How to connect sensors to their r/o electronics?

Wolfgang Lange
DESY Zeuthen

Calorimeters…

- Sampling calorimeters consist of a stack of absorber and sensor layers ‘sandwich’.
- In order to achieve a compact calorimeter one needs a small Molière Radius*.

  ➛ *Total Gaps between subabsorber layers should be as thin as possible.*

- The energy deposited between absorber layers should fully be measured by sensor layers.

  ➛ *Gaps between absorber and sensor layers should be as thin as possible*.

* The Molière radius is a characteristic constant of a material giving the scale of the transverse dimension of the fully contained electromagnetic showers initiated by an incident high energy electron or photon. By definition, it is the radius of a cylinder containing on average 90% of the shower's energy deposition. It is related to the radiation length X0 by the following approximate relation: where Z is the atomic number[1]. A smaller Molière radius means better shower position resolution, and better shower separation due to a smaller degree shower overlaps.

The implications…

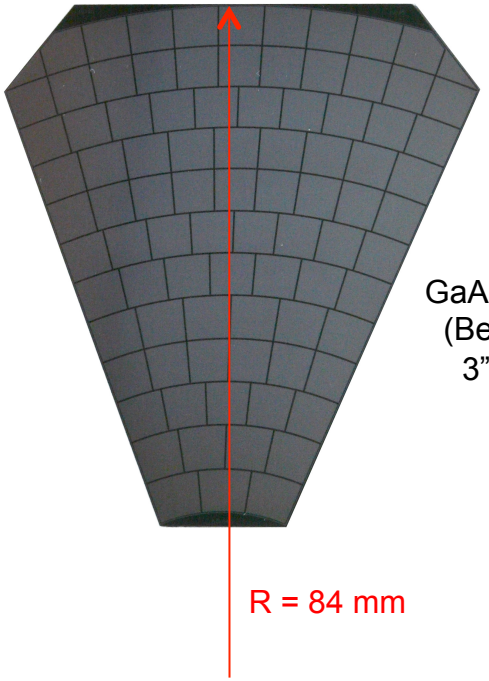
- Thin gaps between absorber layers need thin sensor layers with almost no *additional 'air gap'*.
- Sensors need to be read out within this remaining *additional 'air gap'*.
- Readout tracks to the frontend electronics (situated outside the sensor(s)) should not interact with other tracks or with absorber layers.
- Electrical contacts to sensor structures should not 'add thickness'.

  ➛ thin structures (wiring layers)
  ➛ low capacitance to ground and to adjacent structures
  ➛ sufficient electrical isolation

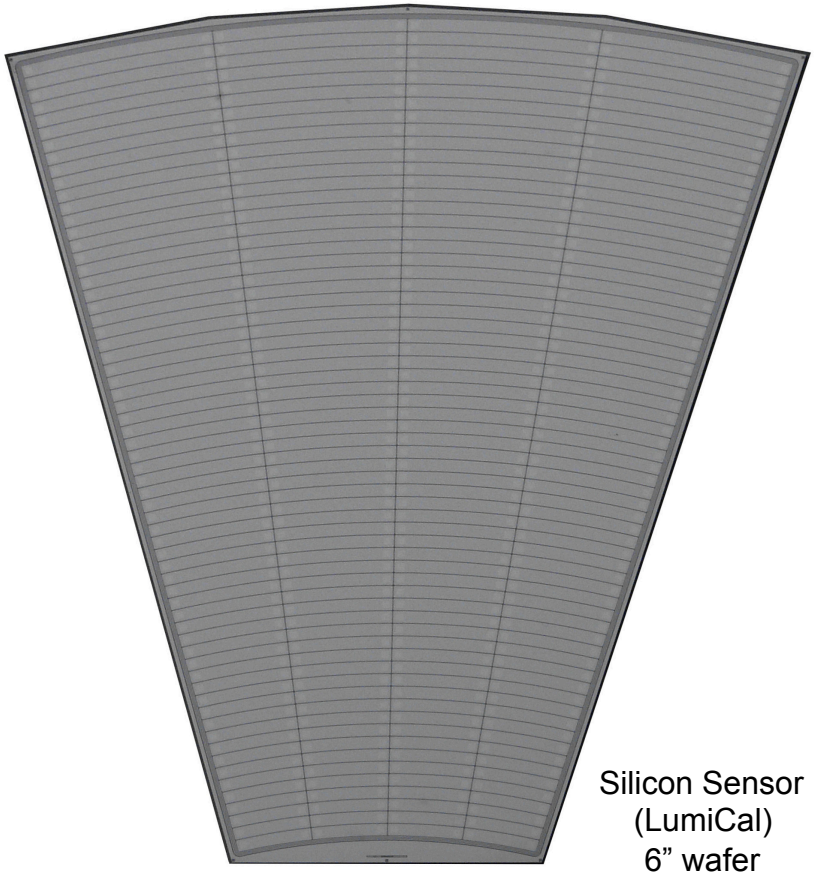
- It is almost squaring the circle.

