Module Design for Silicon vertex detector

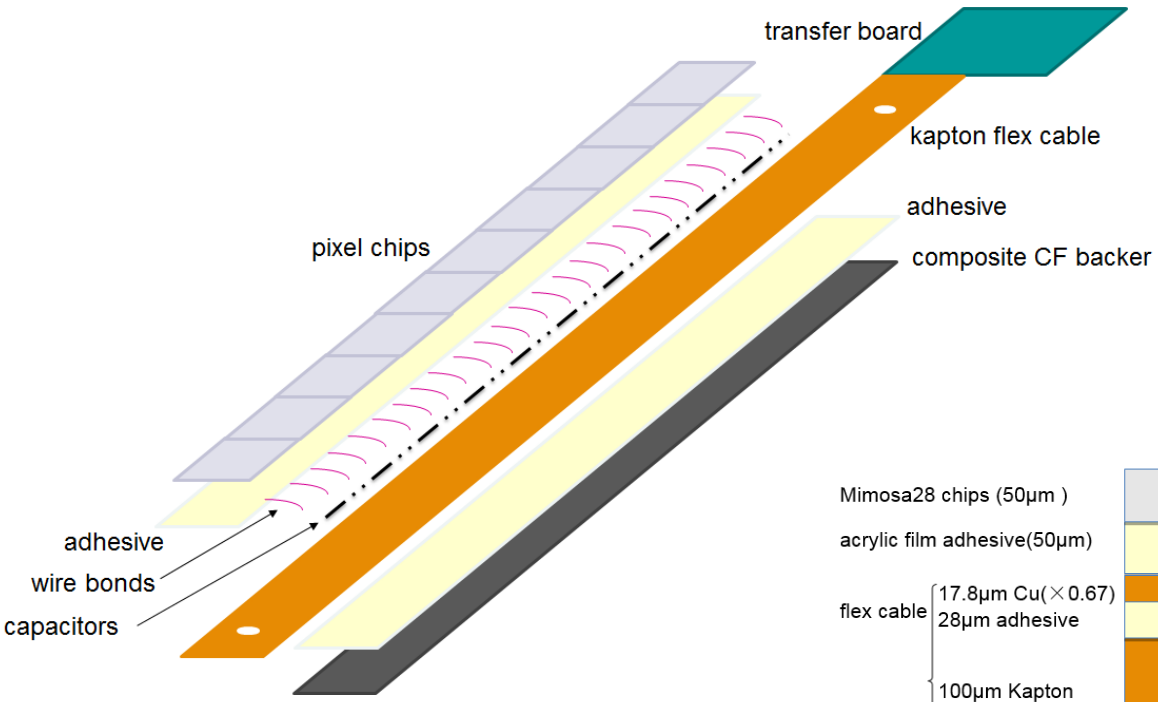
Mingyi Dong

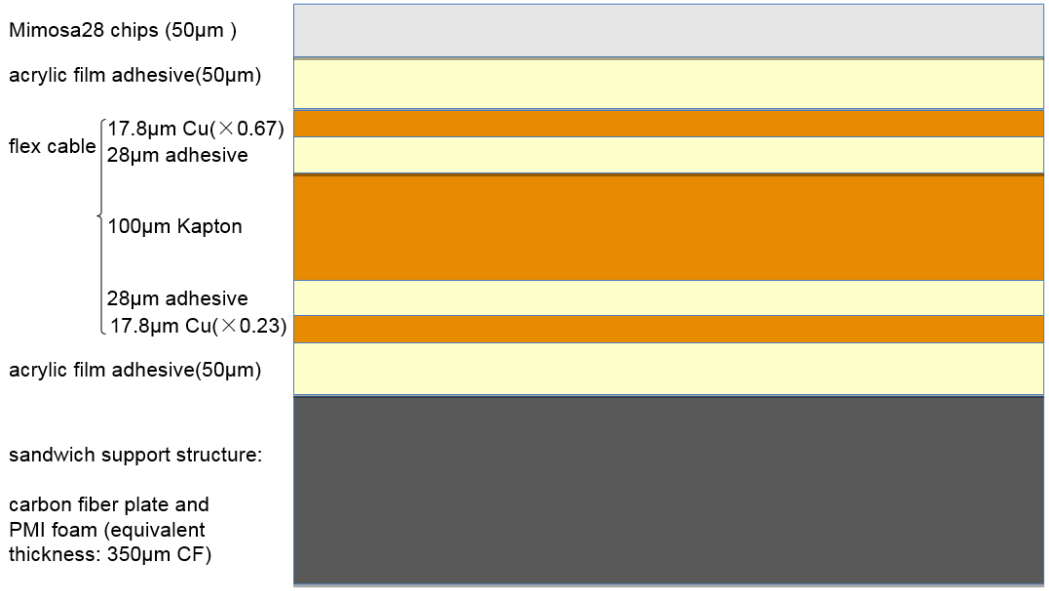
on behalf of the module group

Institute of High Energy Physics, CAS

State Key laboratory of Nuclear detection and electronics

