Structures for SiW–ECAL Calorimeter Stacks

Discussion on larger structure for 2022$^+$

Successful testing of 15 layers in November 2021

- low energy $e^\pm$

Additional layers

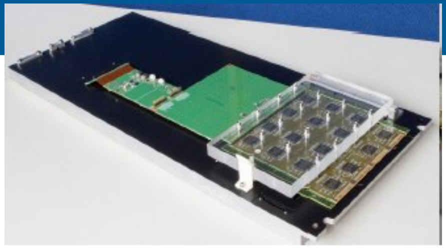
- (nearly) ready : 7 FEV13 + 2 COB
- coming “soon” : 8 FEV2.0 (long slab & stack)

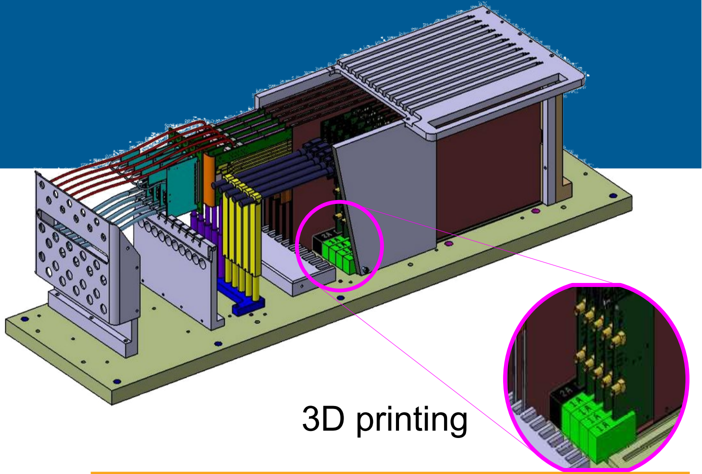
Intermediate BT (DESY22-Q1, CERN22-Q3)

➡ Structure(s) for :

- 30 layers of 1×1 ASU
  - $24X_0$ (84,mm) ➡ full shower containement
  - as compact as possible
  - close to ILD design (2 sections)
  - precise positionning
- 15$^+$ layers of 2×1 ASUs
  - For LUXE experiment (16 GeV e-)
  - to measure dead space between ASUs

Existing structures





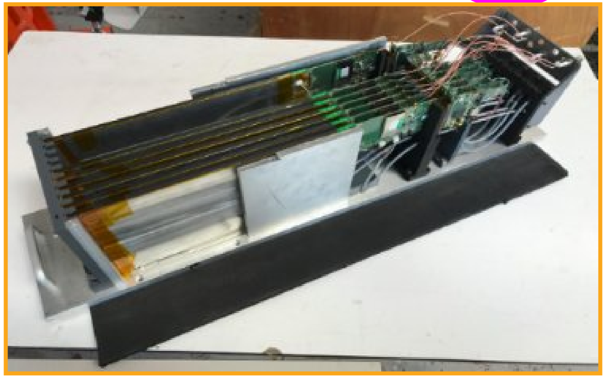
2015 : Aluminium Test boards

- 4 places, alum. case: good perf.

2016-2018 : 1st structure with slabs

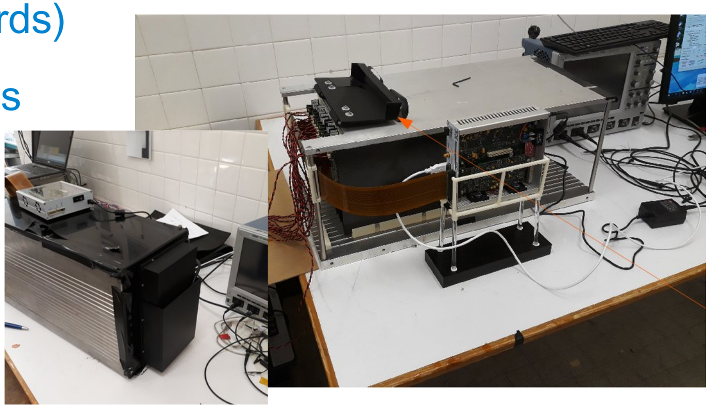
- 10 places ➡ 7–10 boards, HDMI+SMB
- Alu case + holder for the U + W sliders

