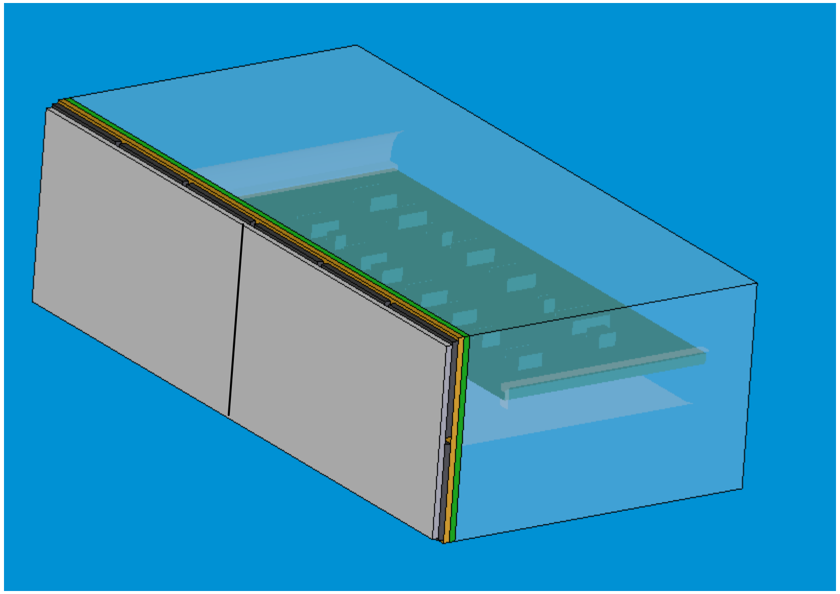
Large-area Medipix3 project



Sabine Sengelmann
Detector Group DESY

Medipix meeting, September 23, 2010

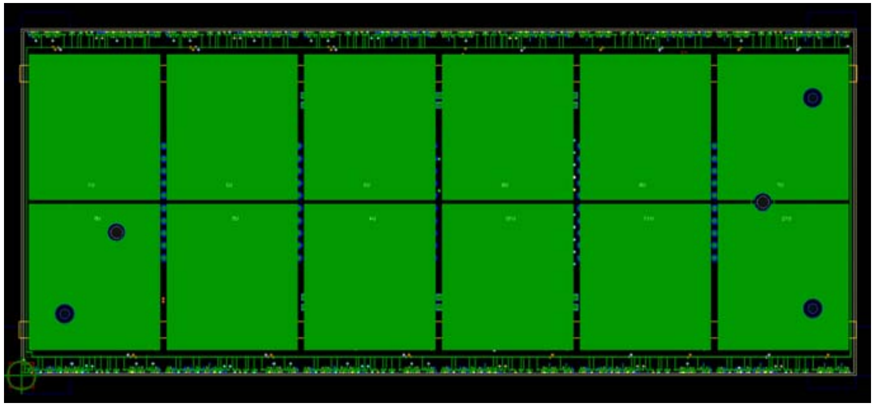
HELMHOLTZ
ASSOCIATION

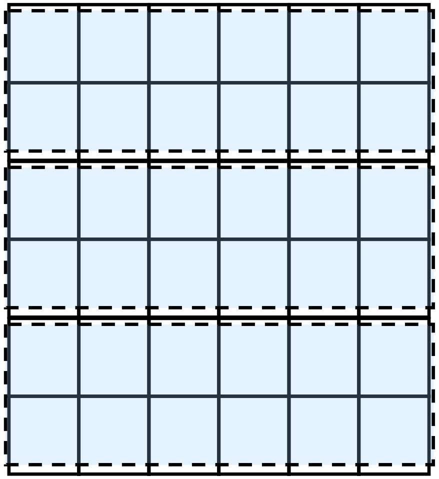
DESY

Large-area Medipix3 project

Requirements:

