Prototype

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PHYSICS

Concept

Build a small 4-layer prototype with something approaching nominal MATHUSLA design specs

- Use 64-channel SiPM array with CAEN (64-channel) FERS DT5202 readout system to emulate what the SLAC group is designing
- Can use “short” scintillator bars (due to high attenuation) with “long” WLSF to give performance similar to nominal ~2.5m long bars
- Use excess WLSF length to route signals back to single SiPM array

Requires:

- ~100m total length of scintillator bars (various lengths [80,140cm])
- 32 lengths of ~6m WLSF
- 1 SiPM array (64 channel)
- Readout electronics
- Support structure etc.
- 1 super-keen and enthusiastic student and/or postdoc

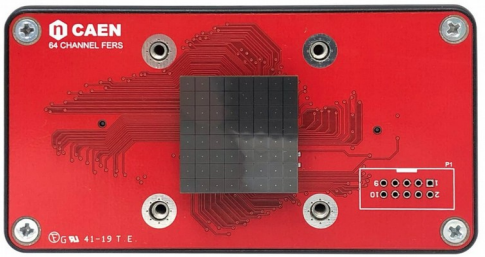
Specifics

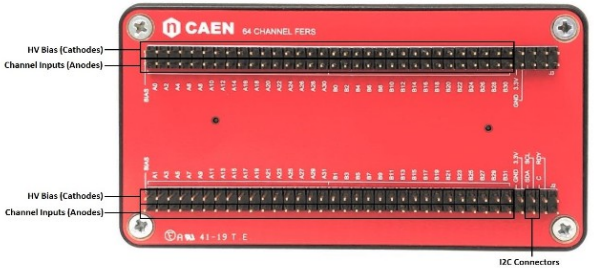
- Hamamatsu S13161-3050-AE-08 is mounted with SAMTEC connectors, compatible with CAEN DT5202 adaptor
  - 64 channel
  - In principle, could daisy-chain additional DT5202 to do a larger prototype at some point (i.e. 128, 256 channels...)
- Scintillator dimensions (width and thickness) are open to discussion, but for this prototype will happily use whatever Jim is willing to provide (5cm x 1cm?)
  - Could always swap in bars of different dimensions at some later date if they become available
  - Length is not a critical dimension, but for practical purposes, ~80cm - ~140cm would work well
- WLSF is somewhat critical. Ideally we would want to use something as close to “MATHUSLA-spec” as possible, but for this first attempt I propose to use 1.5mm BCF-92 (Saint Gobain).
  - Leftovers from Miriam's purchase last year?

Readout: DT5202

2 x 32 channel Citiroc-based CAEN readout system

- NOT a digitizer
- Fast (for trigger) and slow (for amplitude) shaping. User configurable
- Digital out of ToA and amplitude (based on peak-and-hold or ToT)
- User-configurable (internal or external trigger)
- Low and high gain preamps
- Configurable temp feedback and correction
- Individual channel voltage trims
- Multiplexed analog outs
- Timing ADC LSB 0.5ns (Citiroc)

