100MeV Proton Irradiation Test

Tan Yuhang

tanyuhang@ihep.ac.cn

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Introduction:

➢ Status quo

- LGAD has good time resolution without irradiation
- Irradiation can degrade the performance of the sensor

➢ Irradiation particle:

- π,proton,neutron,e

➢ Motivation:

- Research the effect of different irradiation fluences
- Contrast proton irradiation and neutron irradiation

Irradiation Fluence:

Fluence[1 MeV n_{eq}/cm^2]	LGADS
3×10^{14}	6×HPK,6× CNM,8× NDL
7×10^{14}	6×HPK,6× CNM,8× NDL
1×10^{15}	6×HPK,6× CNM,8× NDL
2×10^{15}	6×HPK,6× CNM,8× NDL
3×10^{15}	6×HPK,6× CNM,8× NDL

Contrast with CYRIC

Gain changes a lot

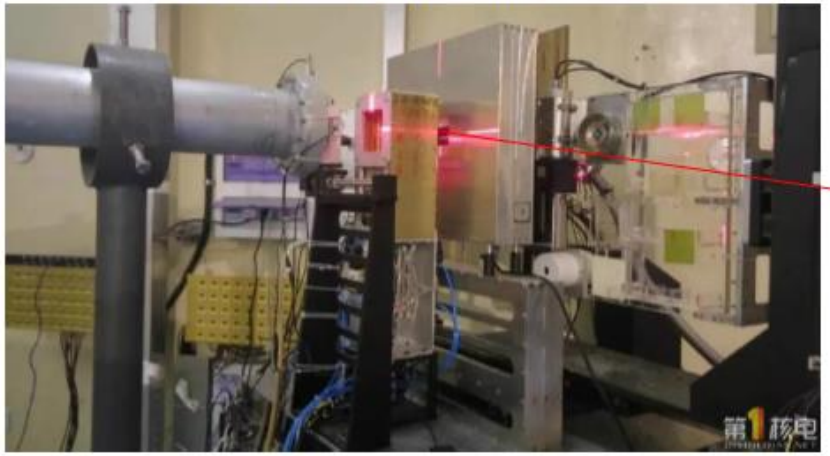
New points

New goal

- Covers well transition of highest gain degradation between 1e15 and 3e15
- 1e15 for comparison with 2018 CYRIC irradiation
- Covers medium and high fluences
- Three new points, and low irradiation fluence 3e14 is good for the NDL sensors of the first irradiation test

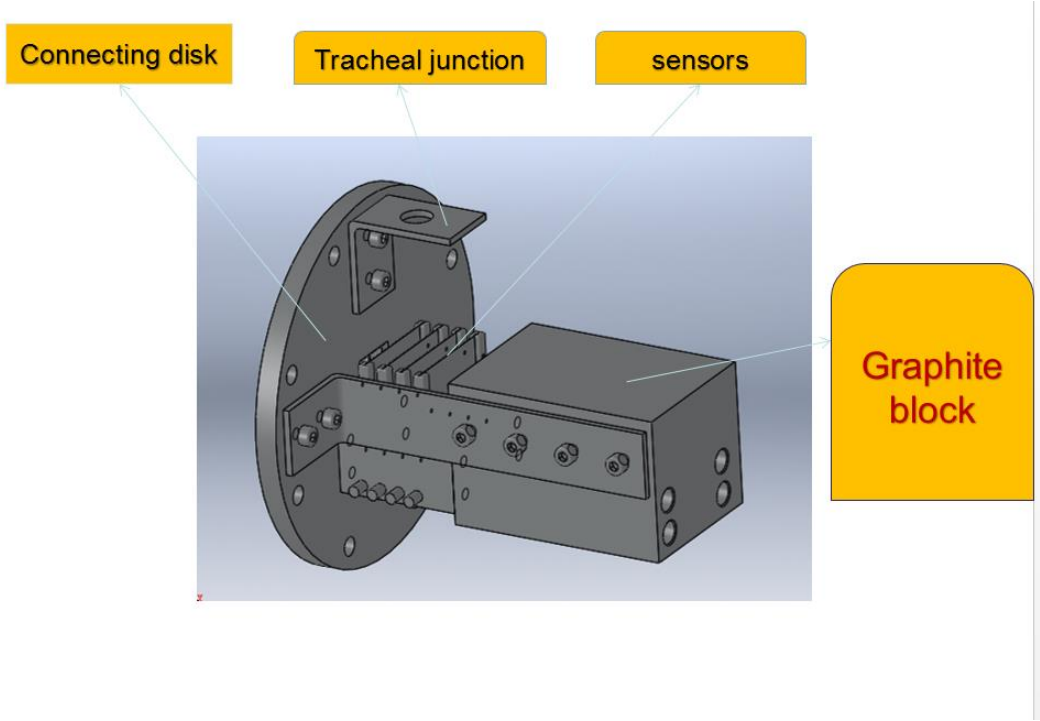
Cooperative Unit: China institute of atomic energy (CIAE)