- Large area
- High frame rate
- experiments up to 100 keV





Assembly

Germanium detector   Large-area Medipix3 project

2 high-Z sensors

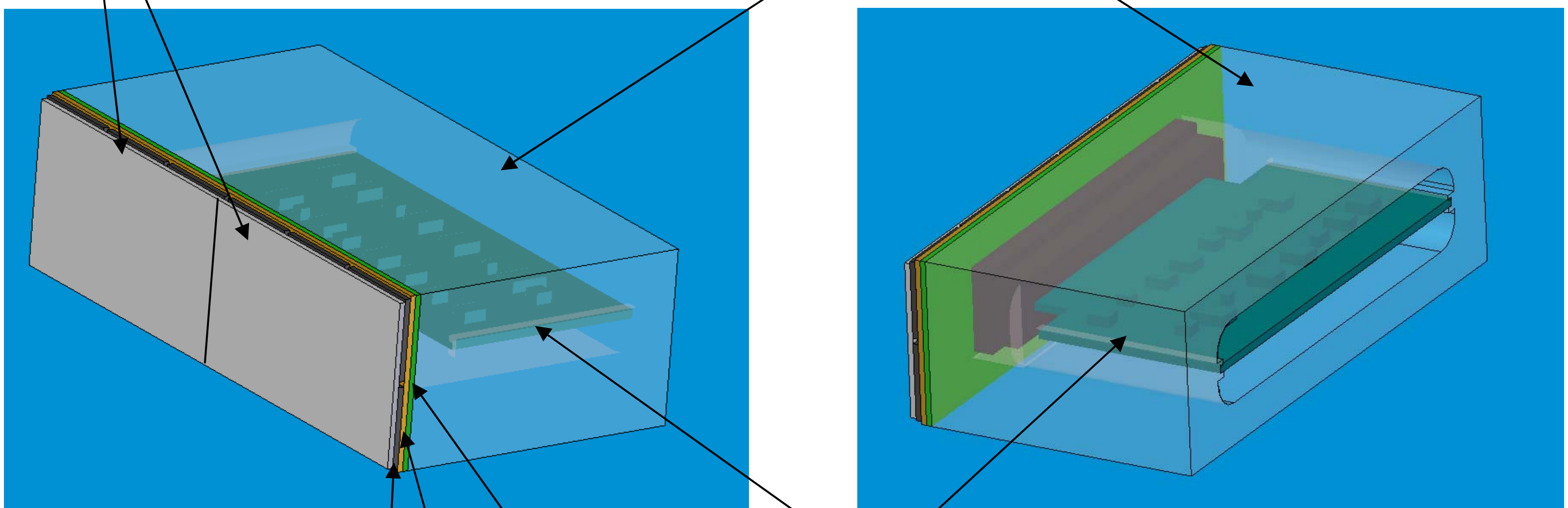
Each 42 mm * 28 mm

or

1 Silicon sensors

84 mm * 28 mm

Cooling block



Module ceramic

Voltage regulator board

Heat spreader

3*2 Medipix 3
chips under each
sensor

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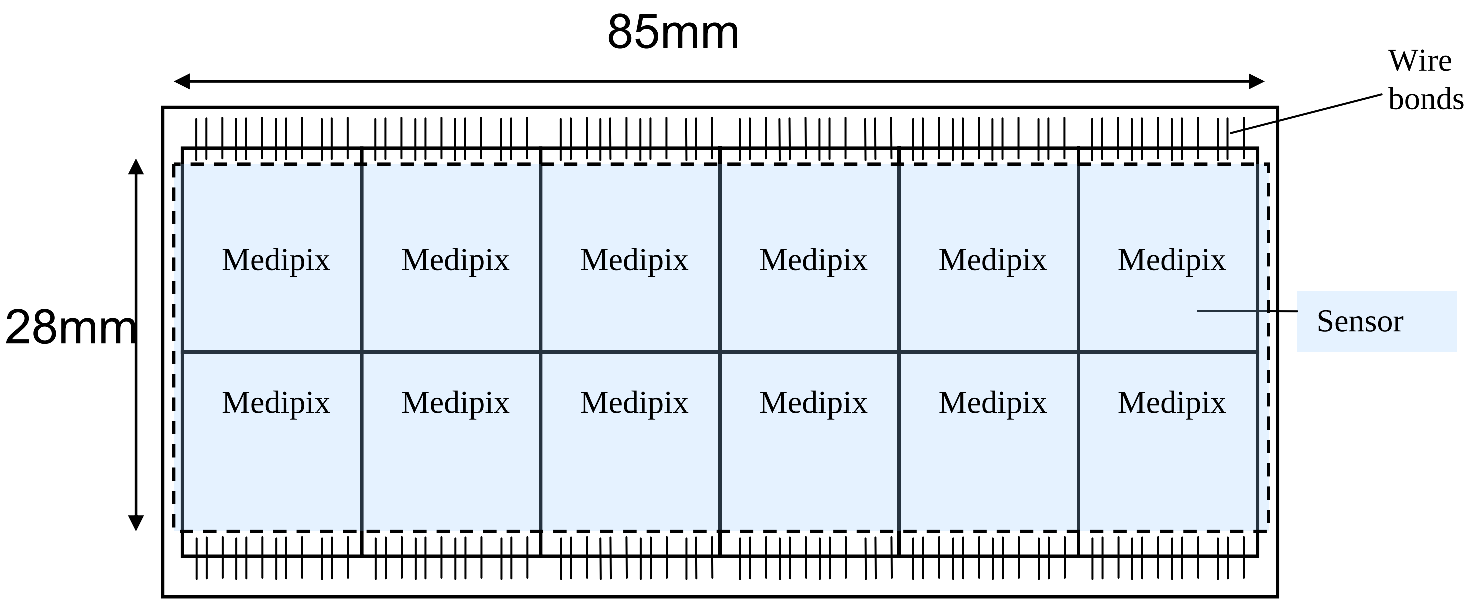
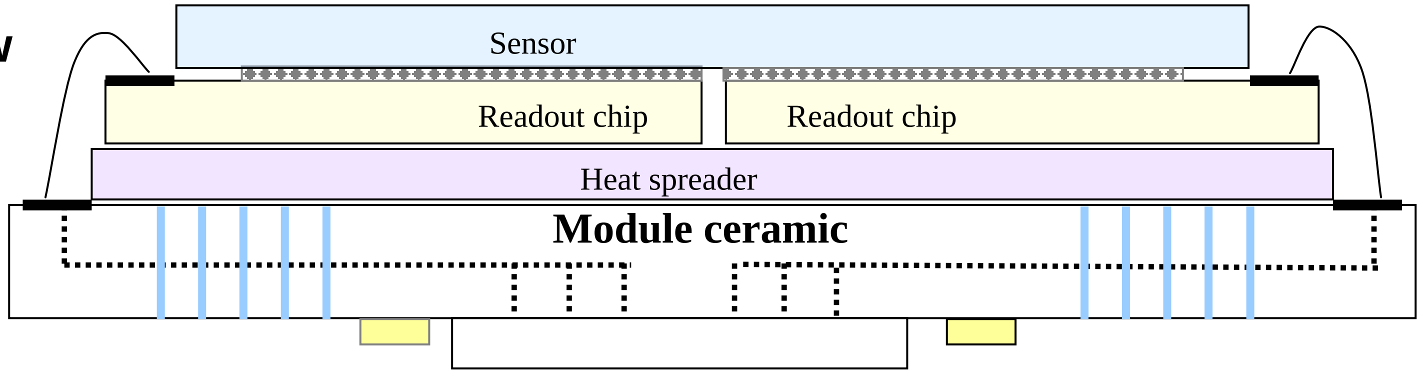
Top view