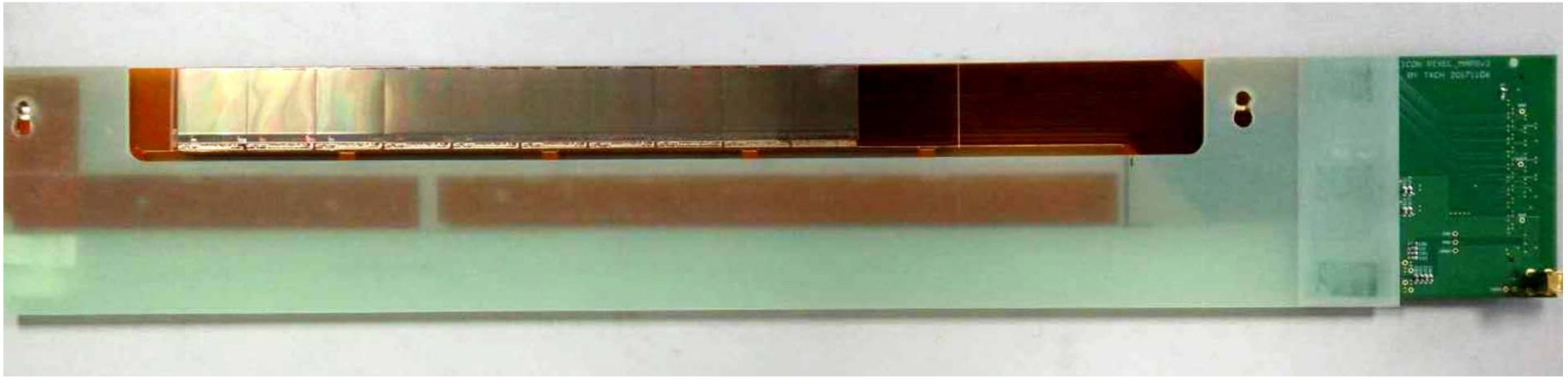
Single-sided Ladder Design



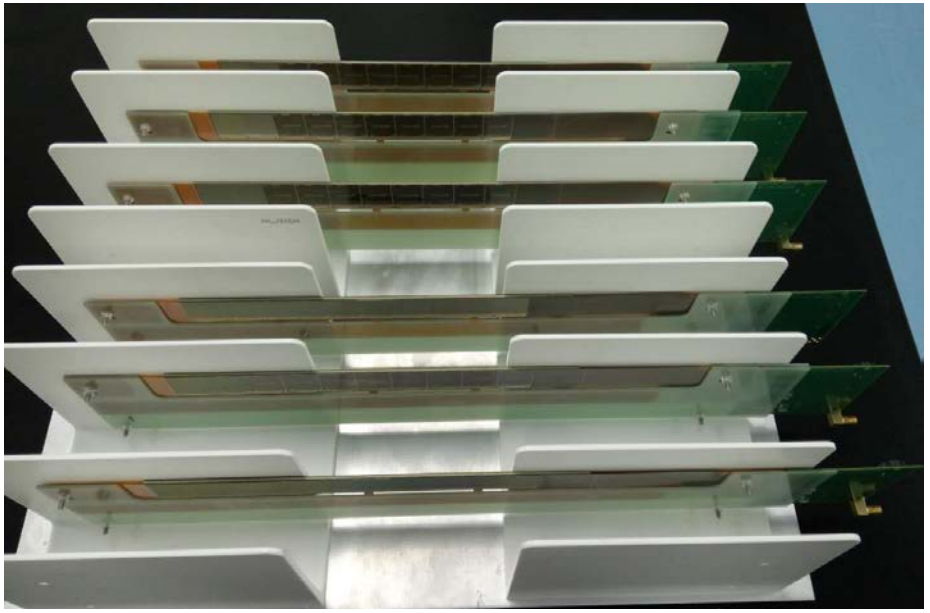


- Ladder: basic building and functional block of the detector, key issue for the prototype
  - 10 Mimosa28 chips (50μm)
  - Flex cable
  - Carbon fiber mechanical support

