Mechanical aspects of FEB for ePIC forward ECAL

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STATUS/WORK UPDATE

- eRD109 funds finally in place, FEB development underway
  - effective start date 5/1/23

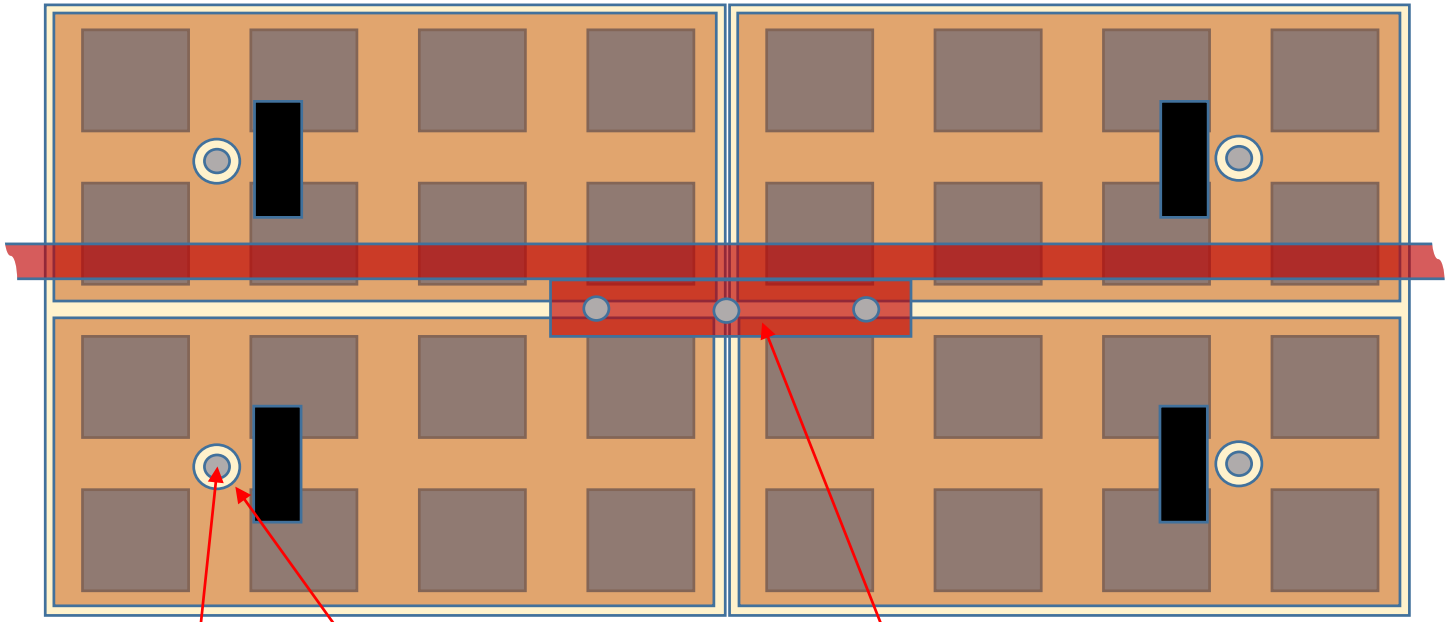
- work now in progress:
  - ADC chip selection and procurement (for 1st R&D prototype)
    - most likely ADC is TI # ADC3422
    - 44% lower cost than nearest reasonable competitor, performance about same (on paper anyway)
    - 4 channel chips (vs. 16 channel competitor); there are pros and cons both ways, will need to really get into layout details before I know my regrets – the PCB layout will be very challenging either way
  - water cooling prototyping (actually was done in January)
    - looks fine w/ standard 3/16” copper tubing @ 0.25 liters/min
  - design and prototyping for DC/DC converter possibility – for cable size/mass and power reduction
  - (soon): FPGA selection and procurement, FEB-RDO interface planning
    - still thinking about Microsemi PolarFire rad-tolerant FPGA’s
      - higher cost, less capable on LVDS serial ADC interface (but good enough??? thinking about it…)
  - SiPM boards mechanical and connectors – plan to make quick cheap dummy PCB (OshPark) soon
    - Potentially this could be a fully functional SiPM board prototype… TBD

FEB & SiPM carrier mechanical cartoons
(dimensioned sketches will be made later)

2-block (32 tower) FEB

This was sketched with old lightguide (one pyramid per tower). This is out of date (see Oleg's presentation). No impact on FEB, so for simplicity (or laziness) I'm not updating it here.

