VCSEL Radiation Results with 20 MeV neutrons

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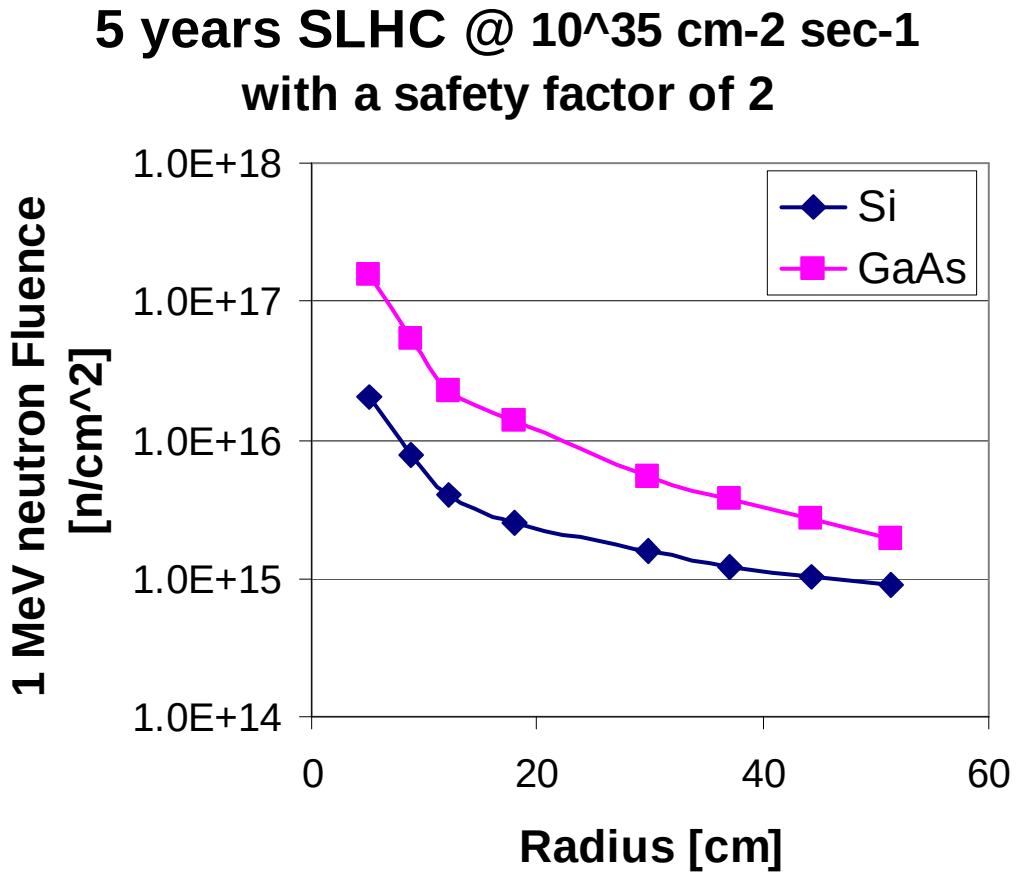
Optoelectronic Working Group Meeting

5 year SLHC fluences in 1MeV neutrons

Challenging radiation environment!!