Station for irradiation in CIAE

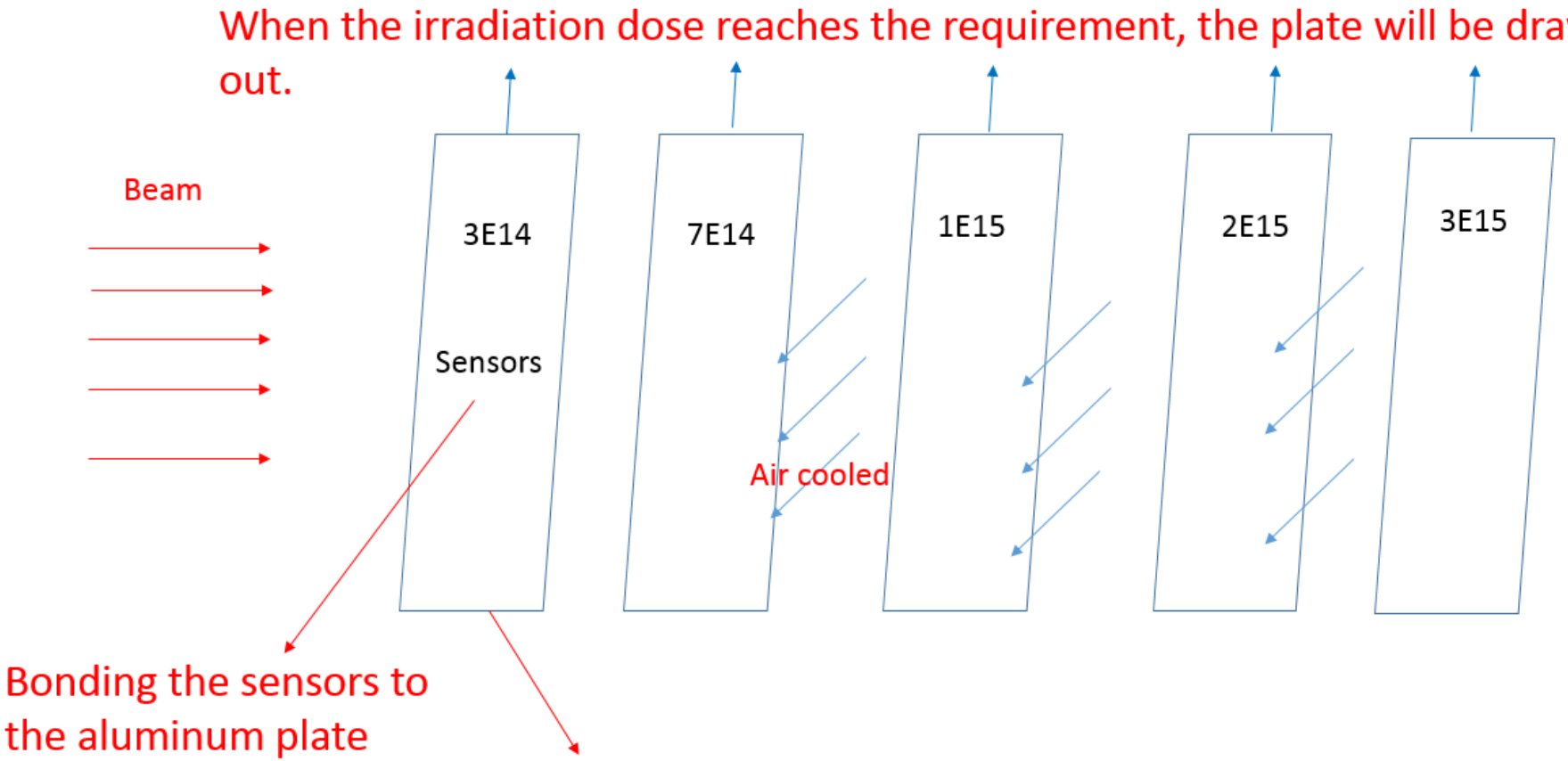


Sensor

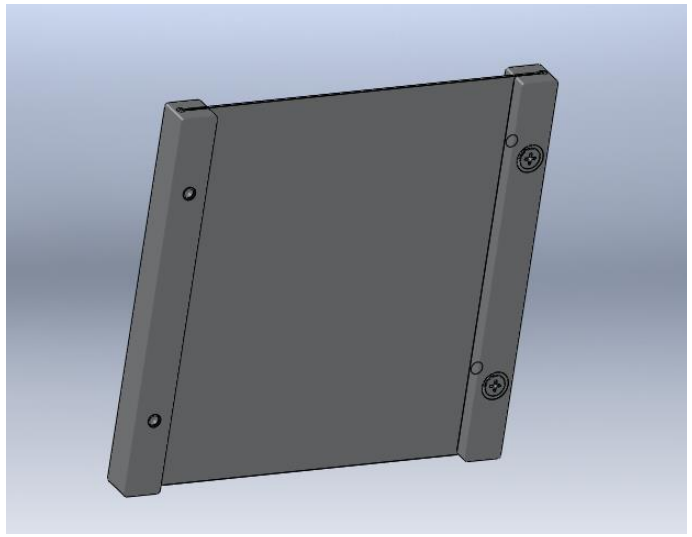
Irradiation device



Irradiation Structure:



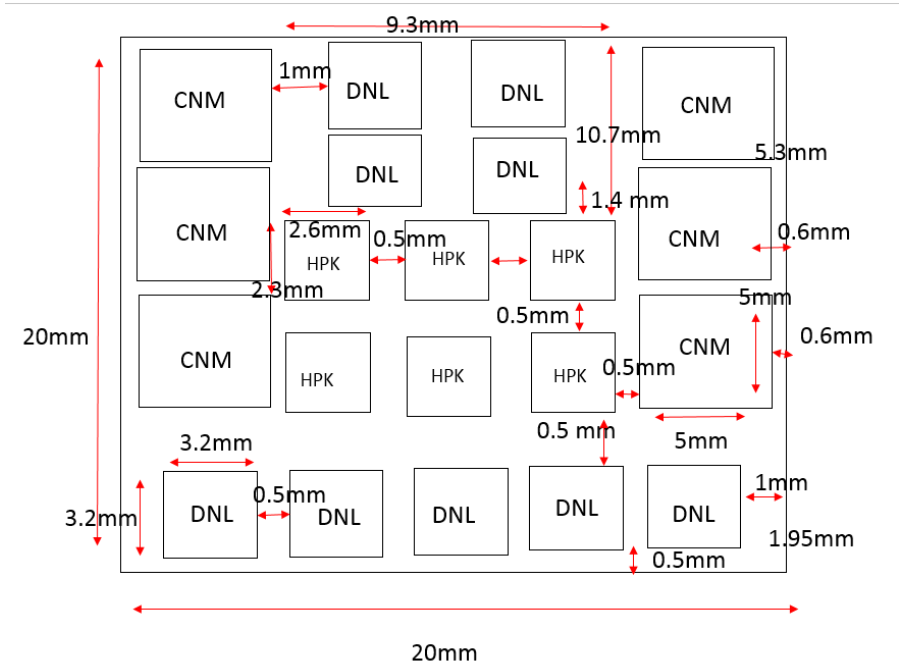
Sensors placement



A piece of aluminum plate is fixed by two fixing members, and both ends of the fixing member are fixed by screws.

Preliminary sensors that we want to place.

Beam size: 20mm×20mm



100MeV Proton Irradiation Test Information:

- Beam current: 0.7pA-1mA If choose 50nA->2% uncertain
- Time: 3E15n_{eq}/cm^2->about 8h.
- If choose 5 different groups irradiation fluences, may take one week.

  Because when one group is irradiated, it takes more than 24 hours to continue to the next group.
- Irradiation need to below 0℃ to avoid annealing.

