \frac{4h}{0.67\pi w(0.8+(t/w))}$$

h=2a

Er	h	w	t	3,14	Z0(ohm)
4,600	0,126	0,160	0,035	3,140	(55,896)
4,600				3,140	#ZAHL!
4,600				3,140	#ZAHL!
4,600				3,140	#ZAHL!
4,500				3,140	#ZAHL!
4,500				3,140	#ZAHL!
4,500				3,140	#ZAHL!
4,500				3,140	#ZAHL!
4,500				3,140	#ZAHL!

Expected on PCB (50,896)

* Er :Dielectric const.
  FR-4 : 4.5~4.8
* t : copper thickness
* w : circuit width
* h : prepreg or thin core height

http://www.leiton.de/leiton-tools-impedanz-kapazitaets-kalkulator.html

Q: max. how many layers vertically?

A: depends on a company and budget

Lagenaufbauten Rev. 4.5 – FR4-Leiterplatten

03.09.2015 - Für den aktuellsten Stand besuchen Sie bitte www.leiton.de

14-Lagen Multilayer - 2,00mm 35µ/35µ

Top L1	Lötstopp / Außenlage		15µm 35µm	Lack Kupfer
	Prepregs		126µm	2x1080 FR4
IL2	Innenlage		35µm	Kupfer
	Kern		100µm	FR4 Kern
IL3	Innenlage		35µm	Kupfer
	Prepregs		126µm	2x1080 FR4
IL4	Innenlage		35µm	Kupfer
	Kern		100µm	FR4 Kern
IL5	Innenlage		35µm	Kupfer
	Prepregs		126µm	2x1080 FR4
IL6	Innenlage		35µm	Kupfer
	Kern		100µm	FR4 Kern
IL7	Innenlage		35µm	Kupfer
	Prepregs		126µm	2x1080 FR4
IL8	Innenlage		35µm	Kupfer
	Kern		100µm	FR4 Kern
IL9	Innenlage		35µm	Kupfer
	Prepregs		126µm	2x1080 FR4
IL10	Innenlage		35µm	Kupfer
	Kern		100µm	FR4 Kern
IL11	Innenlage		35µm	Kupfer
	Prepregs		126µm	2x1080 FR4
IL12	Innenlage		35µm	Kupfer
	Kern		100µm	FR4 Kern
IL13	Innenlage		35µm	Kupfer
	Prepregs		126µm	2x1080 FR4
Bot L14	Außenlage		35µm	Kupfer
	Lötstopp		15µm	Lack

Gesamtdicke	**2,00mm**
Toleranz	±10%
Maximale Dicke	2,20mm
Minimale Dicke	1,80mm

Lagenaufbauten Rev. 4.5 – FR4-Leiterplatten

03.09.2015 - Für den aktuellsten Stand besuchen Sie bitte www.leiton.de

14-Lagen Multilayer - 2,40mm 35µ/35µ

Top L1	Lötstopp / Außenlage		15µm 35µm	Lack Kupfer
	Prepregs		106µm	2x106 FR4
IL2	Innenlage		35µm	Kupfer
	Kern		200µm	FR4 Kern
IL3	Innenlage		35µm	Kupfer
	Prepregs		116µm	1x106 FR4 1x1080 FR4
IL4	Innenlage		35µm	Kupfer
	Kern		200µm	FR4 Kern
IL5	Innenlage		35µm	Kupfer
	Prepregs		116µm	1x106 FR4 1x1080 FR4
IL6	Innenlage		35µm	Kupfer
	Kern		200µm	FR4 Kern
IL7	Innenlage		35µm	Kupfer
	Prepregs		116µm	1x106 FR4 1x1080 FR4
IL8	Innenlage		35µm	Kupfer
	Kern		200µm	FR4 Kern
IL9	Innenlage		35µm	Kupfer
	Prepregs		116µm	1x106 FR4 1x1080 FR4
IL10	Innenlage		35µm	Kupfer
	Kern		200µm	FR4 Kern
IL11	Innenlage		35µm	Kupfer
	Prepregs		116µm	1x106 FR4 1x1080 FR4
IL12	Innenlage		35µm	Kupfer
	Kern		200µm	FR4 Kern
IL13	Innenlage		35µm	Kupfer
	Prepregs		106µm	2x106 FR4
Bot L14	Außenlage		35µm	Kupfer
	Lötstopp		15µm	Lack

Gesamtdicke	**2,51mm**
Toleranz	±10%
Maximale Dicke	2,76mm
Minimale Dicke	2,26mm

!!! Grenzwertiger Aufbau - abhängig vom Layout !!! Bitte anfragen.