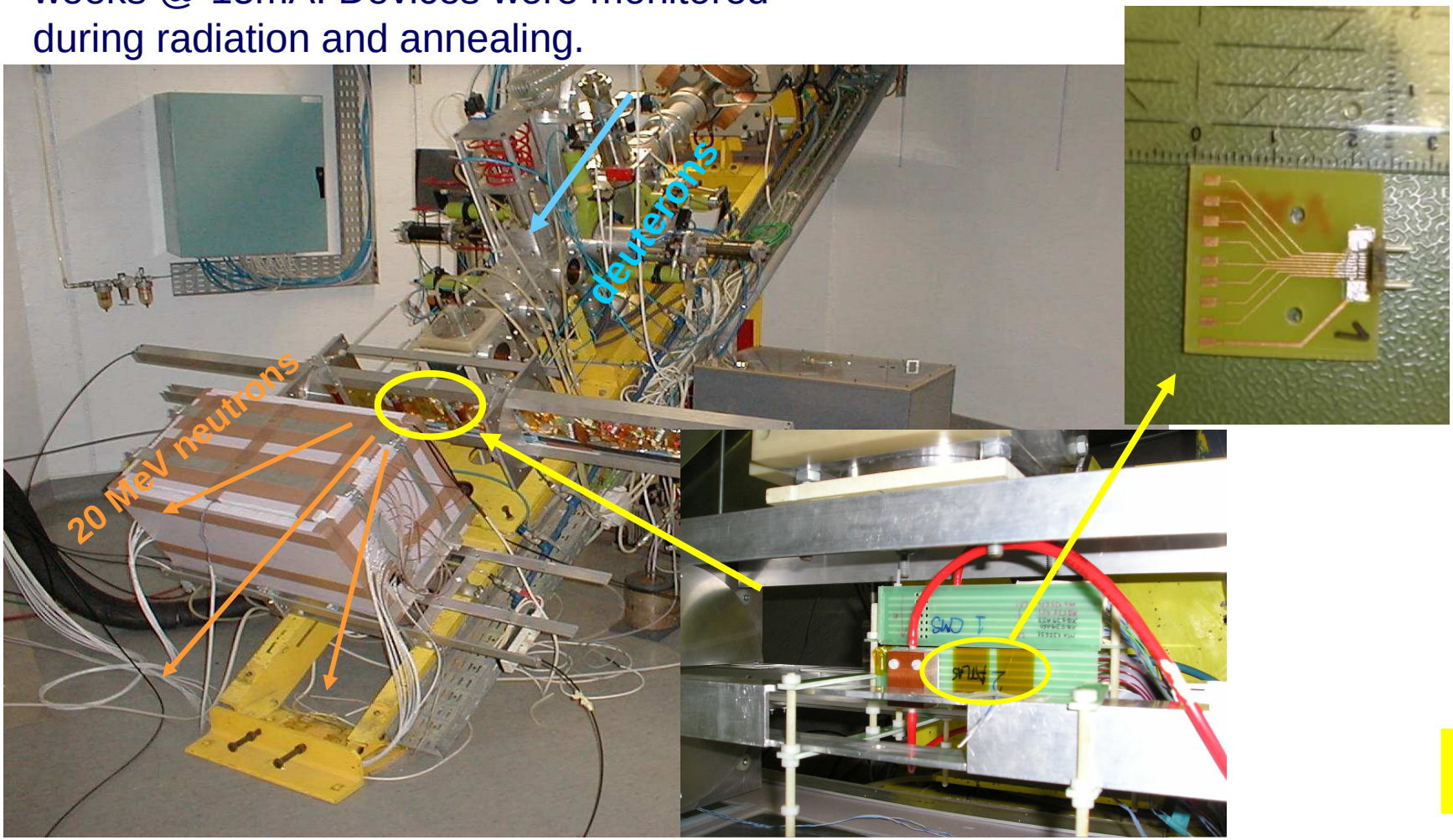


Estimation based on IM. Gregor, Optical Links for ATLAS Pixel Detector, Thesis, WUB DIS 2001 - 03, 2001, Wuppertal

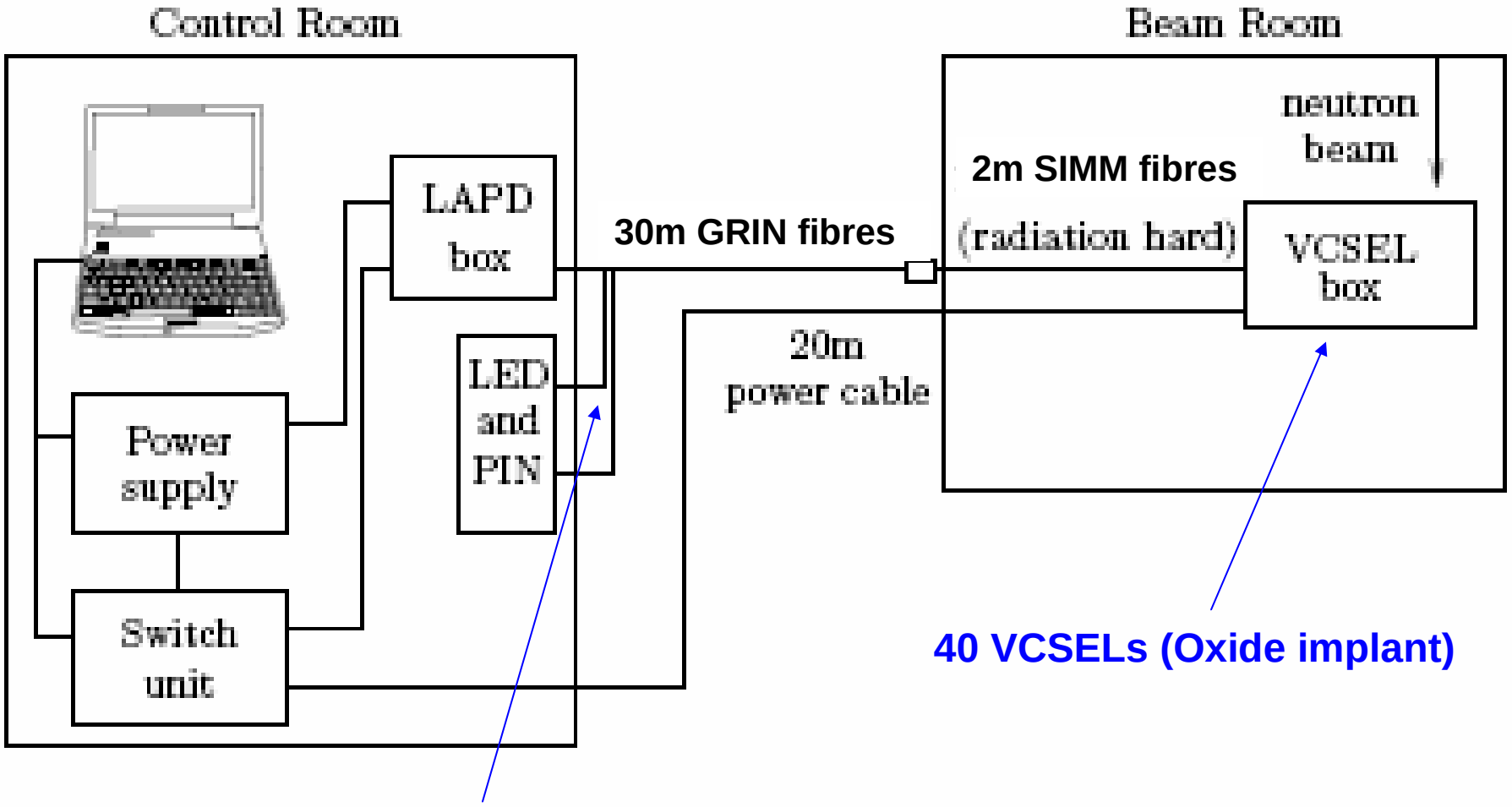
Cyclotron at UCL in Belgium – 20 MeV Neutrons

1st test in collaboration with CMS March 06:
Great success!!

VCSELs irradiated up to ~10^{16} n(1MeV/cm^2) and annealed for 2 weeks @ 10mA and 1.5 weeks @ 15mA. Devices were monitored during radiation and annealing.