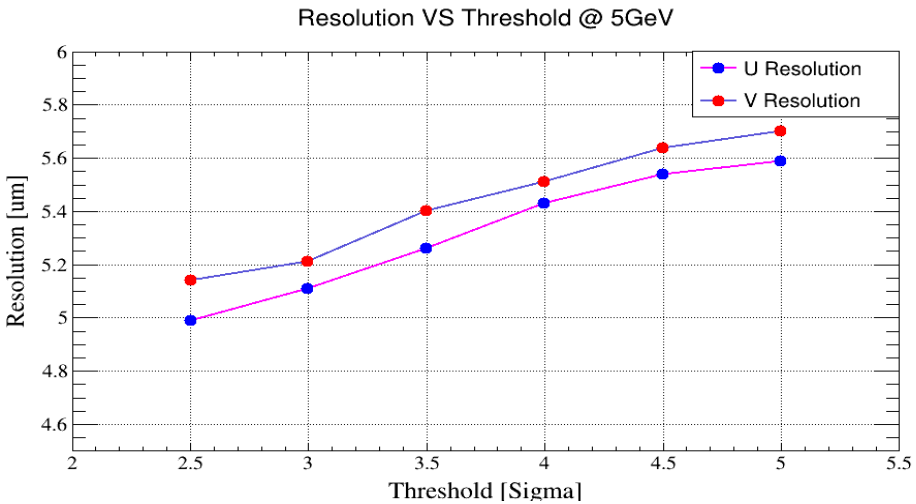
Ladder Assembly



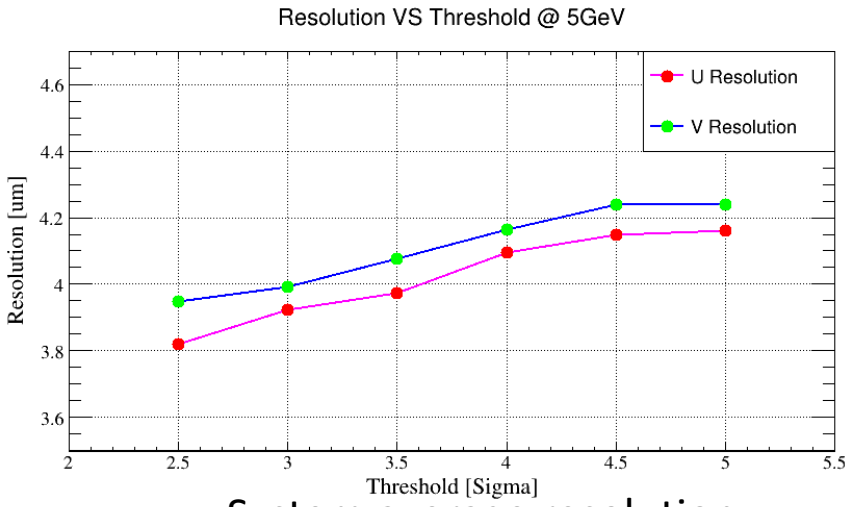
- Material budget of the ladder by calculation: 0.37% X_0 /ladder
- Chip location accuracy measured by imaging machine: < 10µm
- Ladder assembly was operated at a dedicated jigs to ensure the location accuracy of the chips



