Large-area Medipix3 project

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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

Heat spreader

Voltage regulator board

3*2 Medipix 3 chips under each sensor

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Large area

3 modules gives
~9*9cm² (2.3 Mpixel)

12 modules gives
18*18cm² (9.4 Mpixel)

essential:
Minimal dead area between modules
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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**

- **Silicon (500um)**
- **Ge / GaAs (500um)**
- **CdTe (500um)**

**Germanium:**

- Germanium (Canberra),
  - Still tests: How sensitive are diodes to high temperatures
- Indium bump bonding (IZM)
  - Relatively cold bonding (<100°C)
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 $\Delta T \geq 15^\circ C$, 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 $\Delta T = 2^\circ C$ across sensor (plus 5°C through vias)
Ceramic PCB

Thermal expansion:

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

**Result:**

- **Mismatch of (Silicon → Germanium):**
  - ~ 3.5 um
  - from centre to corner

- **Mismatch of (Germanium → Ceramic PCB):**
  - ~ 3.5 um from centre to corner
  - ~ 7 um displacement along diagonal

- **Mismatch of (Germanium → Heat spreader CuG):**
  - ~ 30.1 um

- **Mismatch of (Germanium → FR4 PCB):**
  - ~ 46.4 um
  - ~ 2 um (Ceramic from centre to corner)

- **Mismatch of (Heat spreader CuG → FR4 PCB):**
  - ~ 38.3 um

- **Mismatch of (FR4 PCB → Ceramic PCB):**
  - ~ 76.5 um
  - ~ 28.1 um
Design issues

- Cooling frame occupies space on the back underneath each PCB
- Space available for connectors reduced
- Thermal vias make routing more difficult
Wire bonding

PCB design → Minimise dead area between modules

Challenging:

> Wire bonding
> Routing
> Find a manufacturer

![Diagram of PCB design with labels for sensor, readout chip, heat spreader, and PCB, along with dimensions for ~700 µm and ~500 µm.]
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