Aufbauten rein exemplarisch, Realisierbarkeit hängt teilweise vom Layout ab. 4mil-Leiterbahnen erfordern eventuell 18µm Kupfer in den Innenlagen. Fragen Sie uns, wir beraten Sie gerne! Gemischtem Kupferdicken, 18µm oder asymmetrisch auf Anfrage!

Printed circuits - PCB - Leiterplatten - 印刷电路板 - Circuitos impresos - Plaquettes imprimées - プリント基板 - Circuiti stampati - Placas electronicas - Kretskorts - Printplaten

Q: 180cm PCB board?
A: don’t know yet

- Fa. Ellwest: Standard – 480x580mm; Spezial – 584x1041mm, max. 22 Lagen
- Fa. LeitOn: Standard – 430x370mm, 14-Lagen; auf Anfrage 500x600mm, 24 Lagen
- Fa. PCB-Overseas (Beta): auf Anfrage 1200x500mm, max. 48 Lagen
  - http://www.leiton.de

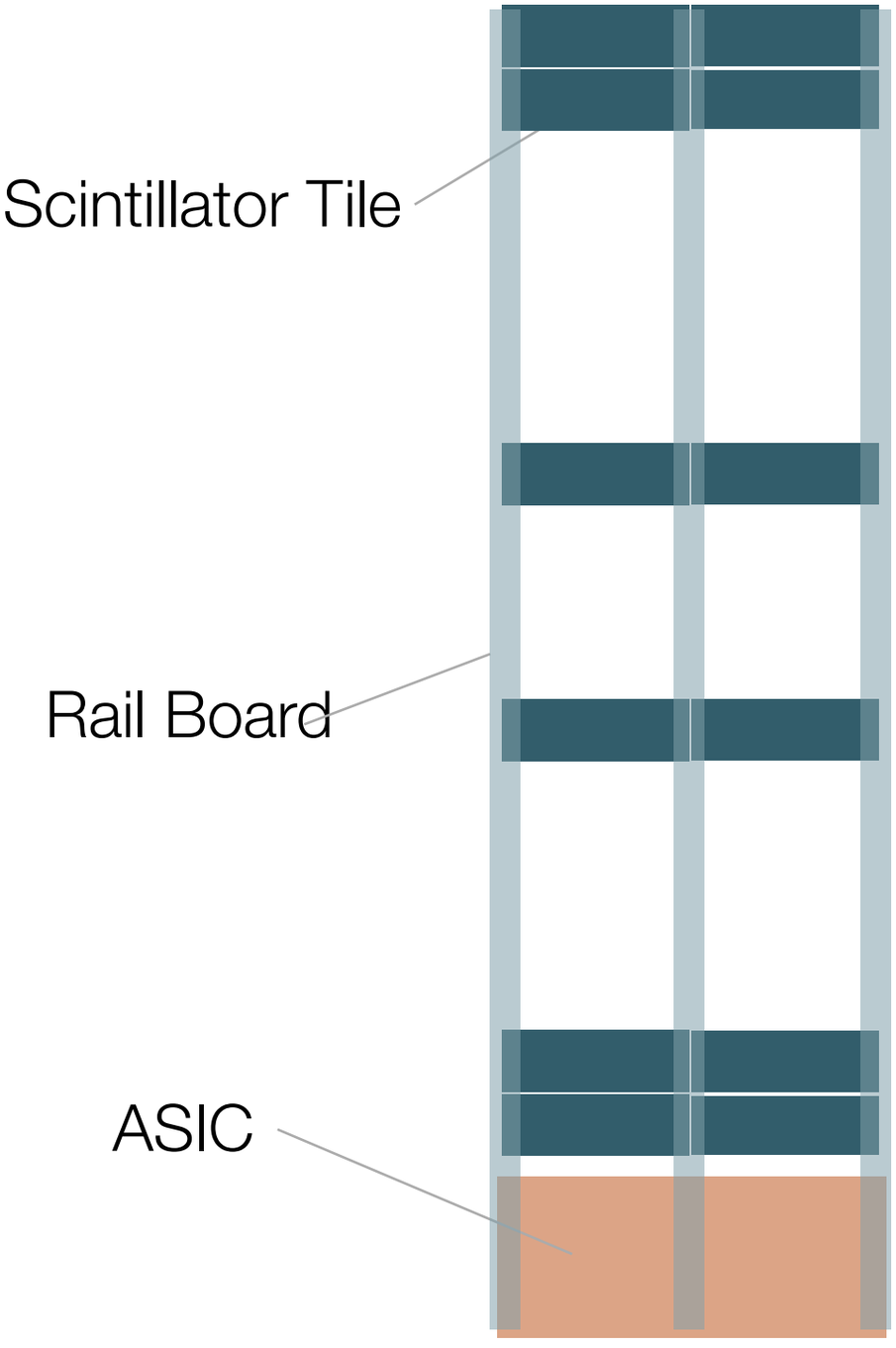
we found a company who can make a multilayer PCB up to ~1 m