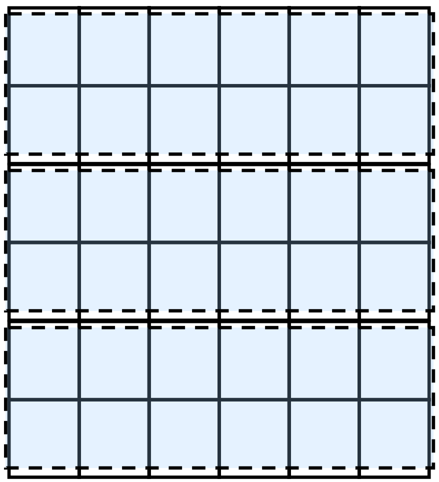


Side view



Large area

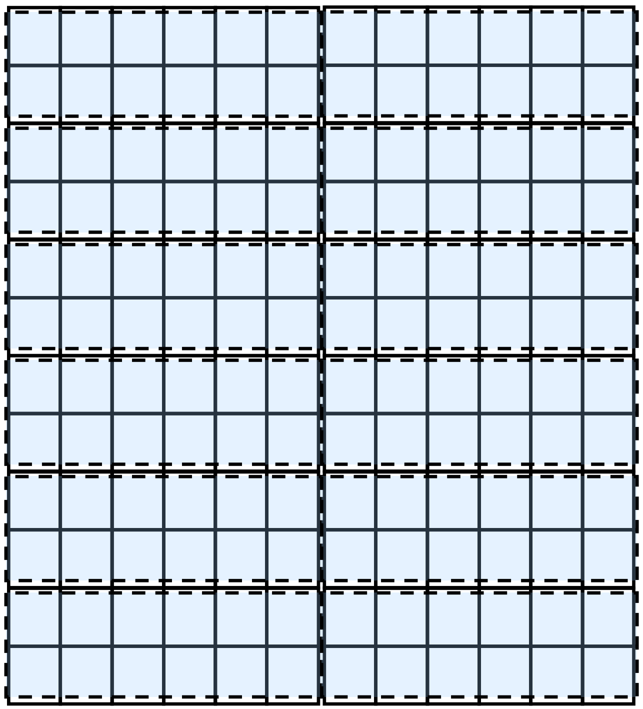
3 modules gives
~9*9cm^2 (2.3 Mpixel)



essential:

Minimal dead area
between modules

12 modules gives
18*18cm^2 (9.4Mpixel)