Sensors

- Two types of sensors
  for BeamCal (GaAs) and LumiCal (Si)
  ➛ thin structures (wiring layers)



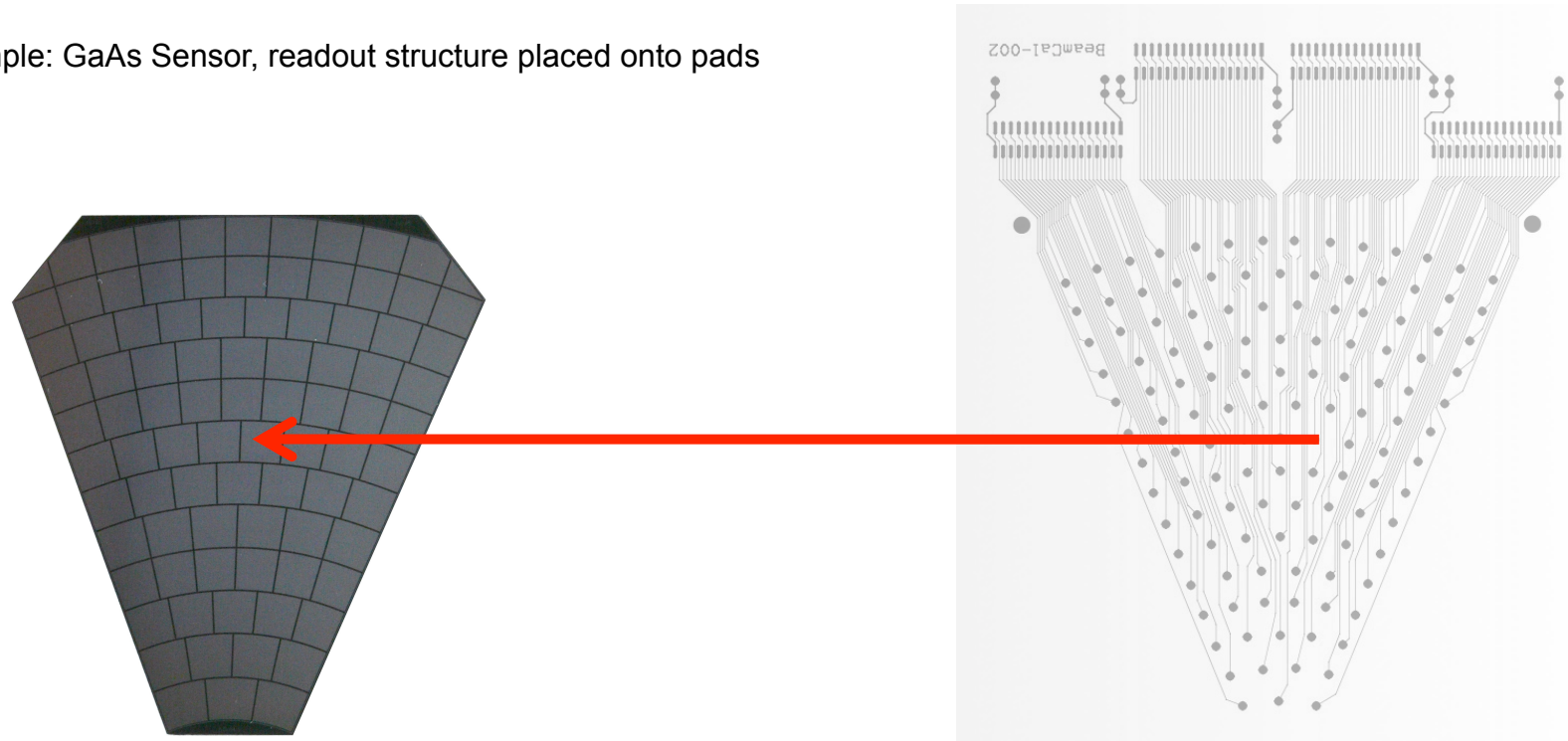
