Layout of dRICH SiPM electronics (prototype)

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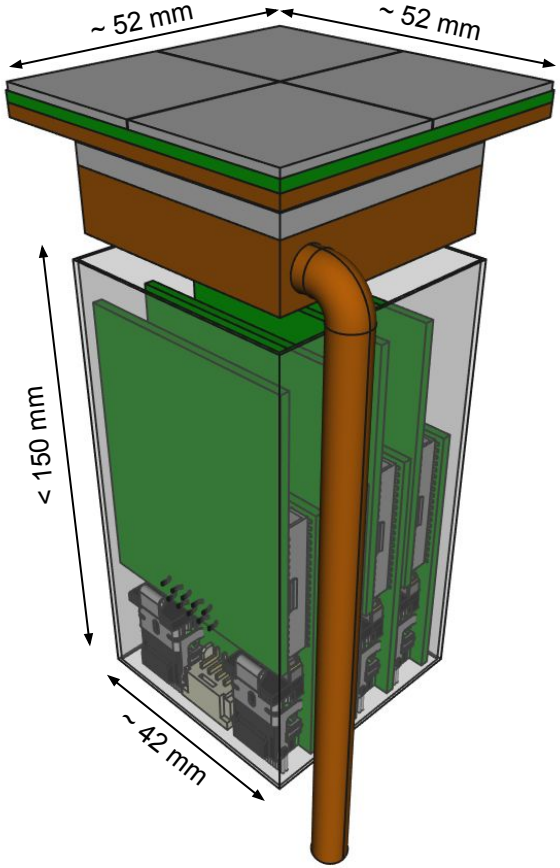
and preliminary material budget estimates

dRICH SiPM optical readout unit (prototype)

- **large-area SiPM optical readout for the dRICH prototype**
  - based on ALCOR readout
  - milestone deadline ~ April 2023
- **SiPM sensors and layout**
  - one readout unit
    - 4 Hamamatsu 8x8 matrices
    - 256 channels
  - ~ 52 x 52 mm² area
- **design with layout as close as possible to needs for final experiment**
  - critical engineering exercise in view of TDR
  - place cooling and electronics on the back of the sensors
- **use as much as possible of current electronics architecture**
  - no manpower capacity to develop new FPGA board this year
  - no manpower capacity di develop new firmware this year
  - use ALCORv2 (32 channels)
- **design new electronics boards to fit the new layout configuration**
  - possibly with the same features, if all needed

dRICH SiPM optical readout unit (prototype)

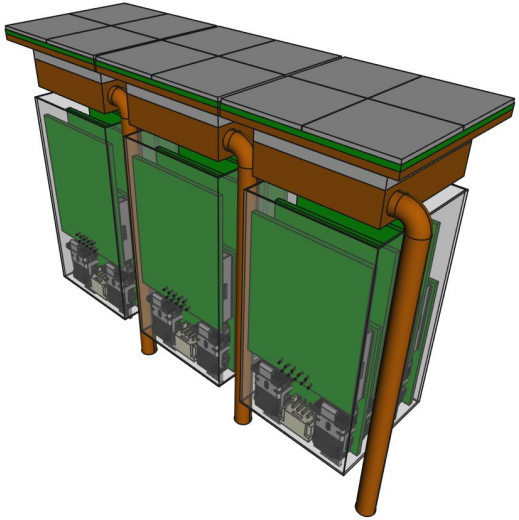


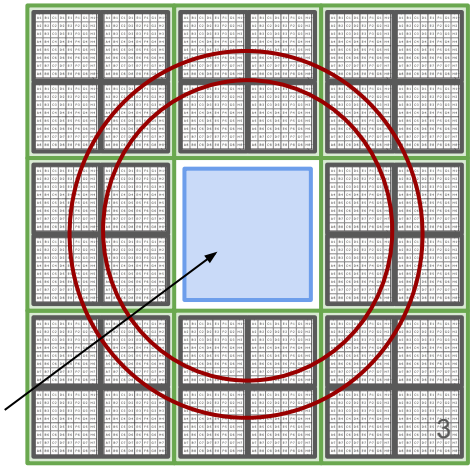
concept being developed for the dRICH prototype