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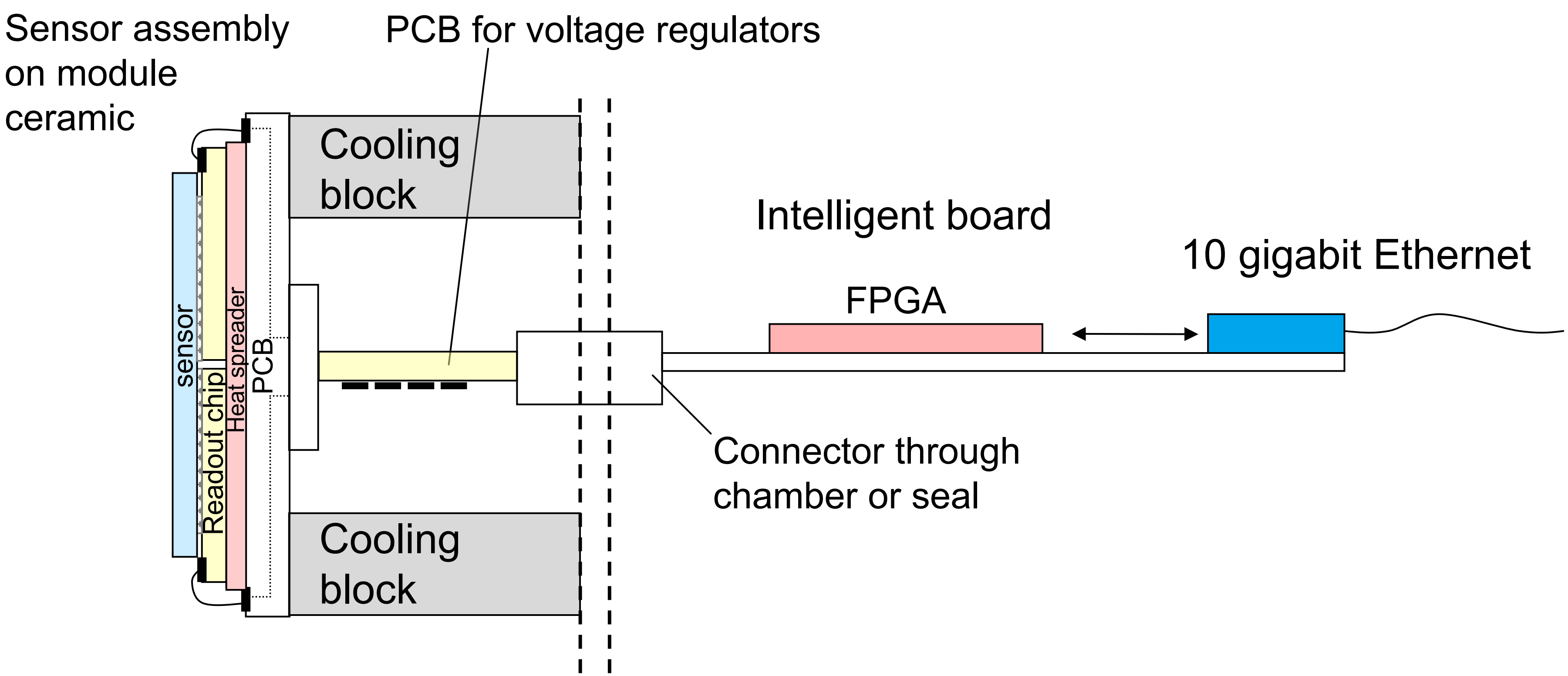


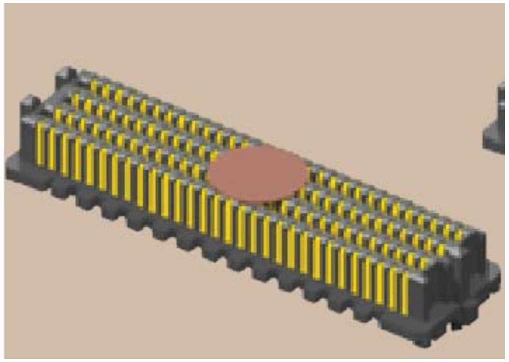
Readout:

First version: FITPIX or RUIN readout

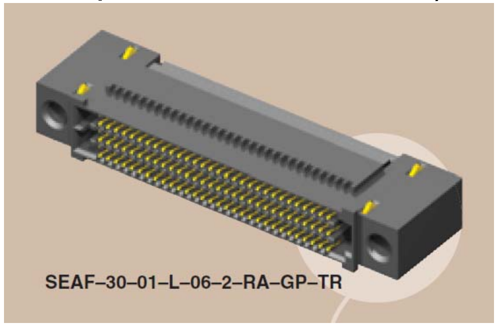
Final version: Modify a XFEL board (designed for XFEL)

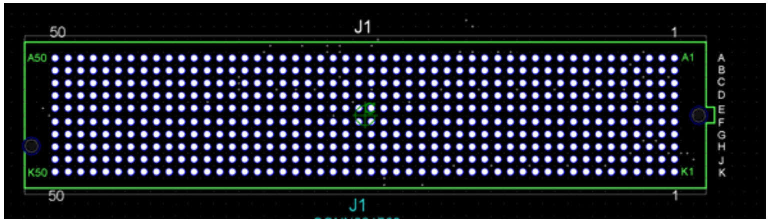
Connections required

- 12 chips, each using 8 DataOut lines to achieve 2000Hz max readout speed
- Parallel O Serial I scheme, dividing chips into 2 sets of 6
  - 26 input + 120 output LVDS pairs
- Power
  - 3 voltage levels
  - Around 11A total current
  - Voltage regulators on second board



240 pin version (no picture of the 500 pin version available)