Prototype-1

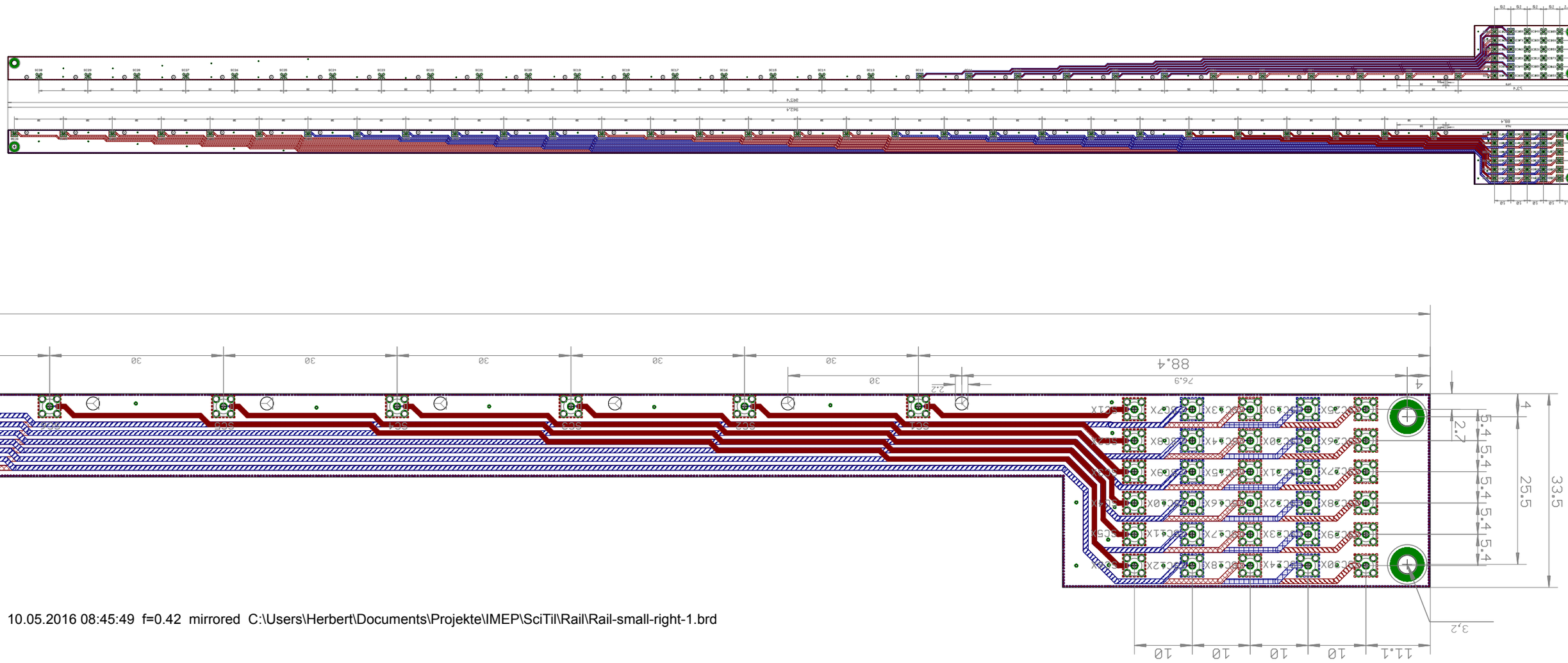
Half length = 180/2 = 90 cm

2 x 60 slots

2 x 4~6 filled



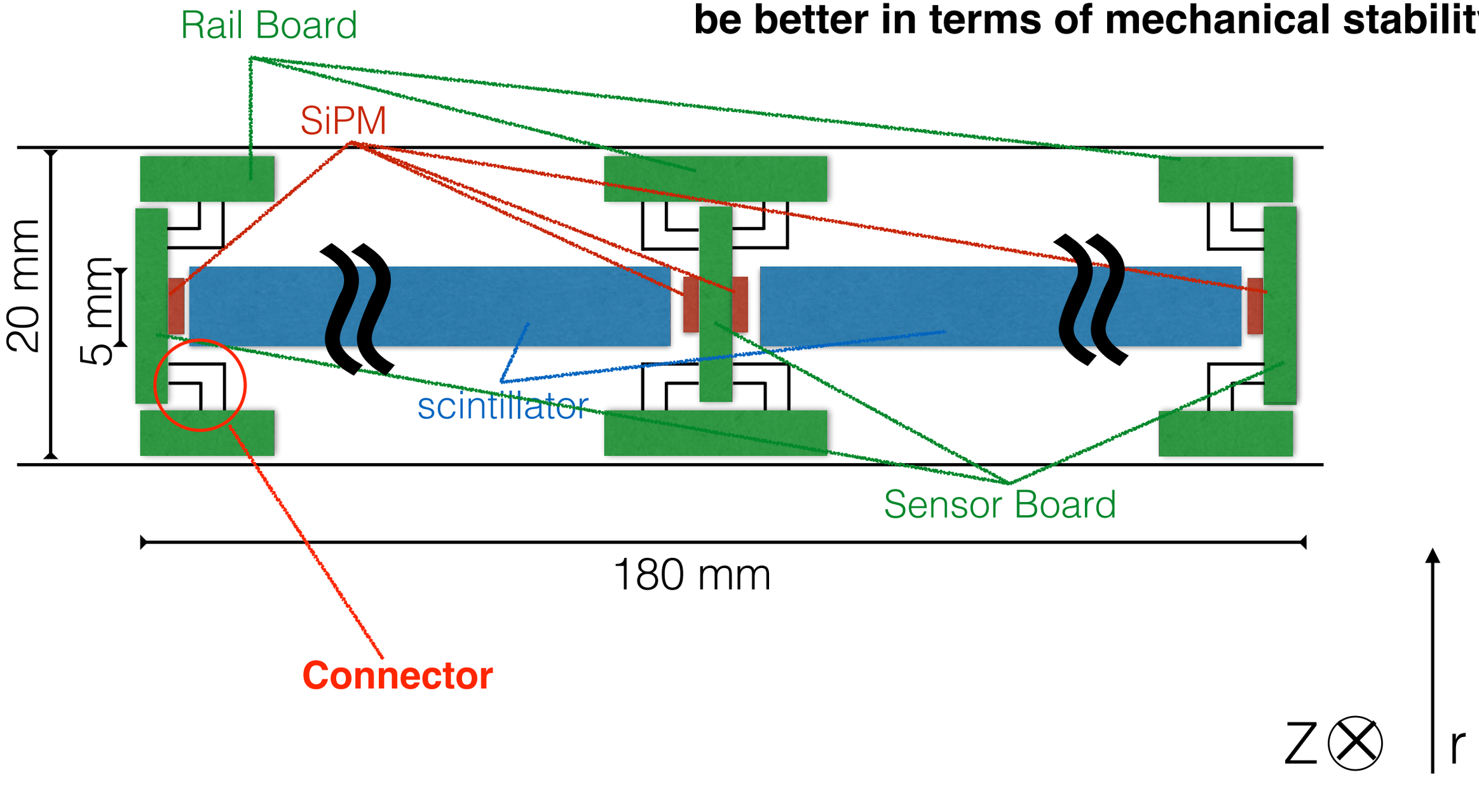
Railboard



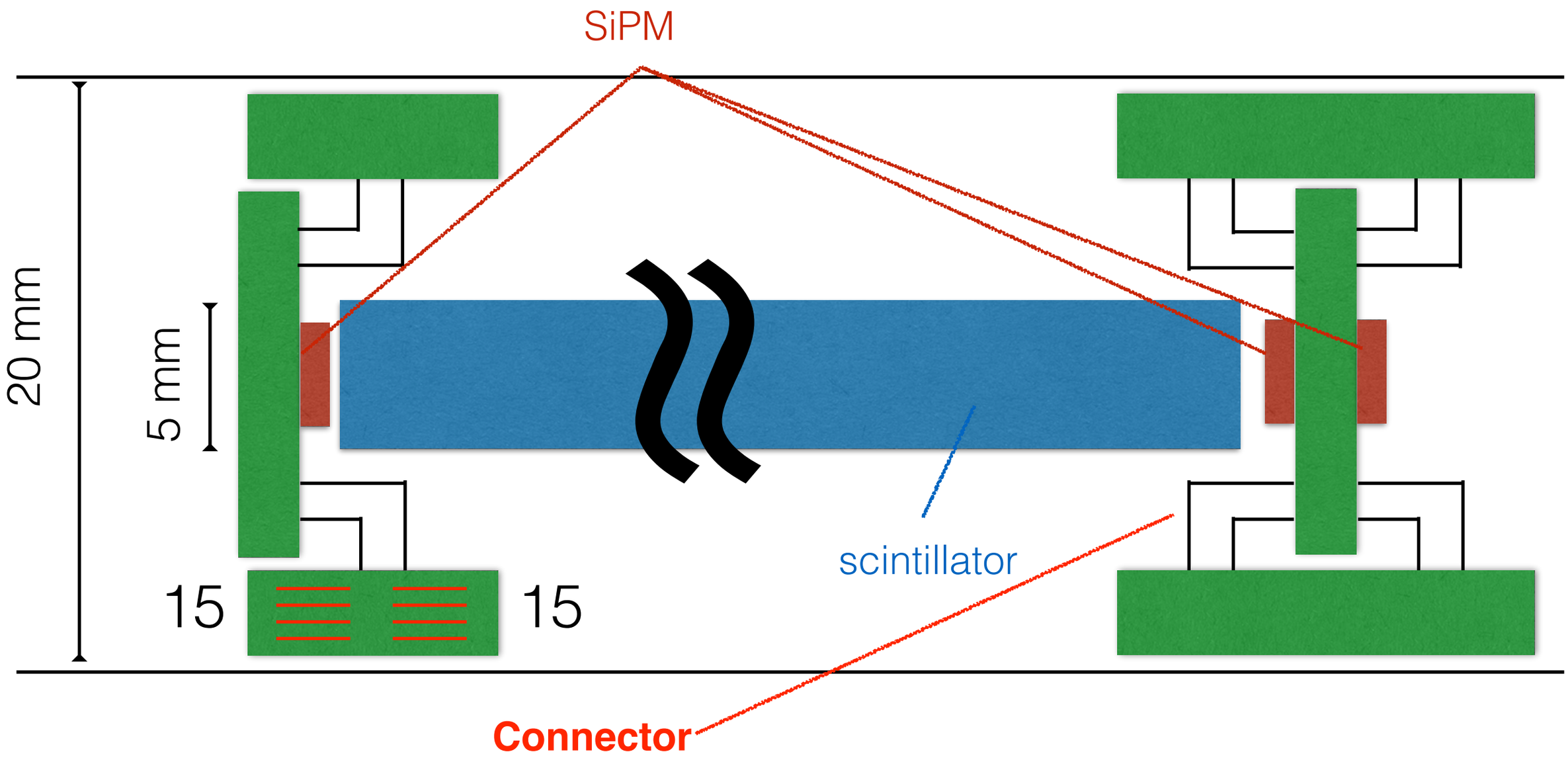
10.05.2016 08:45:49 f=0.42 mirrored C:\Users\Herbert\Documents\Projekte\IMEP\SciTil\Rail\Rail-small-right-1.brd

Super Module Design

Rail Board on two sides (top/bottom) would be better in terms of mechanical stability?



Super Module Design



LEMO00: definitely too large
MMCX: not a big fun of it, too fragile and not reliable?
MCX: good compromise?
Else?