engineers started working on implementation of the electronics

mechanical design of pieces will start soon

arrangement in beam test 2023

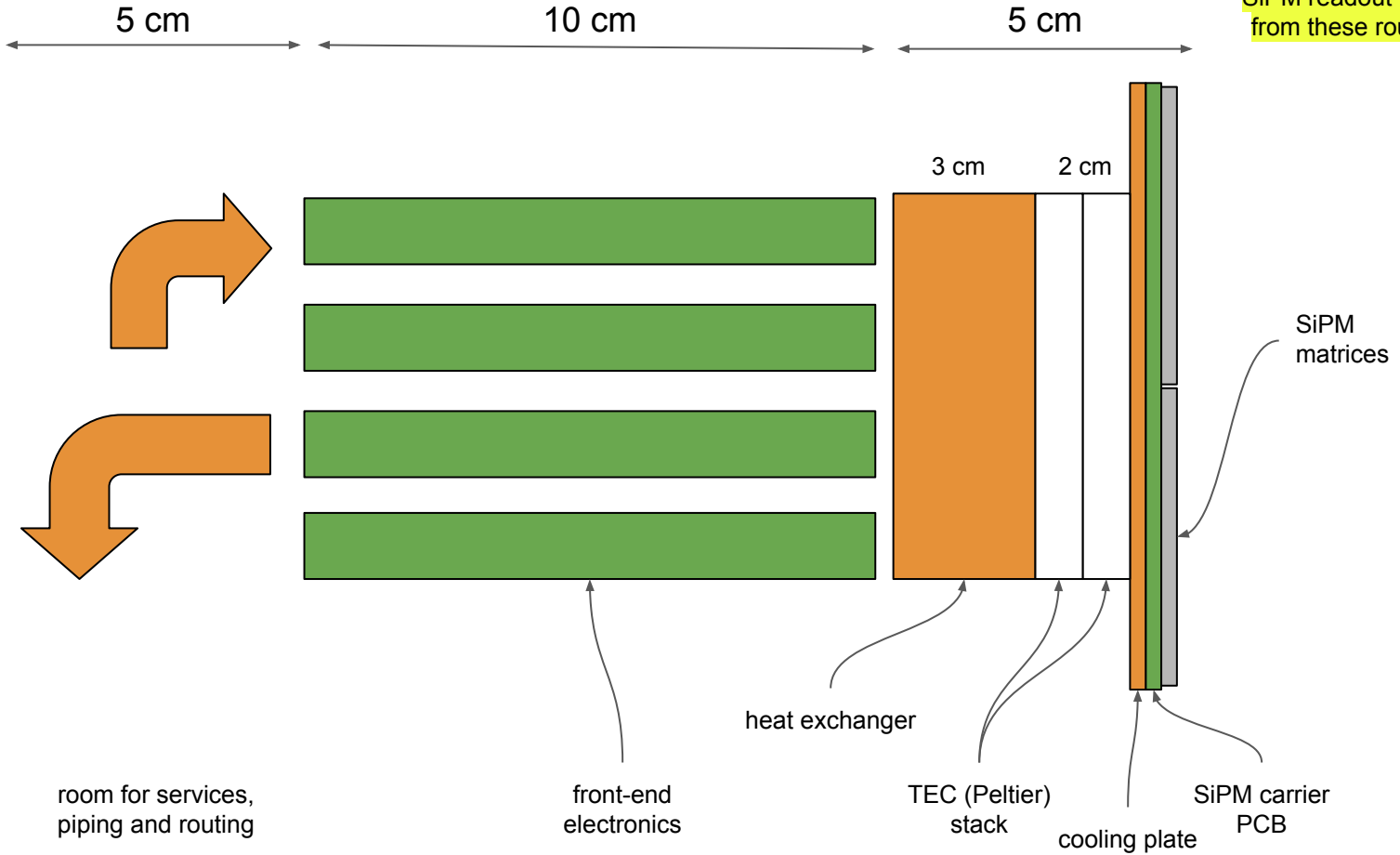




preliminary notes on dimensions of SiPM readout unit

From GDI presentation on 24 October 2022: “Status of SiPM photosensor technology”

20 cm longitudinal space for SiPM readout module comes from these rough estimates