FEB not shown (in this view only)
(but see next page)



standoff **clearance hole** through SiPM carrier PCB

6 or 7 4-40 pan head screws
to attach FEB on 4 standoffs and
2 or 3 thermal tab nuts

cooling water tubing & small "tab" to PCB
0.19" OD, 0.13" ID
copper "refrigeration tubing"
no fittings inside detector

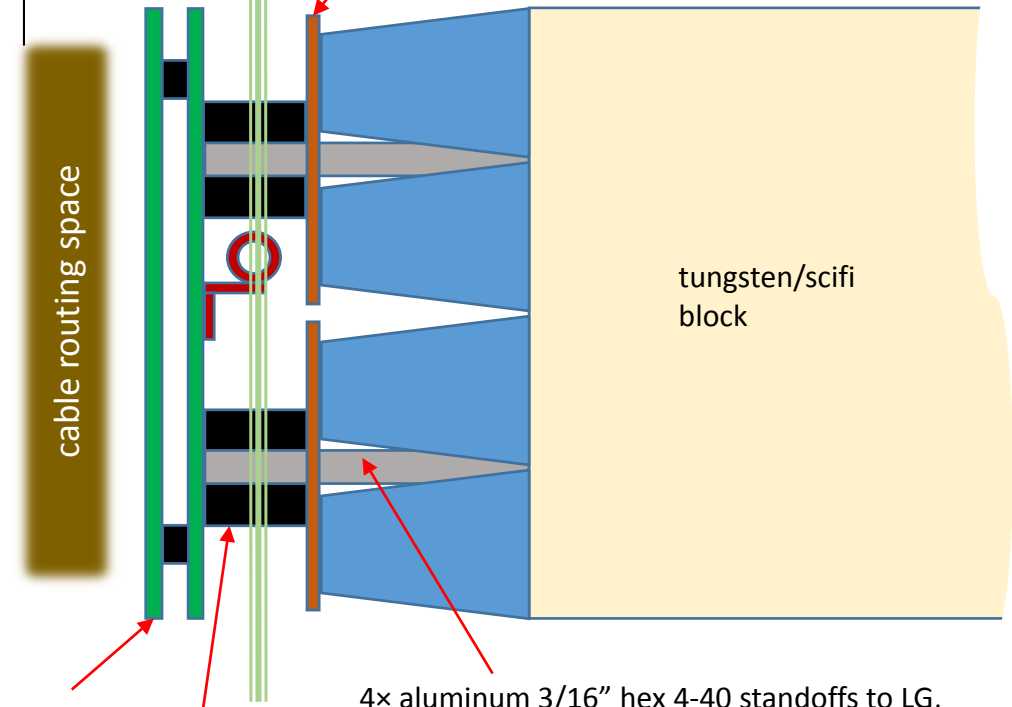
water tubing connection to FEB is also an electrical ground for FEB (important for noise/EMI and safety)

vertical flow air cooling **alternative** (to be studied in R&D) – "plenum" between FEB and SiPM boards

1.4 cm (if water)
3 cm (if air)