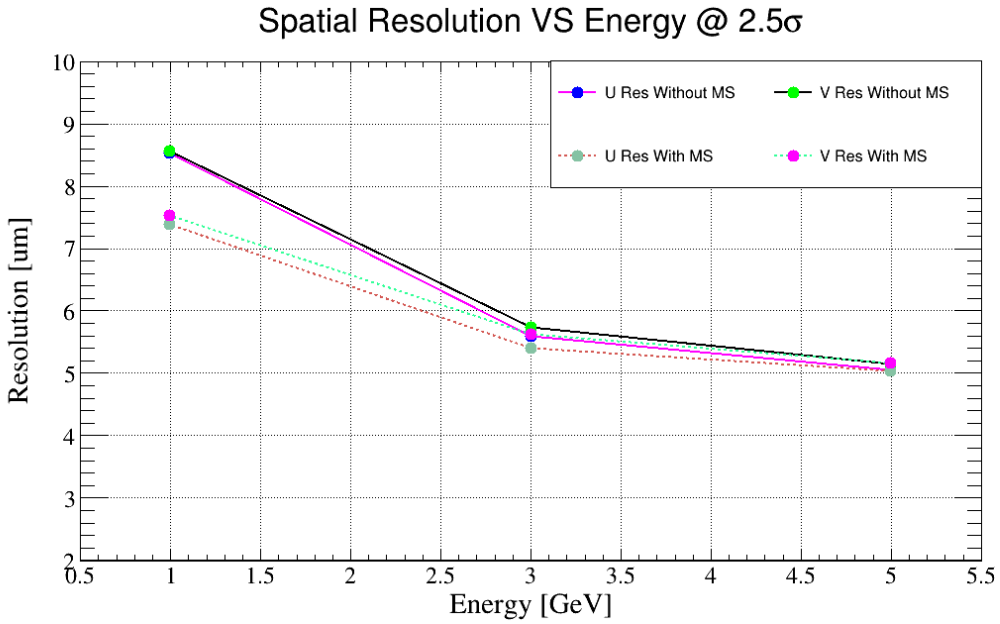
Spatial Resolution



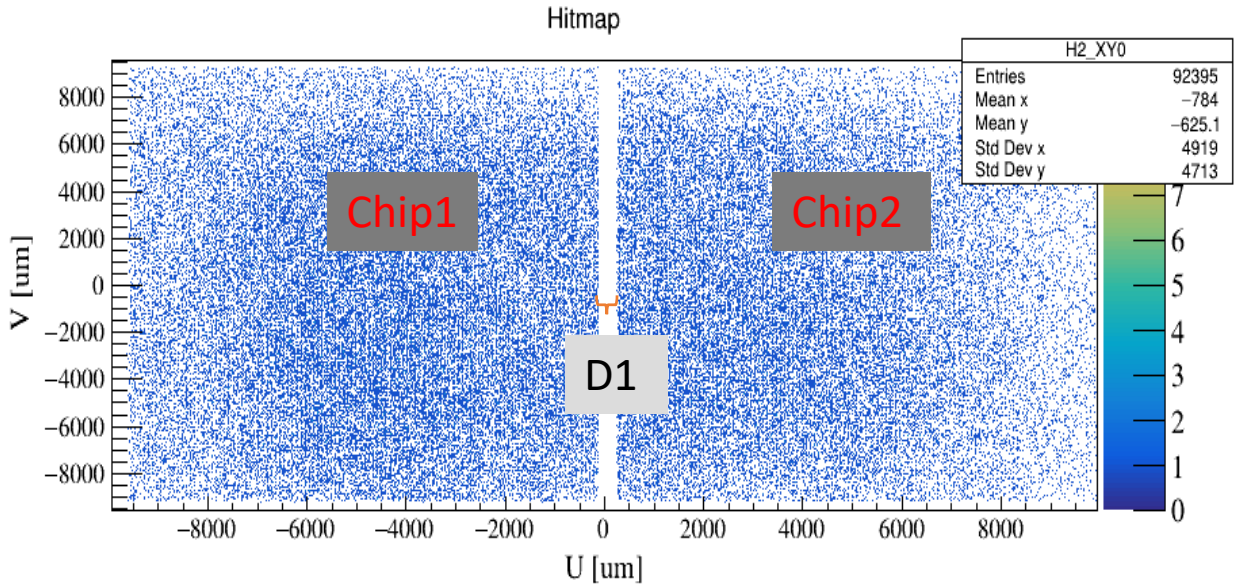
DUT resolution

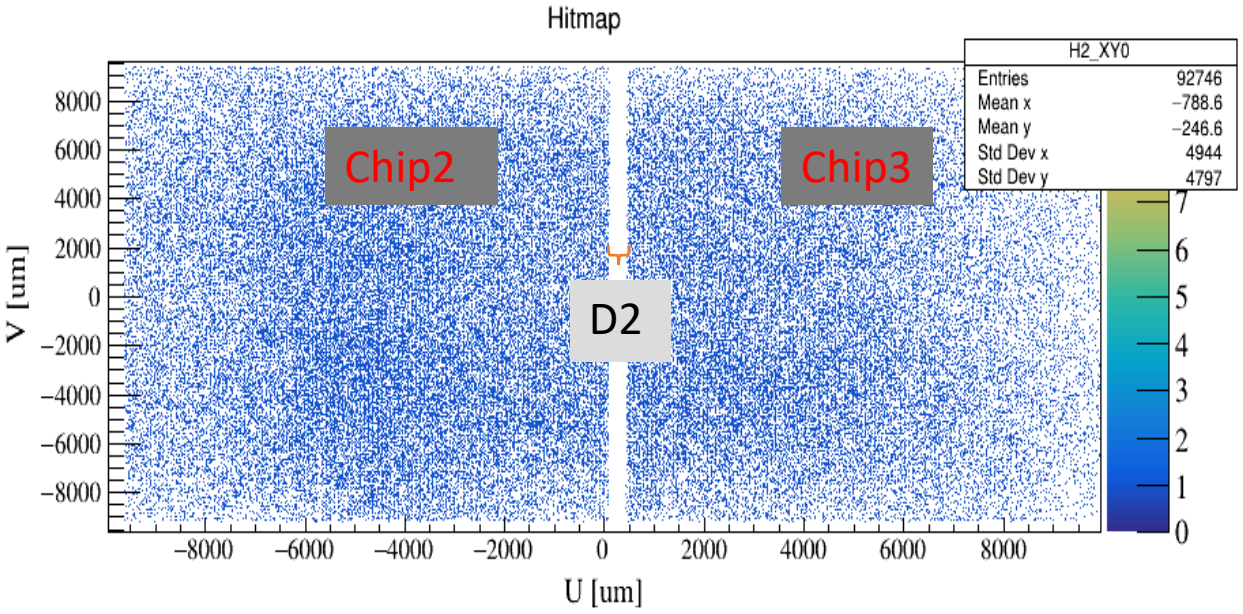


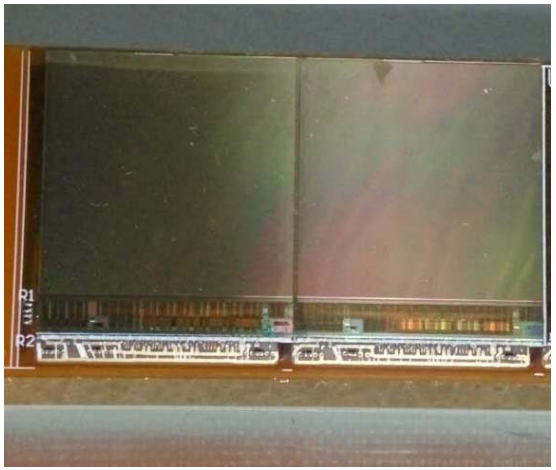
System average resolution



Gap between two chips

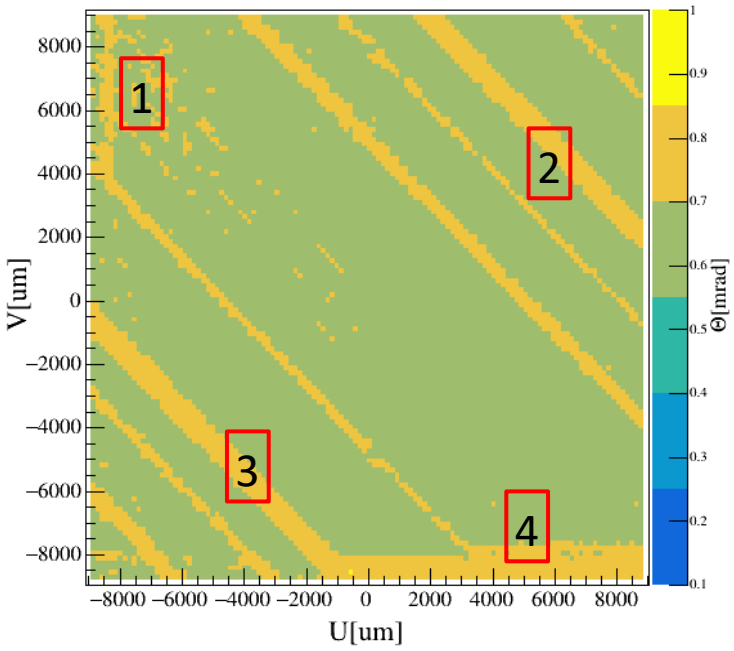


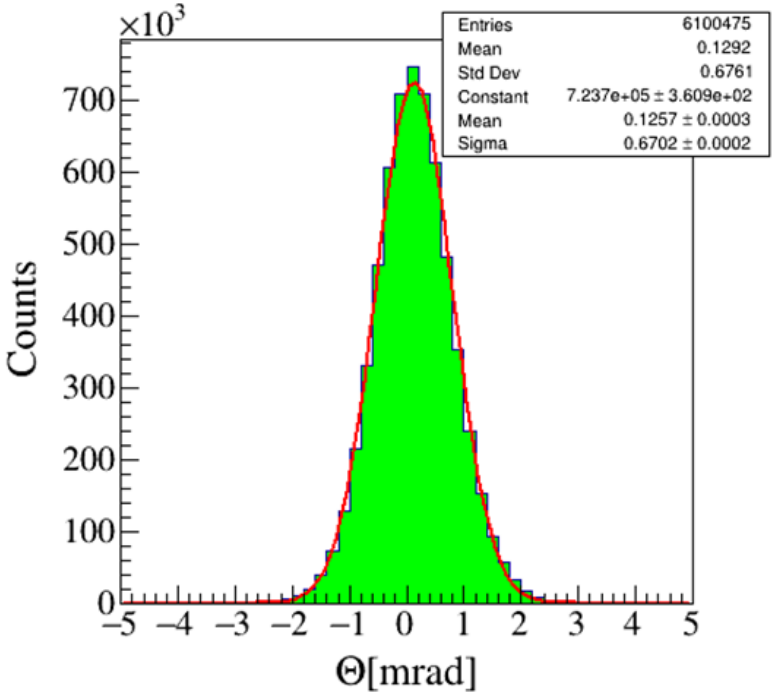


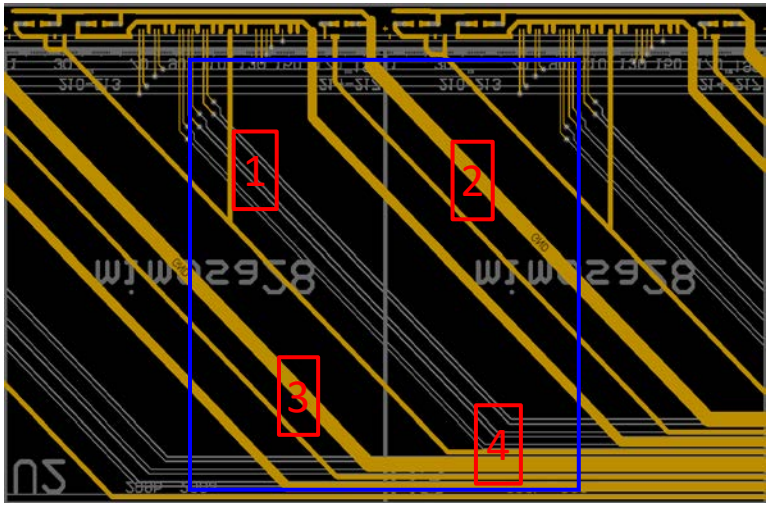


