Integration issues of FPCCD VTX

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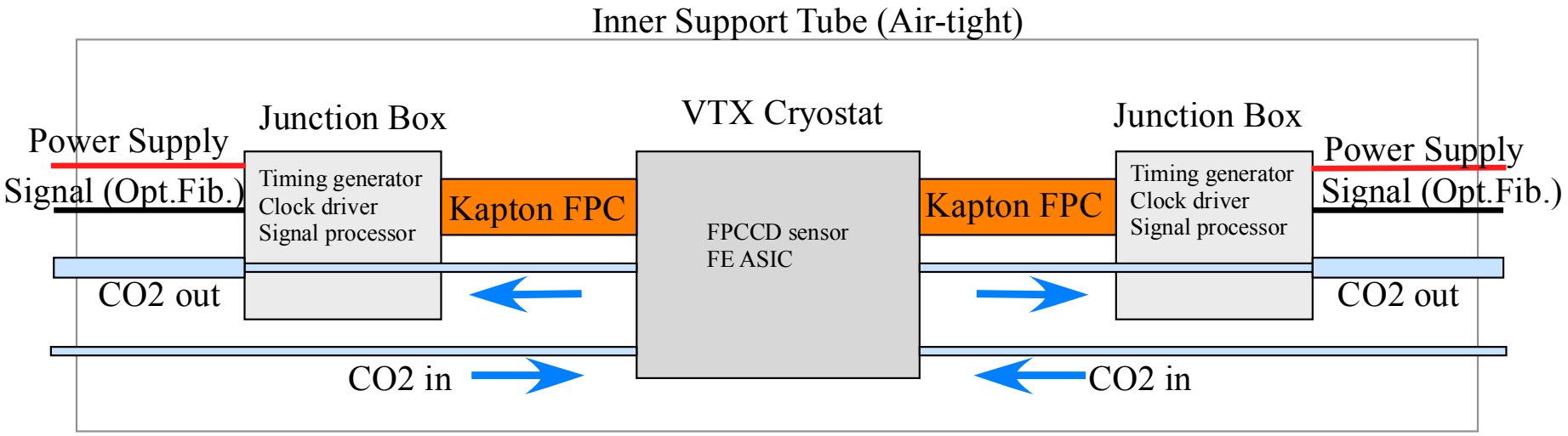
Schematic design

- Very preliminary estimation of material budget has been done for
  - Electronics
  - Cooling pipe

