100MeV Proton Irradiation in china institute of atomic energy

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Outline:

- Determine irradiation fluences and HPK sensors
- Discussion with Koji, head of CYRIC (80MeV proton irradiation)
- Current situation in CIAE
- Temperature debugging at the probe station

100MeV Proton Irradiation in china institute of atomic energy :

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

Gain changes a lot

New points

Lower goal

Contrast with CYRIC

These five irradiation points are the result of our discussions with Vagelis and Joern Lange and so on.

HPK sensors: （ discussion with Joern Lange ）

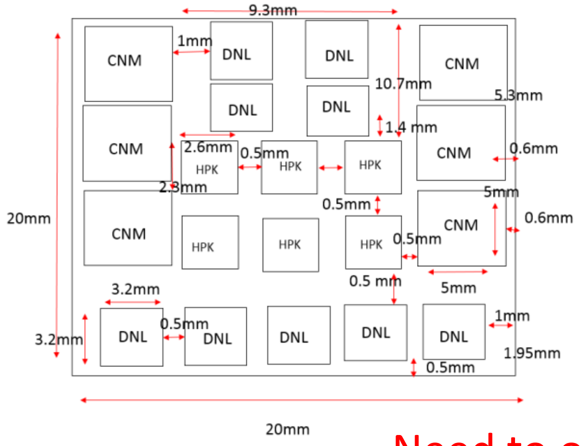
- His proposal：

  - 1x HPK-3.1 W8 Single pad LG1-SE5
  - 1x HPK-3.2 W18 Single pad LG1-SE5
  - 1x HPK-3.2 W18 Single pad LG1-SE3
  - 1x HPK-3.2 W11 Single pad LG1-SE5
  - 1x HPK-3.2 W18 LG2x2-SE5-IP5
  - 1x HPK-3.2 W18 LG2x2-SE3-IP5

- He would take W18 (without) since that's the one we have most experience with, plus another one (e.g. W11) with UBM to compare.
- 2x2 sensors are crucial to study aspects of arrays， in particular inter-pad gap and IV/power dissipation after irradiation.

CNM sensors：

They will decide by themselves. Size:5×5mm

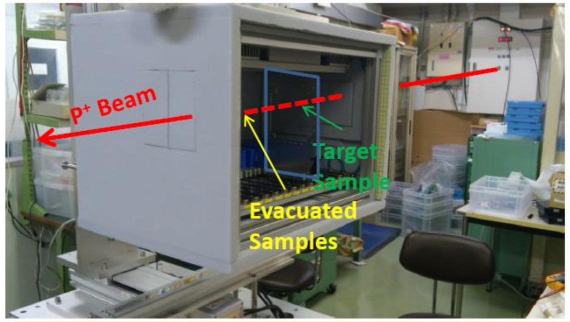


Need to optimize

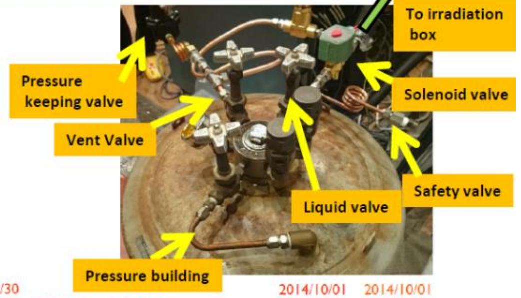
Result of discussion with Koji, head of CYRIC:

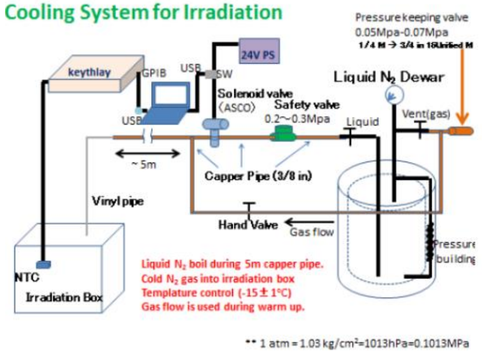
- ➢To make uniform irradiation they repeat 20 times scans over sample during one irradiation (to make un-uniformity less than 5%)
- ➢ Now, our uniform roughly is 70%
- ➢ Our temperature should be kept below zero to prevent annealing
- ➢ Now it can't reach below zero with air cooling.