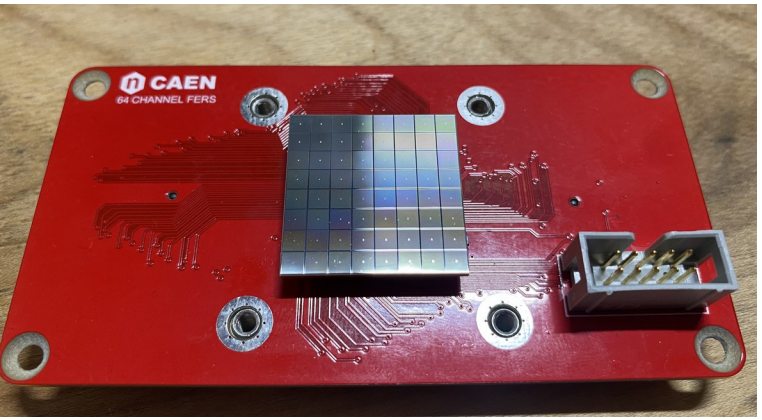


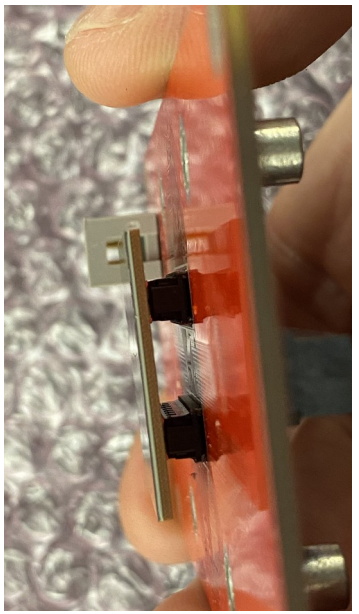


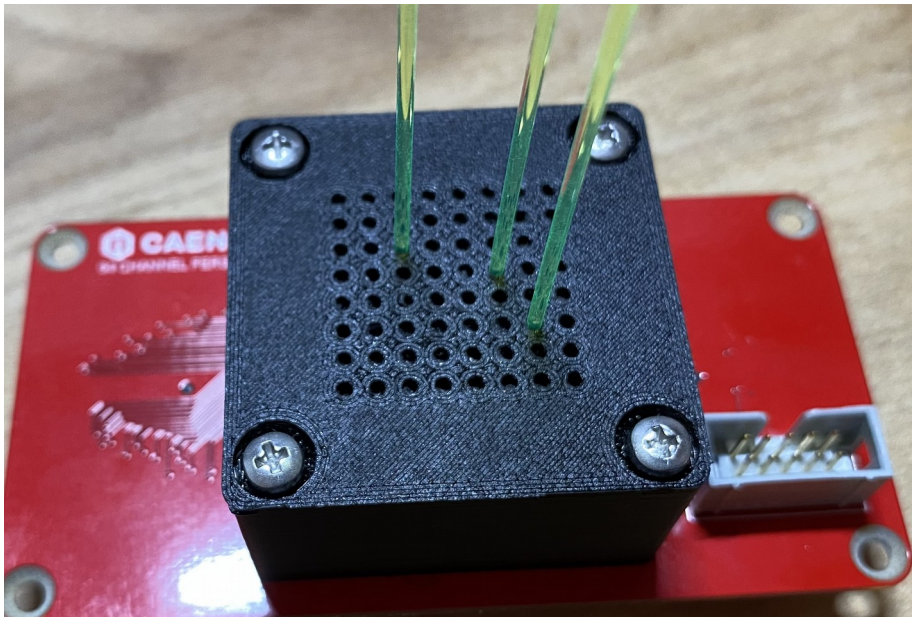
Coupling fibers to SiPM array

Idea is to use excess length of WLSF to rout signals to a single (strategically positioned) SiPM array

- This necessitates coupling each of the fibers rather precisely to the front fact of the array
- Accomplished by modifying the CAEN-supplied “dark box” cover design and 3D printing an array coupler