- D1≈D2 ≈ 340μm
- Average gap between neighboring chips is 340 μm
- Take into account the row sequencer on the chip, chip location accuracy is better than 10μm

Material budget







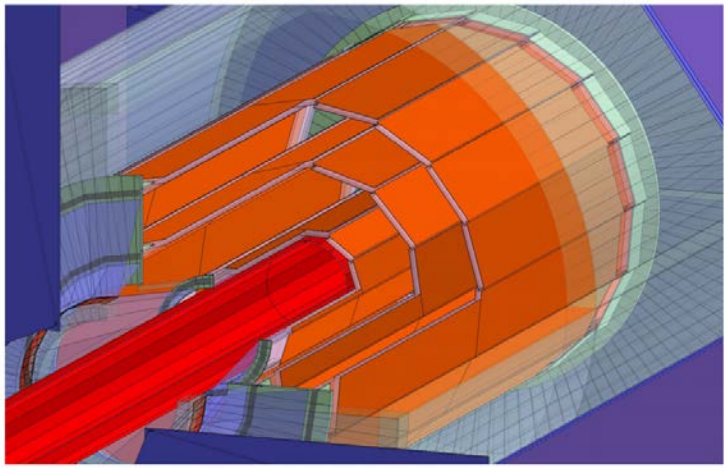
$$\theta_0 = \frac{13.6MeV}{\beta cp} Z \sqrt{\frac{x}{X_0}} \left(1 + 0.038 \ln\left(\frac{x}{X_0}\right)\right) \quad \frac{x}{X_0} = 0.39\%$$

