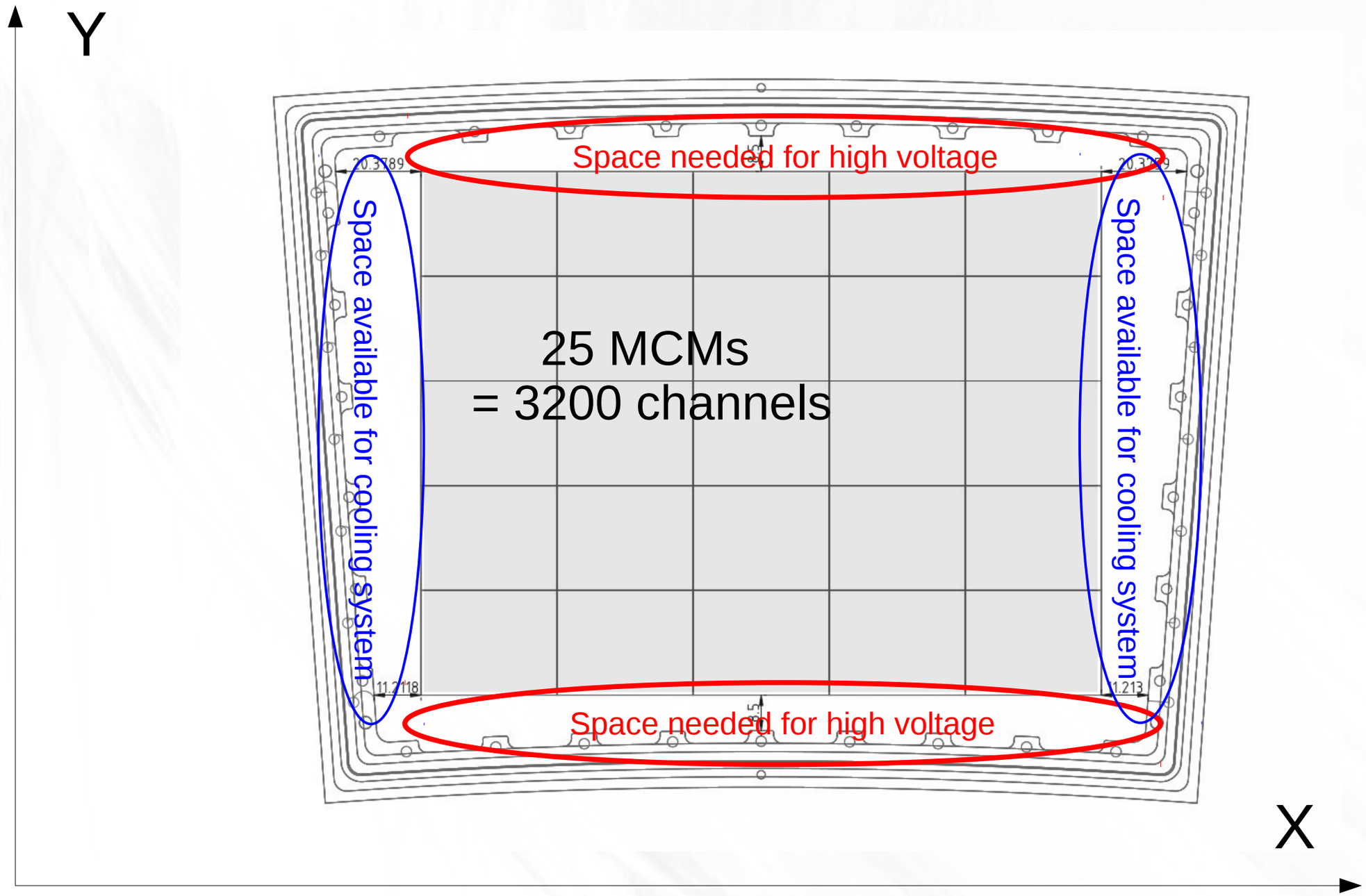
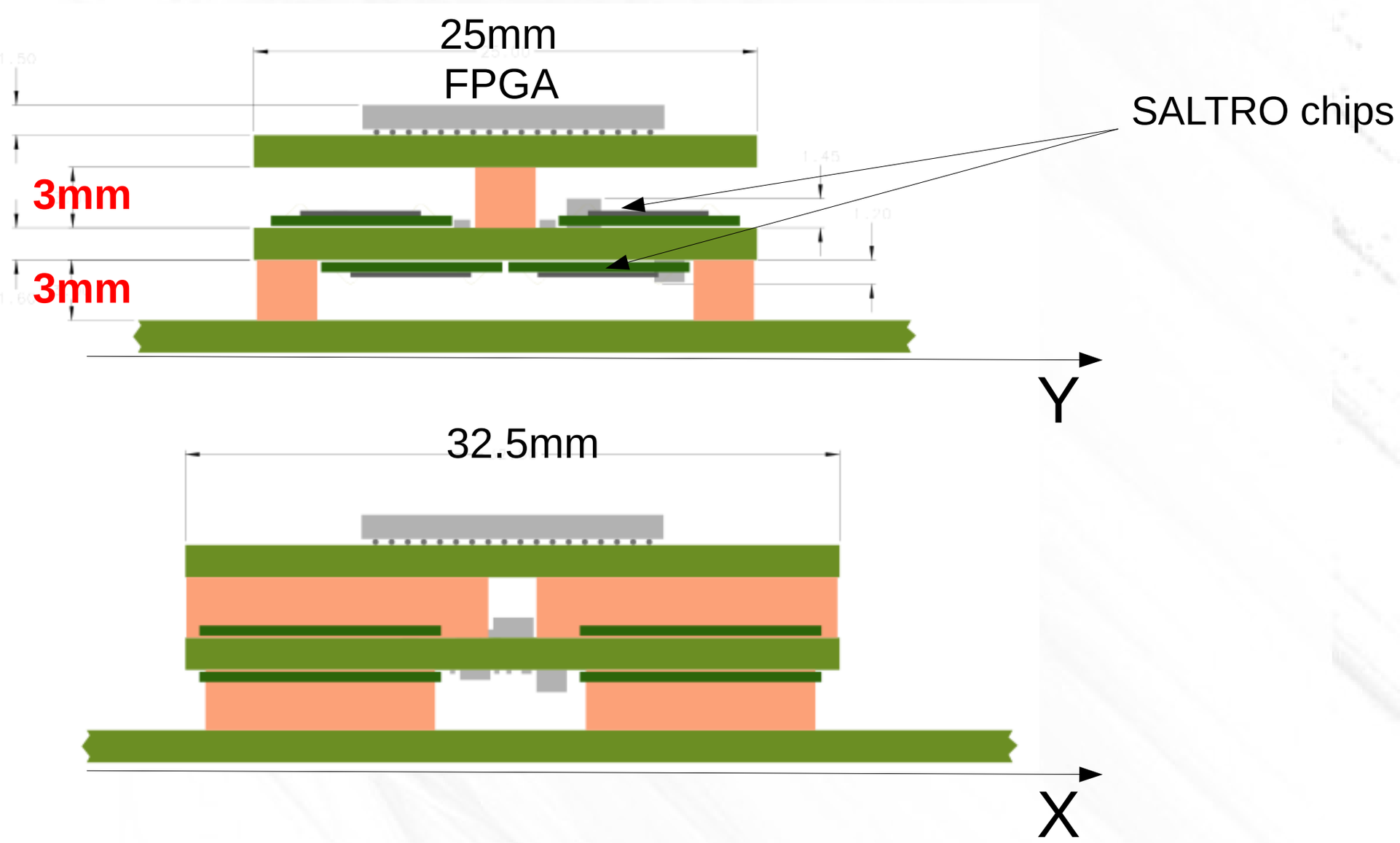
Electronics and pad plane cooling for the LCTPC GEM modules with sALTRO16

