ECAL-P mechanics: assembly of the prototype

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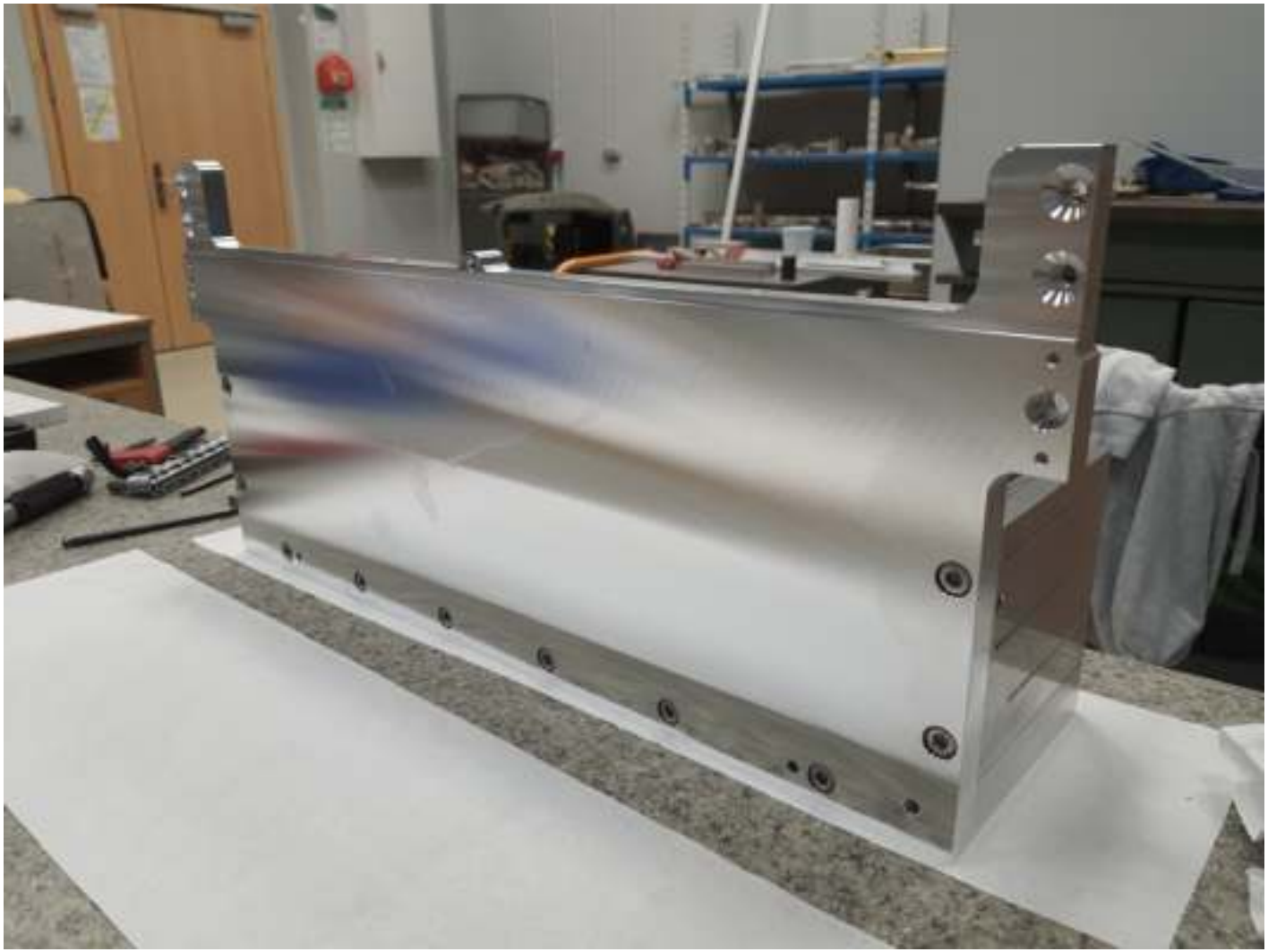
ECAL-P: prototype assembly

- main body plus bottom and side combs are ready
- six tungsten plates were successfully inserted
- gaps measured with the gauge feeler

ECAL-P: main body, front view

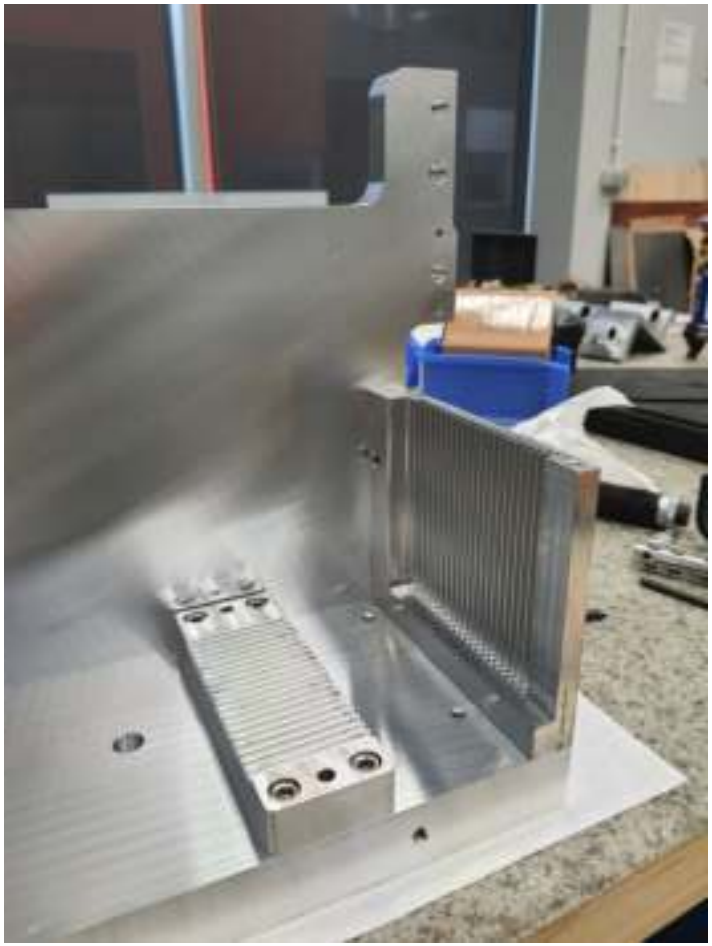
- dural body after machining: junction with screws and positioning pivots
- bottom (30mm thick), backplane (20mm) and combs (20mm and 10mm)
- overall precision of assembly $\sim$ 10 μm ($\rightarrow$ tungsten plates insertion)

ECAL-P: main body, rear view



- dural body after machining: junction with screws and positioning pivots
- backplane: shielding for PCBs plus support for (future) Faraday cage

ECAL-P: main body, zoom on side combs



- combs pitch 4.5mm (= 3.5mm + 1.0mm) (tungsten + sensor sandwich)
- comb gaps (+clearance): 3.5+0.05mm (bottom combs), 3.5+0.07mm (side combs)
- **except of first and last bottom slot:**
- **due to the mistake during machining both slots have exact 3.5mm comb gaps...**