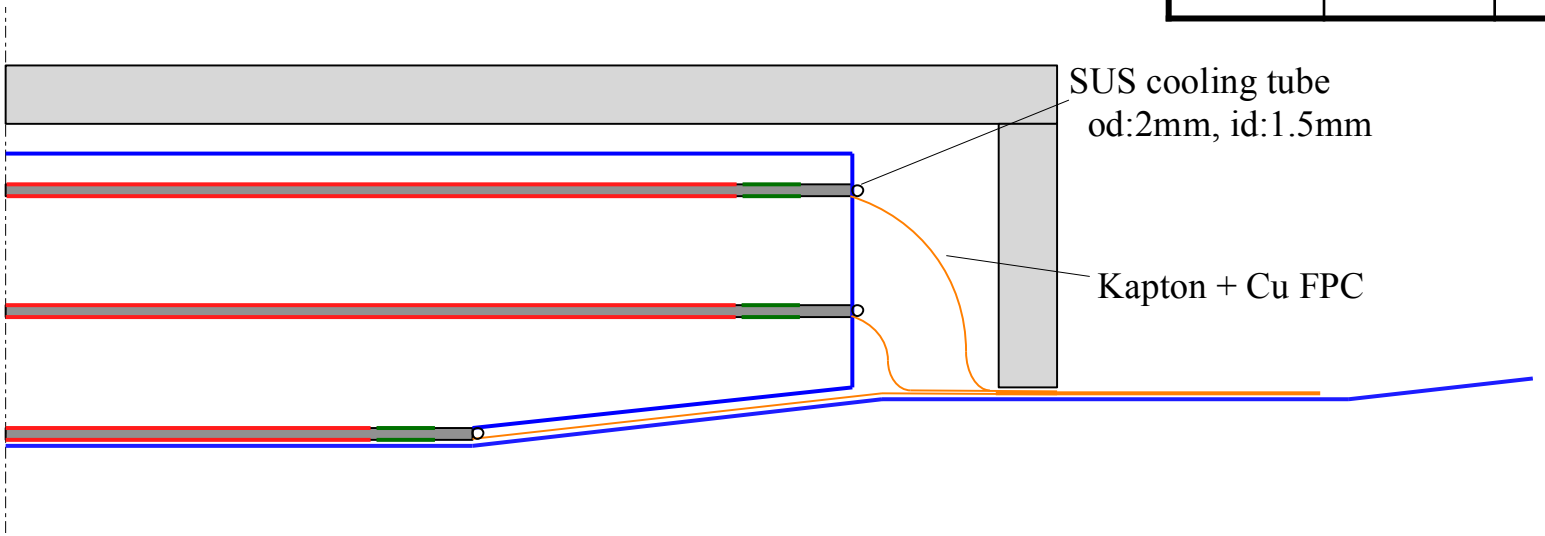


Electronics (1)

- Flexible printed circuit (FPC) cables from double-sided ladders
  - If each ladder has one FPC cables/end of 1cm width and these cables run just outside of the beam pipe, 2.5 layers of FPC (9μm Kapton + 9μm Cu) covers the beam pipe of 24mm radius

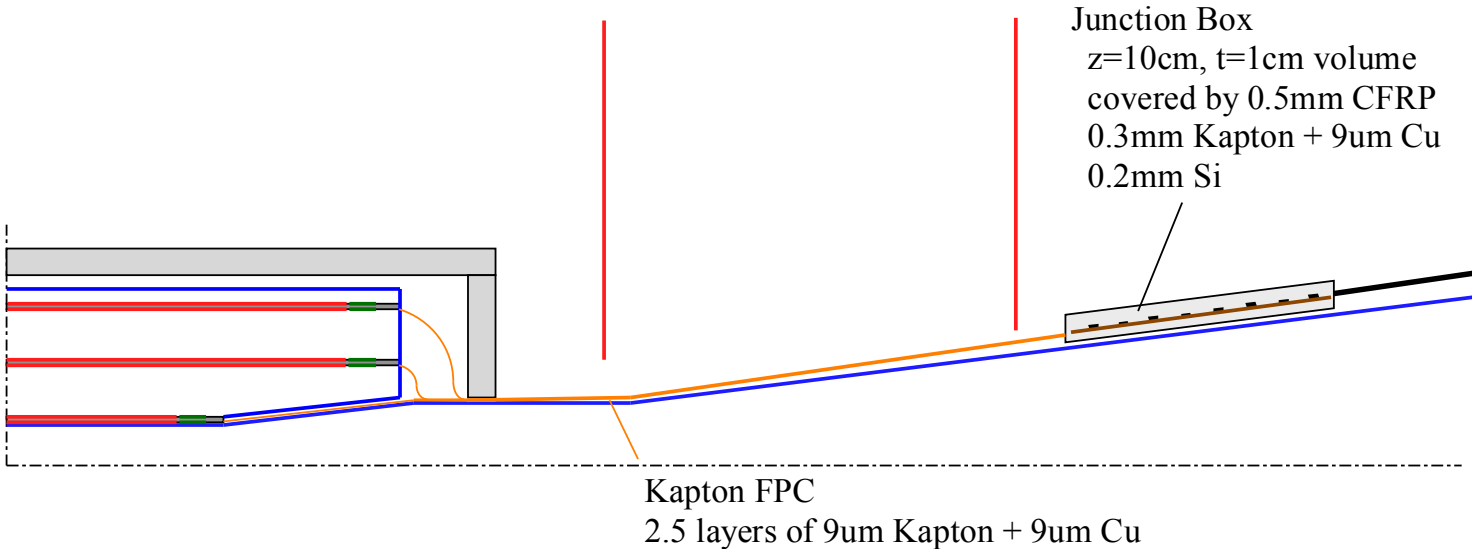
Ladder parameters

Layer	Width	# of ladders
1	11mm	10
2		
3	22mm	11
4		
5	22mm	17
6		



Electronics (2)