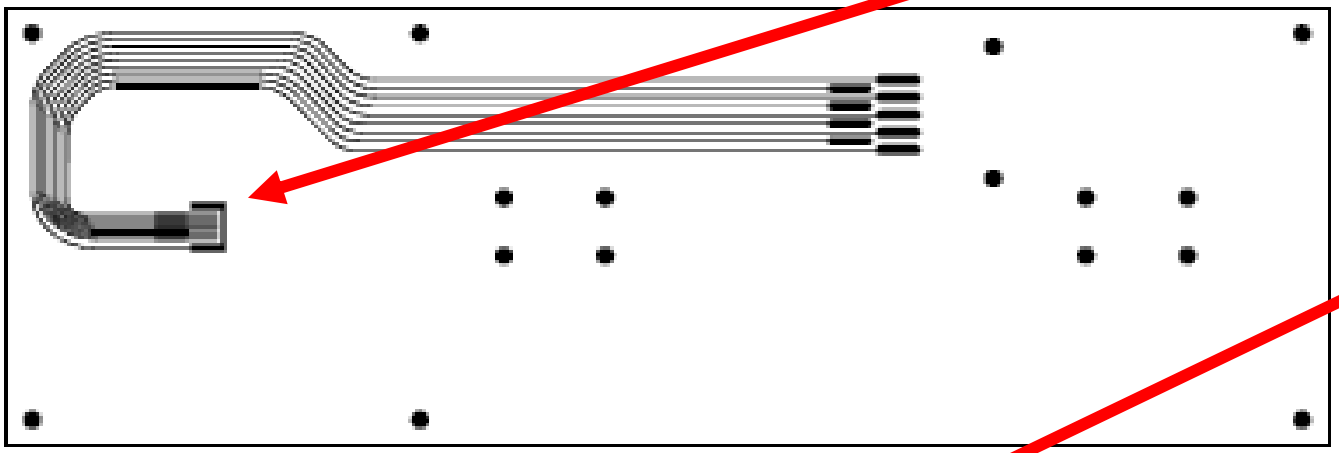


Experimental Setup



Experimental setup

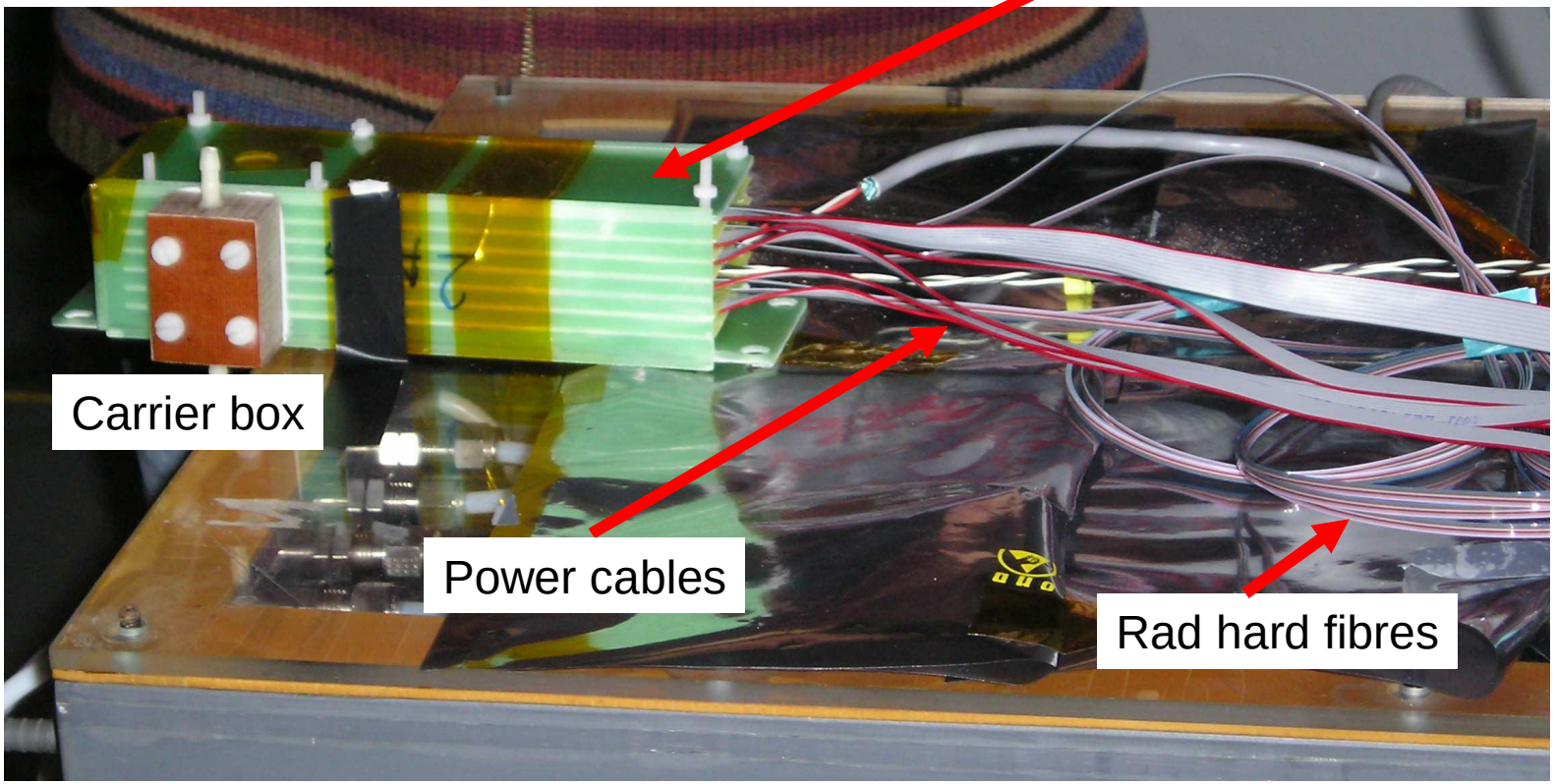
Array with 8 VCSELs



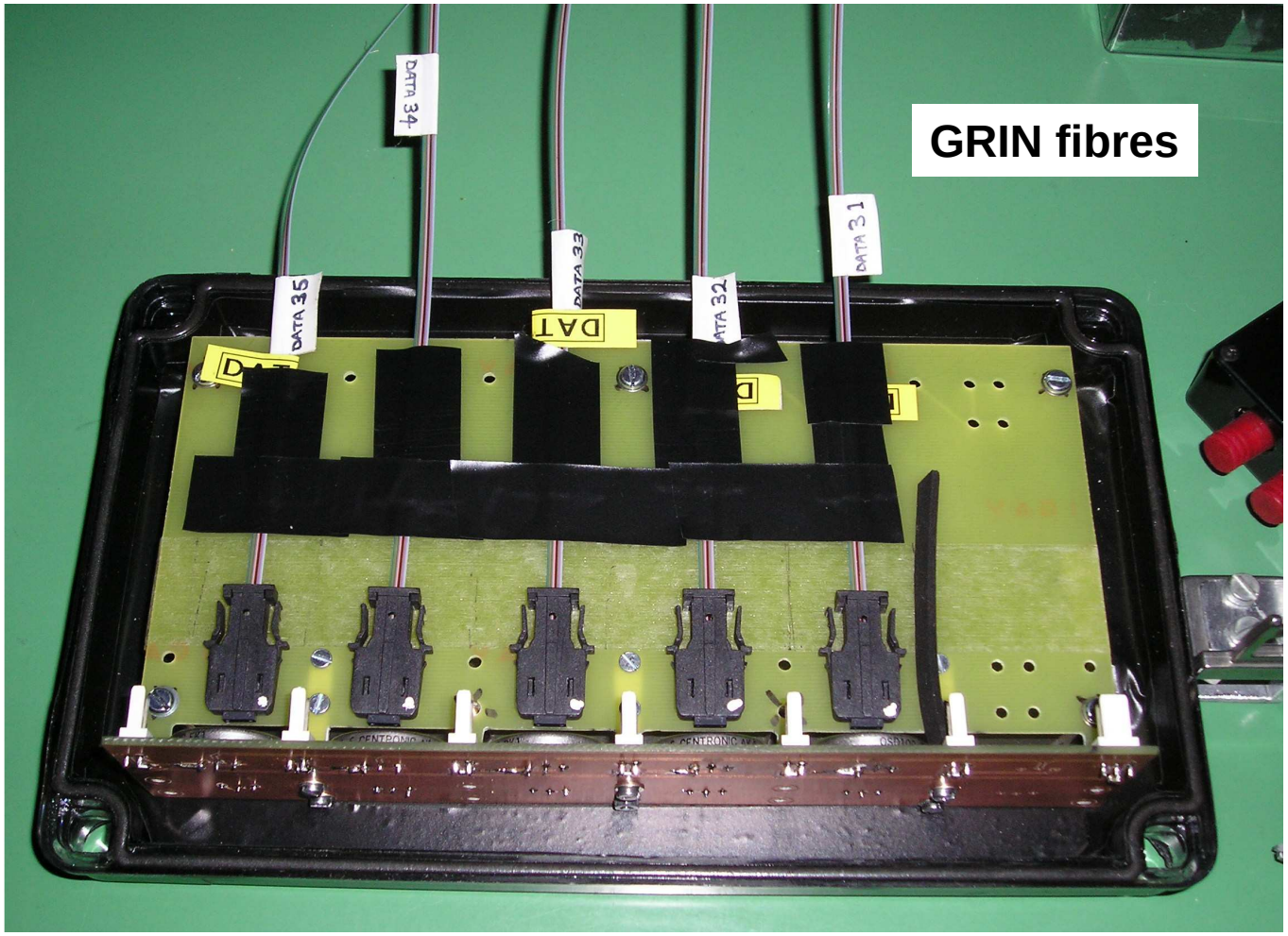
5 of these boards