5 cm

SiPM carrier PCB, qty. 4,
8 towers (32 SiPM's) each,
glued to lightguide block



FEB PCB stack
2 – 3 PCB's

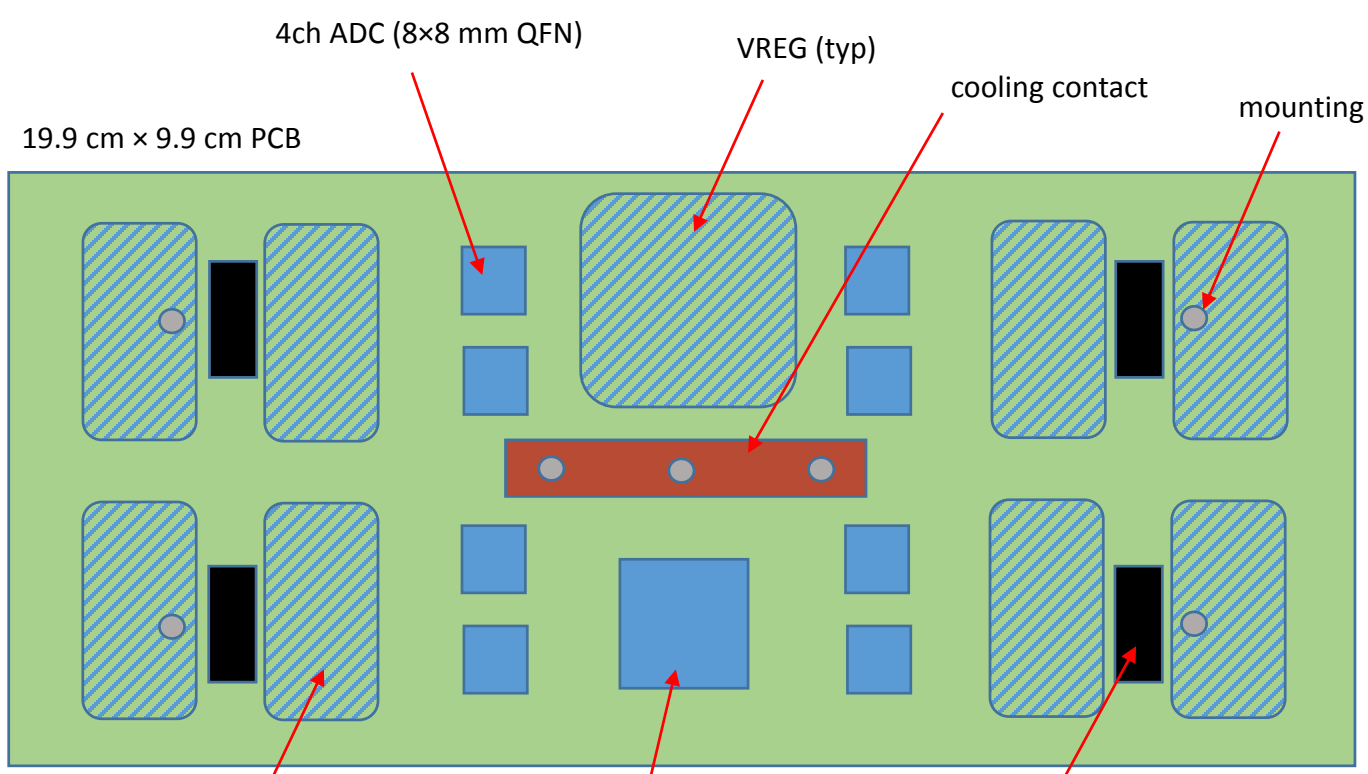
4× aluminum 3/16" hex 4-40 standoffs to LG, support FEB **independent of SiPM boards**

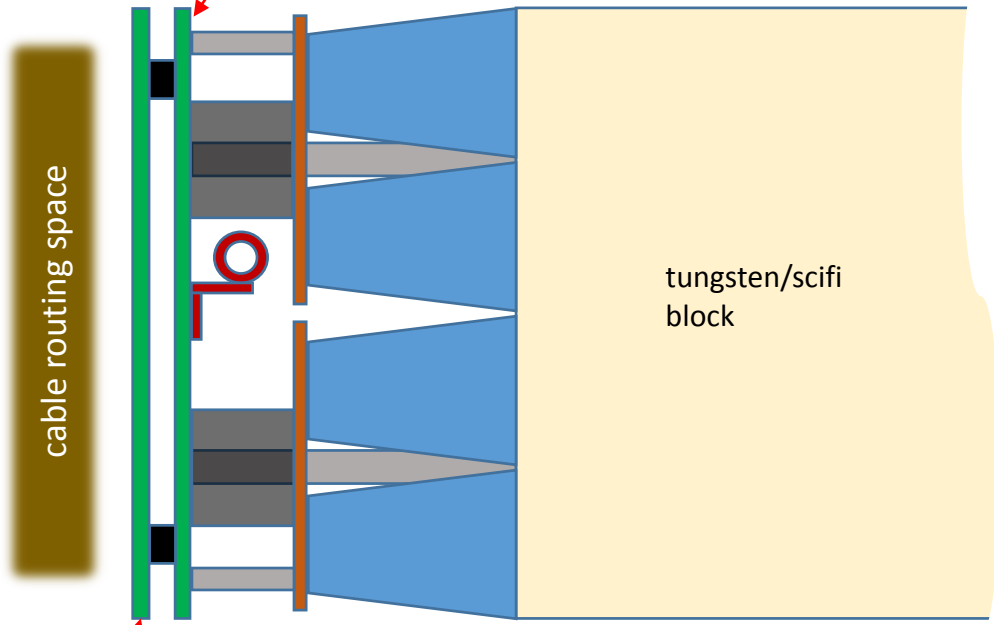
floating connectors, 1 per SiPM carrier
JAE AX01 series (30 pos) or similar