CMM: global dimensions XYZ

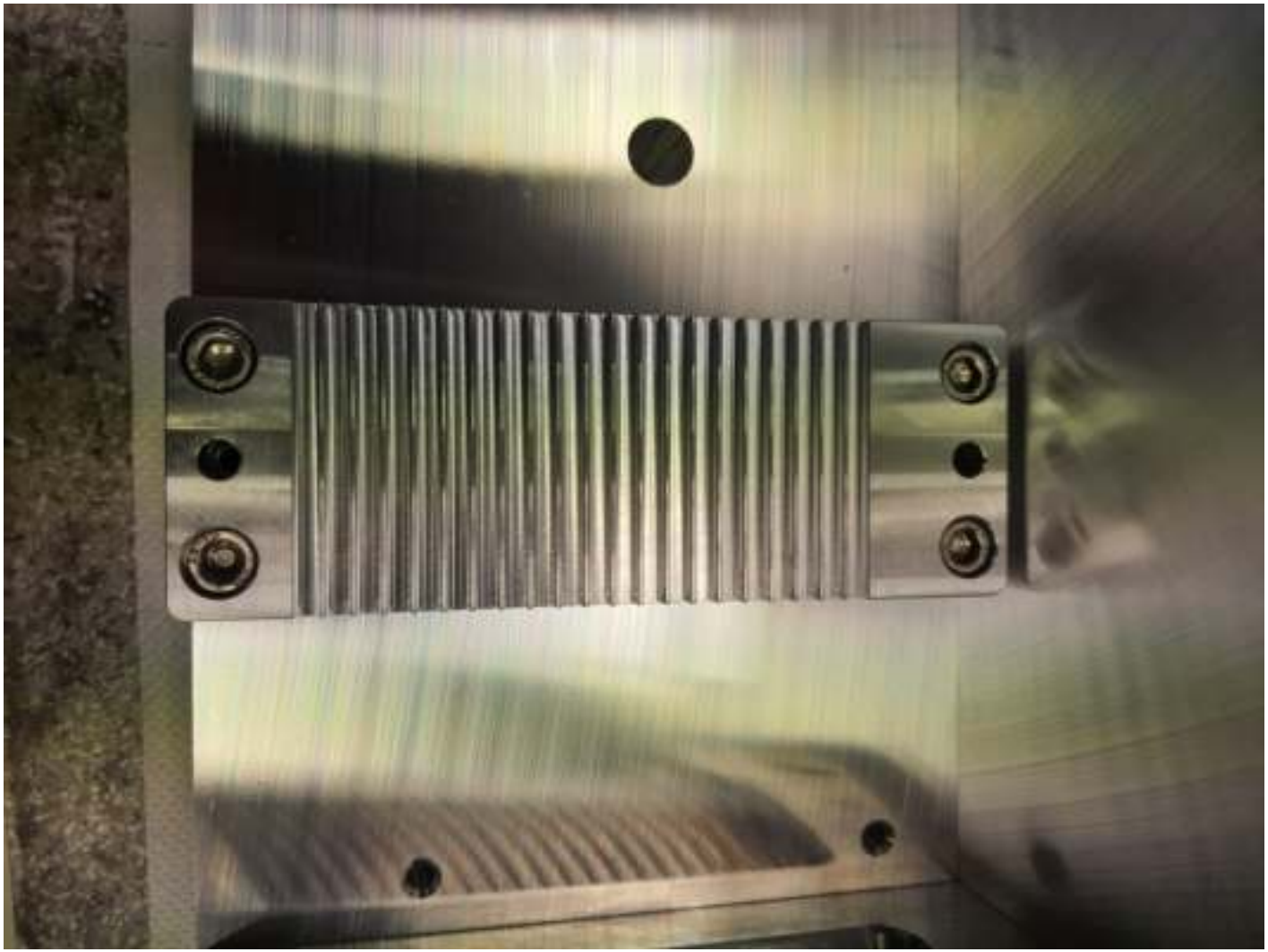
XYZ dimensions (mm)			
Plate	X	Y	Z
X1	555.1039	100.0907	3.5593
X2	555.1047	100.0864	3.5429
X3	555.1388	100.0964	3.5407
B1	555.0785	100.0640	3.5451
B2	555.0654	100.0458	3.5547
B3	555.0637	100.0366	3.5701
Nom	555.00±0.20	100.00±0.20	3.50±0.05

- XY: average over 10 grid points
- Z: average over ∼250 grid points (over full surface)
- **thickness in Z oversized by $\gtrsim$50 μm, few microns out of spec. for all plates**

ECAL-P: main body, zoom on bottom combs

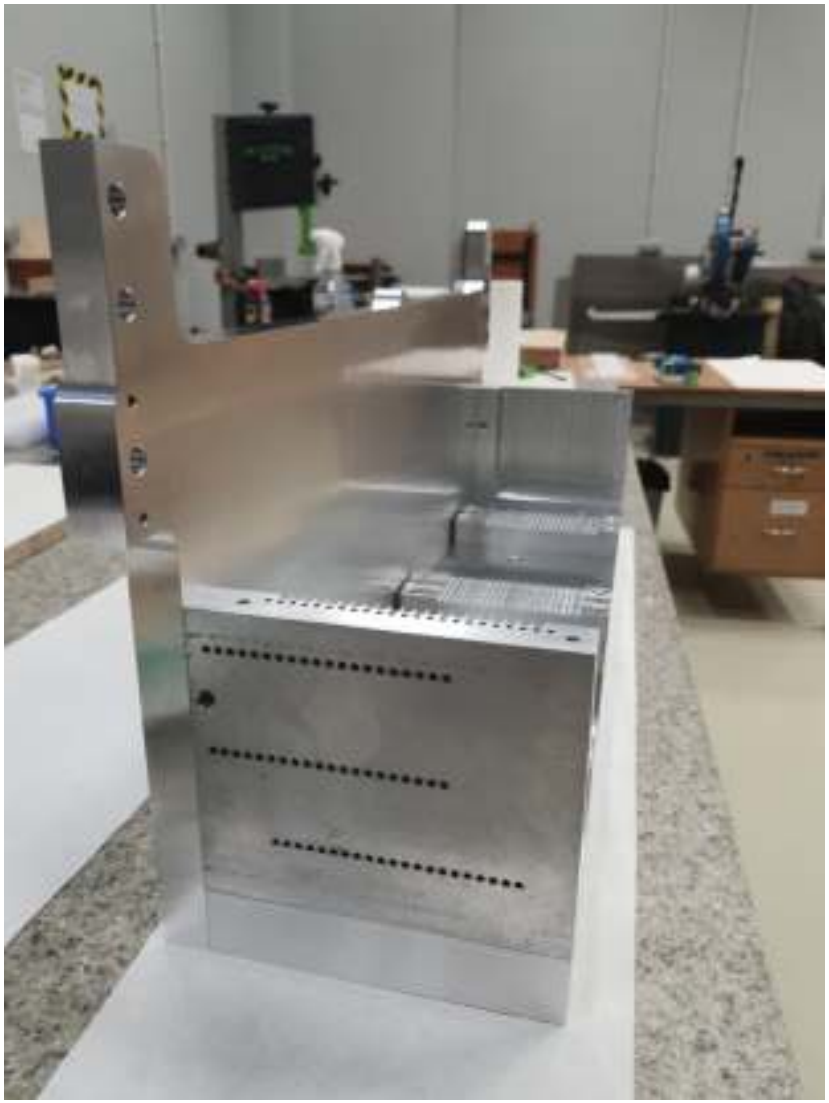
- gaps (+clearance): 3.5+0.05mm (bottom), 3.5+0.07mm (side combs)
- **good news: comb ribs help to correct a bit the bending of the plates !**