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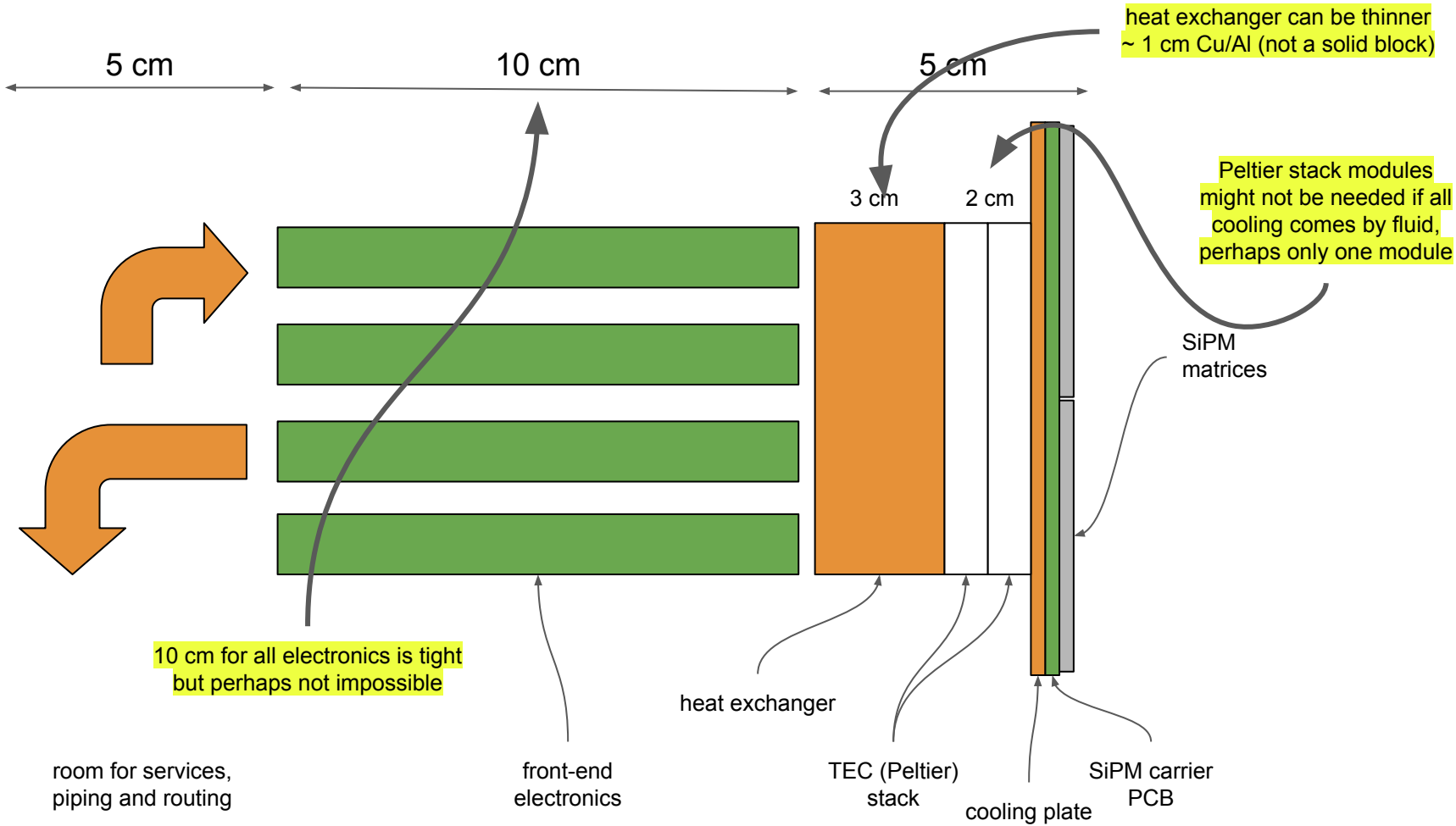