prototype FEB mounting standoff

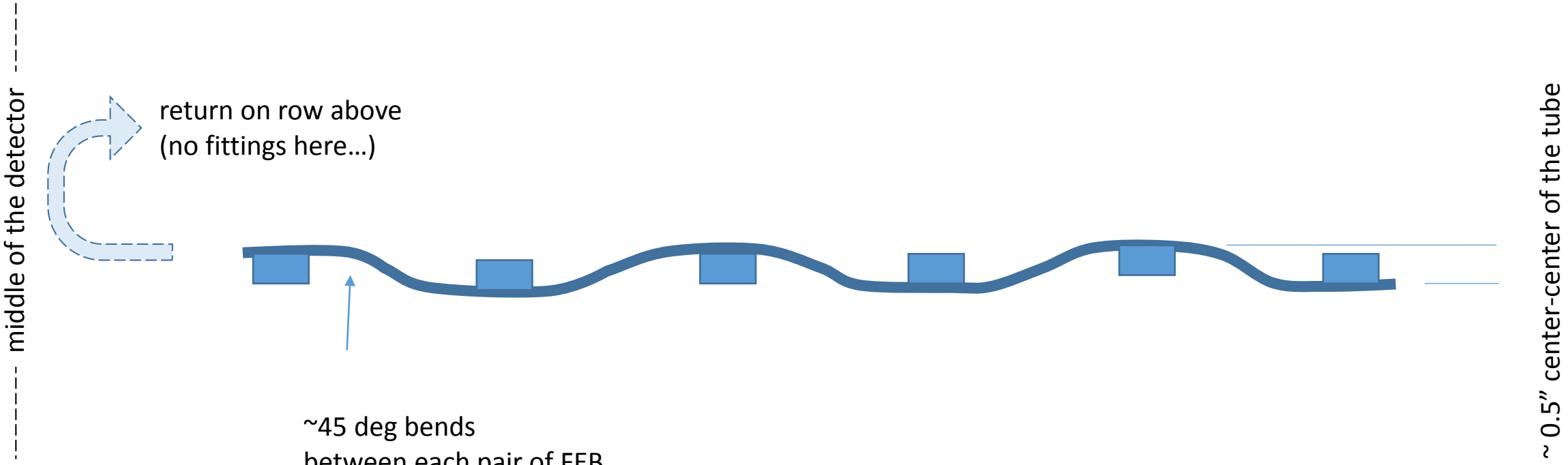
all cables and water tubing route basically *only horizontally* on detector

rear view of inner FEB PCB





water tube: probably use snake pattern, tabs alternating up and down,
this will eliminate trouble from reasonable tolerance on tab position



nut holes of the tabs all in line, of course
(not shown)