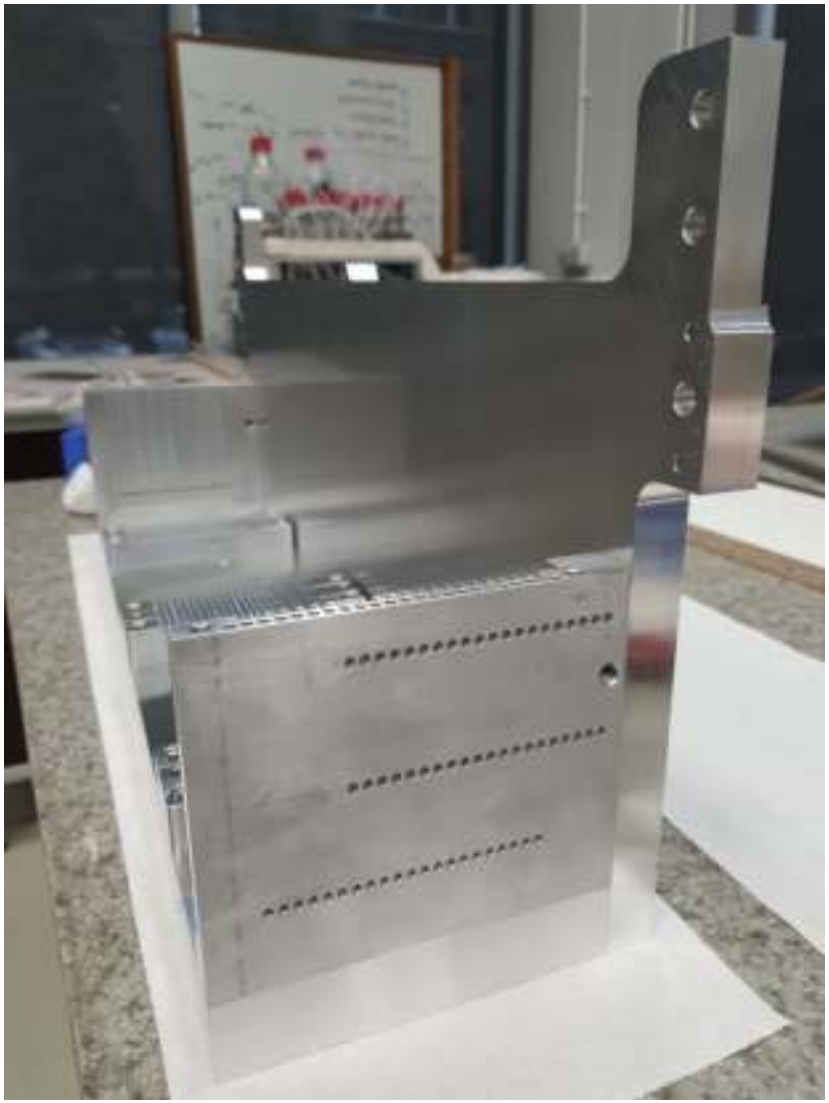
ECAL-P: main body, zoom on bottom combs



- good news: comb ribs help to correct a bit the bending of the plates !
- **but working at the edge of specification...** all clearance consumed by plates

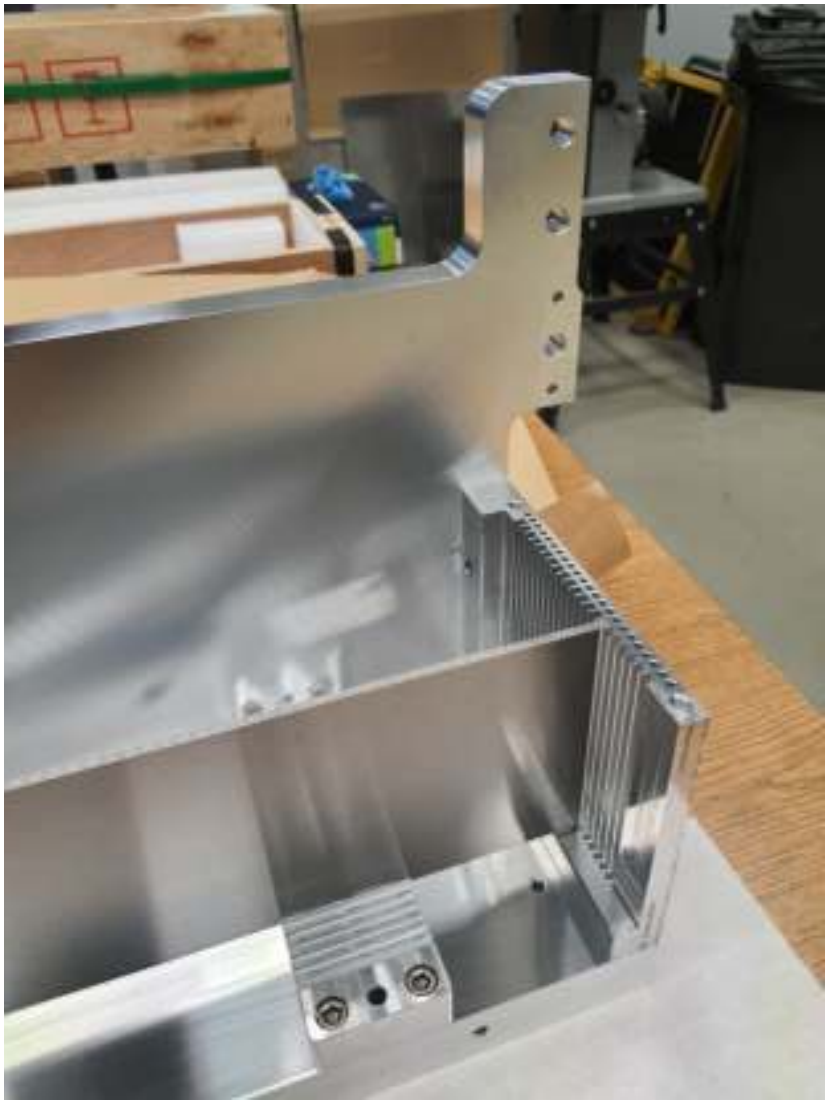
ECAL-P: main body, zoom on side combs, outer surface