Boards put into carrier box

Box was kept at constant T



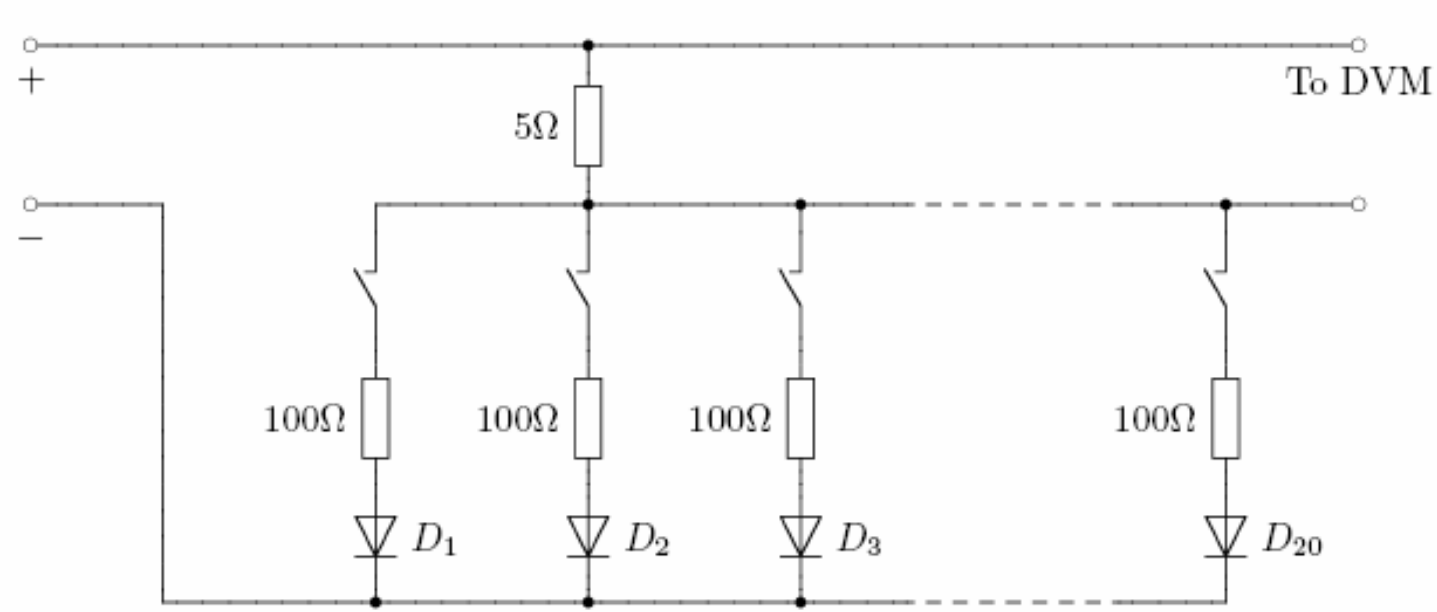
Experimetal Setup LAPD Box (open)



Not shown in picture: Each LAPD was separated by light tight walls from each other.