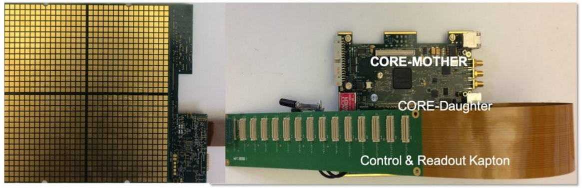
All with fixed spacing



2019-2021+ : SLBoards

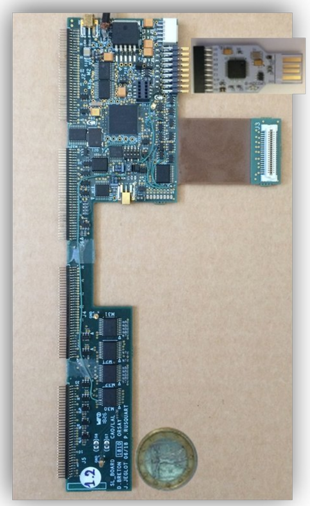
- 15/17 places (7–15 boards)
- Alu base plate + grooves
- W on the C plates
- Cooling

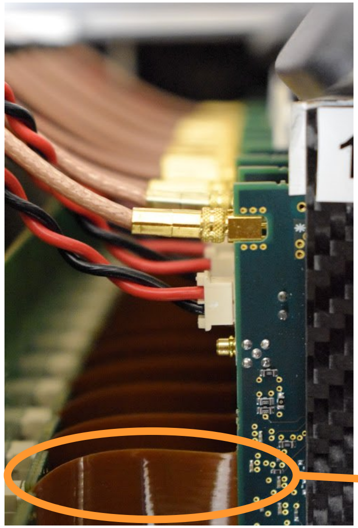




Reminder on compact readout

Current detector interface card (SL Board) and zoom into interface region

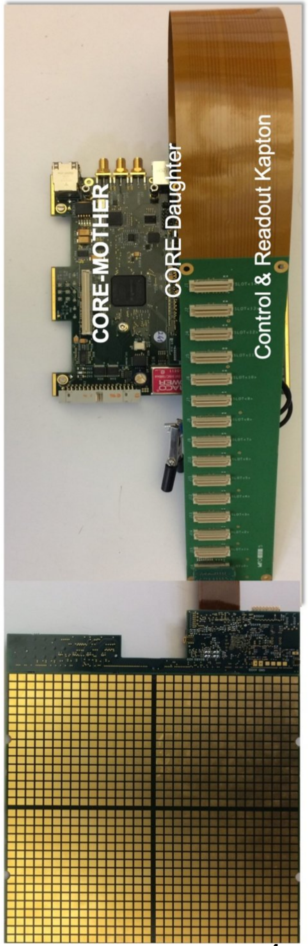




Complete readout system

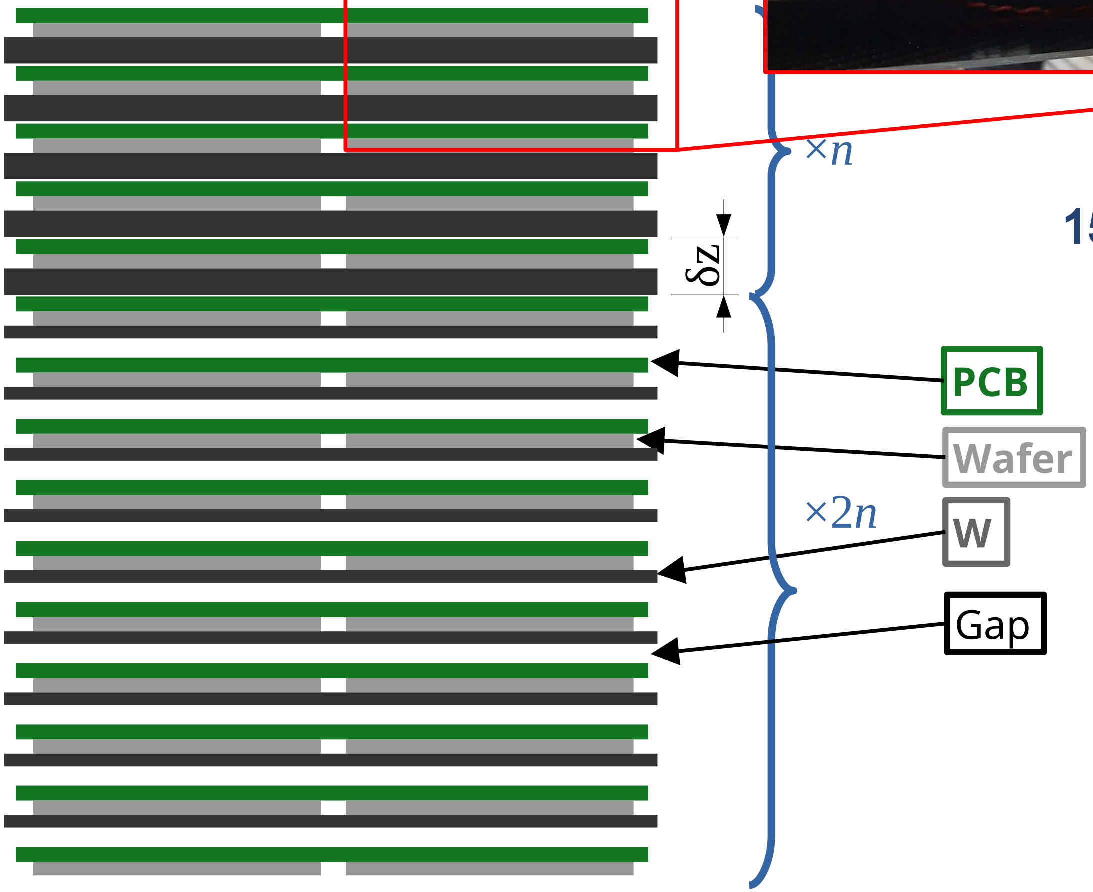
More compactness
⇒ Less flexibility
~ in CRK

margin ~ ±2×2 cm ?

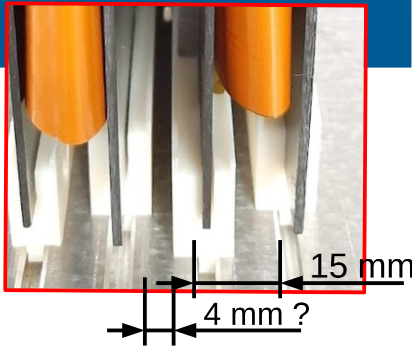


- “Dead space free” granular calorimeters put tight demands on compactness
- Current developments in CALICE meet these requirements
- Can be applied/adapted wherever compactness is mandatory
- Components will/did already go through scrutiny phase in beam tests

DESY21



Gap ~ 1 mm ?



~5.4mm air gap from sim.
≤1mm due to SLboard pins, ...

15 Layers

- δz = 15 mm
- $\sum W$ = 5 × 4,2mm + 9 × 2,1mm
  = 10.8 X_0

DESY22

Main goal:

- Test DAQ with AHCAL (+telescope ?)

Secondary goal:

- Have some contained showers ?

Same structure as DESY21

- Same 15 layers
- all with 4.2 mm of W

  $15\times 4.2\text{ mm} = 63\text{mm} \Rightarrow 18\ X_0$

Requires:

- Additional W layers (avail. at LLR)
- Reprint some “4.2” support structures
  - Gan we gain on positinning precision ?
    - ±1 mm ?

CERN22 ~ June – September ? (if accepted)

Noiser EM environment

- ➡Faraday Shielding
  - keep cooling...

Integrate more layers ?

- DESY21 + 7 FEV13 + 2 COB ? = 24 layers
- 24X0 (84mm) ➡ 8 × 2.1mm + 16 × 4.2mm
- 2 readout partitions

New structure needed

- What form ?