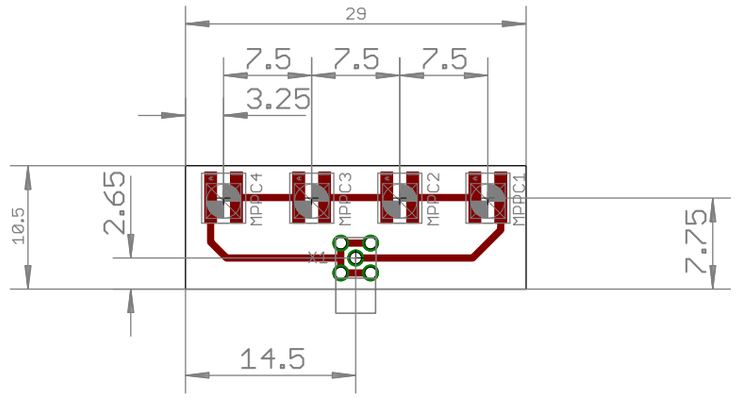
Sensor Board

- accommodates 4 SiPM connected in series.

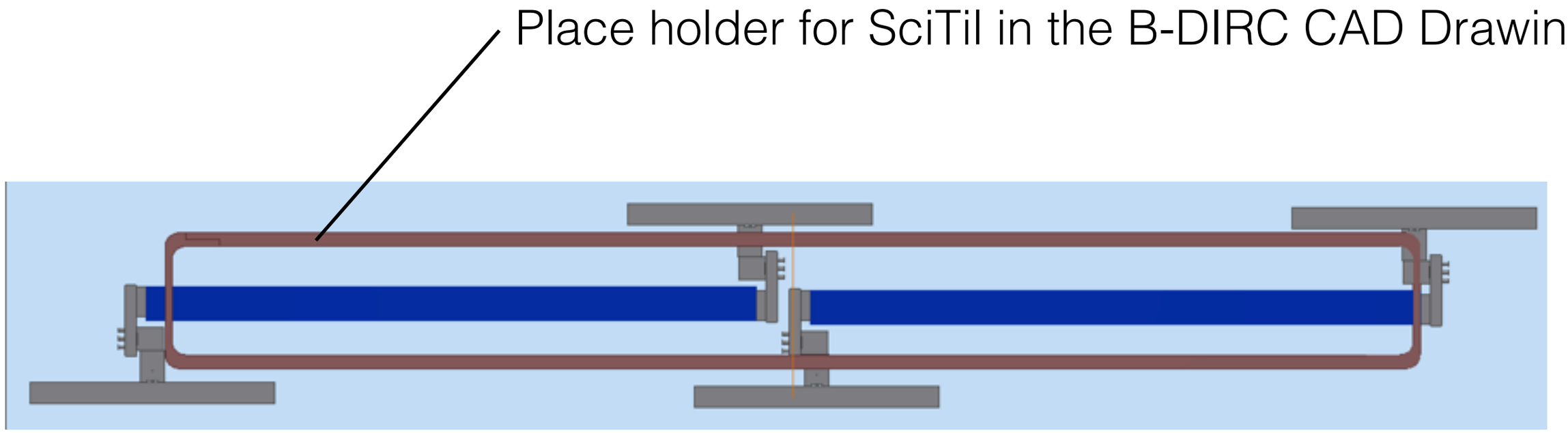
- two versions
  - side of the SM. SiPMs on one side
  - middle of the SM. SiPMs on both sides

- L-shaped connector to connect to the Rail Board

Example of MEG2 TOF



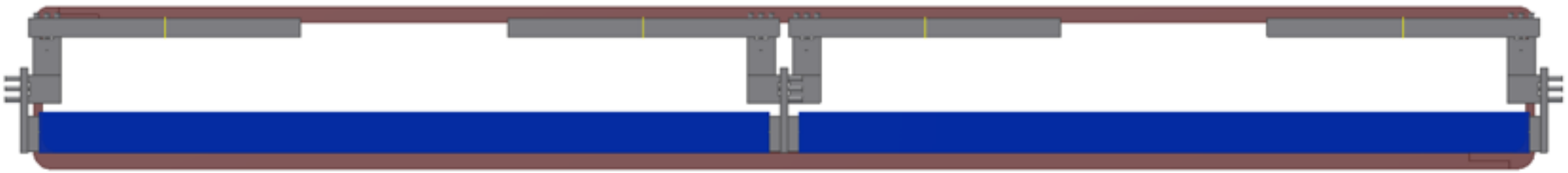
Railboard two sides or one side?