- Junction box
  - Kapton FPC cables are connected to electronics circuit with the function of clock generator/driver and signal processor put inside an annulus of junction box which is surrounded by 0.5mm CFRP and placed outside of the SIT region
  - Rough estimation of the material budget is 0.3mm Kapton + 9μm Cu for PC boards (rigid-flex PCB), and 0.2mm Si for surface-mount components
  - These PC boards have a length of 10cm in Z, and locate surrounding the beam pipe

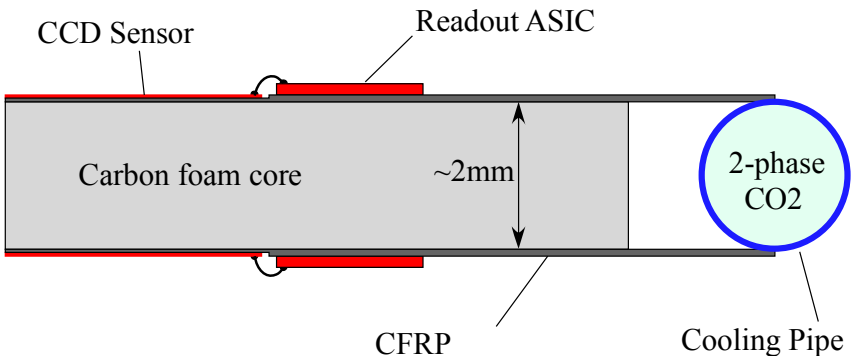


Electronics (3)

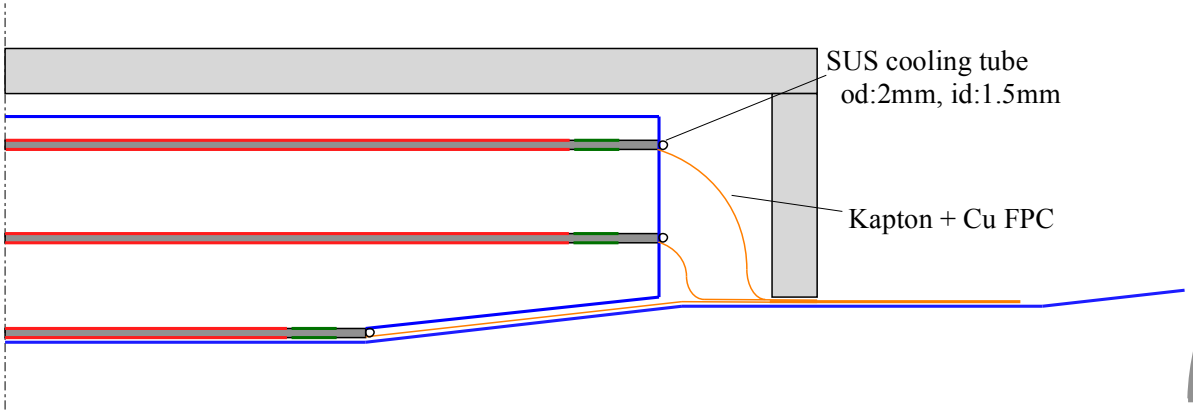
- Power consumption
  - Inside cryostat: 2112 readout channels/side → ~50W/side
  - Outside cryostat: Junction box which contains timing generators, clock drivers, and signal processors ~200W/side
- Power cables from outside to the junction box
  - Each power supply current is less than 25A (No power pulsing)
  - 8mm^2 cable (R=2.2mΩ/m) gives ΔV<0.5V @10m: Acceptable
  - 16 lines/side (4 kinds of voltage x2 (return ground) x2 (two half shells)) of 8mm^2 cables are enough
- Material budget of optical fibers is not estimated yet