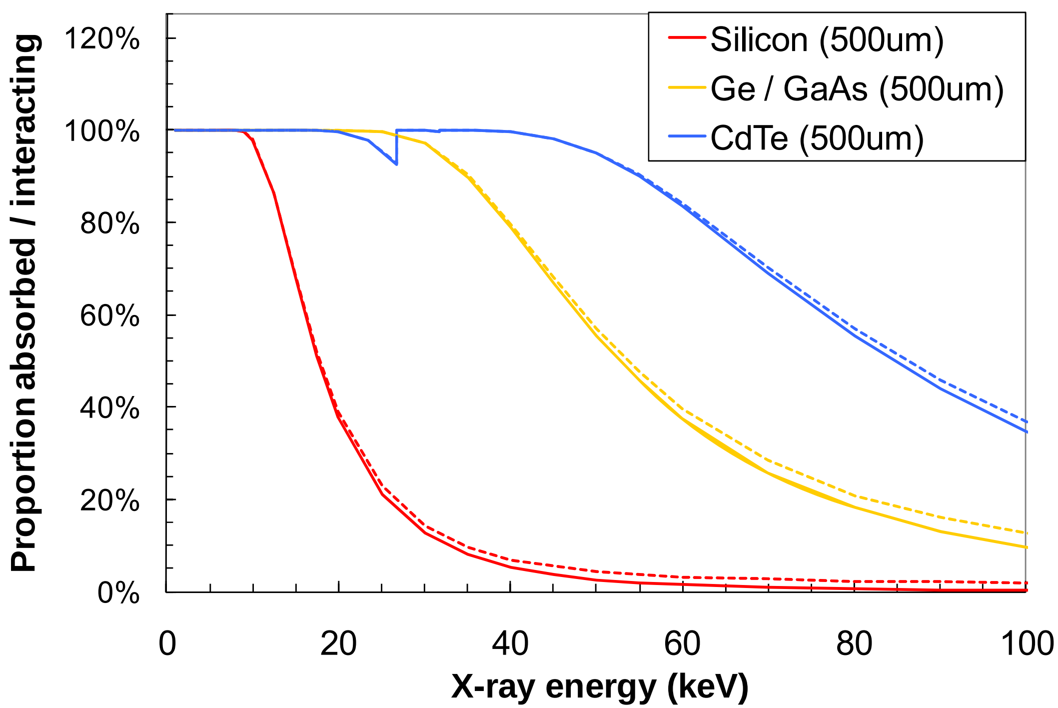


500 pin version

High-Z materials

> Many Petra-III (DESY synchrotron) experiments up to 100 keV x-ray
  - Replace silicon with another semiconductor

X-ray absorption / interaction



> Germanium:
  - Germanium (Canberra),

    Still tests: How sensitive are diodes to high temperatures
  - Indium bump bonding (IZM)

    Relatively cold bonding (<100°C)

Germanium Mechanics and cooling

- Germanium detector needs -50°C
  - Avoid large temperature differences (leakage doubles every 9°C)
- Each chip up to 1.5W → design for 18W power
- Normal heat-spreader and cooling block at one side is not sufficient
  - Estimate $\Delta T \geq 15°C$, even with thermal contacts at each end

- Thermal vias through board
- Thermal coupling to each chip
  - *Heat spreader* reduces heat gradient and helps match CTE
  - Estimate $\Delta T = 2°C$ across sensor (plus 5°C through vias)

Ceramic PCB

Thermal expansion:

- Silicon: ~ 2.5 ppm/°C
- Germanium: ~ 5.9 ppm/°C

→

- difference of 3.4ppm/C
- operate at -50°C – 75°C
- **7um** displacement along diagonal

diagonal of 51mm

temp difference 100K

- Germanium: ~ 5.9 ppm/°C → 30.1um
- Heat spreader CuG: ~ 7-8 ppm/°C → 38.3um
- **FR4 PCB: ~ 12 – 18 ppm/°C** → **76.5um** →
- **Ceramic PCB: ~ 5.5 ppm/°C** → **28.1um** →

Result:

mismatch of
(Silicon → Germ.)

~ 3.5um

from centre to corner

mismatch of
(Germ. → PCB)

~ 46.4 um (FR4)

~ 2 um (Ceramic)