Layout

Up

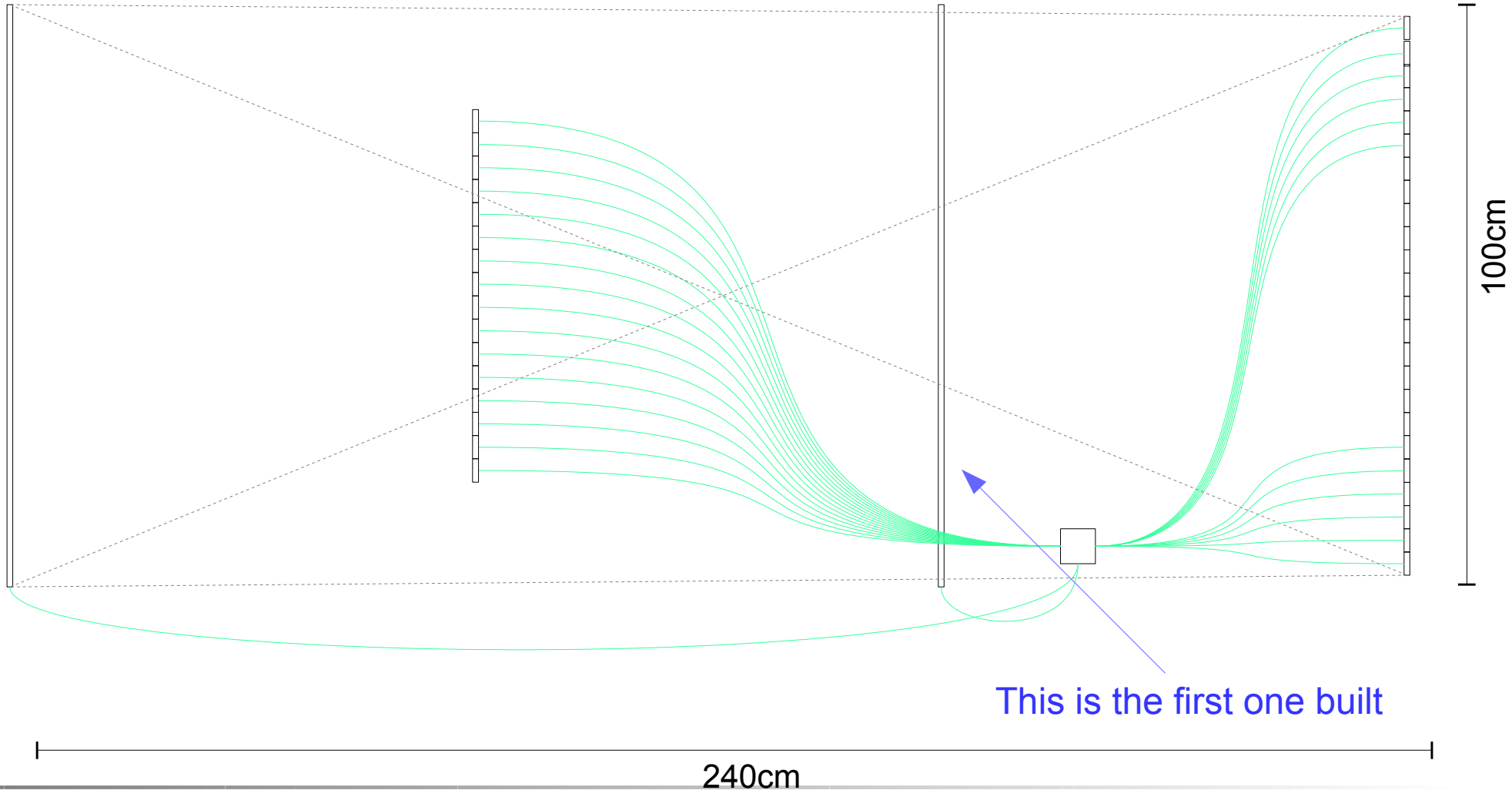
Frankenstein layer

20 bars
20 channels

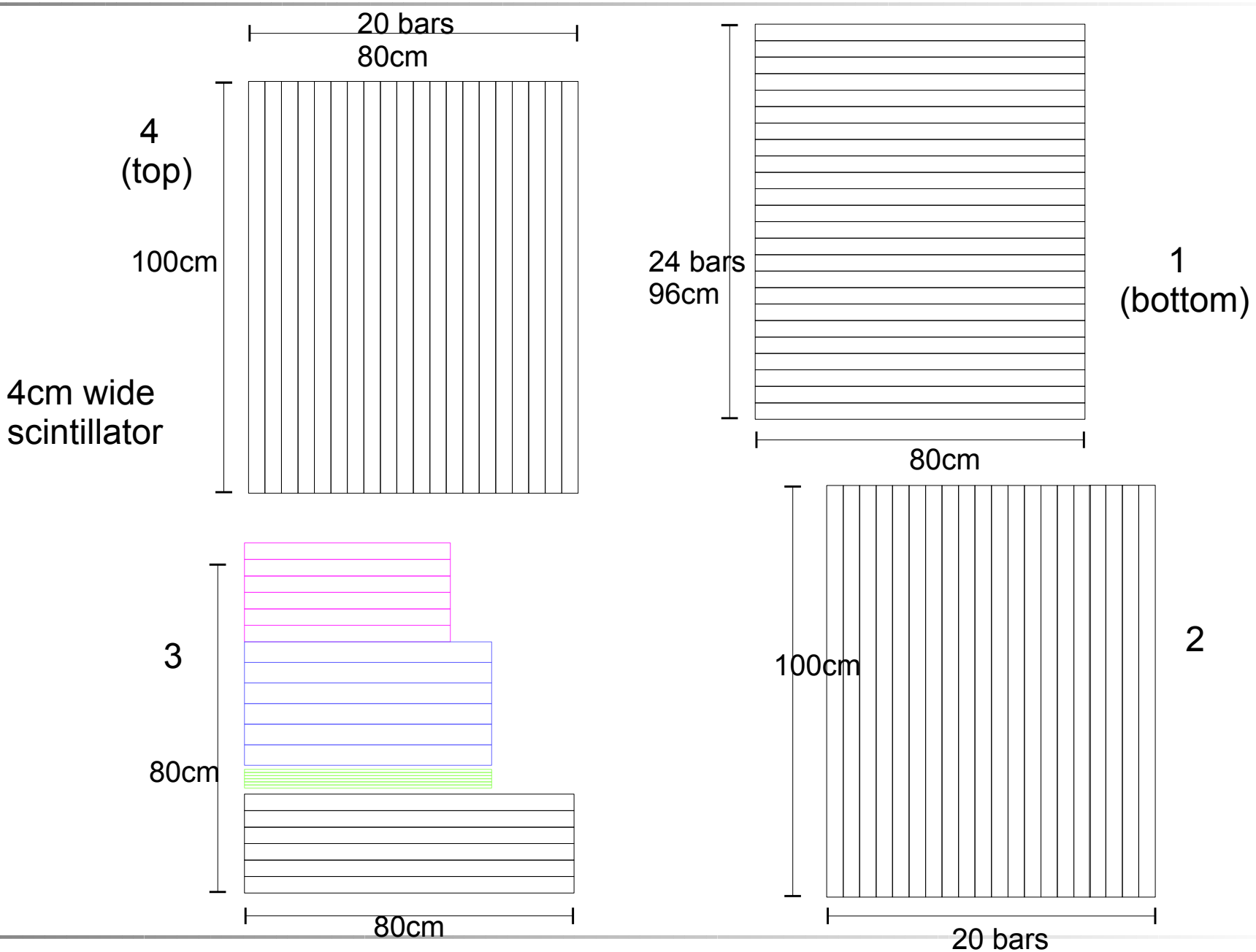
?? bars
22 channels

20 bars
10 channels

24 bars
12 channels



Layout


20 bars
80cm
4
(top)
100cm
4cm wide
scintillator
24 bars
96cm
1
(bottom)
80cm
3
80cm
80cm
100cm
2
20 bars
80cm

Kuraray recommend 30cm bending diameter
Saint Gobain recommend??

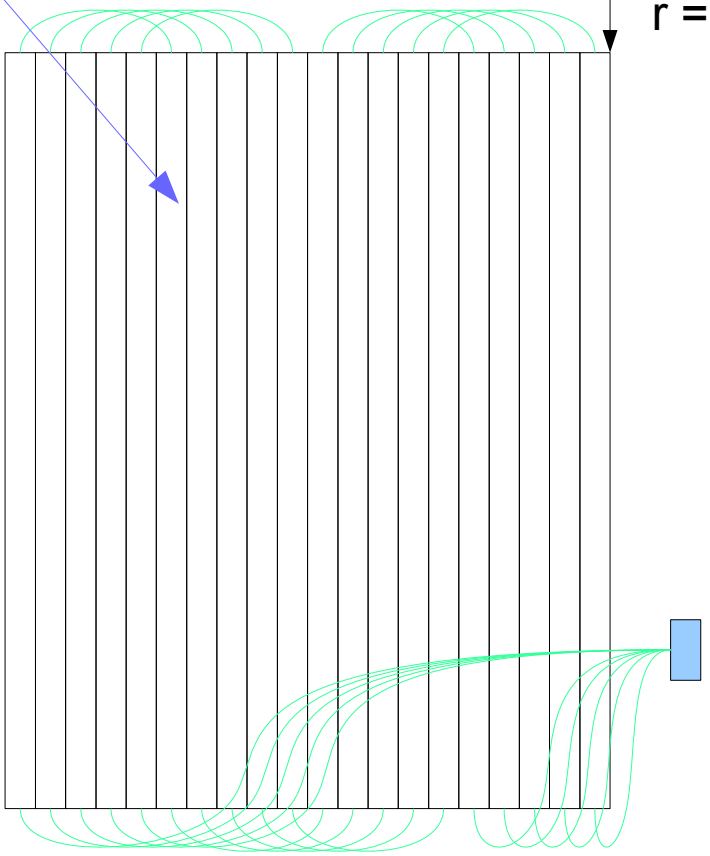
Layer 2

(20 bars, 10 channels)