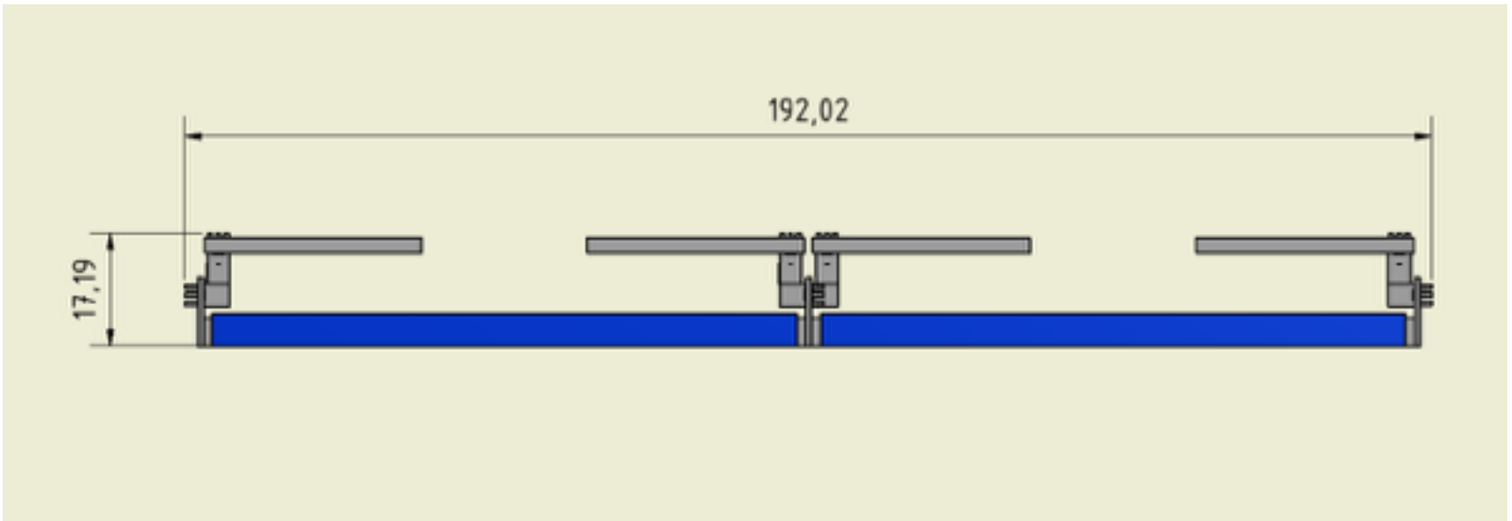


Having the railboards on two sides of the scintillator, we exceed the radial space limit of 2 cm.