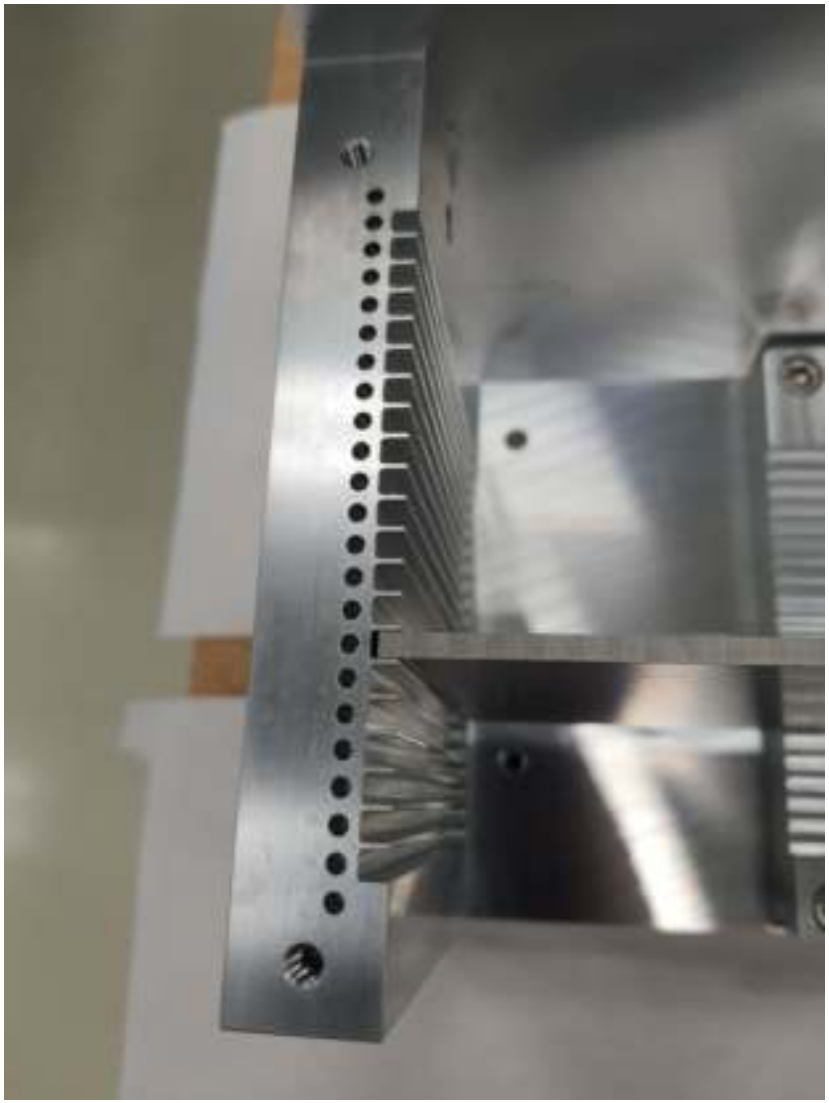
- technical holes: for (future) lowering mechanism and
- for screws canceling mechanical play of tungsten plates (see next slides)

ECAL-P: main body with first tungsten plate



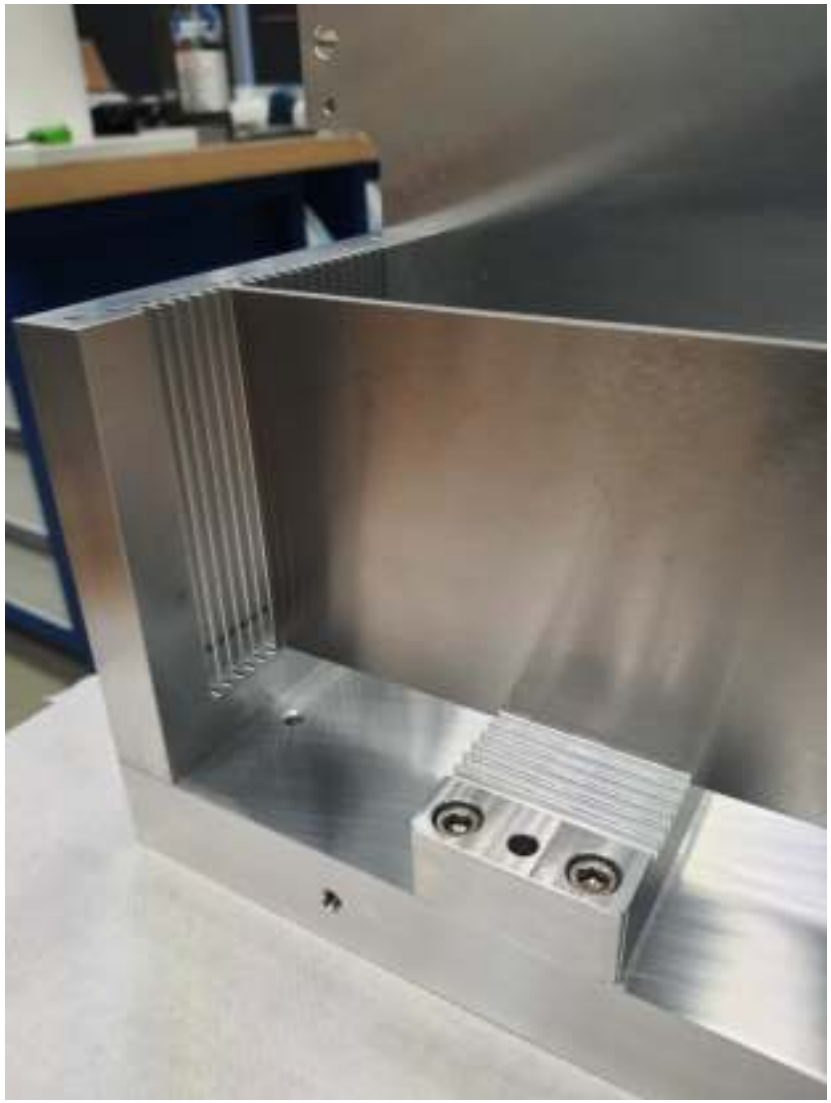
- plates were inserted smoothly by hand, no obstacles observed

ECAL-P: main body with first tungsten plate, top zoom on combs



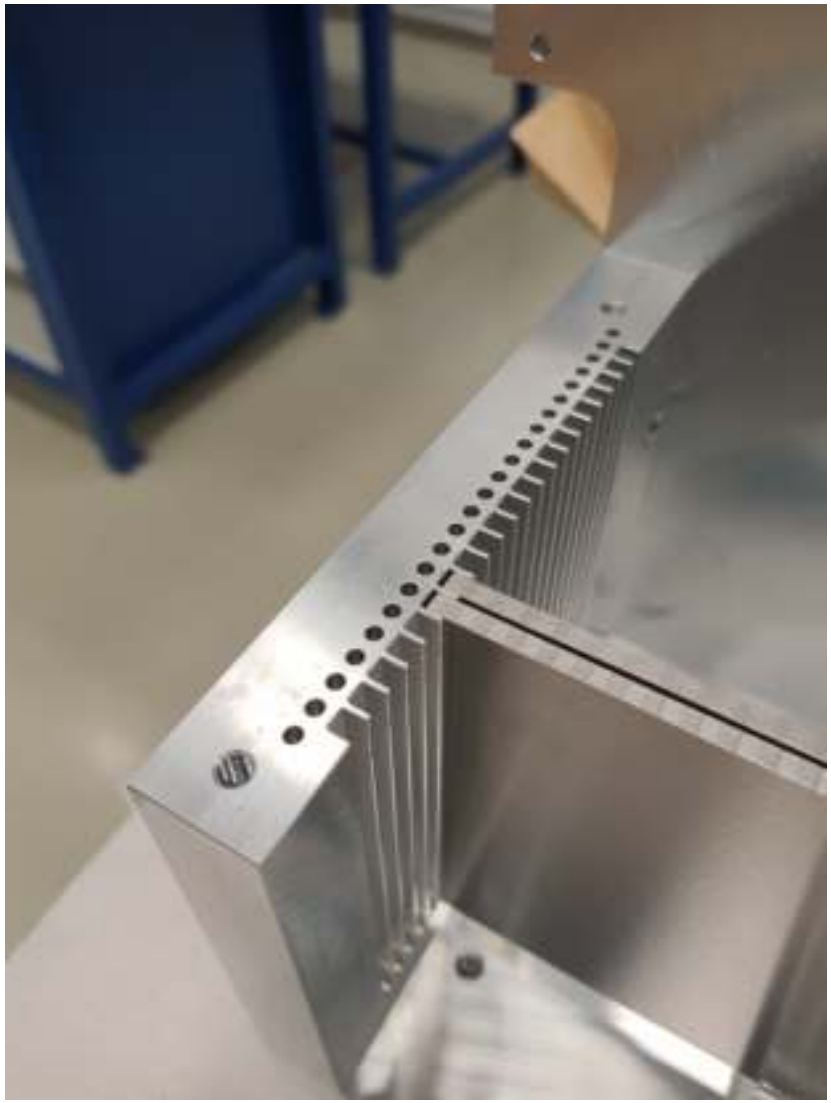
- 1mm X direction clearance to facilitate plate insertion (to be canceled by screws)
- plate in final position aligned to the right (beam-pipe) side