GaAs Sensor
(BeamCal)
3” wafer



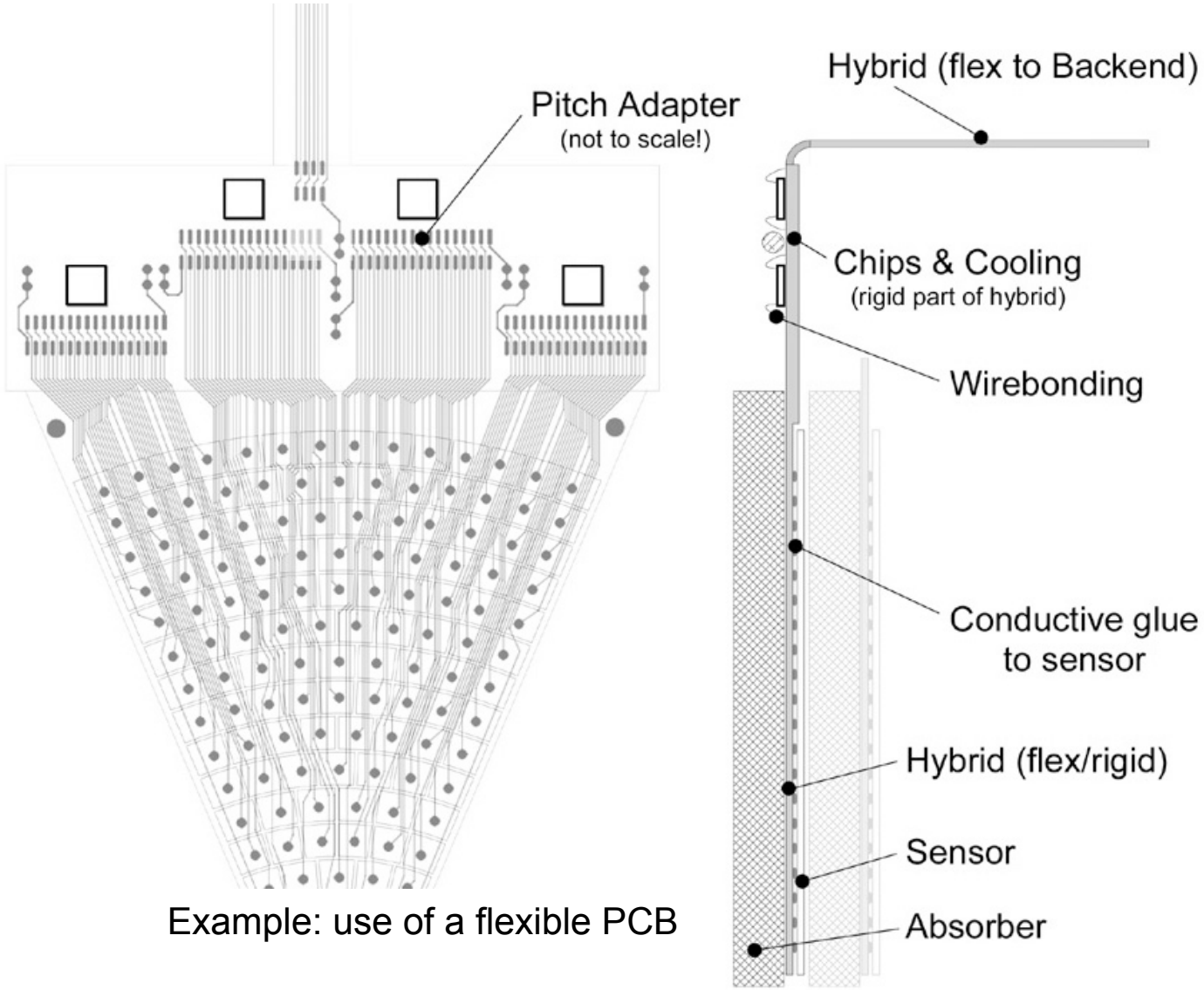
Silicon Sensor
(LumiCal)
6” wafer

Sensor Readout (view from top)