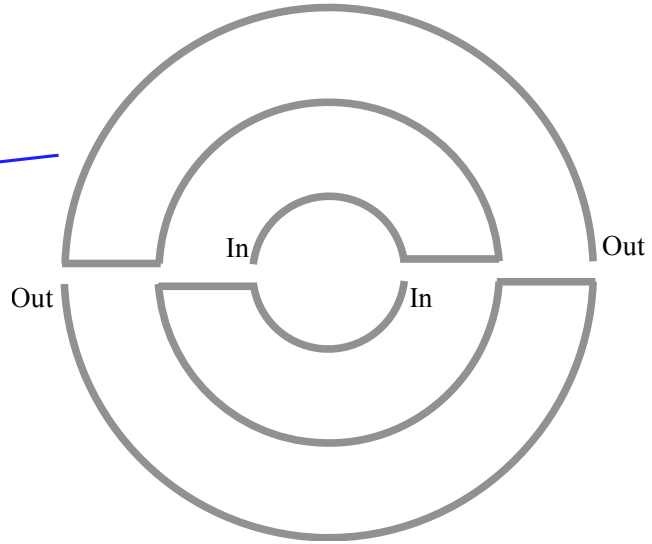
CO2 cooling

- FPCCD is operated at very low temperature (-40~-30 degree) in order to improve radiation immunity
- We plan to use 2-phse CO2 cooling at both ends of the ladders to remove the 100W power and keep sensors at low temperature
- 2-phase CO2 is also used to cool the electronics inside the junction box
- Tube (SUS316) diameter
  - Inlet line, inside cryostat: 2mm/1.5mm (od/id)
  - Outlet line (cryo – junction box): 2mm/1.5mm
  - Outlet line (J.B. – outside IST): 4mm/3mm (or 2mm/1.5mm)
  - Tube wall thickness of 0.25mm could be much thinner
- Inner Support Tube should be air-tight and filled with dry air/nitrogen in order to prevent condensation



CO2 cooling

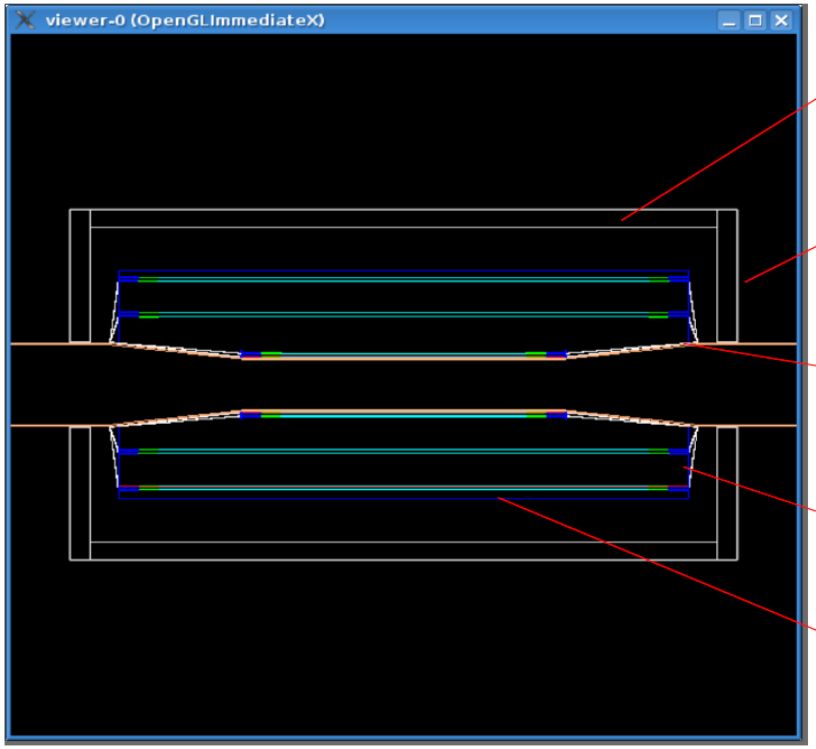




- Tube material budget
  - Averaged over endplate:
    0.5%(Fe)+0.03%(CO2) X_0
    (tube for innermost layer excluded)
  - This value can be reduced by using tubes with thinner wall thickness