from centre to corner

Mechanics and cooling

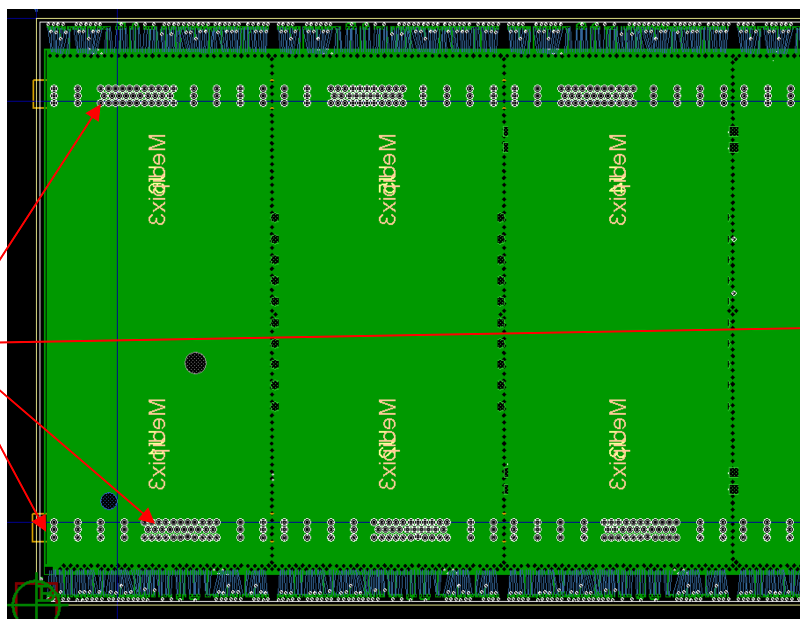
Design issues

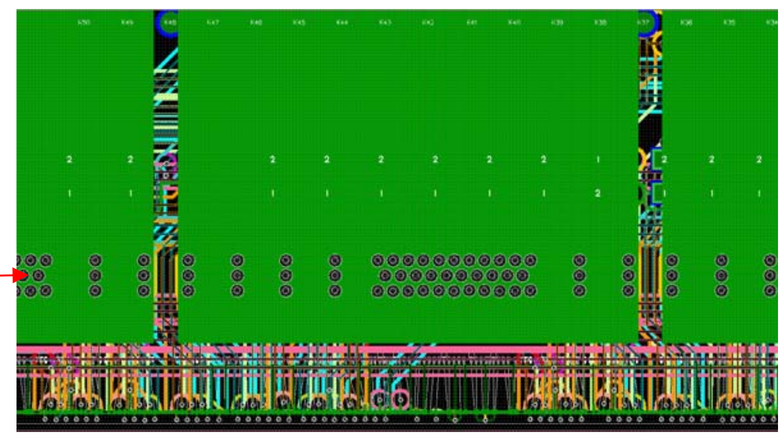
> Cooling frame occupies space on the back underneath each PCB

> Space available for connectors reduced

> Thermal vias make routing more difficult

Thermal vias



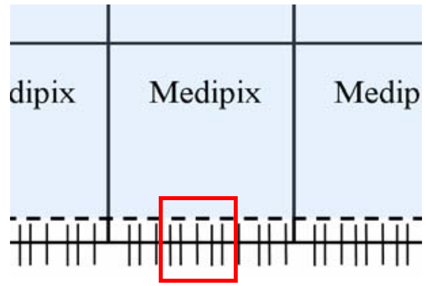


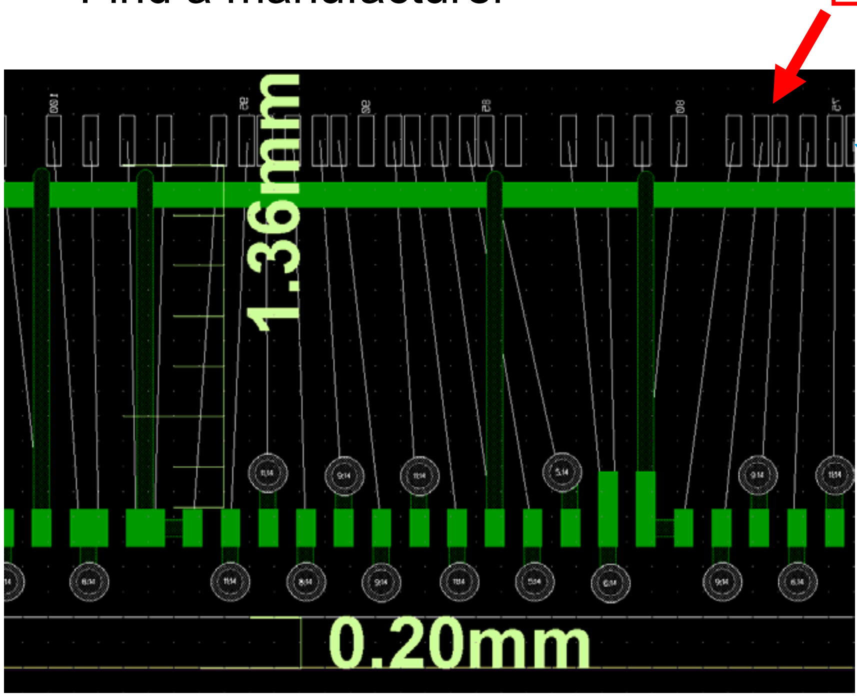
Wire bonding

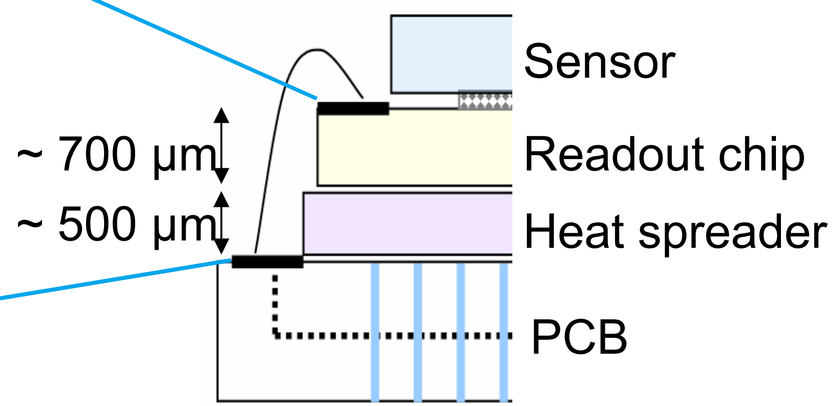
PCB design → Minimise dead area between modules