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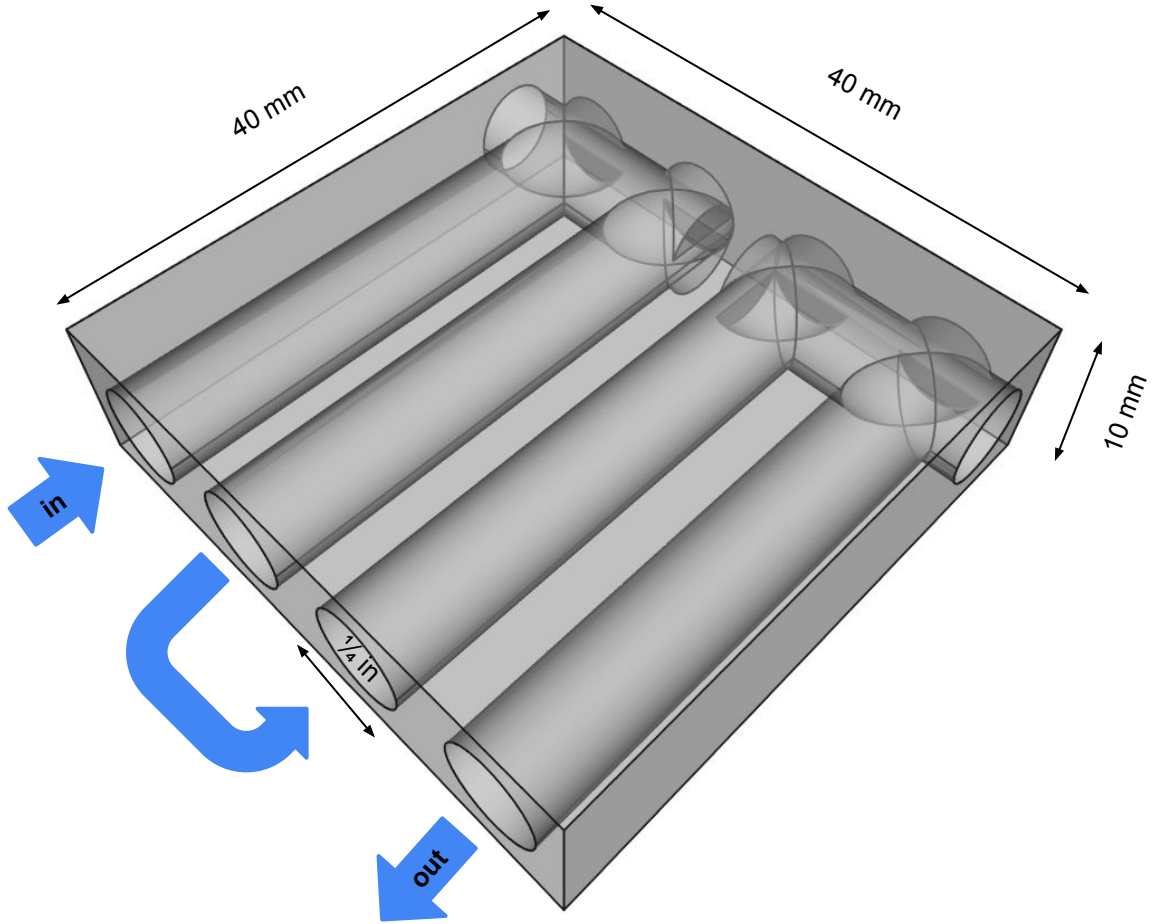
SiPM cooling block

conceptual design



4 x 4 x 1 cm = 16 cm³
remove 5 ¼ inch holes = 6.3 cm³
V = 9.7 cm³

Aluminium: 250 W/mK thermal cond.
ρ = 2.7 g/cm³
M = 26.2 g
X = 1.64 g/cm²

A = 16 cm²
X_0 = 24.1 g/cm²
X/X_0 = 6.8%

we can do slightly better
plus 1% of water = 7.8%

Copper: 400 W/mK thermal cond.