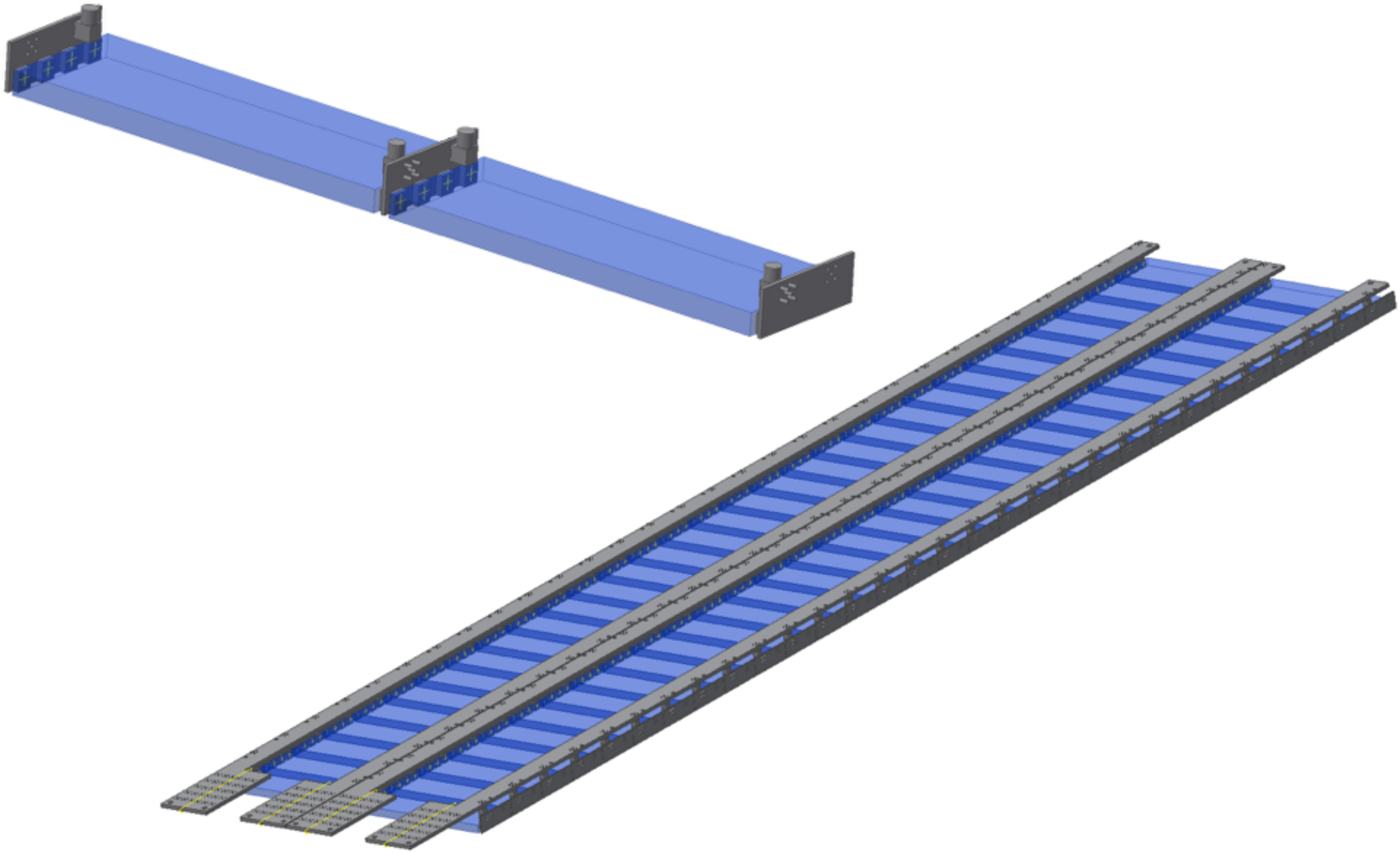
A: One side.

Proto1 design





Proto1 design

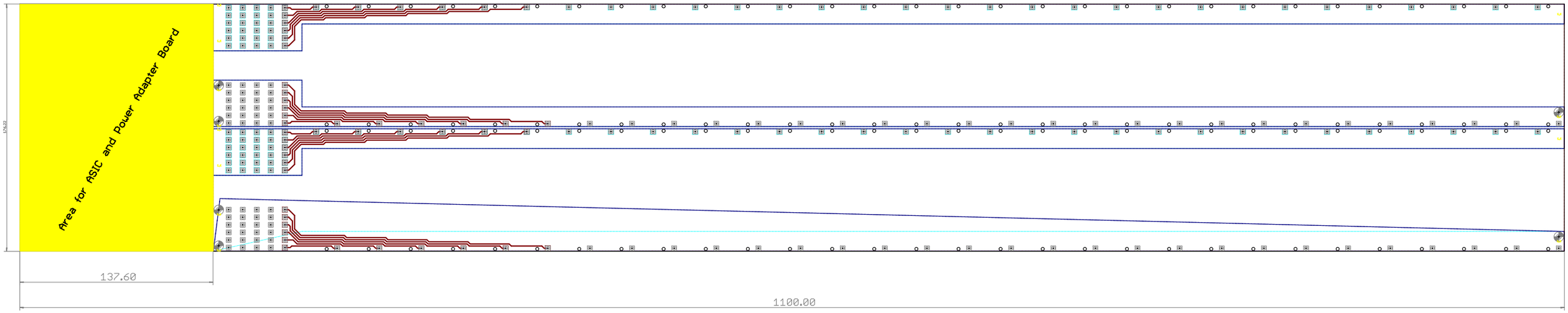


What else?

- Support structure of SciTil SM
- Fixation to the B-DIRC
- Mounting procedure
- FEE
  - TOF-PET chip
- Interface to the out side
  - minimum cables forseen, a few LV and ethernet

A big PCB solution?

that combines 4 railboards and FEE



- even less connections
- more mechanical stability
- more homogeneous material thickness

Summary and Outlook

- The first SciTil Supermodule Prototype, design and construction on going (pre TDR)

- Main thing to test is
  - the railboard concept
  - mechanical stability
- Half length (18x90 cm^2 instead of 18x180 cm^2)
- To be ready by the next PANDA collaboration meeting