Built this one

d = 20cm

r = 10cm



loop=31.4cm

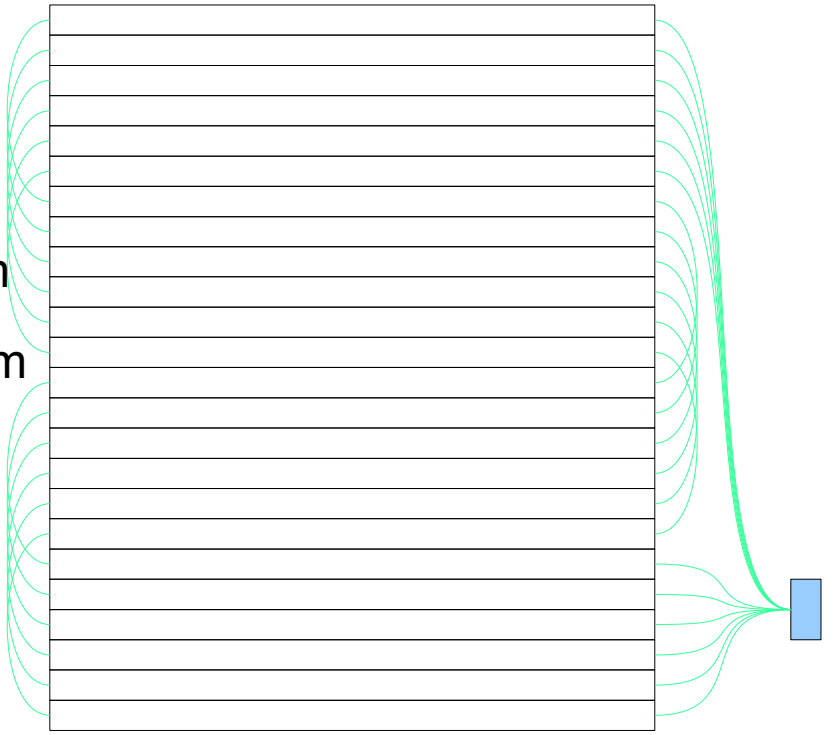
total L = (4x100cm)+(3x31.4cm)+(2xE)
E ~53cm

Layer 1 (i.e.bottom)

(24 bars, 12 channels)

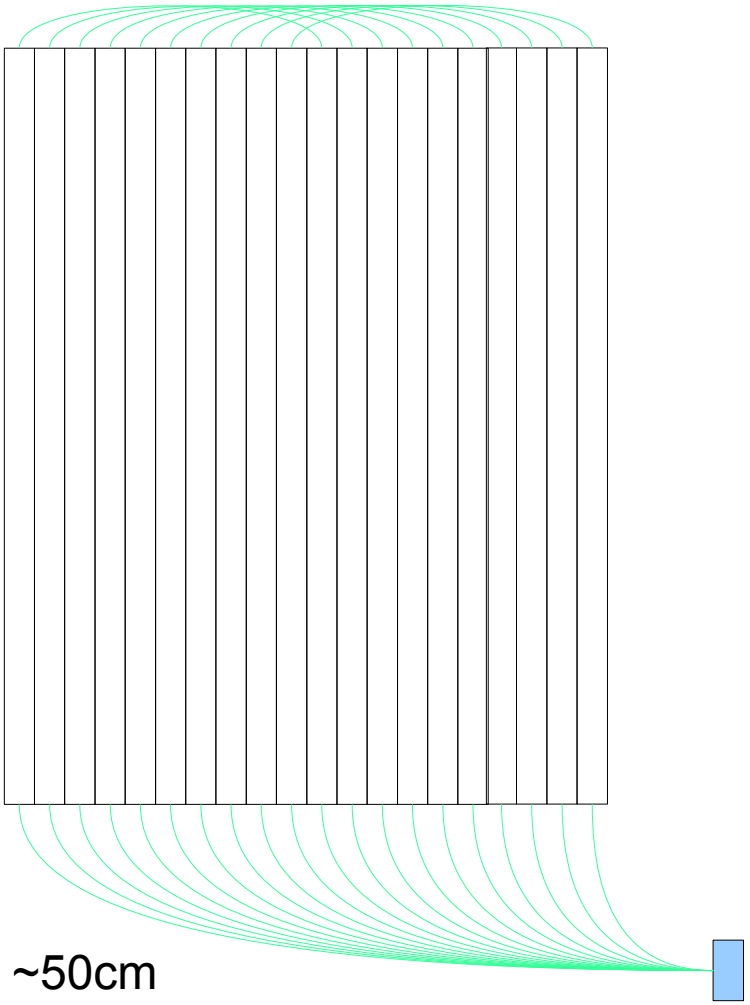
d = 24cm

loop=37.7cm

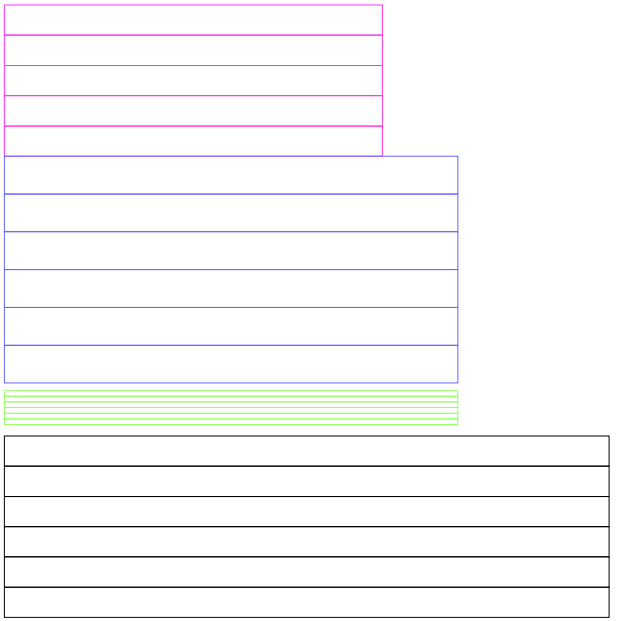


total L = (4x85cm)+(3x37.7cm)+(2xE)
E ~73.5cm

Layer 4
(20 bars, 20 channels)