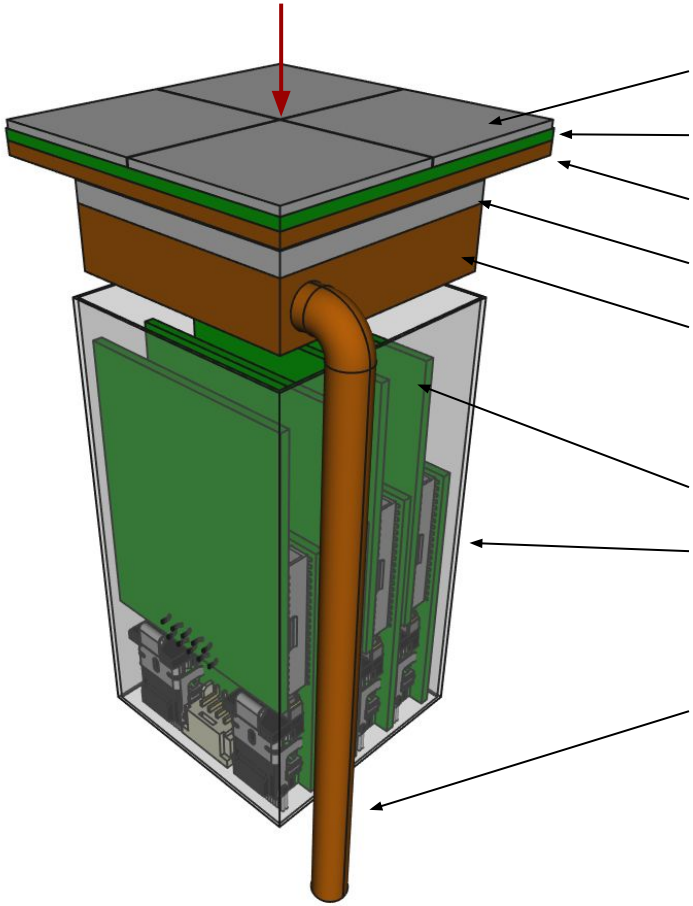
ρ = 8.96 g/cm³
M = 86.9 g
X = 5.43 g/cm²

X_0 = 12.86 g/cm²
X/X_0 = 42.2%

Copper, no way

Material budget estimates

average for a particle hitting normally (electron-side RICH)



SiPM array: Si, 0.5 mm + 1 mm FR4 = 0.5% + 0.3% X/X_0

support PCB: FR4, 1.6 mm = 1% X/X_0

cooling plate: Al, 1-2 mm = 1-2% X/X_0

Peltier modules: likely not in final design

heat exchanger: Al, 10 mm (hollow) + water = 8% X/X_0

SiPM <u>with cooling</u>
~ 12% X/X_0 center
~ 4% X/X_0 periphery
~ 9% X/X_0 average

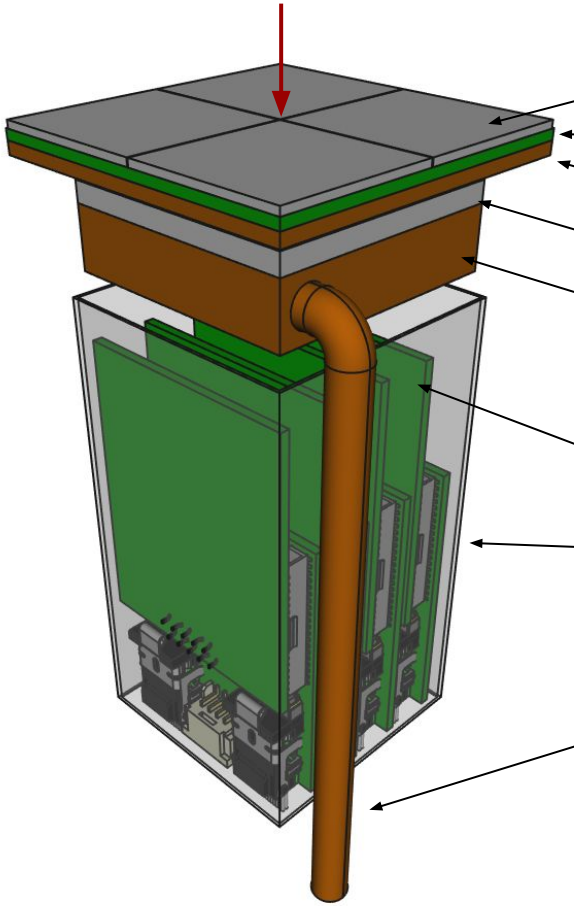
front end electronics: FR4, < 150 mm (8 boards) **< 28% X/X_0**

mini-crate: not defined yet (Al, plexiglass, … ?)

cooling pipes: not defined yet (nylon, rilsan, … ?)