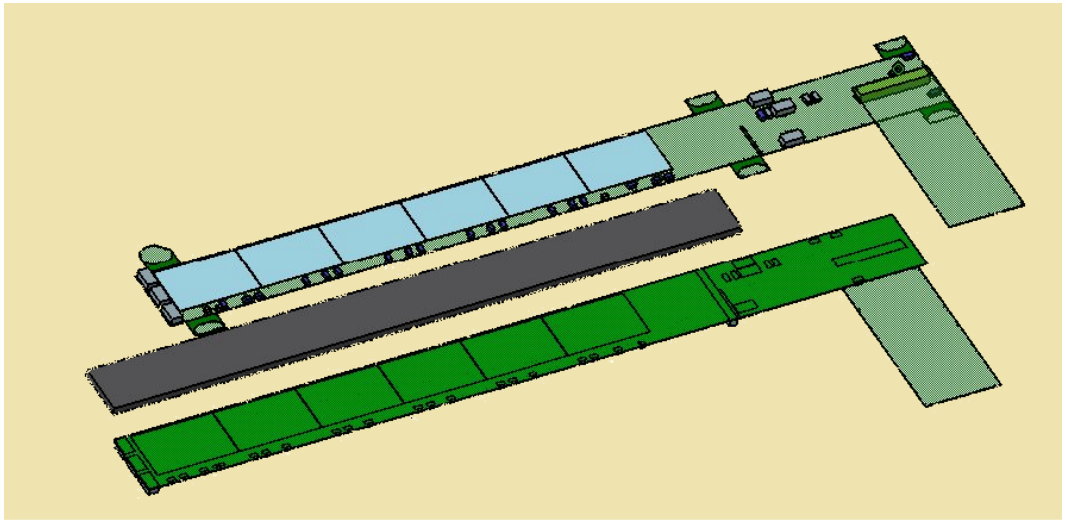
θ_0=0.0006702 rad

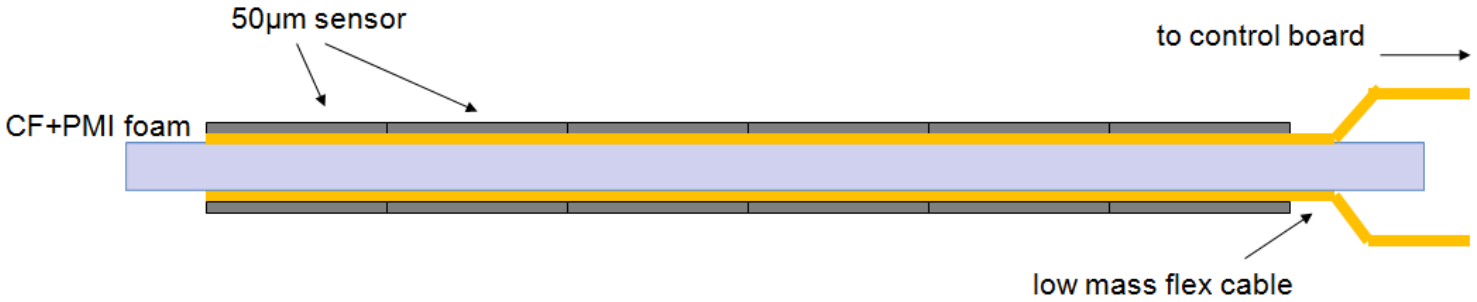
P =1GeV

- Be consistent with the calculation result

Double-sided ladder concepts

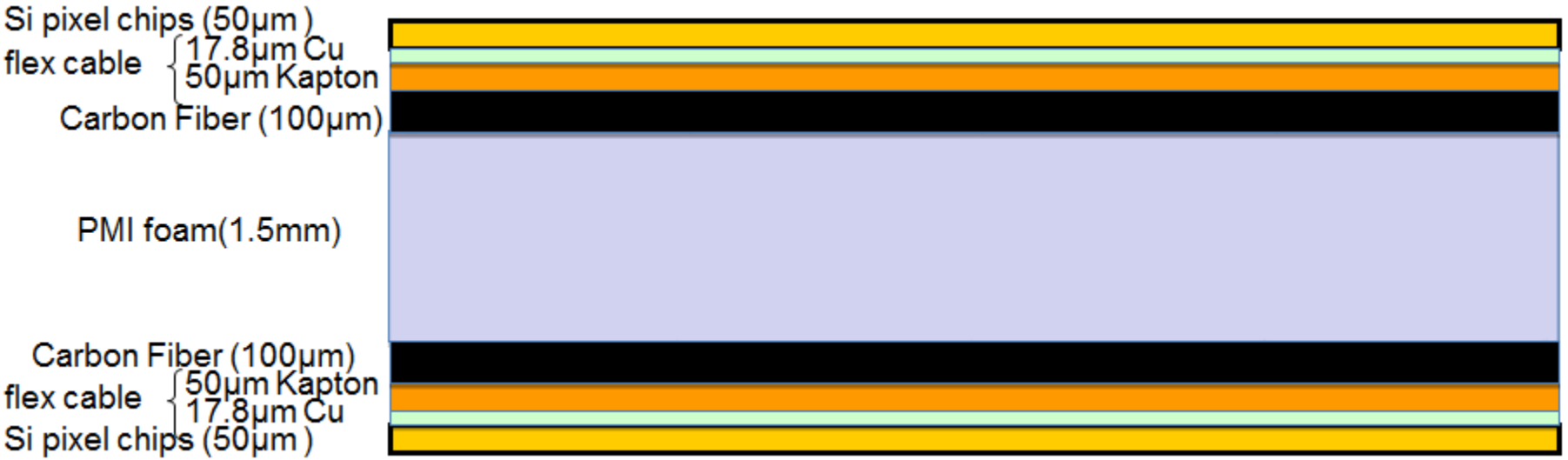






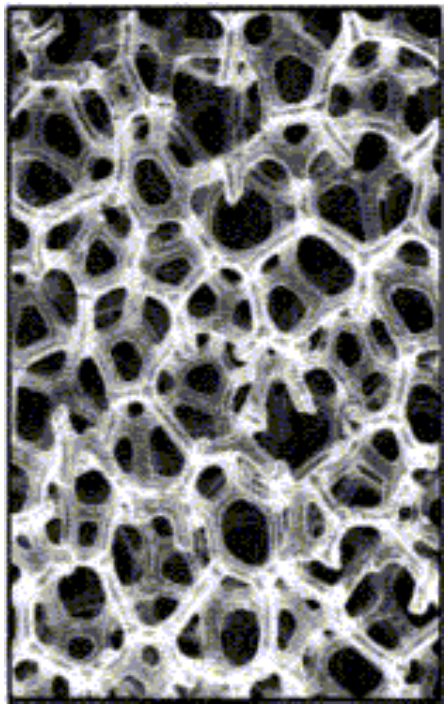
- Single-sided ladder→ Double sided ladder (CEPC vertex R&D)
- Why Double-sided? Has features attractive: low material budget (two layers share one support), high rigidness, high resolution