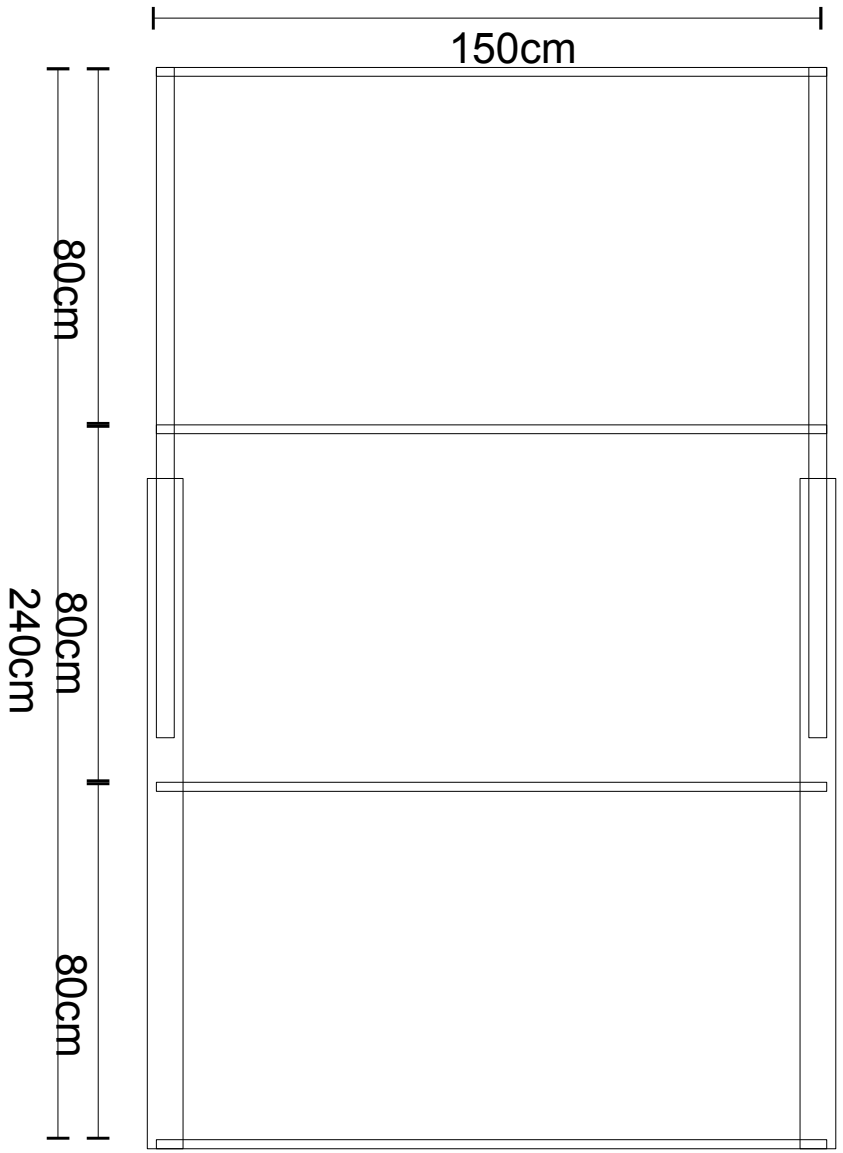
Layer 3
(?? bars, 22 channels available)

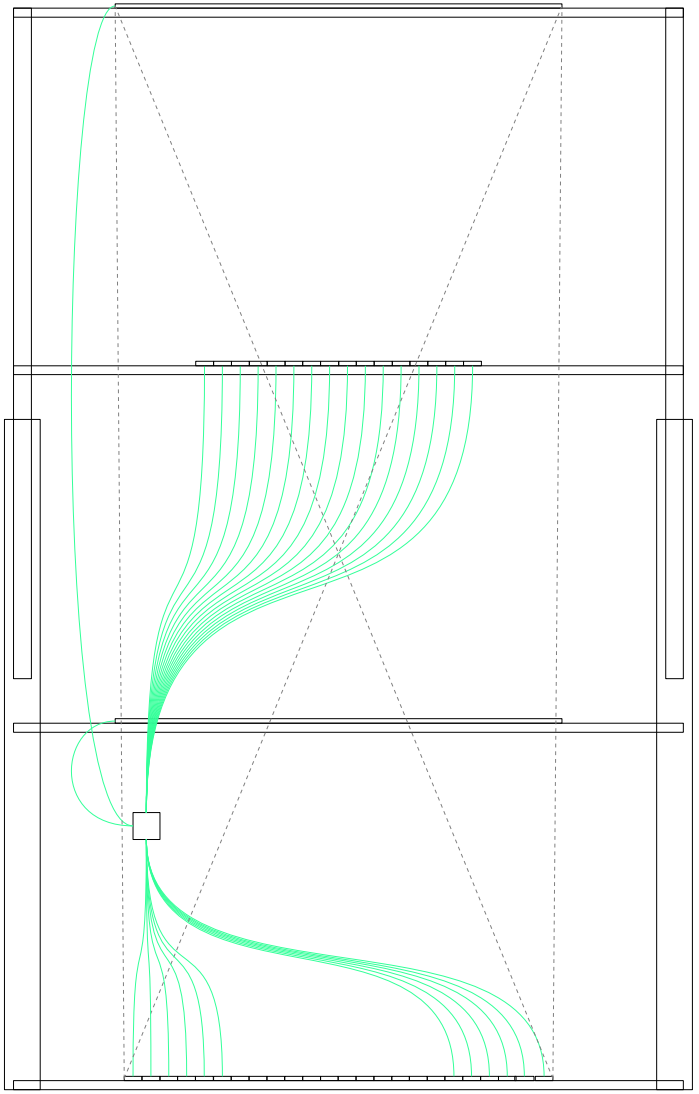


Have a collection of misc. 1cm thick scintillator, so will build a “Frankenstein” layer to compare performance