Material budget estimates

average for a particle hitting normally (electron-side RICH)



SiPM array: Si, 0.5 mm + 1 mm FR4 = 0.5% + 0.6% X/X_0

support PCB: FR4, 1.6 mm = 1% X/X_0

cooling plate: Al, 1-2 mm = 1-2% X/X_0

Peltier modules: likely not in final design

heat exchanger: Al, 10 mm (hollow) + water = 8% X/X_0

SiPM <u>with cooling</u>
~ 12% X/X_0 center
~ 4% X/X_0 periphery
~ 9% X/X_0 average

how much material is an **HRPPD** module? 5 mm quartz window is already 4% X/X_0

front end electronics: FR4, < 150 mm (8 boards) **< 28% X/X_0**

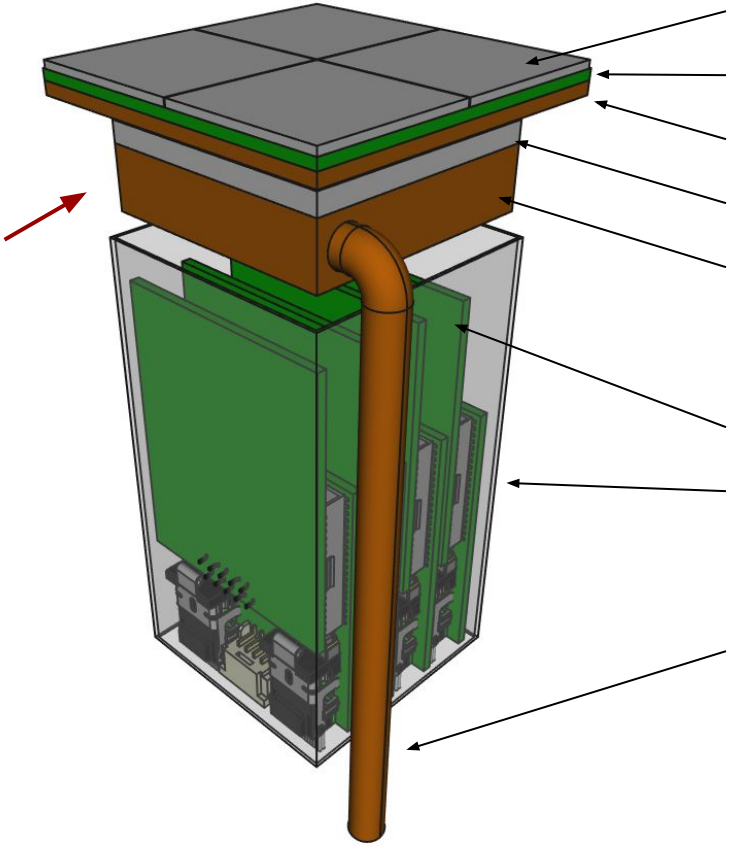
mini-crate: not defined yet (Al, plexiglass, … ?)

cooling pipes: not defined yet (nylon, rilsan, … ?)

most of material is in electronics
<u>note:</u> this is based on current architecture: 8 32-channels ALCOR chips. We know how to reduce complexity (as well as material)

Material budget estimates

average for a particle hitting sideways (worst-case dRICH)



SiPM array: Si, 0.5 mm + 1 mm FR4 = 55.5% + 30% X/X_0

support PCB: FR4, 1.6 mm = 30% X/X_0

cooling plate: Al, 1-2 mm = 58.4% X/X_0

Peltier modules: likely not in final design

heat exchanger: Al, 10 mm (hollow) + water = 31% X/X_0

SiPM with cooling
~ 35% X/X_0 average

off course this hase spikes here and there like for any detector placed sideways

front end electronics: FR4, < 150 mm (8 boards) **< 8% X/X_0**

mini-crate: not defined yet (Al, plexiglass, … ?)

cooling pipes: not defined yet (nylon, rilsan, … ?)

Summary

- **design of dRICH prototype SiPM readout**
  - concept idea on the table
  - INFN engineers working on realisation
- **SiPM cooling system based on Al heat exchanger**
  - not that “bulky”, less than 10% of a radiation length
  - how does material of SiPM + cooling compare to 12x12 cm HRPPD tile?
  - will ask engineers to run simulations to optimise it
  - Peltier modules will be used for prototype, likely not for EPIC
- **put all this stuff into EPIC simulation**
  - at least as first step towards a realistic readout system
  - with space allocation
  - and material allocation