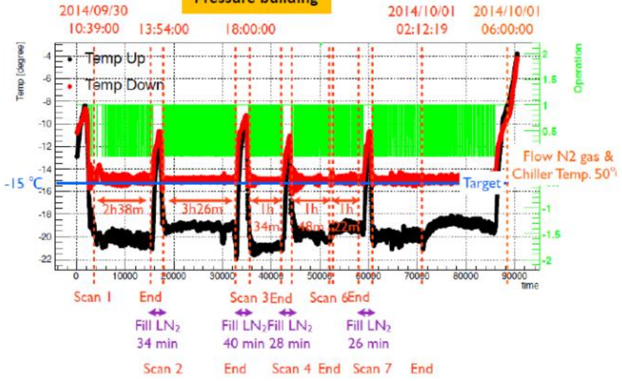
- CYRIC@Tohoku Univ. is a irradiation facility with 70MeV proton beam (~1μA)
  - This allows 2-3 pixel module with back Al plain at the same time(3% E loss/pixel)
  - Operated at -5℃ temprature with dry N_2 gas. ➔trying to make lower Temp.
- Programmable X-Y stage and "push-pull" mechanism are implemented to the machine.
  - choose one or a few target samples in max 15 pre-installed samples.
- Scanning over full pixel range during irradiation.



- New challenge at Oct 2014 irradiation :
  - Used N_2 Dewar with thermal feedback system.
  - Could control temperature at -15±0.5°C
  - Keep the temp for ~5h w/o re-fill of Liquid N_2

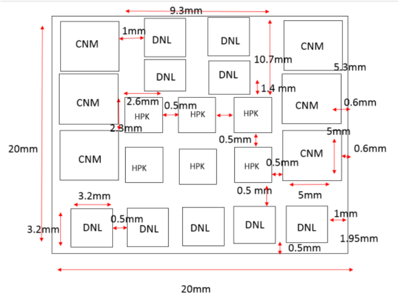






Current situation in CIAE:

- Temperature:
  - Now: compressed air blowing can't lower the temperature to below zero
  - Plan: replace compressed air with liquid nitrogen
- Uniform:
  - Beam uniformity: about 1%-10%
  - Position uniformity is accordance with Gaussian distribution, but it is difficult to determine the specific fluences.
  - CIAE is calculating the value.



Correction Irradiation fluences:

Before use 0.71

1.276 is conversion of proton dose into neutron dose factor

50nA

Irradiation dose= $\frac{beam\_current \cdot time}{e \cdot beam\_area} = 3 \times 10^{15}/1.276$

1.6×10^{-19}C $2\times2\ cm^2$

protons.xls

for actual use of this tabulation, please refer to:
A. Vasilescu and G. Lindstroem
Displacement damage in Silicon
on-line compilation: http://sesam.desy.de/~gunnar/Si-dfuncs

proton induced displacement damage in silicon
-most reliable data, listed for kinetic energies between 1 keV and 9 GeV-
G.P. Summers et al., IEEE NS 40 (1993) 1372
M. Huhtinen and P.A. Aarnio; NIM A 335 (1993) 580 and priv. comm.*)
*) tabulation see also: A. Ferrari (ATLAS TDR '97), priv. comm. 1997

Summers

Ekin [MeV]	D/(95MeVmb)
3,000E+01	2,346E+00
5,000E+01	1,907E+00
7,000E+01	1,552E+00
1,000E+02	1,276E+00
2,000E+02	9,525E-01

Time=8.4h (before 30h)

- NIEL: Conversion factor for particle irradiation damage.

https://rd50.web.cern.ch/rd50/NIEL/default.html

Temperature debugging at the probe station in the sensor test:

Target temperature: -30°C for irradiation sensors test

- Liquid nitrogen cooling (this can reach -30 °C)
  - Liquid nitrogen tank is too small. It can only be used 1-2 times.
  - Unstable, I tried twice this week, and did not reach -30°C, only can reach 0. The main reason is the lack of liquid nitrogen.
- Water cooling
  - Stable, may take longer to cool down
  - Our laboratory water cooler can only reach -20°C
  - Solution: Buy a new water cooler which can reach -40°C

Device	Price
RH40-12A	28425 RMB
RH40-25A	37125 RMB

Water cooler

Plan

- Plan to irradiate on June 17 or June 24
- Replace liquid nitrogen cooling with water cooling
- May need to buy a new water cooler (-40°C)

Thank you