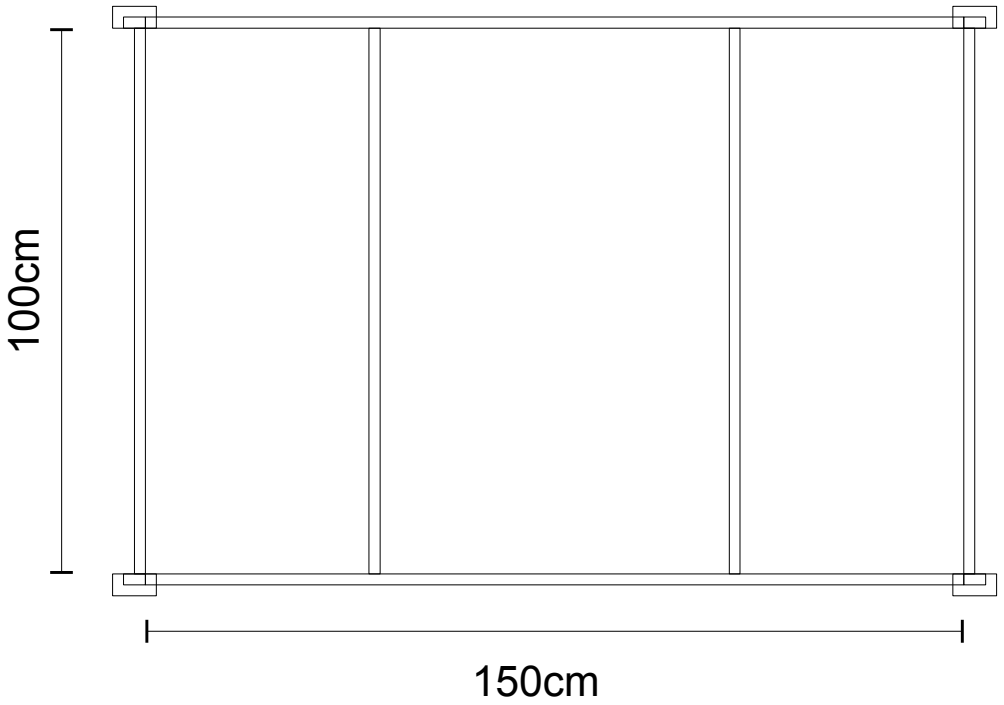
loop ~50cm

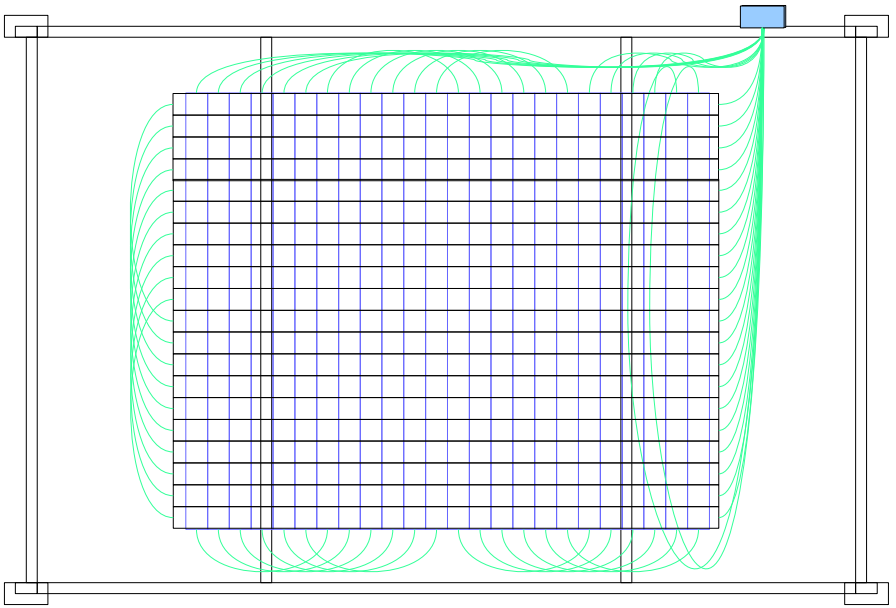
total L = (2x100cm)+(1x50cm)+(2xE)
E ~175cm


150cm
80cm
80cm
240cm
80cm



Mechanical structure (top view)