LGAD sensors measurement plan:

- Using the probe station to measure unirradiated sensors at room temperature(about 20℃) by June 20

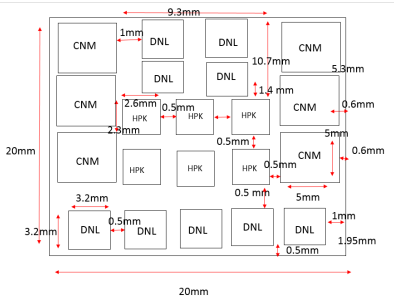
- Upgrade cooling system. Change liquid nitrogen to water cooling. One month.

- Measuring irradiated sensors at -30 ℃

- Measurement content:
  - Use probe station to measure I-V,C-V, doping profile
  - Use TCT to measure time resolution

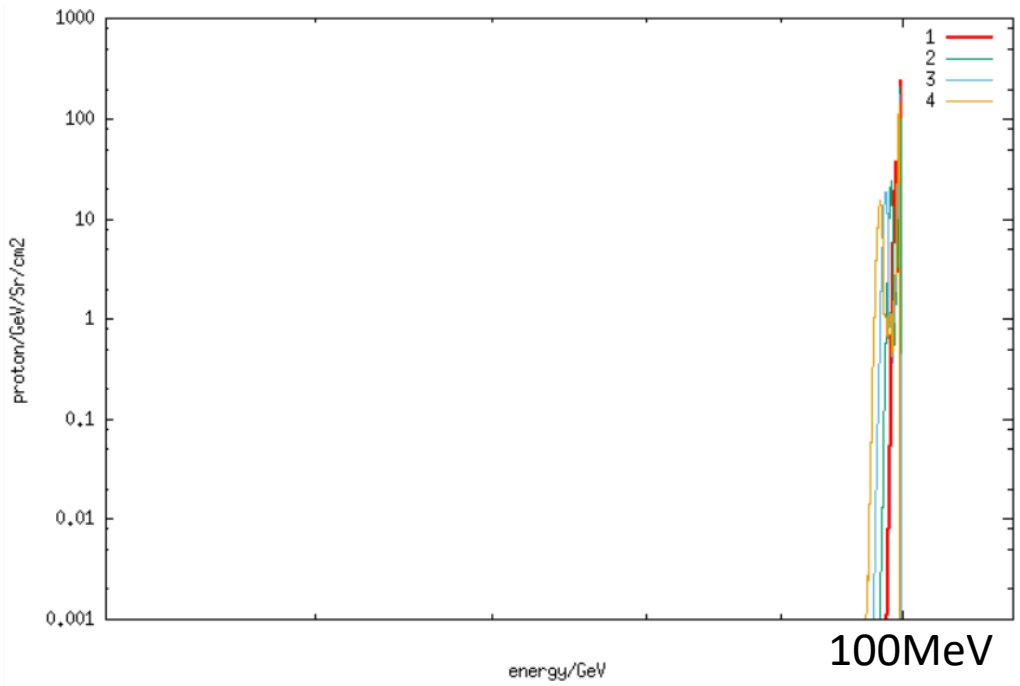
Issues:

- Temperature:
  - Now: Compressed air blowing can't lower the temperature to below 0℃
  - Plan: Replace compressed air with liquid nitrogen
- Uniform:
  - Beam uniformity: about 1%
  - Position uniformity is accordance with Gaussian distribution, but it is difficult to determine the specific fluences
- Irradiation attenuation
  - The proton energy and quantity of each layer may be different
  - We are doing simulation calculations



Simulation calculations:

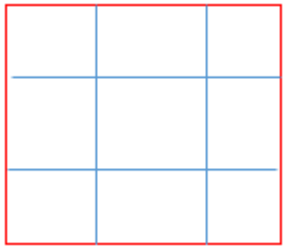
The first simulation result



100MeV

- Irradiation attenuation
  - Spectral distribution of proton beam
  - Less change in the number of protons per layer is ignored

- Irradiation Uniform
  - Divide the area within ±10mm of the beam center into 9 equal parts, simulate the number of protons and energy in each area
  - Actual situation may be different



Beam Size:
20mm×20mm

Plan:

- This week: Go to CIAE and try to replace air cooling with liquid nitrogen cooling
- Simulation: Irradiation attenuation and irradiation uniform
- Discuss with CIAE how to measure uniform accurately
- Plan to irradiate by June 21 or June 28

Thank you