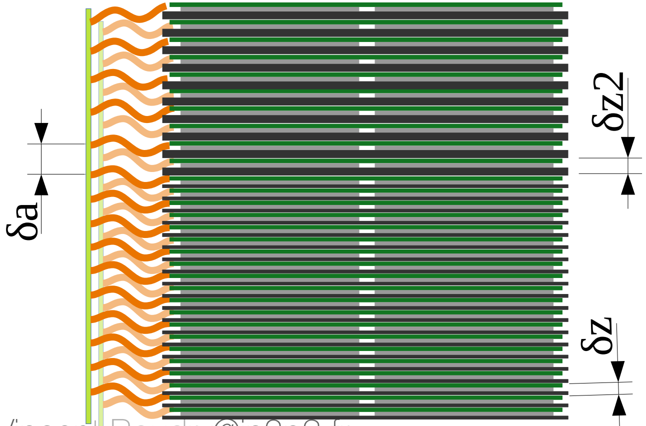
Option 1: Pile-ou-Face (upside-down)

Same side readout but up-side-down

- 2 core modules

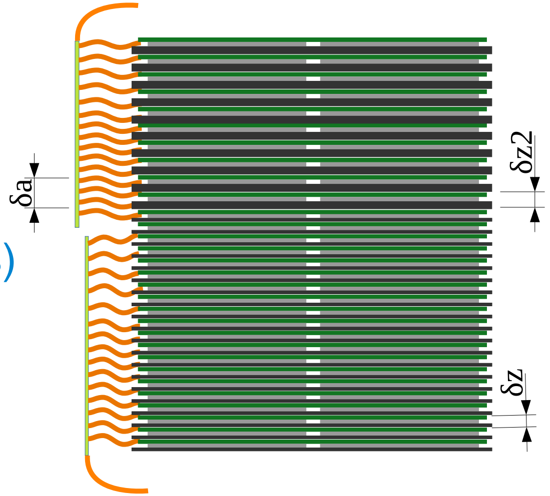
Interleaved :

- interleaved (1 up 1 down)
  - ➡ δa = δz2 (~15mm) ➡ new CRK ?
  - or is the flexibility of kaptons enough ?



Front/Back

- 1 RO
  from the front
  (could be 1st 9 layers)
- 1 RO
  from the back
  (last 15 layers) ?

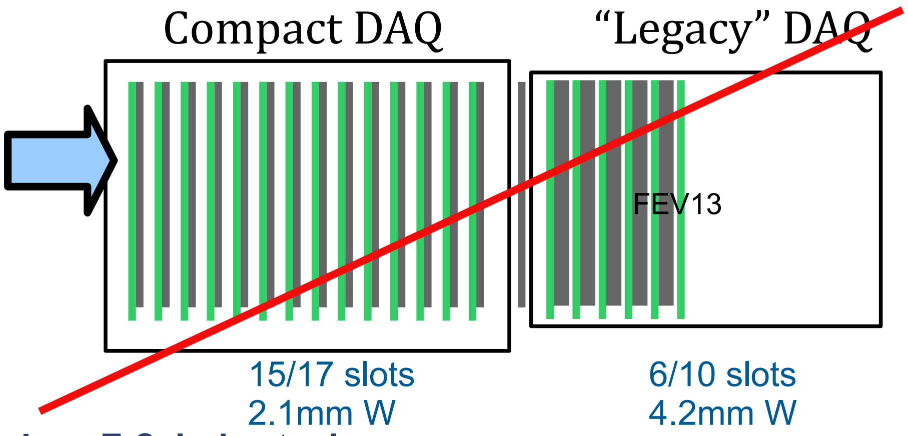


Open Questions:

- FEV13 shifts : OK if in front ?
- Compactness ↔ Flexibility
- 1 set of ASU is “back to the beam” (interleaved)