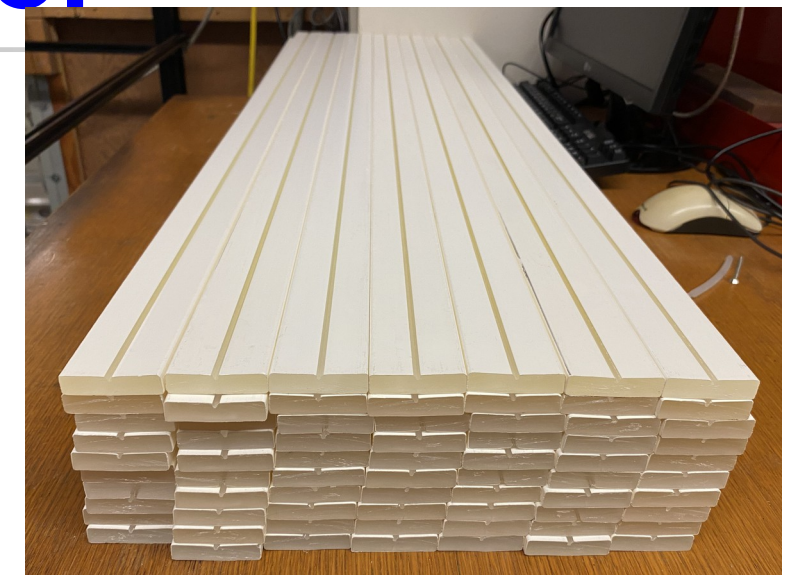


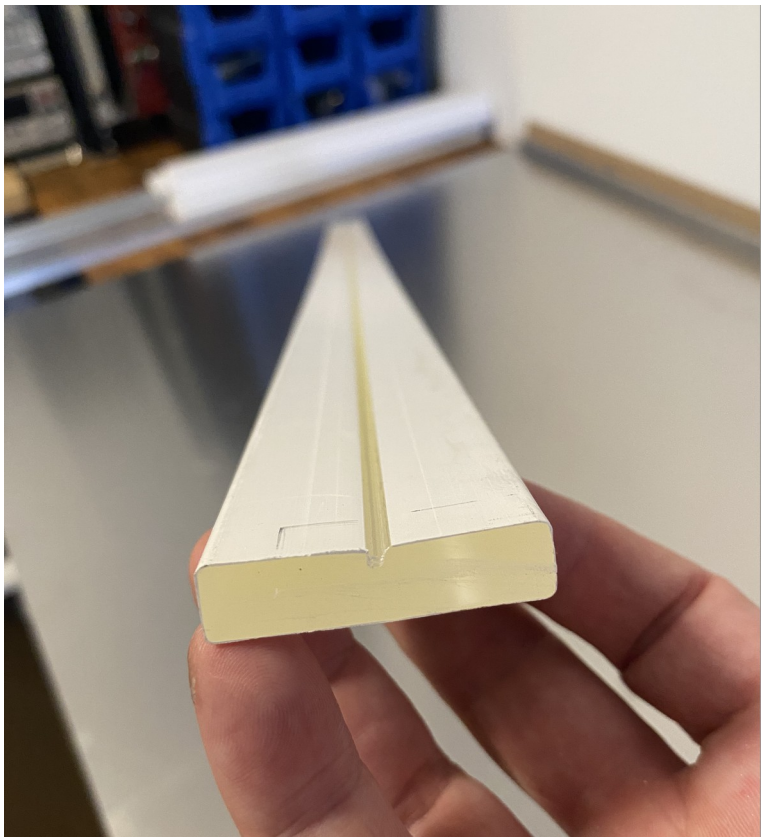
Structure existence proof:

- Constructed from 2020 V-slot aluminum extrusion

Scintillator

- 4cm x 1 cm FNAL scintillator with co-extruded coating and milled (or extruded) fiber channel at surface
- 100cm length; 70 bars in total