Double-sided ladder design



- Material budget: 0.48% X_0 (flex cable with copper traces)
- Reduce to 0.29% X_0 if using aluminum traces

Carbon Fiber support

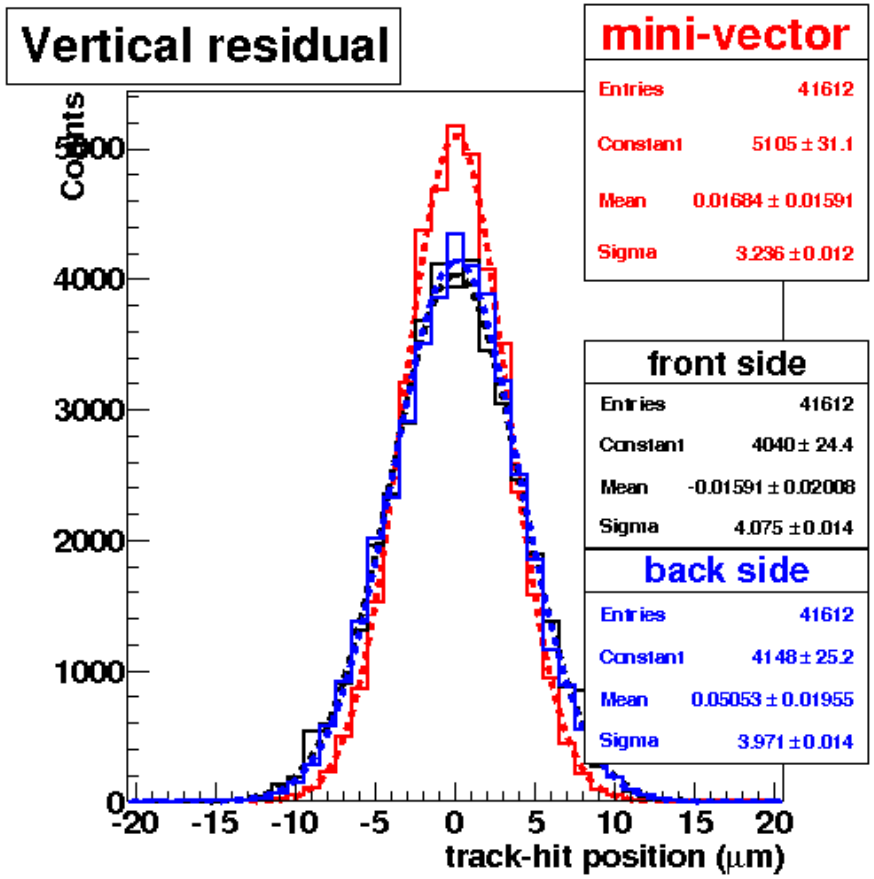


- Sandwich structure : CF(150µm) + Foam (1.5mm) + CF (150µm)
- Optimization of the material and thickness
  - foam with different material and different fill factor (8%-4%)
  - CF with different elasticity modulus