ECAL-P: main body with first tungsten plate, bottom zoom on combs



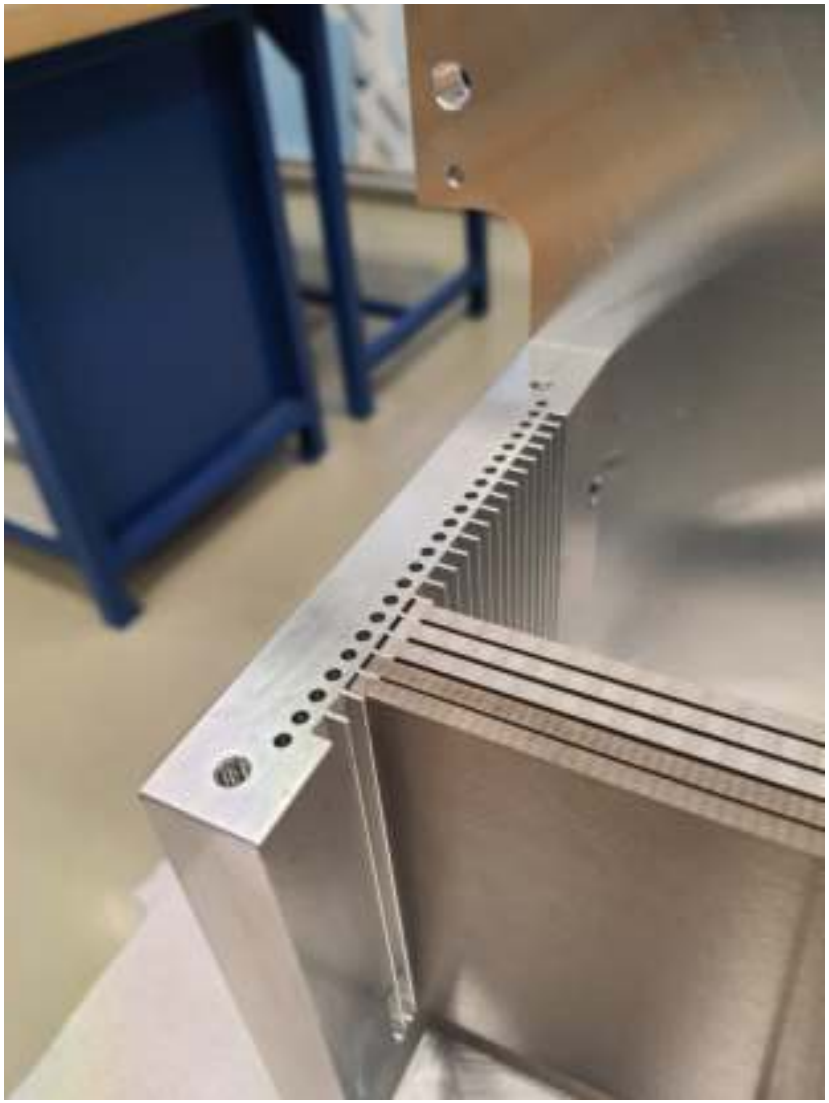
- up-down alignment only on bottom combs: clearance left on side combs

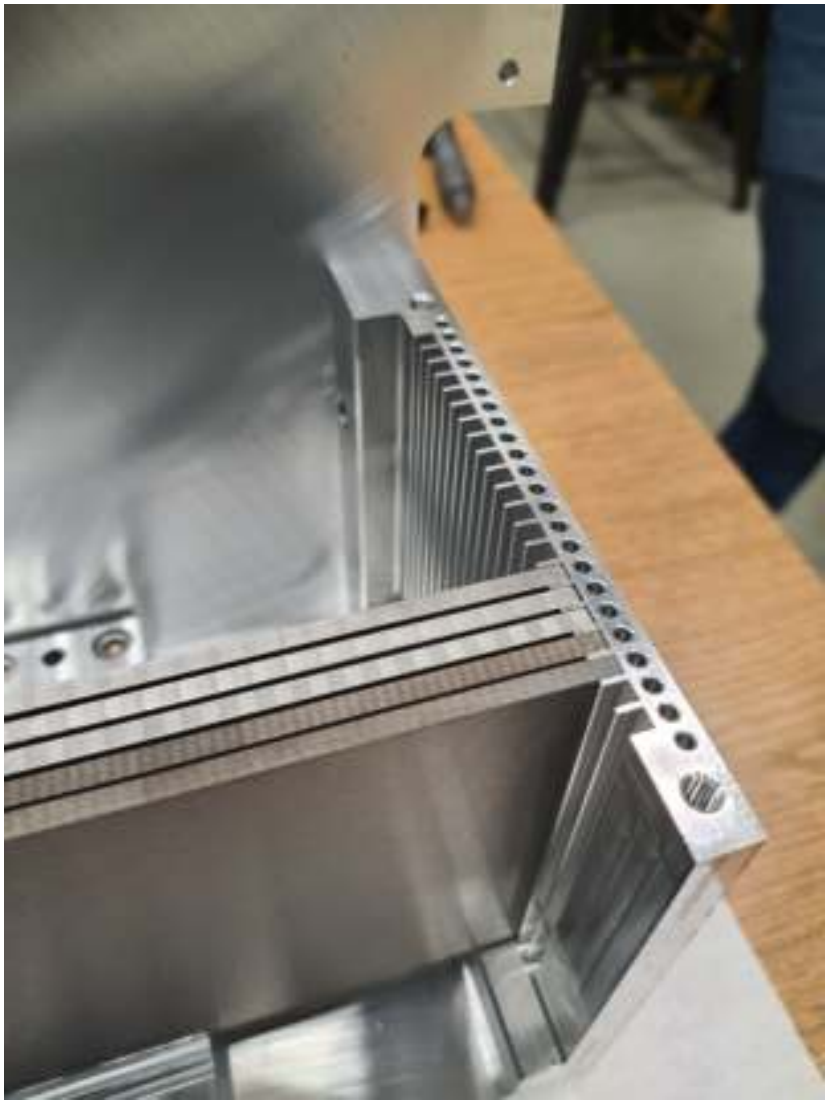
ECAL-P: main body with two tungsten plates



- two Xiamen plates on place, gap to be measured :).
- there is enough space to manipulate next plate only with one side access