Overall mechanical structure

- We don't have realistic design of VTX mechanical structure
- Design implemented in MOKKA does not seem realistic to me, particularly Be endplate (0.494mm ←→ 5mm for SLD)
  - Any mechanical simulation?
- We need consensus on material budget to be put into the simulation



Cryostat tube:
0.5 alu + 10 stryropor mm thickness
z 2*170.25 mm
R-out 100 mm

Cryostat endplate:
0.5 alu + 10 stryropor mm thickness
z 170.25 mm
R-out 100 mm

Kapton:
0.0094 mm thickness
z-begin (-)83 mm (145.5)
z-end (-)150 mm

Beryllium endplate:
0.494 mm thickness
R-out 65 mm

Beryllium shell:
0.494 mm thickness
z-begin -145 mm
z-end 145 mm

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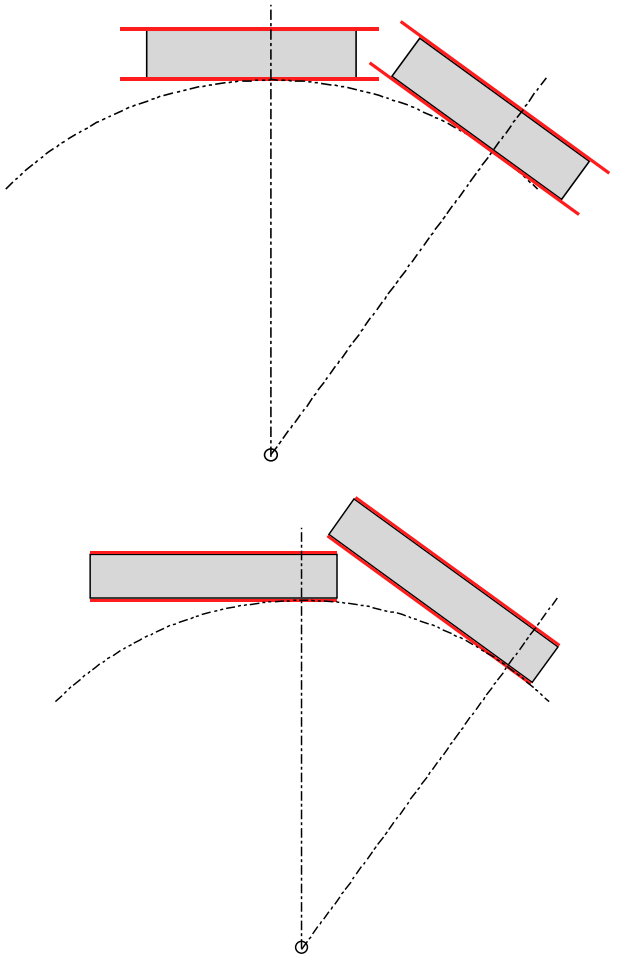
Ladder layout

- Design in MOKKA assumes a tricky ladder overlapping
- Shall we keep this design? Or change to a normal overlapping? (Average R is larger in case of the normal overlapping



Proposal for simulation model

- Design should be similar to CMOS option inside the cryostat, but some difference outside it
- For MOKKA model, combination of conservative (larger X_0) parts is one possible option

	FPCCD	CMOS
Ladder	C foam	SiC foam
Cooling tube	SUS	?
Connector at cryostat	No	Yes
Kapton cables around BP	Yes	No
Junction box	Yes	No