Module layout



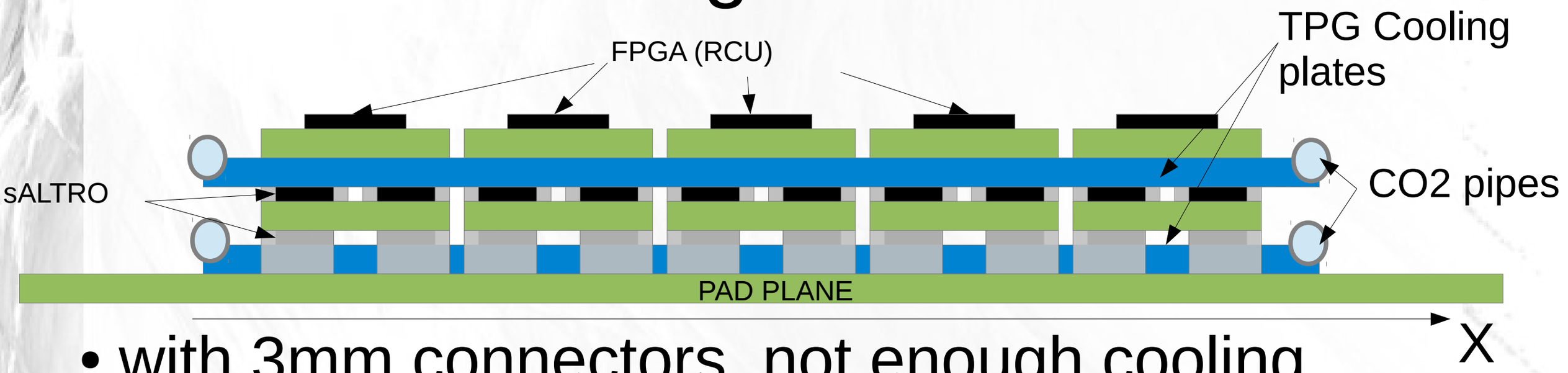
Electronics layout proposal: MCM



Cooling suggestion

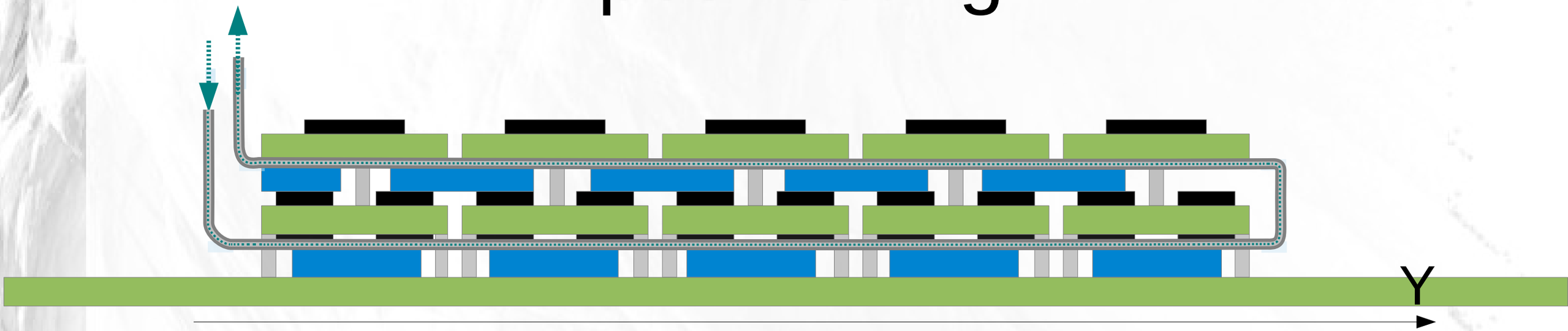
- 2 phase CO_2 cooling
- Remove heat with conducting material:
  - Special material: TPG (Thermal Pyrolytic Graphite)
  - Light, high thermal conductivity
  - Can be sandwiched with Aluminum for better structural properties

Cooling Solution



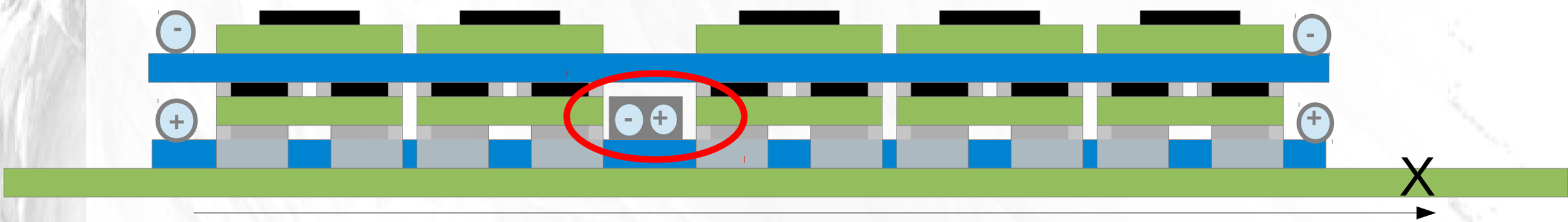
- with 3mm connectors, not enough cooling
  - running without power pulsing, too high gradient on the pad plane
- Possibilities:
  - add cooling pipes
  - increase gap => thicker cooling plates