2^{nd} stack for 15 X_0 ECAL ? *(2020 proposal)*

Combined structure



Low-E Calorimeter layer

+ "Core shower" = 4-5 X_0 of W in Front

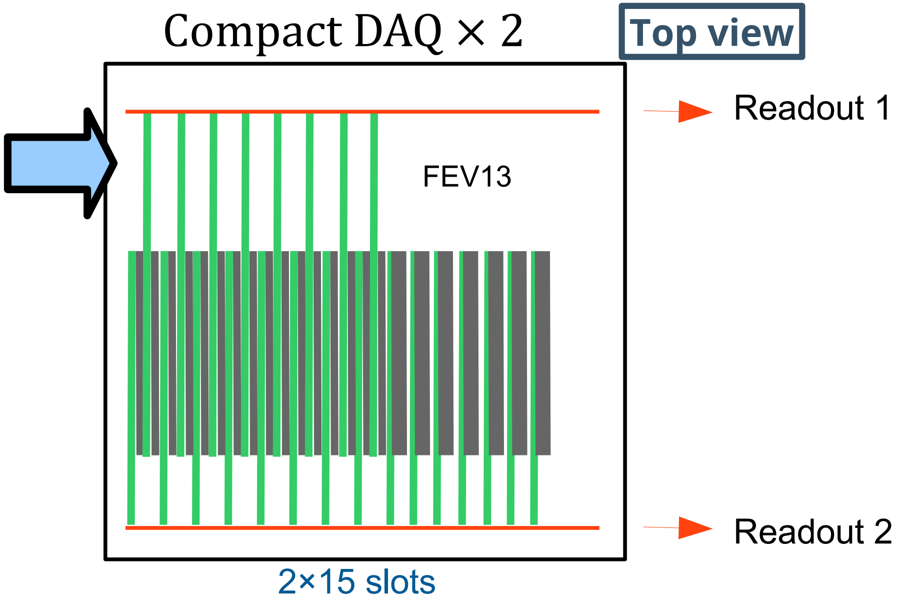
- ~ same response in all layers

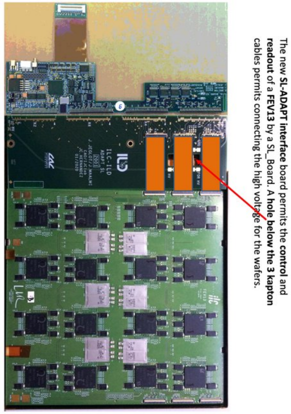
A possible calorimeter layout ?

- Mix perf ⊗ New / Tested ⊗ Shower profile

To be readout by 2×15 ladder in Nov ?

- ⇒ novel structure for compact layout

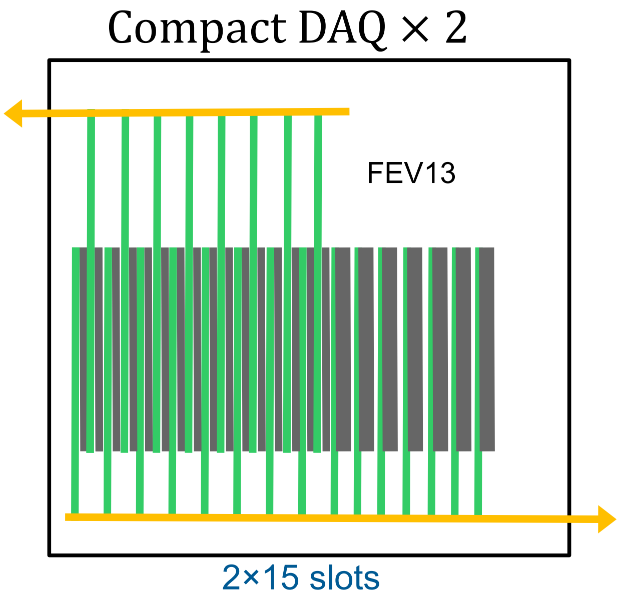




‘Face-to-Face’

Both side readout :

– 2 core modules



Open questions:

– 1 set of ASU is reversed, by either:
  - 180° / beam axis (readout 2 ≠ heights)
  - 360° / ASU center (readout at the same level, but ASU “back-to-beam”)