Example: GaAs Sensor, readout structure placed onto pads



Sensor Readout (cut)



Example: use of a flexible PCB

Various Proposals

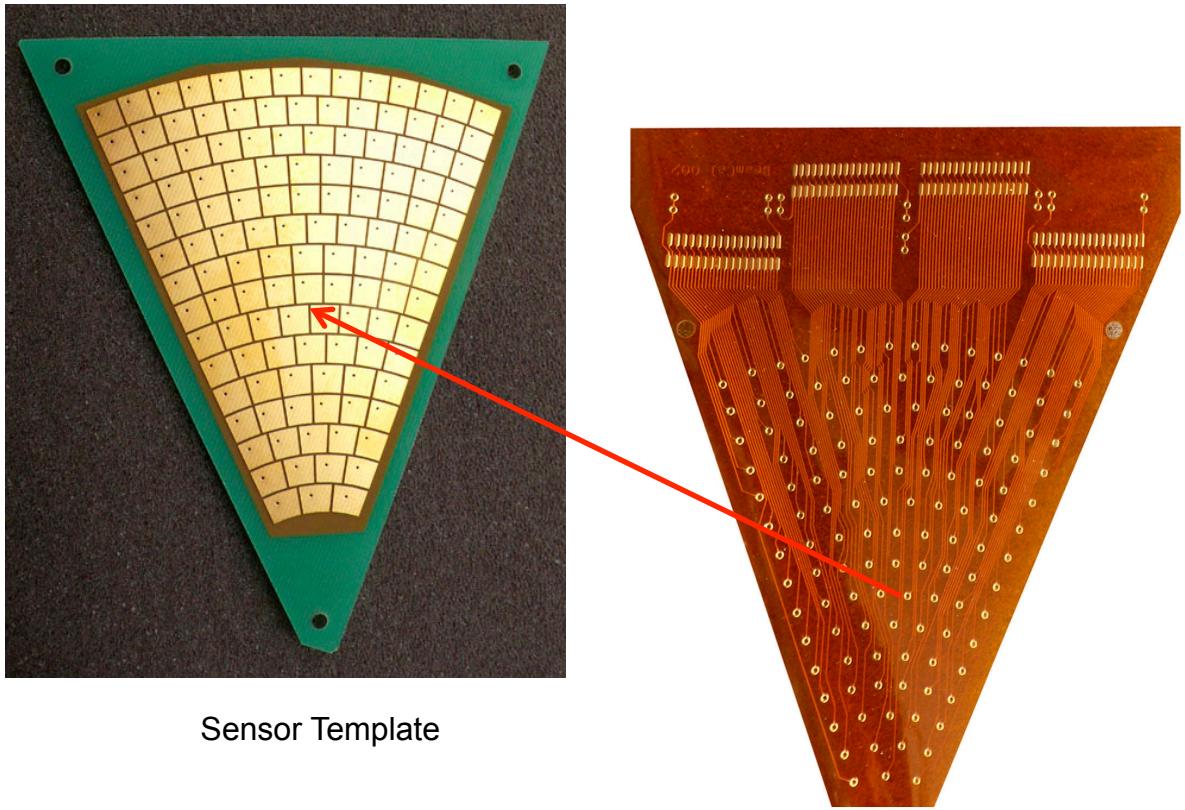
a) PCB (flexfoil) with dedicated connections (glue, wire bonds): rather simple, lab

b) double metal layer on the sensor itself: dielectric layer, ‘vias’, crosstalk
   I. Connection to readout electronics at the outer edge
   II. Chips glued onto the (extended in size) sensor – less connections to outside

c) sensors with integrated readout electronics: difficult on GaAs and high Ohmic Si

d) other ideas welcome (this workshop)

Practical Experience



Sensor Template