Pipes routing



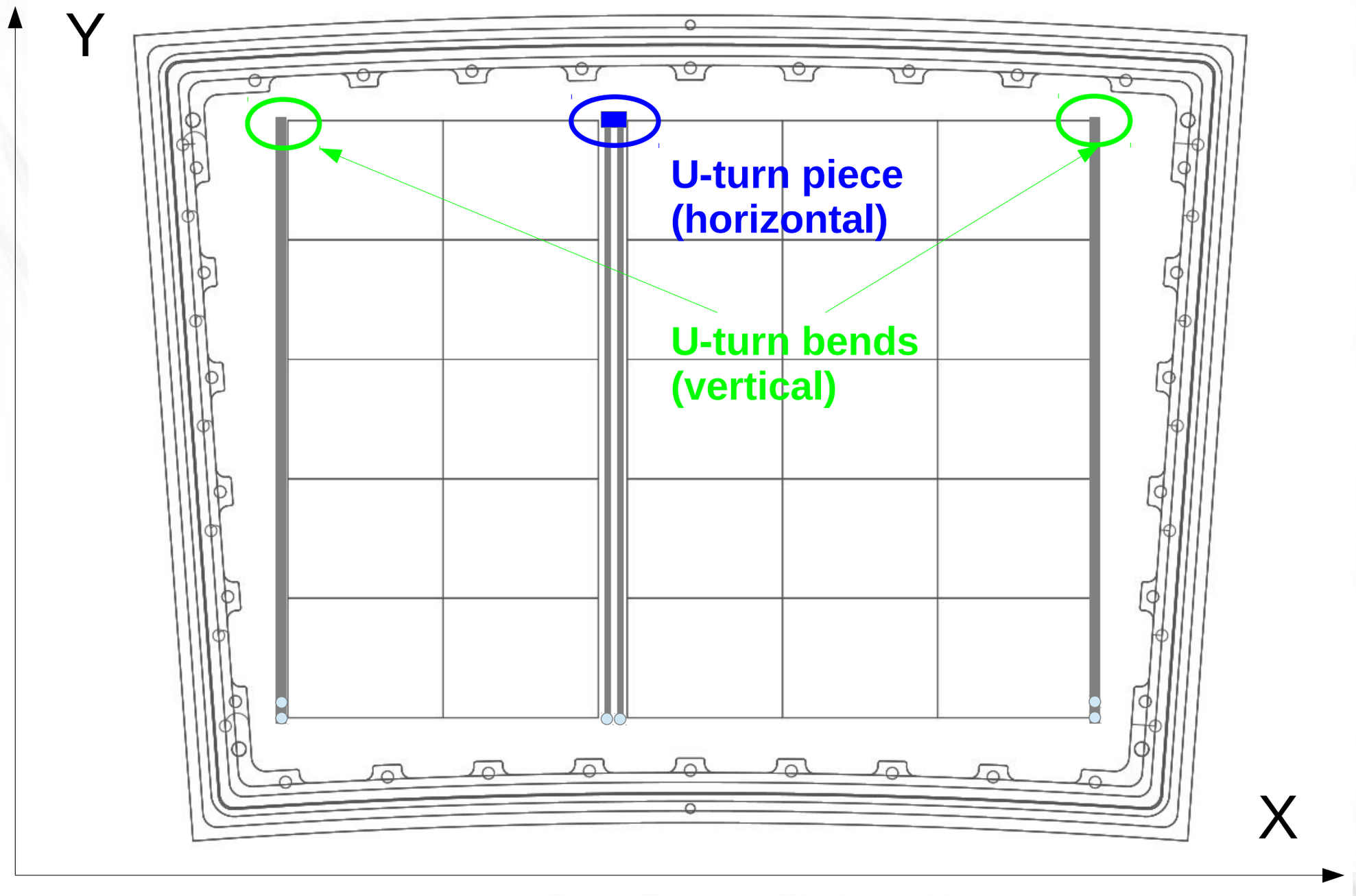
- Small loops
  - simple
  - only on the sides of the module
  - save space at the top and bottom of the module for high voltage