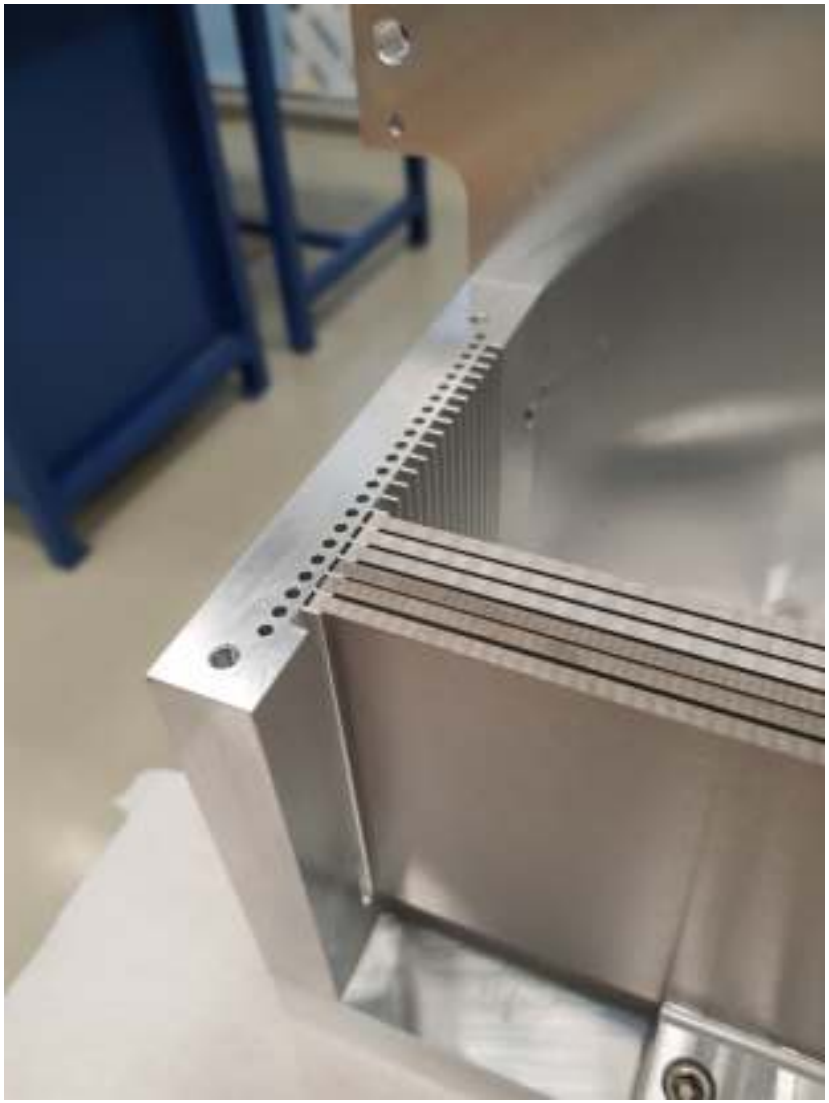
ECAL-P: main body with five tungsten plates, top zoom on combs

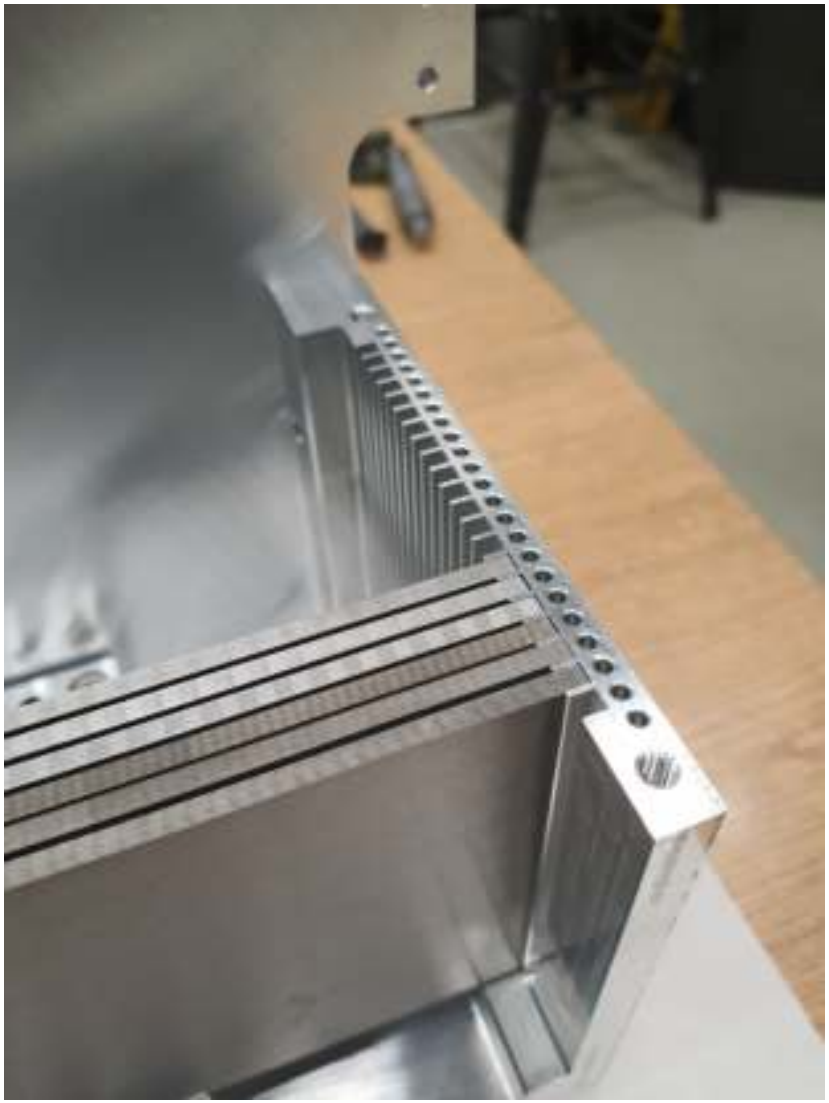




- lighter plates (Xiamen), darker (Beijing)

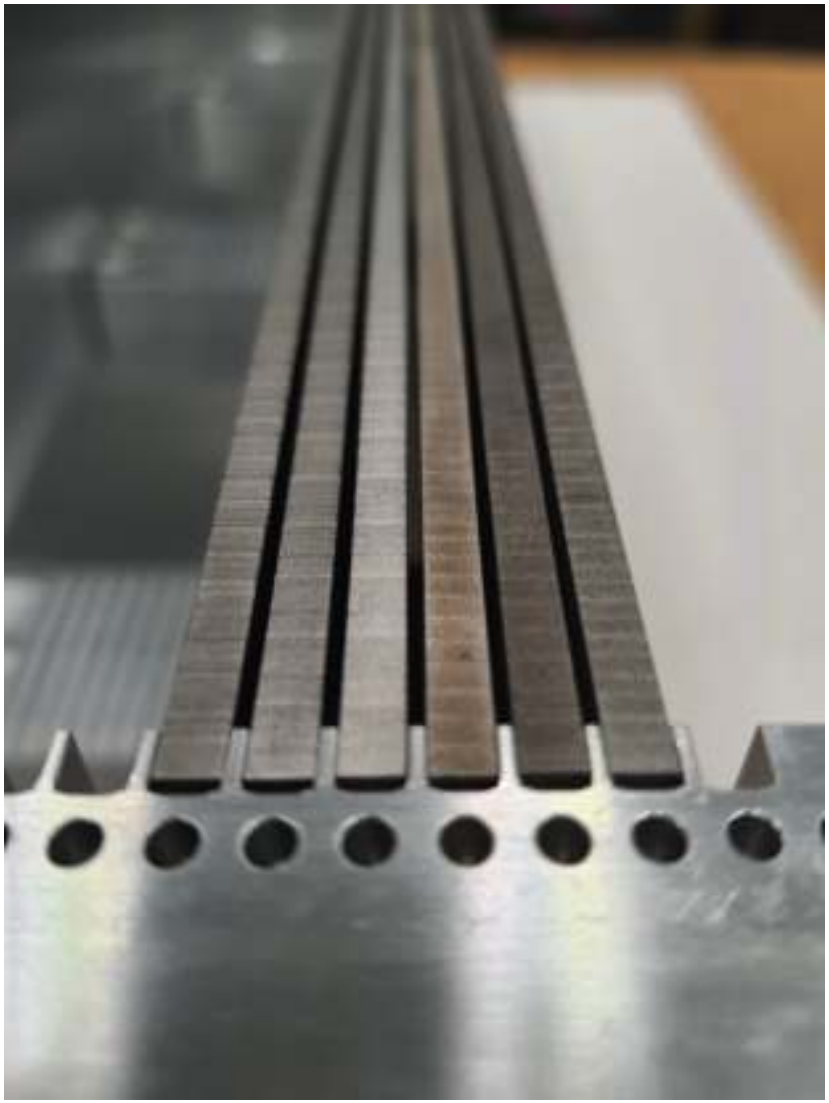
ECAL-P: main body with six tungsten plates, top zoom on combs