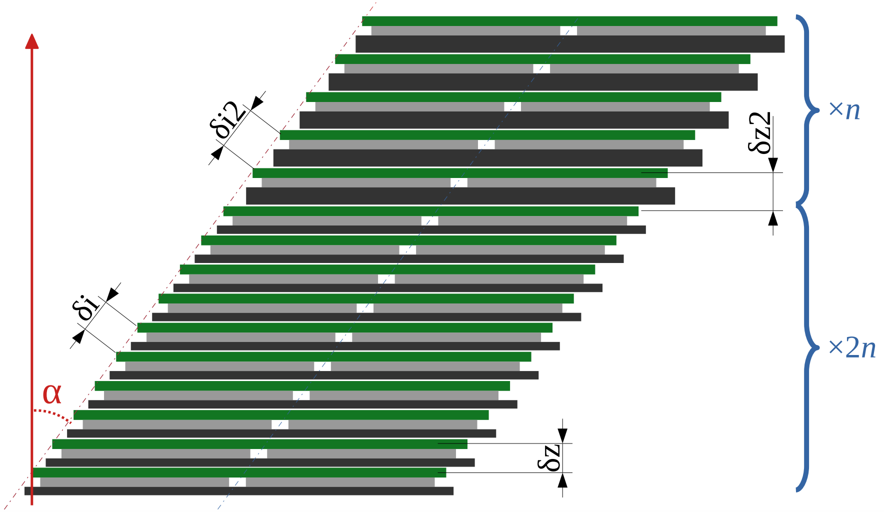
– Partitions:
  - 1 partition for FEV13 + another ASU (shifted)
  - mix ?

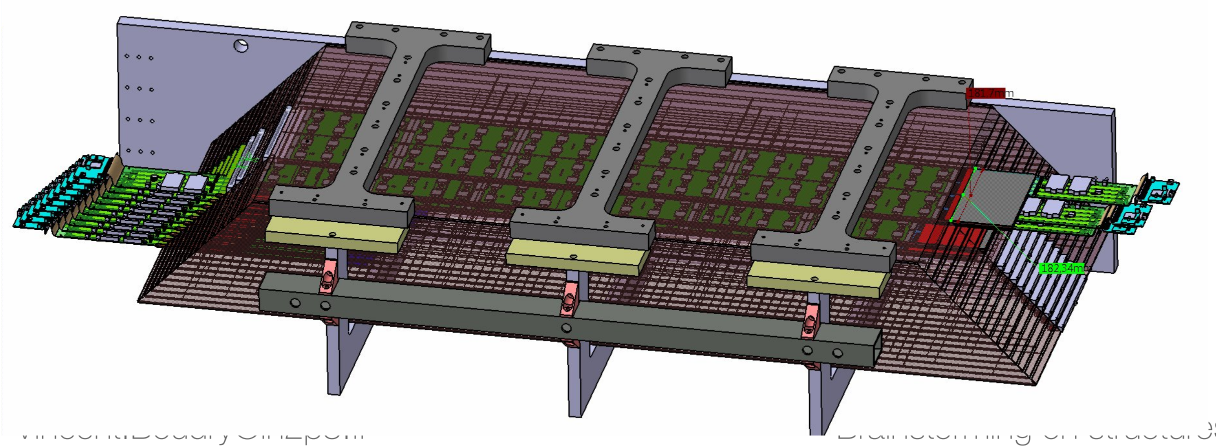
Interleaved vs Front/Back

– interleaved:

➡ δa = δz2 (~15mm) ➡ new Connector boards ?

CERN23 : Compacter layout ILD-like design ?