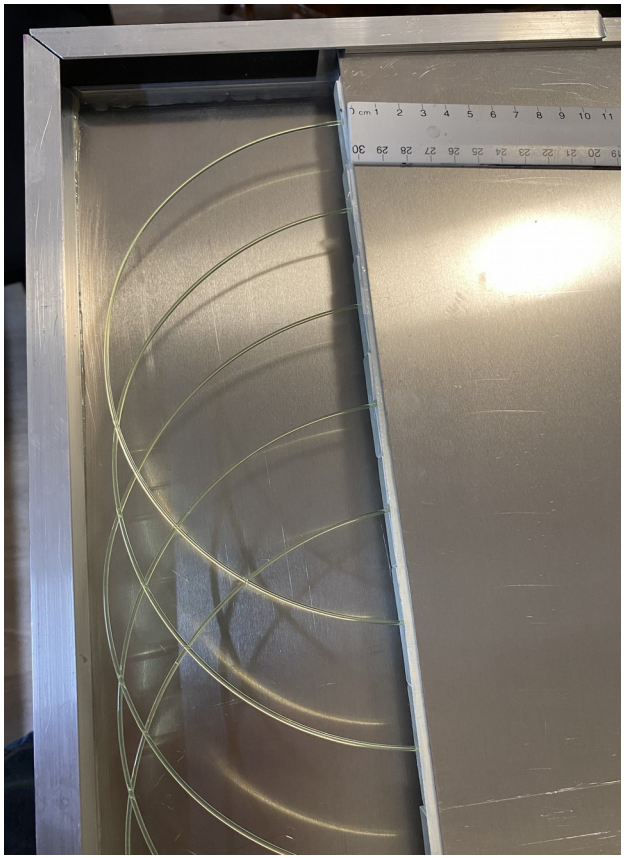


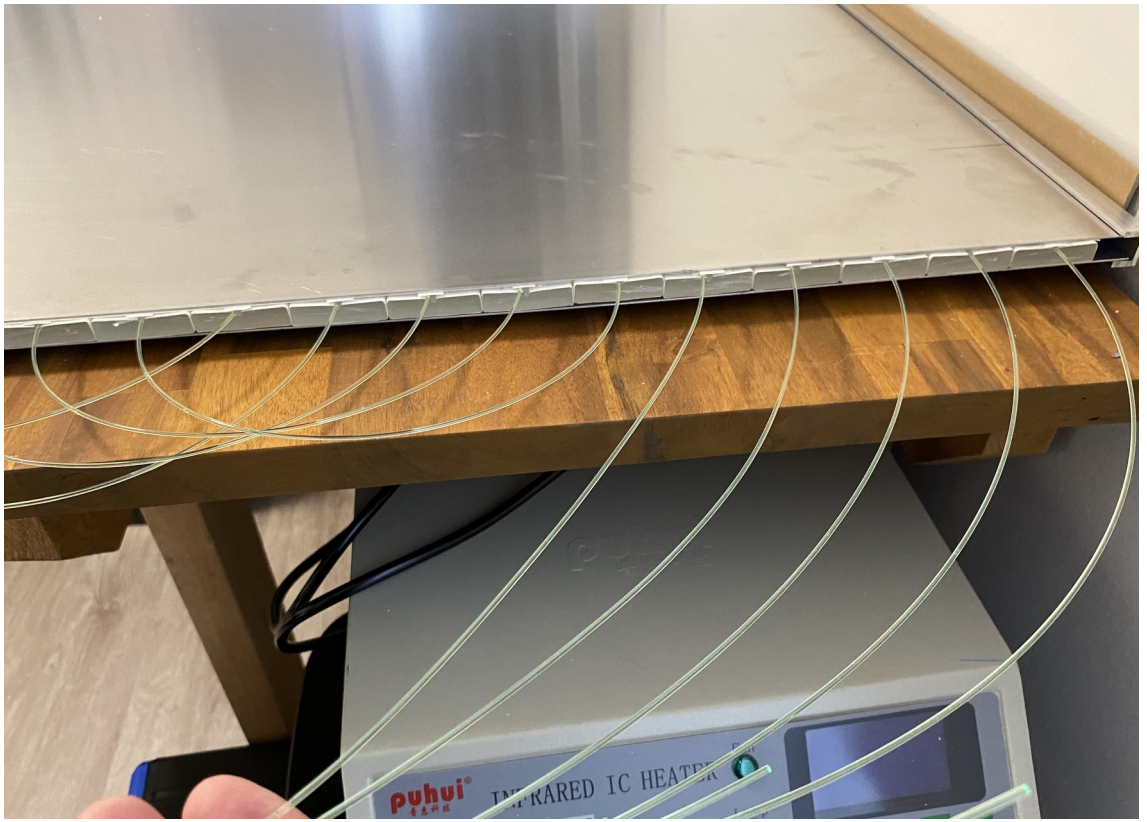
Assembly

- Scintillator attached to 1mm (actually 0.040”) aluminum sheet using double-sided tape
- Aluminum channel on long edges to provide stiffness (epoxy)
- Tyvek strips taped along fiber channels and WLSF threaded (looped through 4 bars in this module)
- 3D printed shims (blue) used to ensure snug fit

Assembly

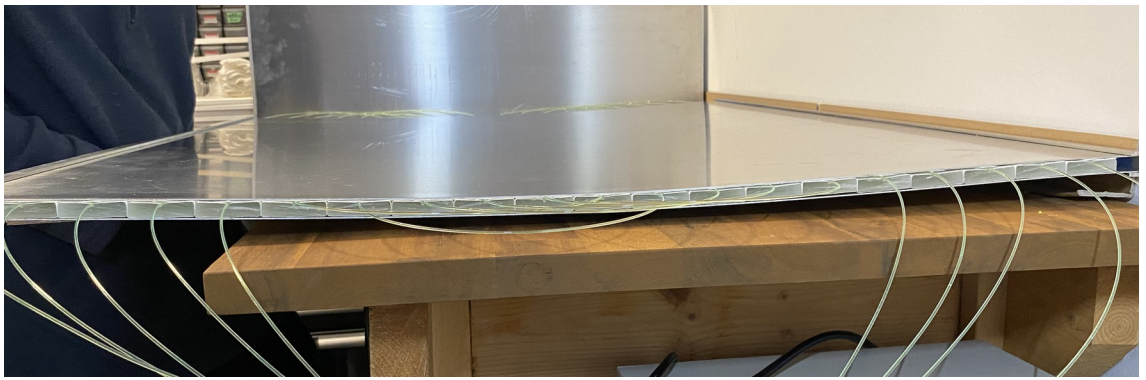
- Protective aluminum box around fiber loops. Can't do this on the side with the fiber ends, but can do it temporarily for moving the module





Completed module

- Module is rigid enough to move around safely, but (as expected) shows significant flexion under its own weight perpendicular to bar axis (note that aluminum channel provides additional rigidity along bar axis)

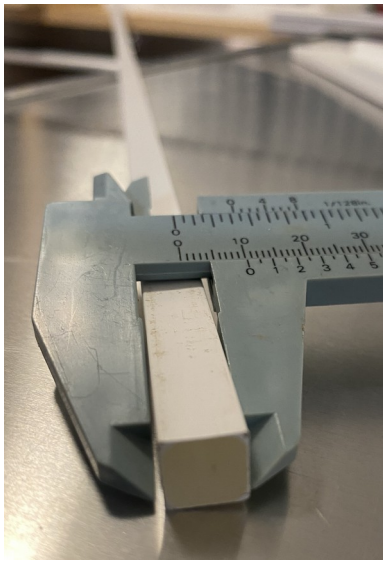


Completed module

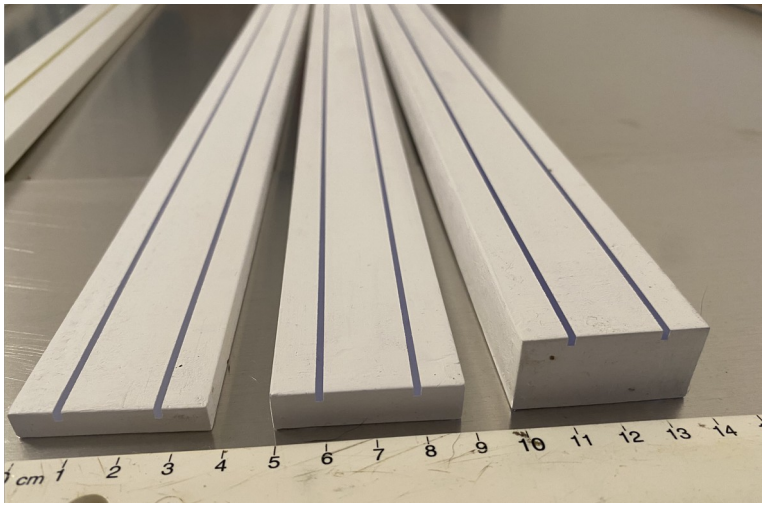
- With protective end caps in place it is pretty rigid and easy to move without risk of damage
- Will make a modified end cap with one side left open as permanent protection for the side with the fiber ends

Other layers

- Will start on layer 1 next. This has 24 bars, of 80cm length, so they will need to be cut (no problem).
- Don't have the material to make protective end caps for layers 1 & 3 so will have to decide what to do about that.
- Details of Frankenstein layer still to be decided. Could potentially have 2 smaller modules with 1cm and 2cm thick scintillator (?)



From Scott Oser



Uniplast

FNAL