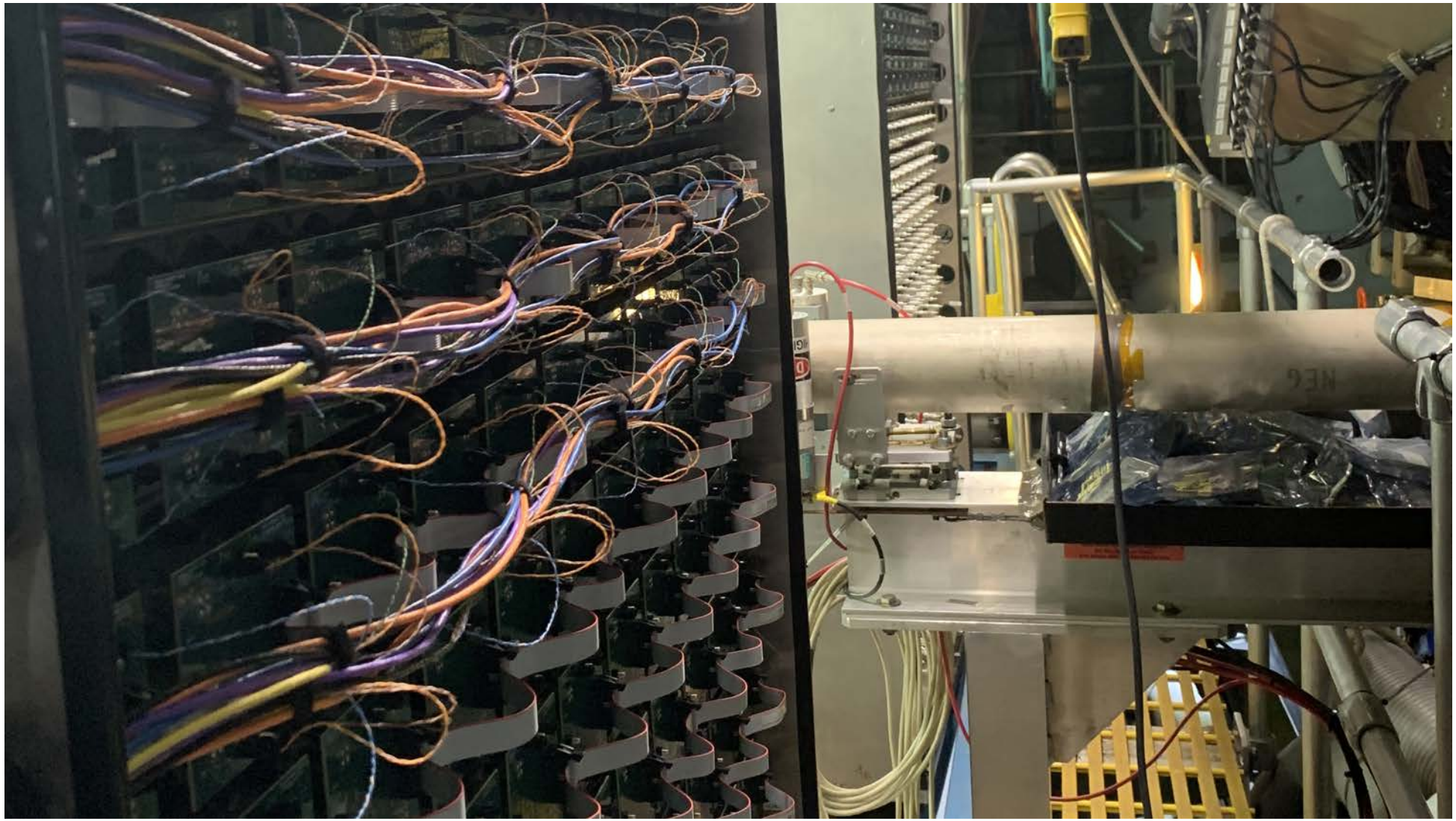
Pressure drop in the cooling line (back and forth over two rows of the detector)
estimated <1 PSI – we can certainly use negative pressure cooling, as suggested in review.

SUMMARY

- FEB and SiPM boards completely independently supported from the rear side of lightguide blocks
  - No worries about FEB or cable forces adversely affecting SiPM-lightguide optical joints
- FEB and SiPM boards fit within envelope of the blocks they serve (1mm margin)
- FEB needs to handle two adjacent horizontal blocks
- Depth of SiPM + FEB + cable space is 6 – 8 cm, starting from lightguide face
- Water cooling with no fittings inside the detector, “impossible” to leak
  - Nevertheless, negative pressure water is worth considering, and pressure drop is going to be low enough
  - Despite no fittings, nothing is captive behind the water lines. (Although installation probably done after SiPM board installation.)
- We expect no need for any air cooling in addition to water. (It could be considered as an alternative to water, but probably hard.)