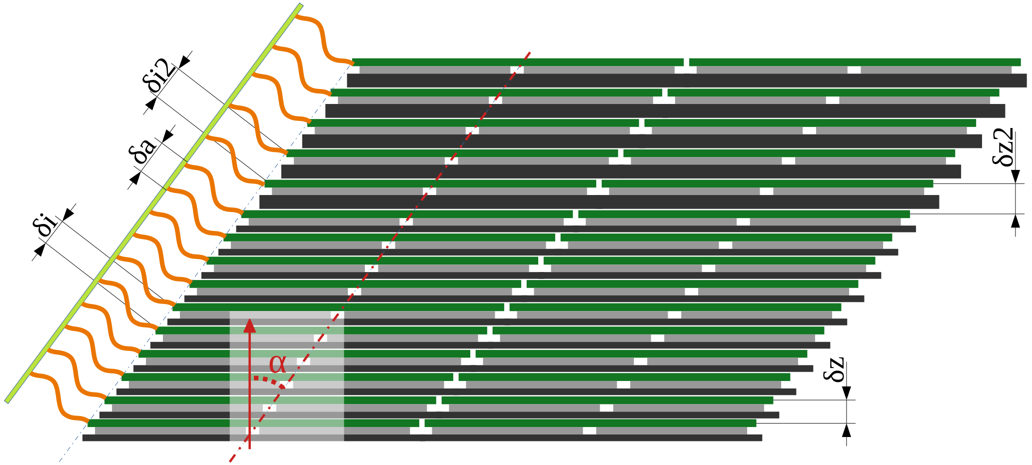
For ILD :

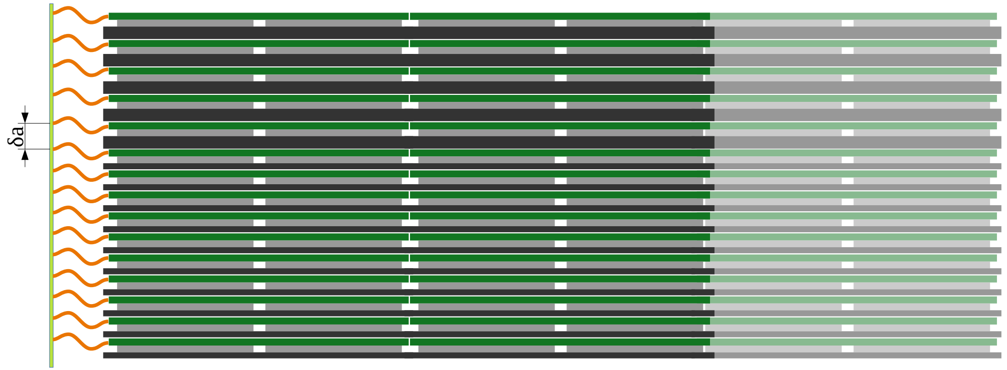
- α = 45°
- ∑W = 24 X_0 / 84 mm

Single Layers:

- 15 FEV10/11/12
  + 7 FEV13
  + 2 COB
  + 8 FEV2.0 = 32 layers

deLUXE set-up





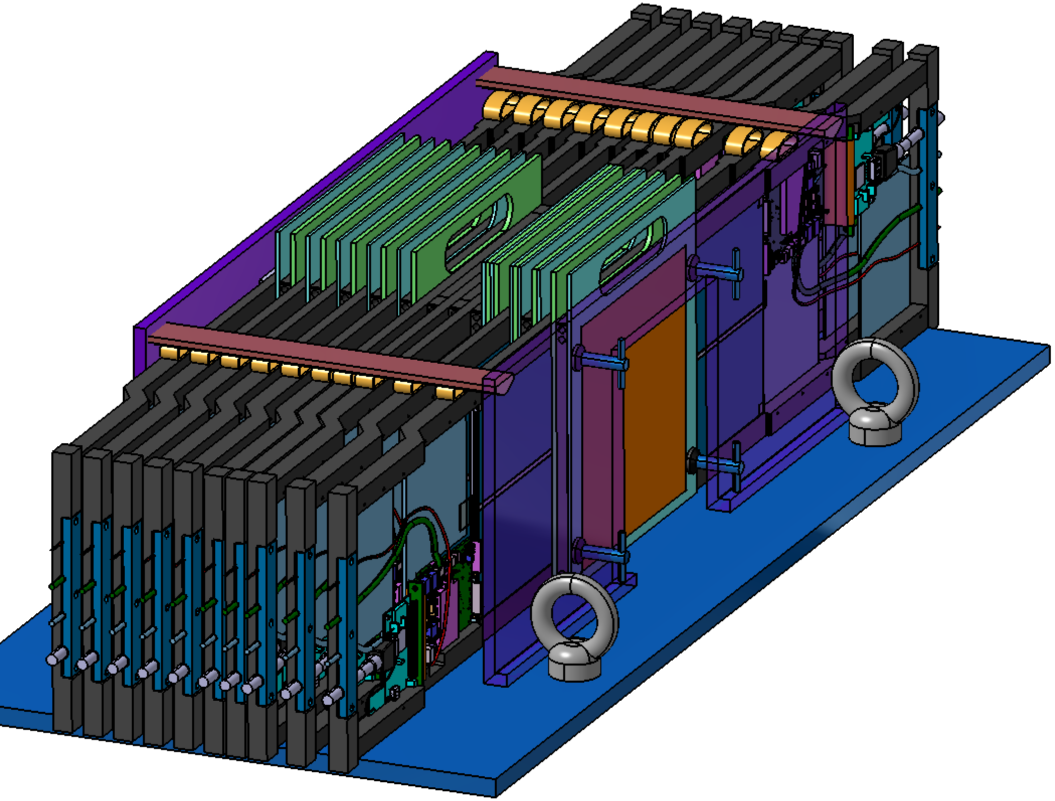
Compatibility of "fixed" δa for RO ?