Experimental Setup

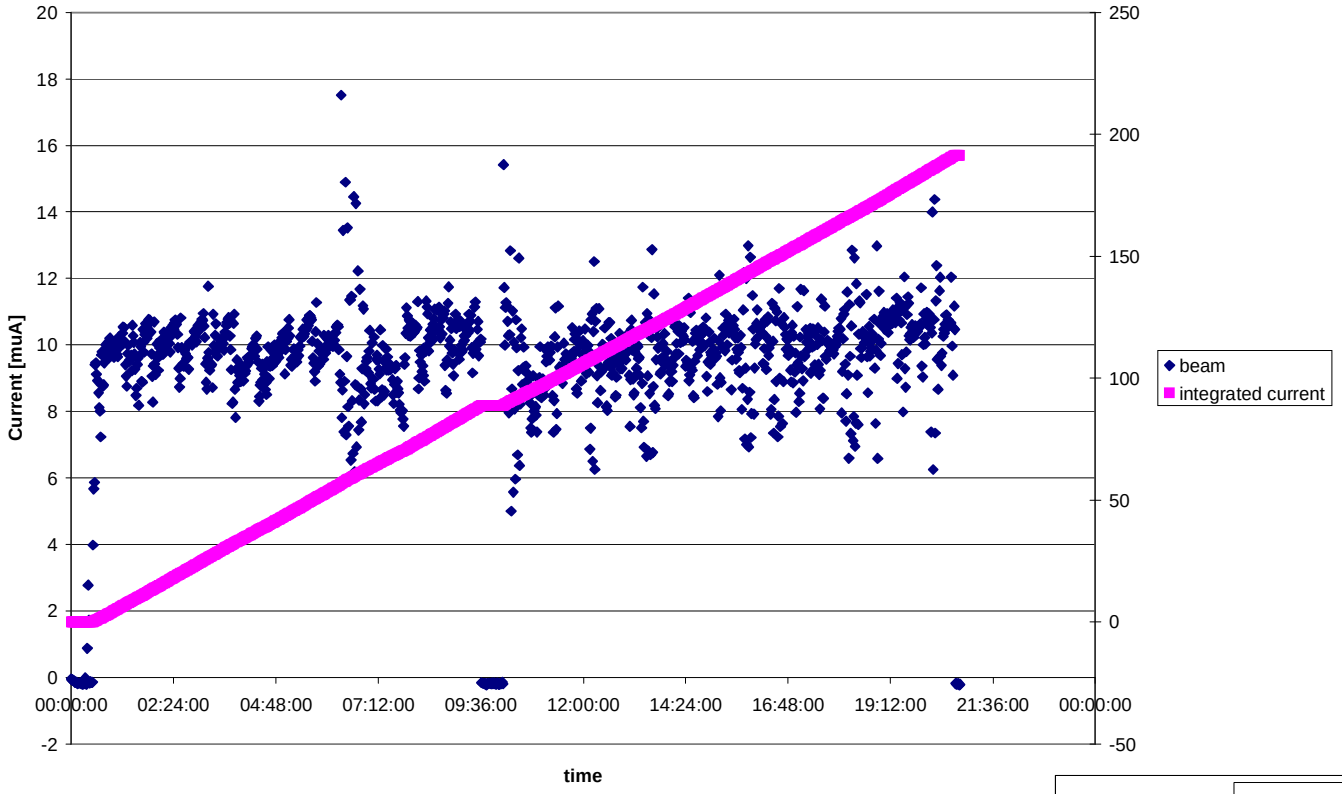
Circuit of switch unit



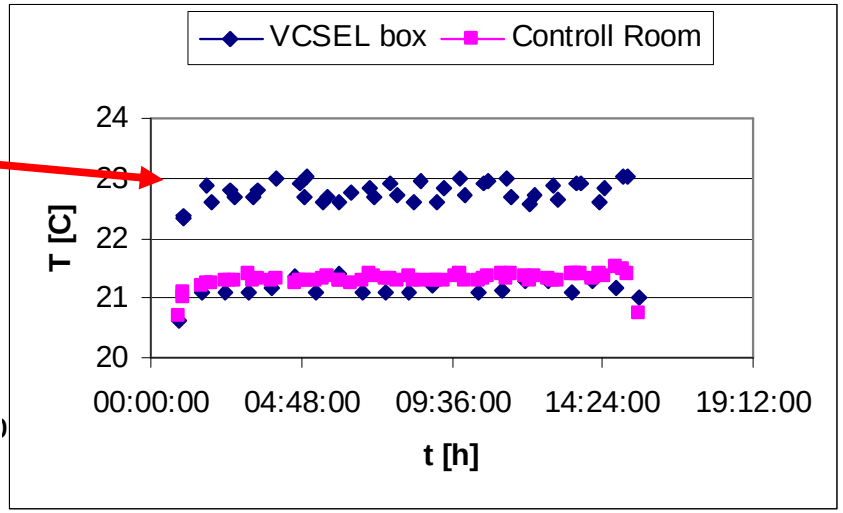
Had 2 switch units

- 30 VCSELs were biased in parallel during radiation.
- 10 VCSELs were not biased during radiation.
- After 20min biasing L-I-V of each VCSEL was taken.