Solution 1: 3mm connectors extra CO2 pipes

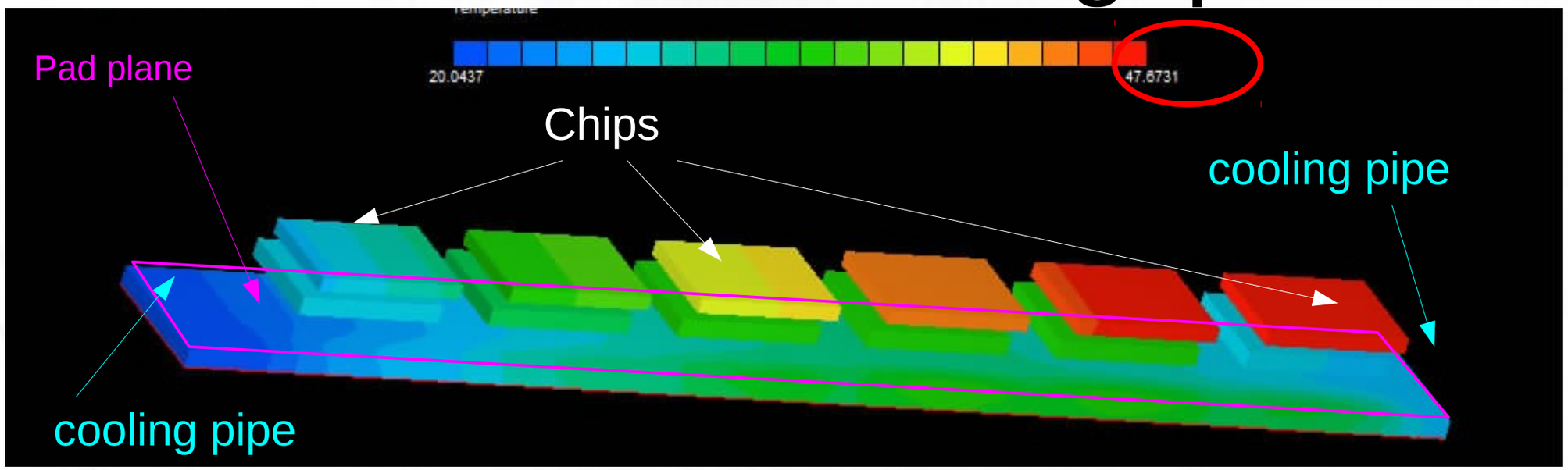


- Extra pipe loop in the middle (by increasing the distance between 2 MCM blocks)
- Extra cooling on the pad side only
- The central loop could perhaps be integrated in a plate instead of round pipes

Solution 1: 3mm connectors extra CO2 pipes



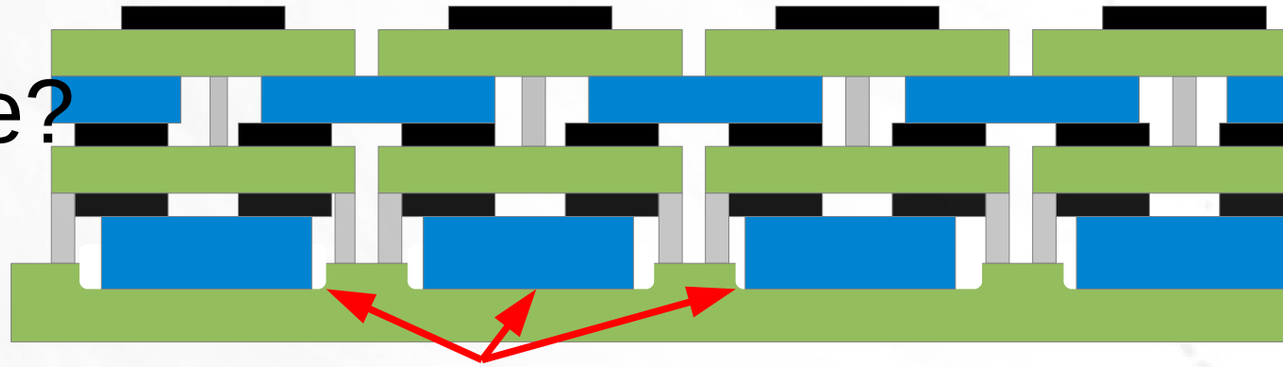
Simulation 3mm gap:



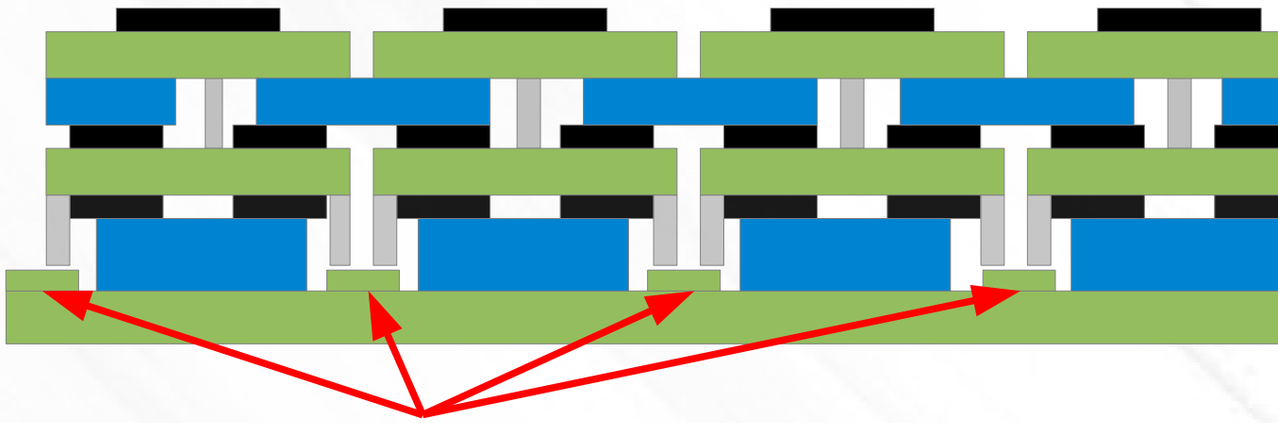
- Simulation with 6 chips, 3mm gap, 1.5mm thick cooling plates
  - temperature of the chips **<50°**
  - Pad plane: Temperature gradient **~10K**
- More space needed, or...

Alternate solutions for extra space

- Carve the Pad PCB
  - Technically possible?
  - PCB flatness?



- Make “elevating” PCB
  - Alignment?



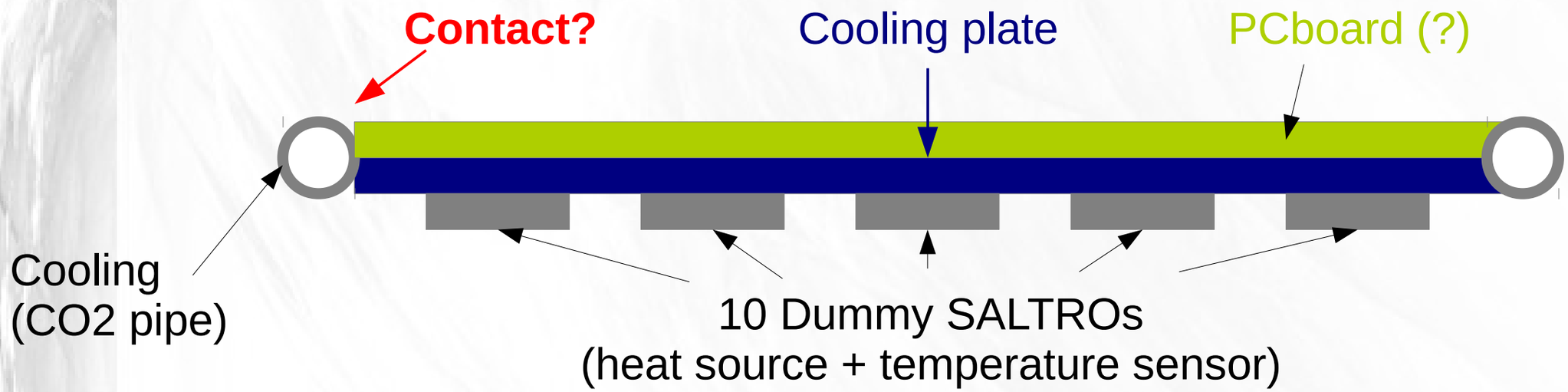
Can we relax the requirements?

- What temperature gradient is acceptable on the pad plane.
  - How would it translate in the drift volume
  - How would it influence the gain fluctuations
- How much do we really need to use the chips without power pulsing?
  - Do we need noPP and good pad plane temperature at the same time?
- => A possible (non maximal) solution:
  - Keep electronics safe at full power
  - good pad plane conditions with Power Pulsing

Conclusions on sALTRO16 cooling

- Cooling with 2PCO2 + TPG cooling plates should be fine for sALTRO16 without power pulsing
- In compact configuration the chips are safe, but the pad plane temp. is difficult to control
- To have proper gas temperature control without power pulsing, extra space is needed
- Some tests are needed to confirm simulation and test material manipulation/machining