Challenging:

- Wire bonding
- Routing
- Find a manufacturer





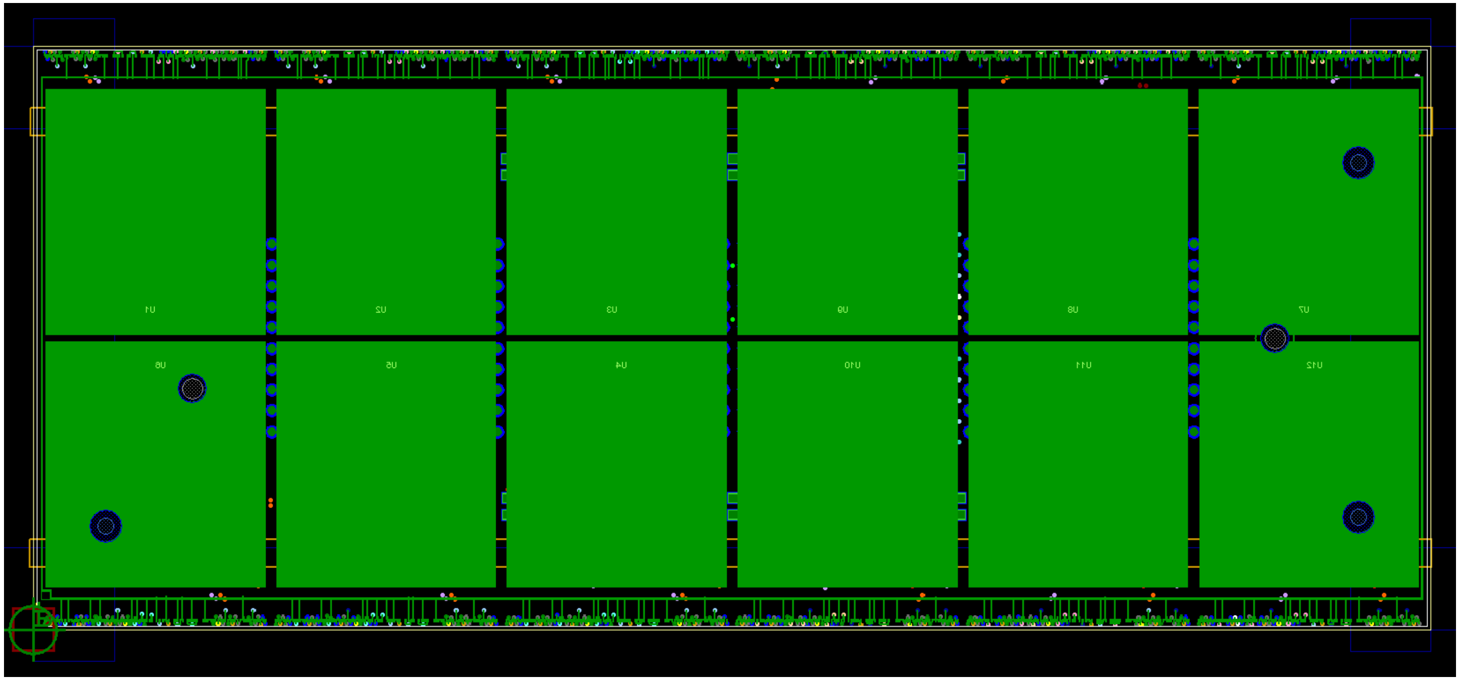


Status of the project

Status of the project – Ceramic PCB

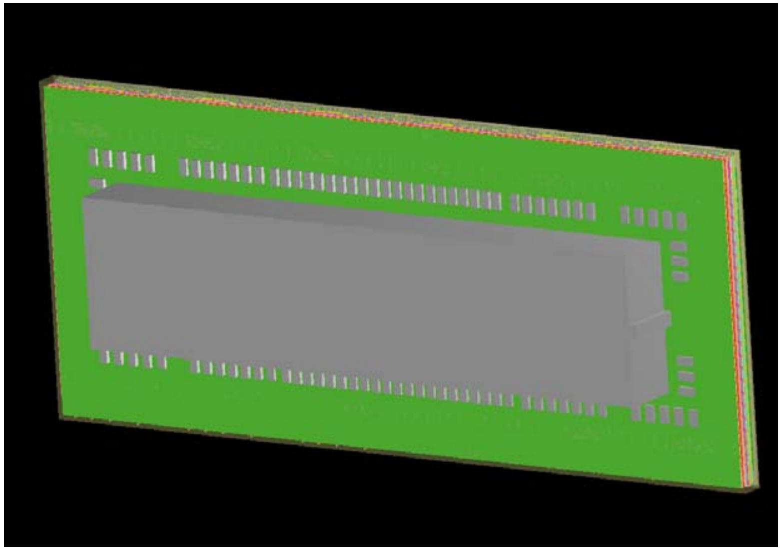
Production of the ceramic PCB will start next week