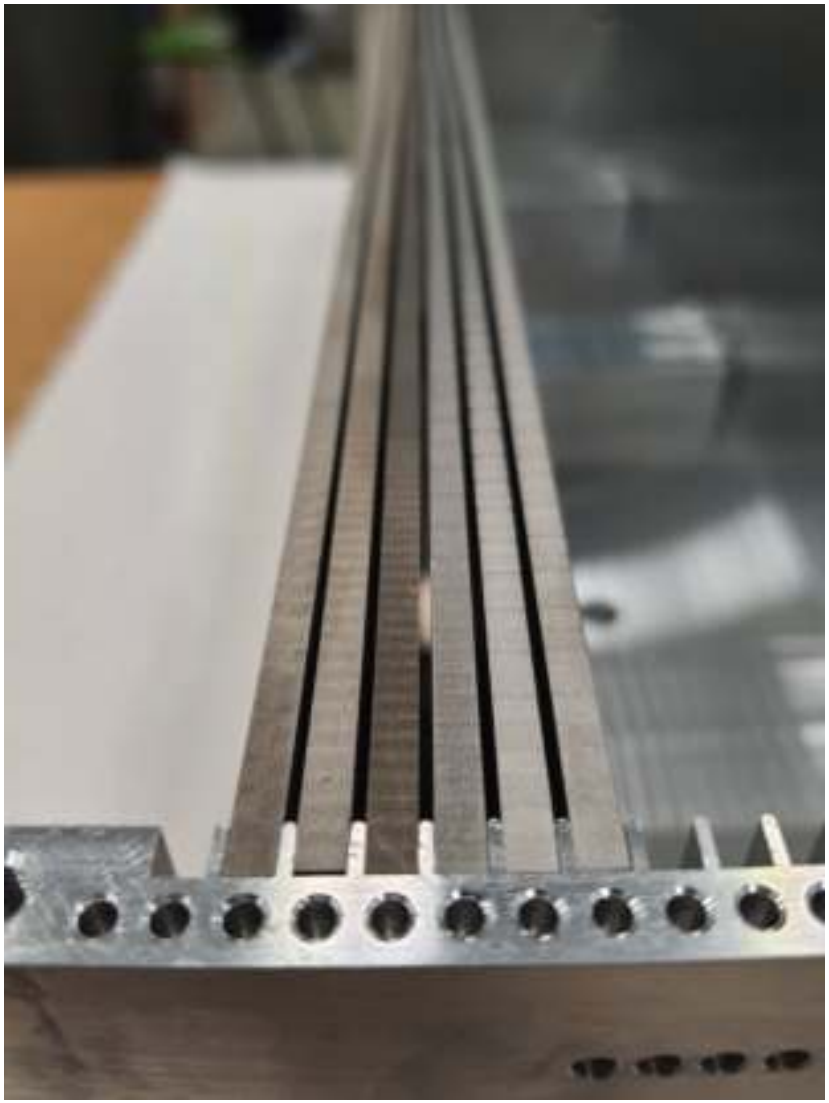




- **next to the last plate do not fit to the very bottom of the comb gap**
- gap width affected by optical illusion: 5^{th} plate sticks out higher by $\sim$0.1mm

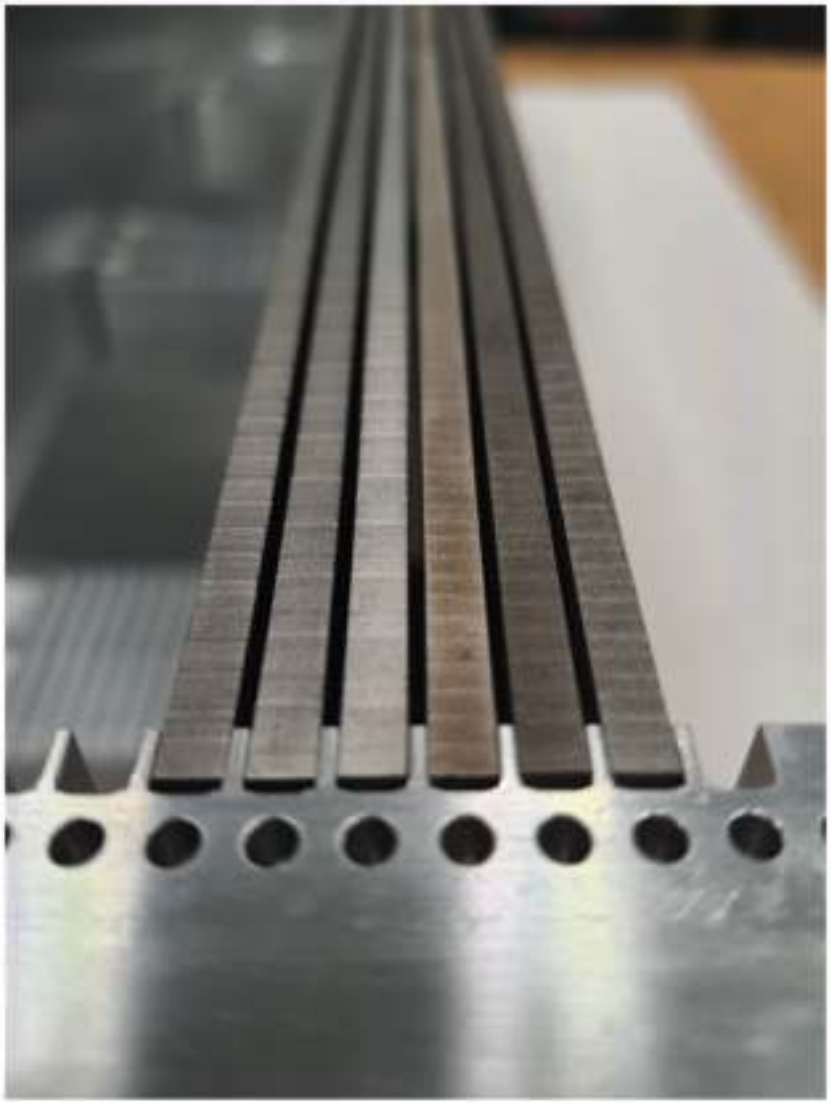
ECAL-P: main body with six tungsten plates, top zoom on gaps