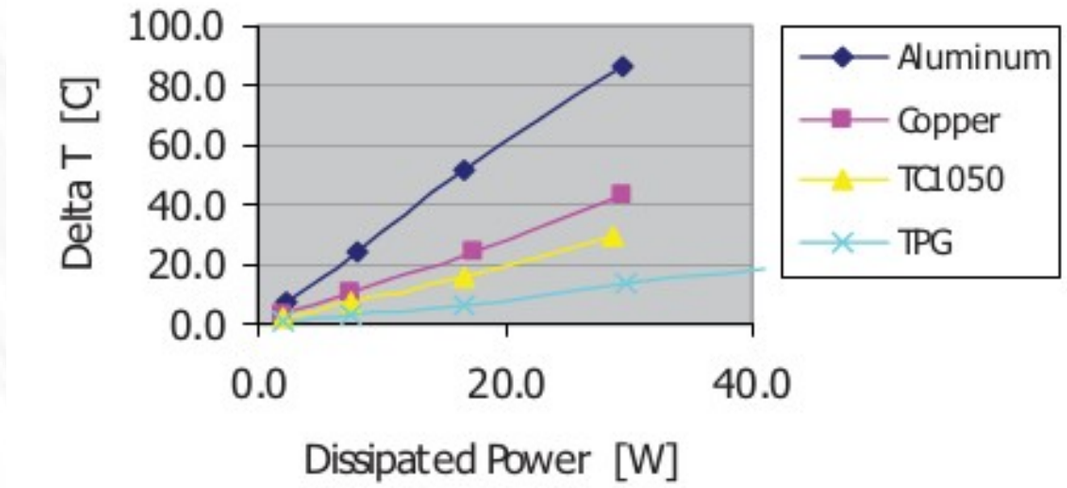
Test for sALTRO16 cooling

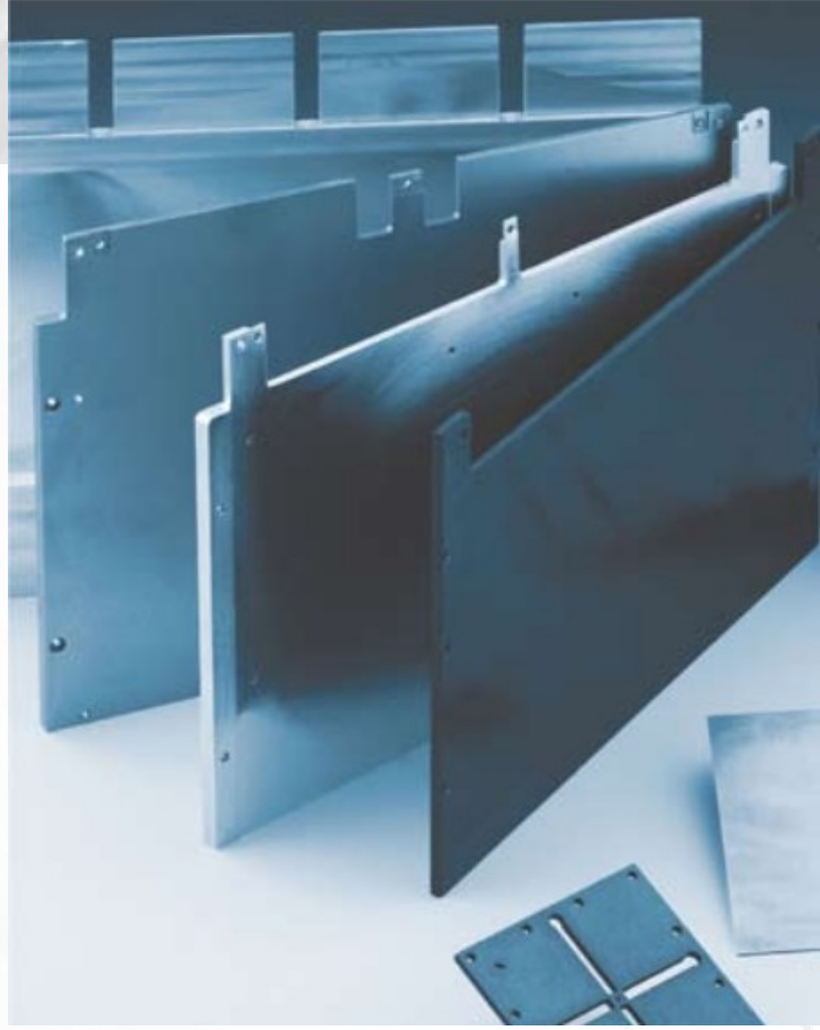


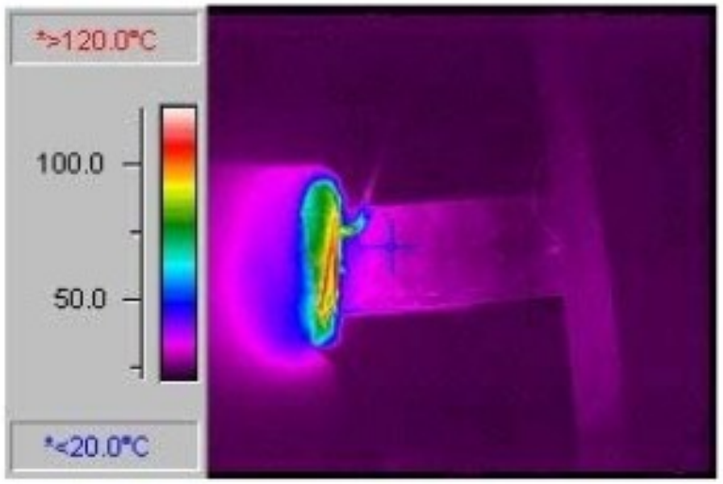
- To test:
  - Actual conductivity of TPG (compare with simulation)
  - Contacts pipe-plate
- To be done when material samples available (september?)

Back up

TPG & TC1050
Company propaganda