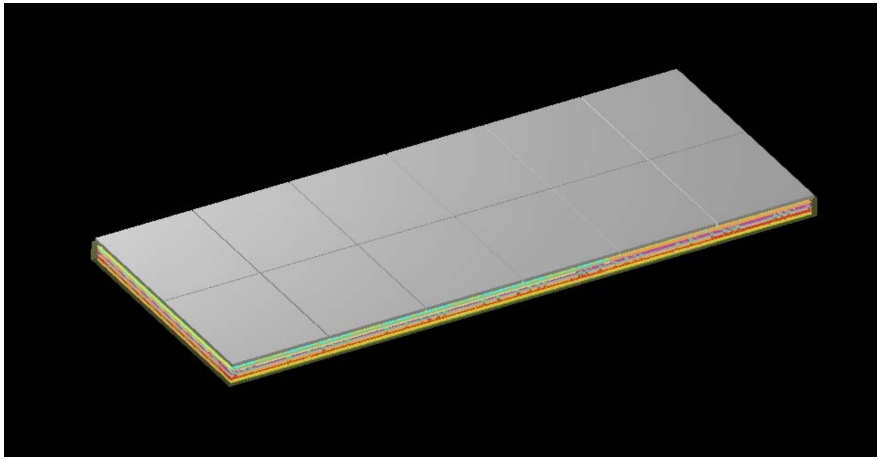
few companies are using LTCC (Low temperature co-fired ceramic) multi-layer technology → clearances of some still to big



Status of the project – Ceramic PCB

Connector side



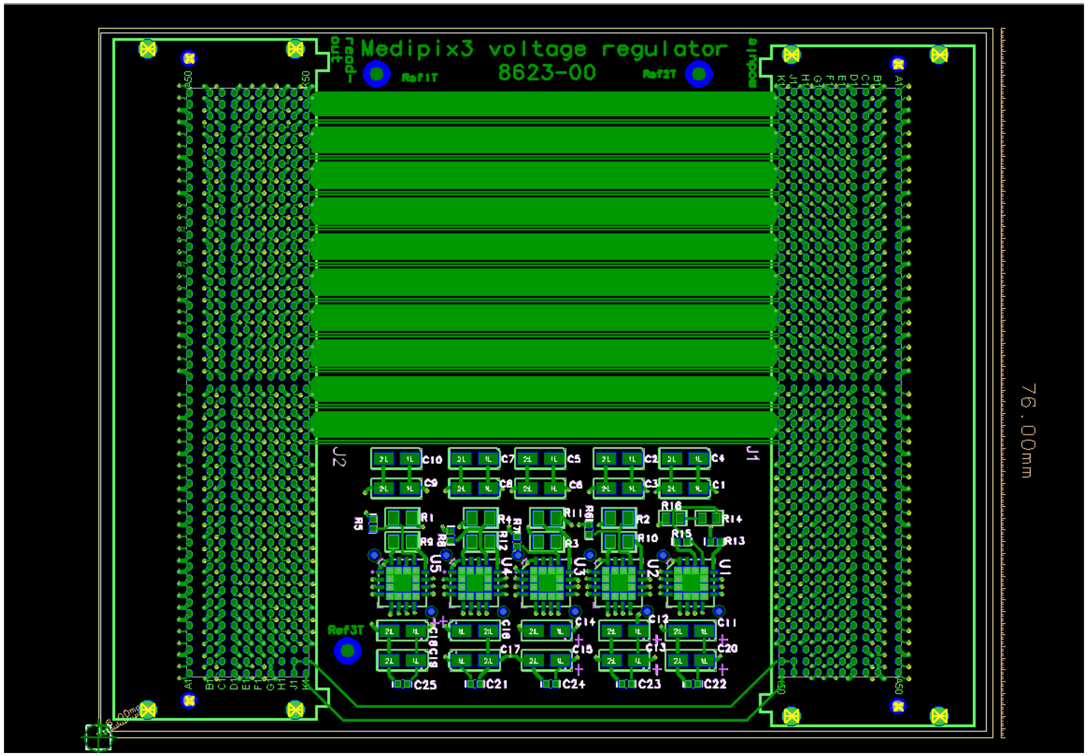


Sensor / Heat spreader side

Status of the project – Voltage regulator PCB

Production of the Voltage regulator PCB started 2 weeks ago

Material: FR4



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Outlook

> End of this year:	Board tests
> Beginning of next year:	Mounting full Si-sensors
> Next year:	Fast readout

Thanks for listening