- T was monitored and was kept at constant level.

Beam Stability and Temperature



Biasing VCSELs



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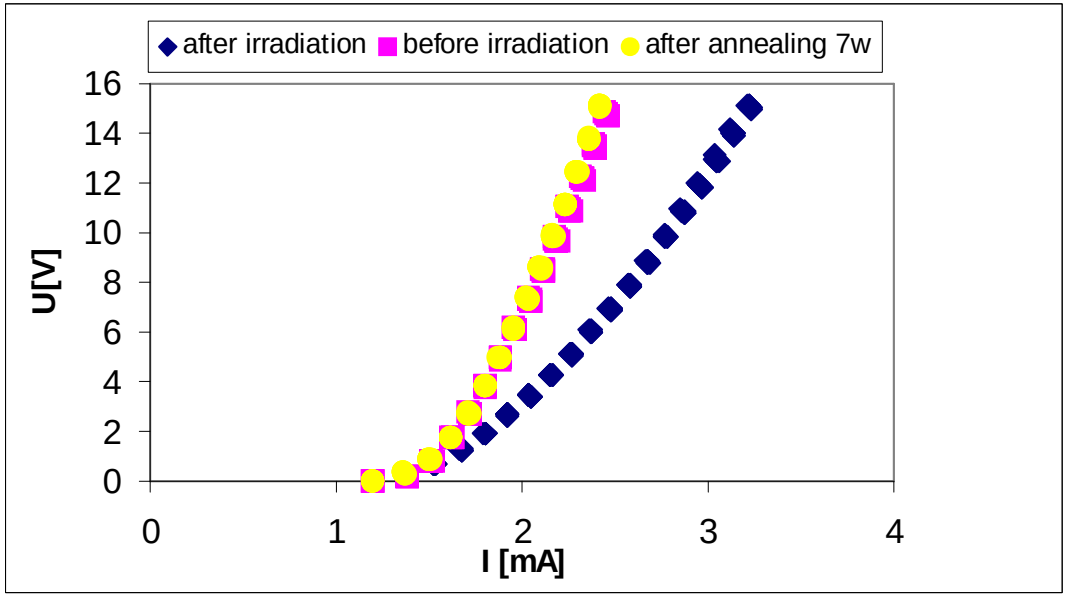
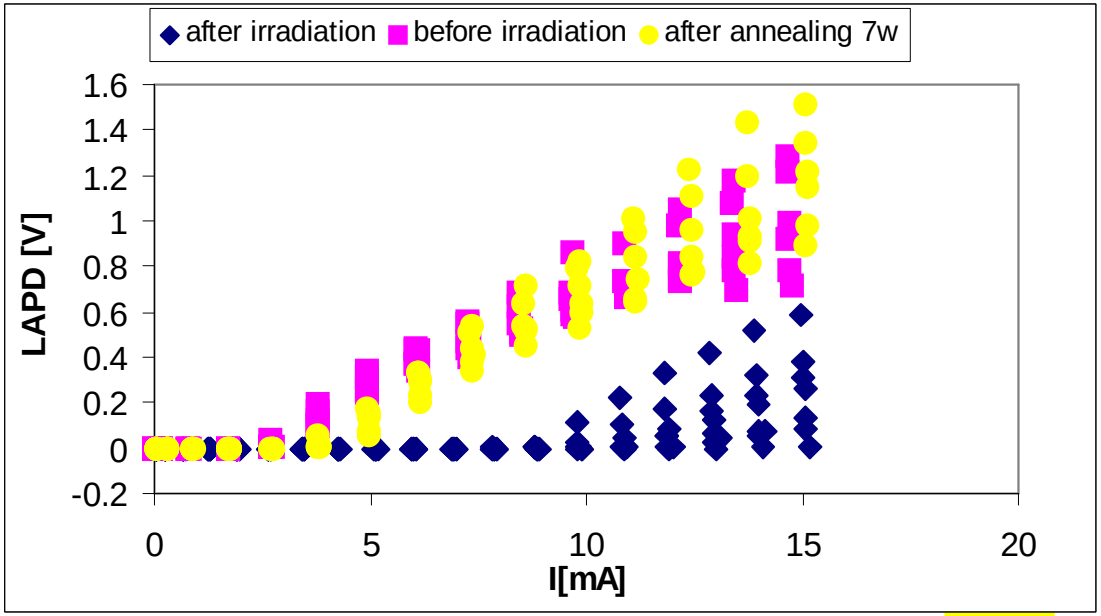
Absolute T has an offset of ca. 4 C