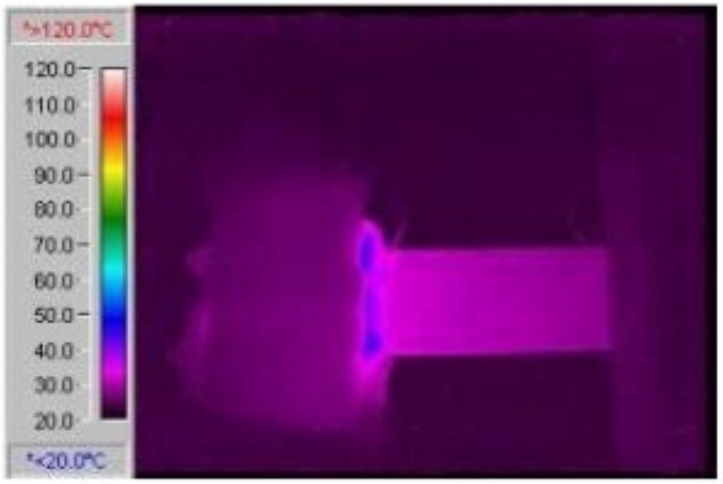






6061 Aluminum

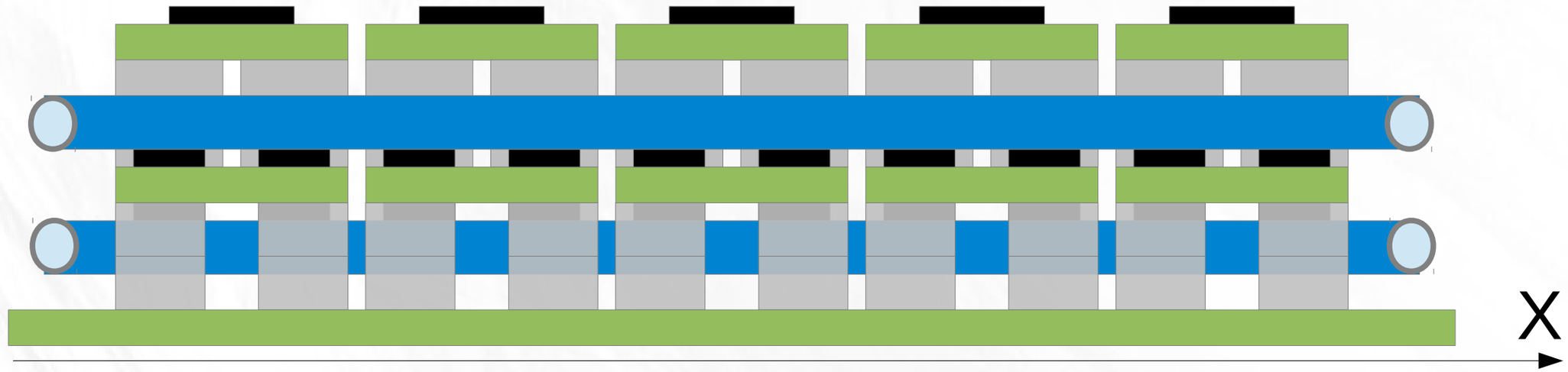
T_{max} = 115°C



TPG

T_{max} = 44°C

Solution 2: Increase the gap double connectors? New MCM?



- Challenges:
  - Make double connectors or adapt MCM for higher connectors
  - Build support for the cooling plate on the pad board
    => need sturdy cooling material: TC1050