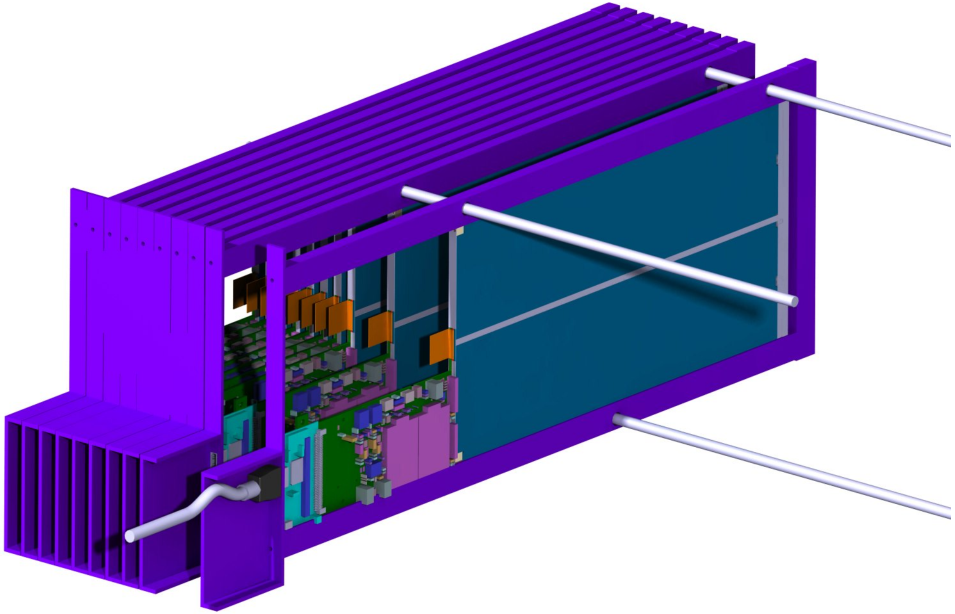
- new RO boards needed
  - also SLboards

Adjustable α ?

- Depends on W / Board thickness vs cos(α) [see table]

Stackable structure ?





Summary of discussion

For CERN22, need to

- collect dimension information:
  - Min space to next W ? *a priori* δz2 stays at 15 mm = δa
  - Min space for cooling ?
  - Maximal extention of small kaptons (e)
    - This might fix δz
- Estimate possible spacing between
  - Core Kaptons (d)
  - Layers in different readout partitions (g)
  - distance from last PCB to the HCAL (f)
- Investigate for 1 vs 2 boxes
- See how to maintain the core kaptons
- Enlarge the access trap

Make sketchs (Catia v6 for inter-lab collab ?)