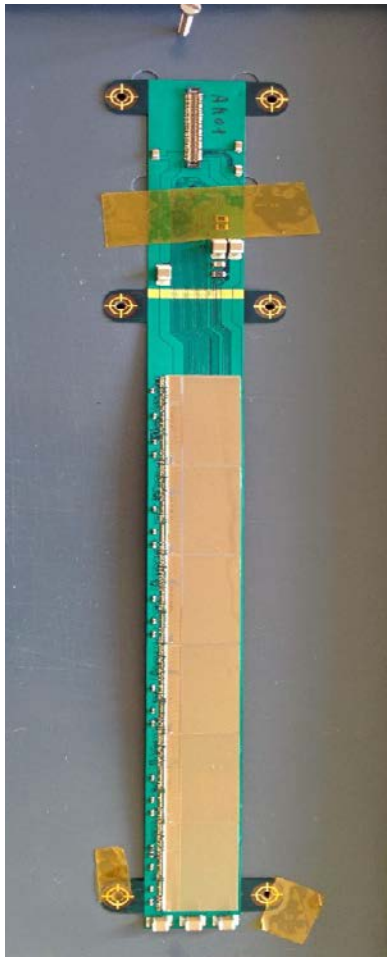
Assembly

- Step 1
  - Aligning & gluing sensors to flex cables
  - Using automatic placement machine
- Step 2
  - Wire bonding between chips and flex cable on individual flex cable
  - To get 2 individual single-sided ladders
- Step 3
  - Gluing 2 modules on both sides of a CF fiber support
  - Operating manually with a dedicated jigs

PLUME ladder



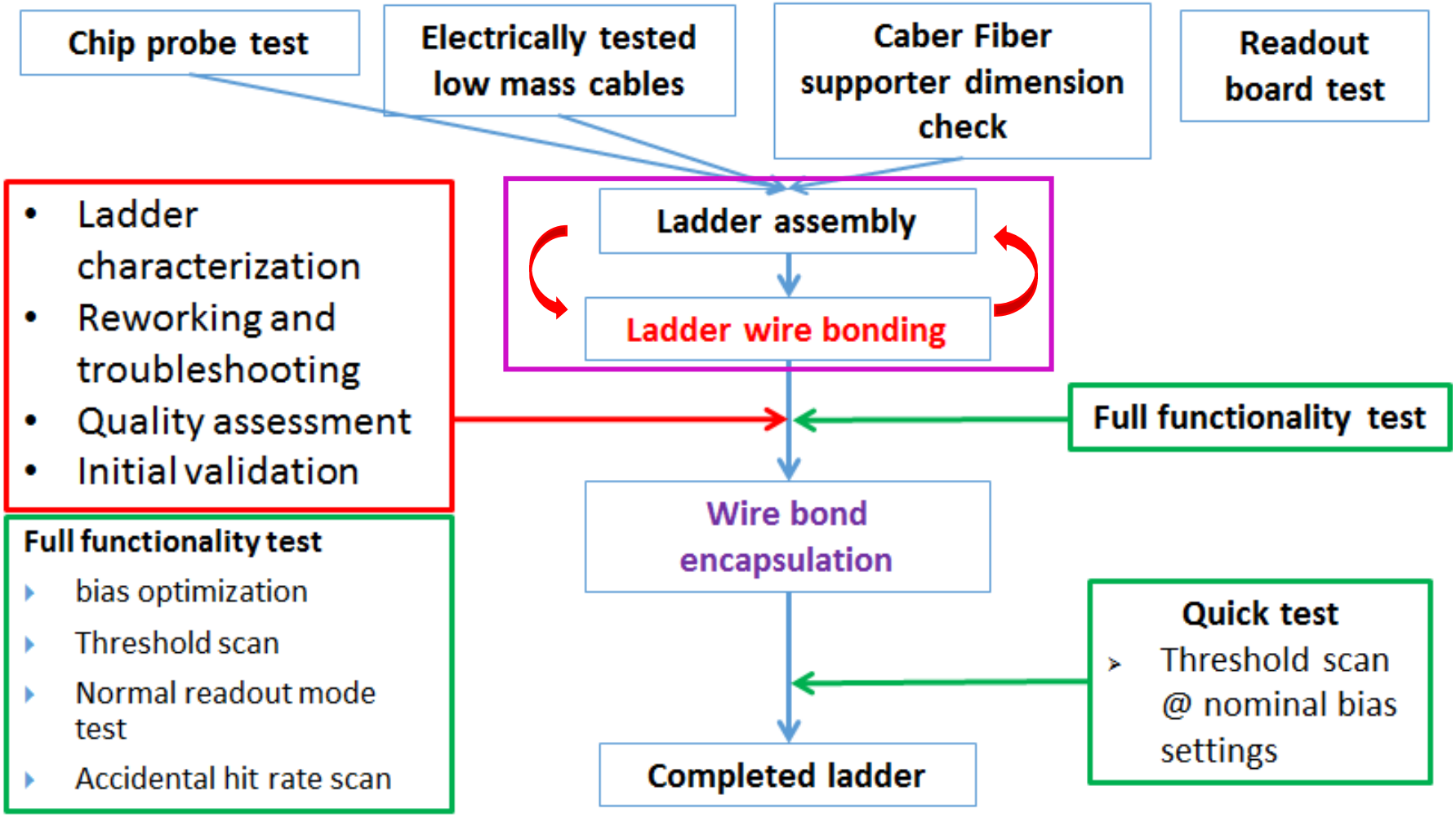
PLUME-1



PLUME-2

- Material budget of PLUME-1 ladder (Cross section)~ $(0.47 \pm 0.02)\ \%\ X_0$

Key procedure of ladder development



Thanks for your attention !