IV and LI Curves for VCSEL array @ $8x10^{15}$ n/cm^2



Annealed for 2 weeks @ 10mA
and 1.5 weeks @ 15mA



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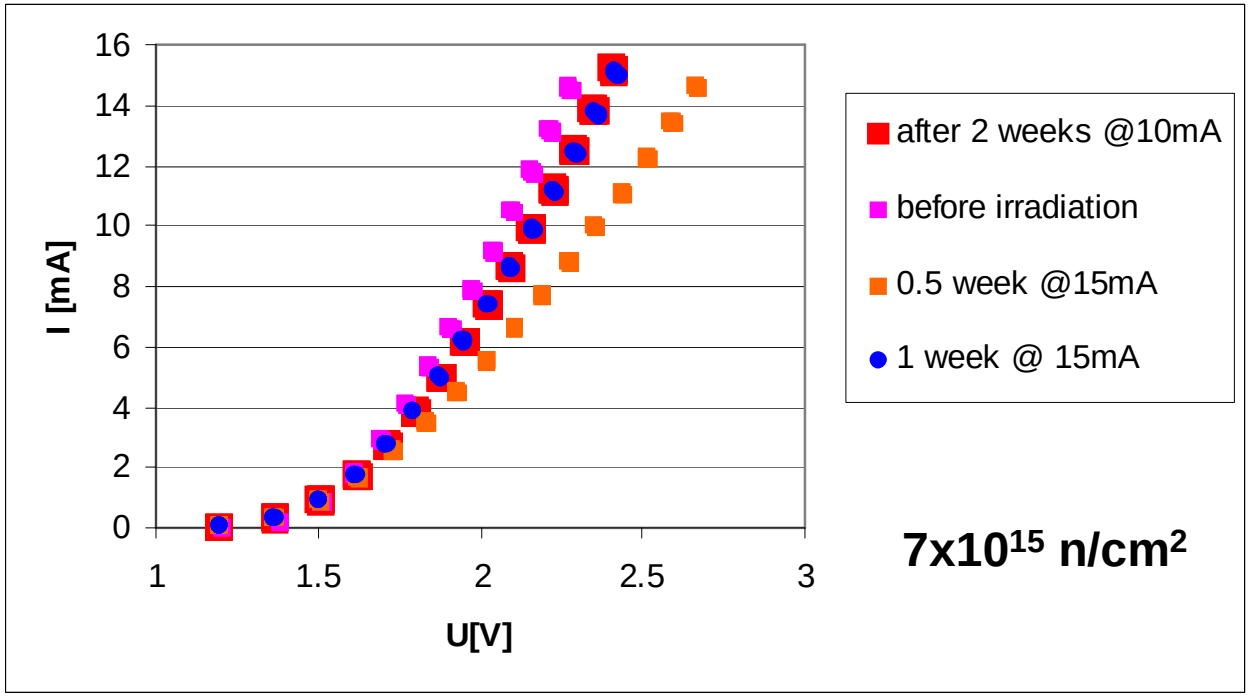
IV Curve developments during annealing

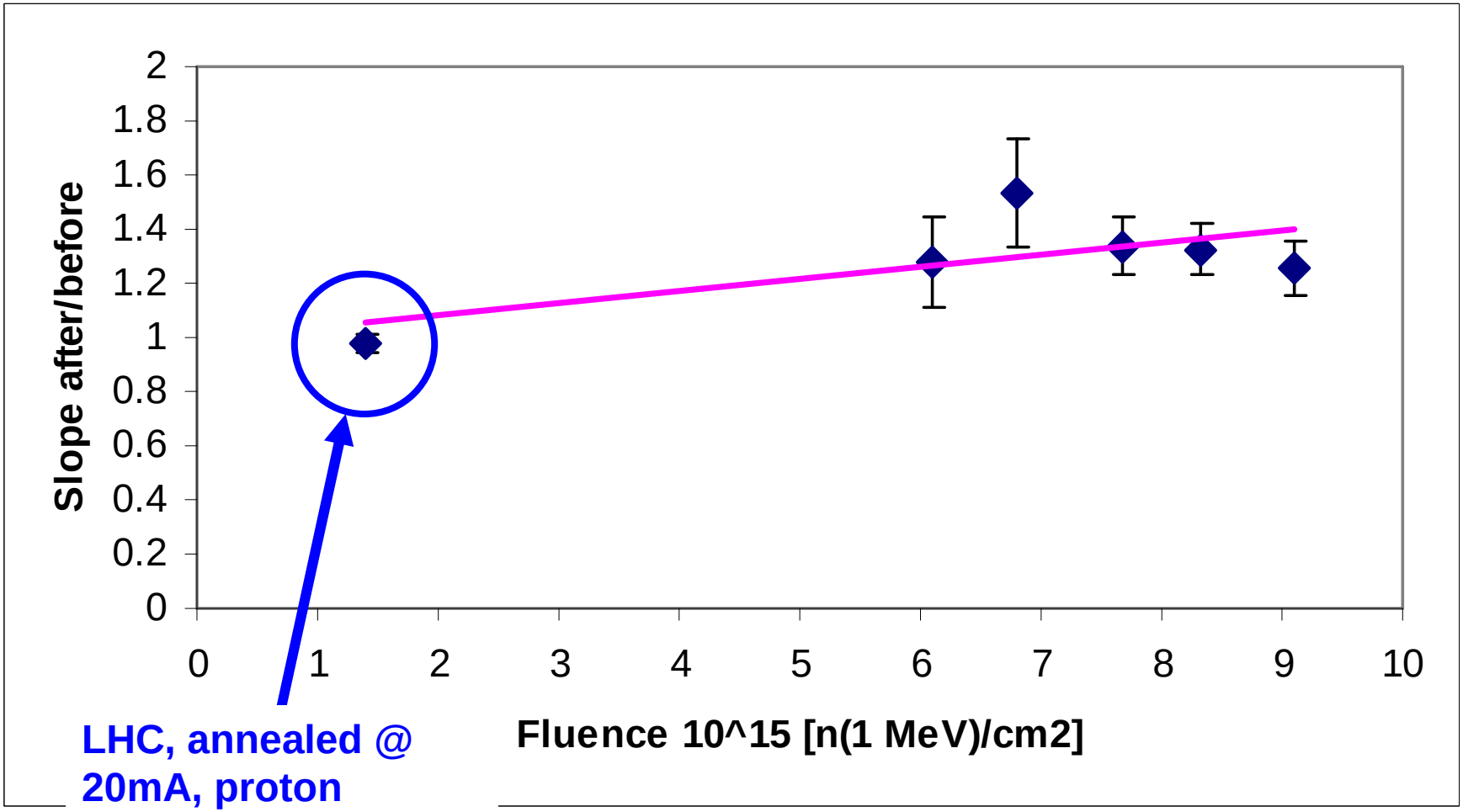
Following is observed during annealing for 3 VCSEL arrays:

- **Slope resistance increases and decreases.**
- **Light output is improving with annealing constantly.**



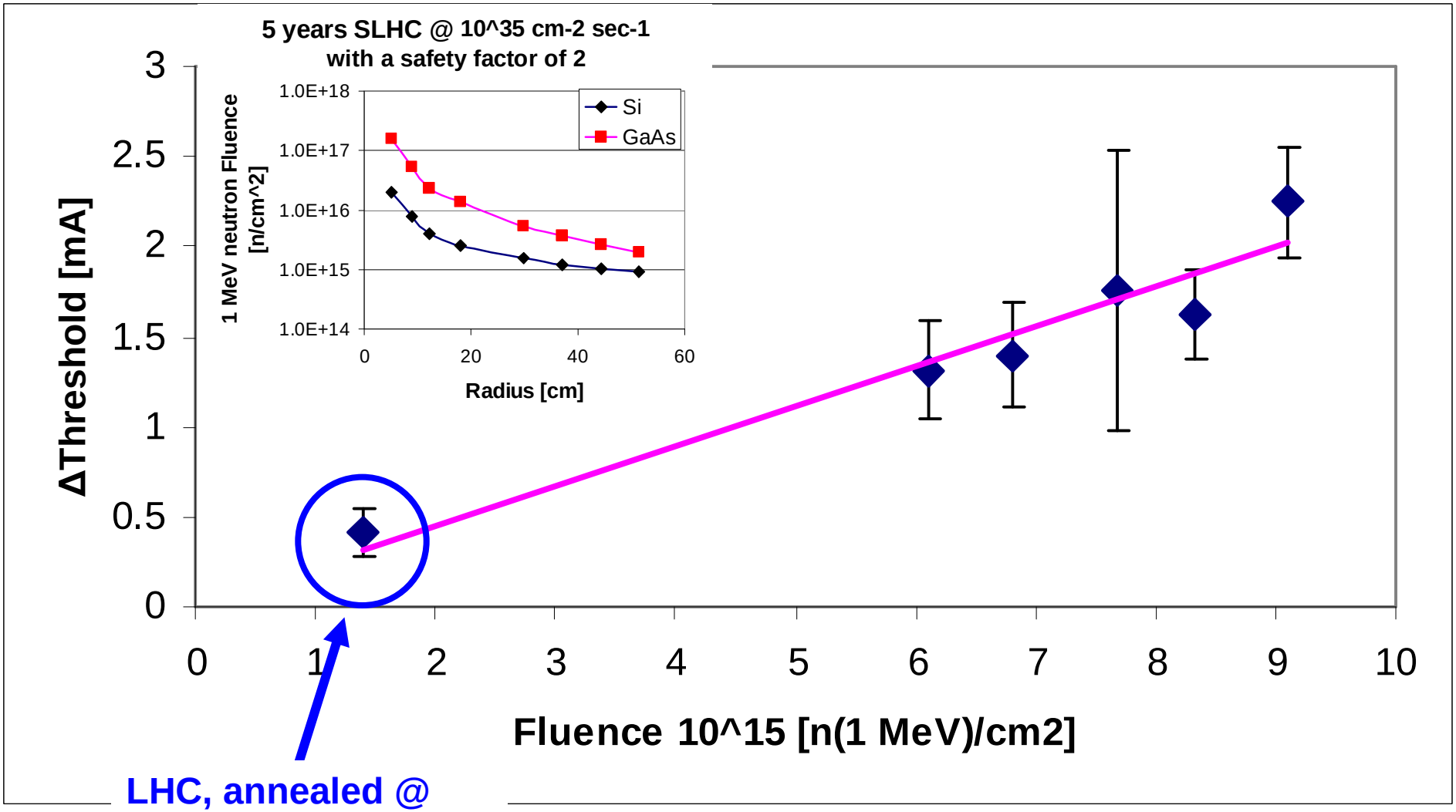
Results – Slope Efficiency After/Before

2 weeks @ 10mA annealed and 1.5 weeks @ 15mA annealed



Results – Threshold Shift (After-Before)

2 weeks @ 10mA annealed and 1.5 weeks @ 15mA annealed



Summary

- First test in collaboration with CMS Great success.
- Irradiated 40 VCSELs up to $9x10^{15}$ 1MeV n/cm^2 with 20MeV neutrons at UCL in Belgium.
- Monitored VCSEL performance during radiation and annealing.
- Stable environmental conditions.
- VCSELs are all back after annealing at 10mA and 15mA.
- No fatal failures observed.
- Thresholds increases as function of fluence.
- More to analyze and future tests are planned to increase statistics and fluence.
- We will continue to anneal.

Future Tests

- Irradiate more VCSELs at UCL to higher fluences
- Irradiate Si p-i-n arrays at UCL
- Fibre irradiations