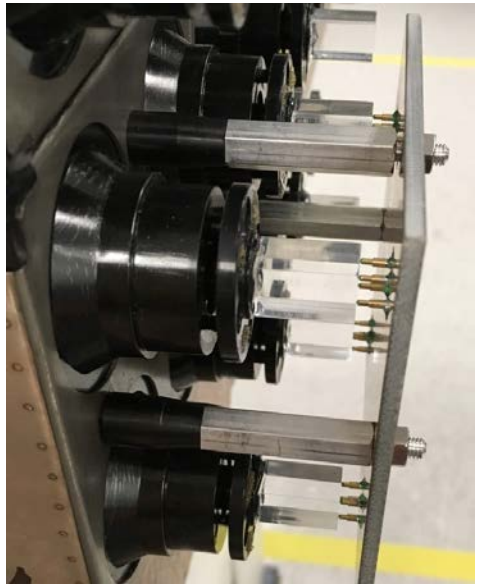
BACKUP SLIDES – some pictures from STAR FCS

The integration issues of ePIC forward ECAL FEB are very much like STAR FCS ECAL, except we could use a generous amount of space there.
We just need to pay much more attention to make a compact design, but most of the concepts will be same.
Apart from: On-board digitization and water cooling vs. air cooling.



FCS FEE Connections

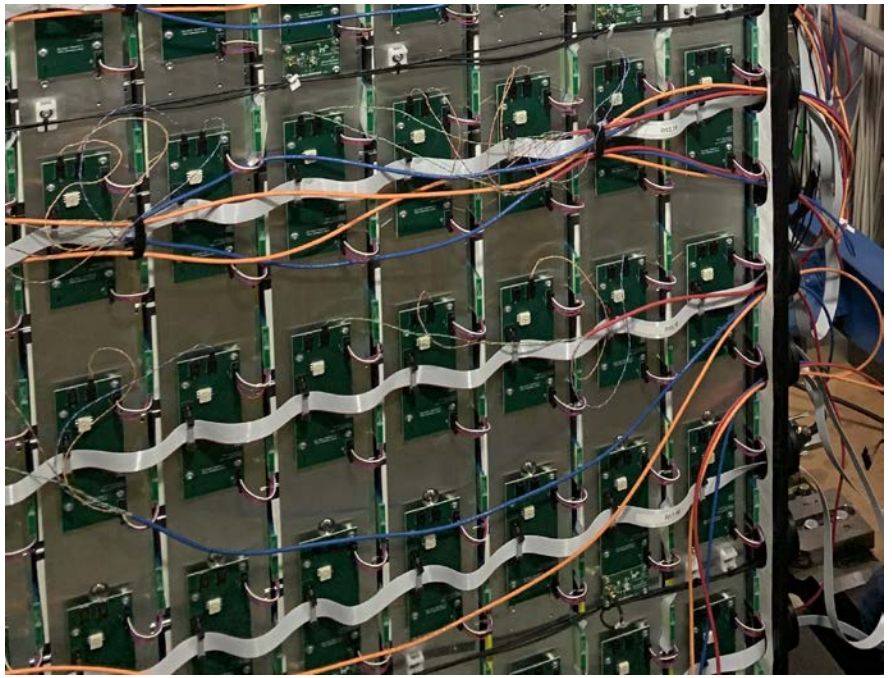
SiPM board per tower, glued to light guide. Connection from FEE by pogo pins. Large tolerance of transverse location (several mm). **Easy blind installation** (*once dimensions verified by fixture*).



Cooling of FEE: Air is drawn out from top of the enclosure. Enters at bottom, through baffles for light tightness.

Power inside detector: 180 mW/ch (e.g. ½ ECAL is 136 W)

Patchpanel boards on sides of detector: Transition to long signal cables. Group power rows into power groups. +80V power supplies.



HCAL: Same concepts, except short cable connection to SiPM board instead of pogo pin connection. Much more room than on ECAL.


ROW01
STAR FORWARD ECAL
4 CHANNEL SiPM FEE