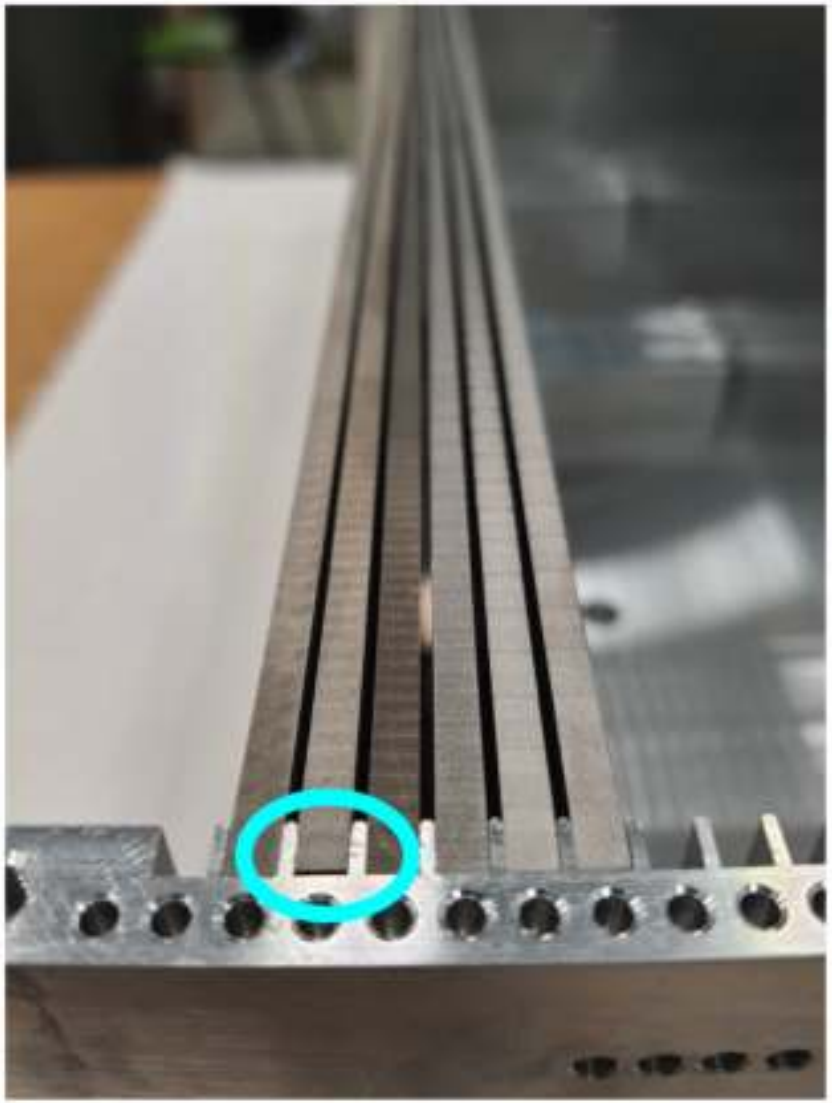




- **looking along plates gaps are uniform, no visible deviations**
- plate 5^{th} few microns thicker ($\rightarrow$ sticks out higher): out of the comb tolerance

ECAL-P: main body with six tungsten plates, top zoom on gaps





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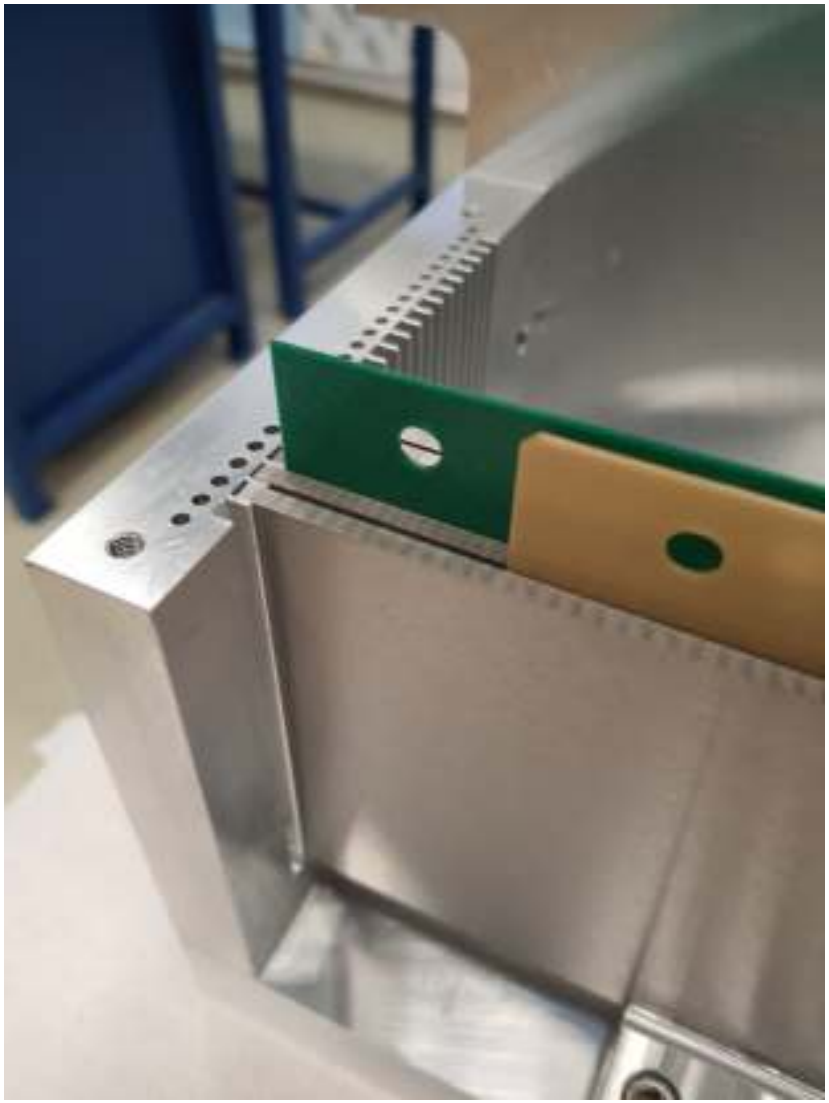
ECAL-P: main body with six tungsten plates: dummy sensors



- dummy sensor sandwiches (3D printed: 0.8 – 0.9mm thickness precision)
- fitting along all gaps, perceptible little friction forces

ECAL-P: main body with six tungsten plates: 0.9mm gauge feeler

- 0.9mm thick steel gauge feeler fits into all gaps but with (some) friction
- NOTE: single feeler consumes also tolerances (in side combs) on neighbor gaps...
- PLAN: prepare more 0.9mm thick steel dummy sandwiches, populate many gaps

Summary

- main body of the ECAL-P prototype was assembled
- six tungsten plates were smoothly inserted, no obstacles
- measured gap size is $\sim$0.9 mm ($<$ 0.9 mm ?)
- **lesson learned:**
  plate thickness specification should be $3.5^{+0.0}_{-0.1}$ mm, not 3.5 ± 0.05 mm

- **Question: is 0.9mm gap OK for the Si-sensor sandwich ?**
- CF width = 0.23mm, not 0.2mm as assumed
- what about kaptons and glue thickness ?
- (Si+CF+2 kaptons + 3 glue layers) = 0.32+0.23+0.12+0.07+3*0.05 = 0.89mm !
- where can we spare some thickness ?
  (double side scotch between CF and signal kapton ? 0.02mm ?)
- **should we fabricate backup combs with gap width 1.1mm (or 1.2mm) ?**
- we should know this before starting the fabrication of upper combs

- $\rightarrow$ next plan: fabrication of upper combs: T-frame holders (for PCB and sensors)
- $\rightarrow$ next plan: more T-frames