

Options for Optical Links at SLHC

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with input from ATLAS and CMS colleagues

- Margins of existing ATLAS and CMS TK OL
- Options for OL upgrades
- Some proposals
- The joint optoelectronics working group
- Conclusion



Optical Links for the ATLAS and CMS Trackers

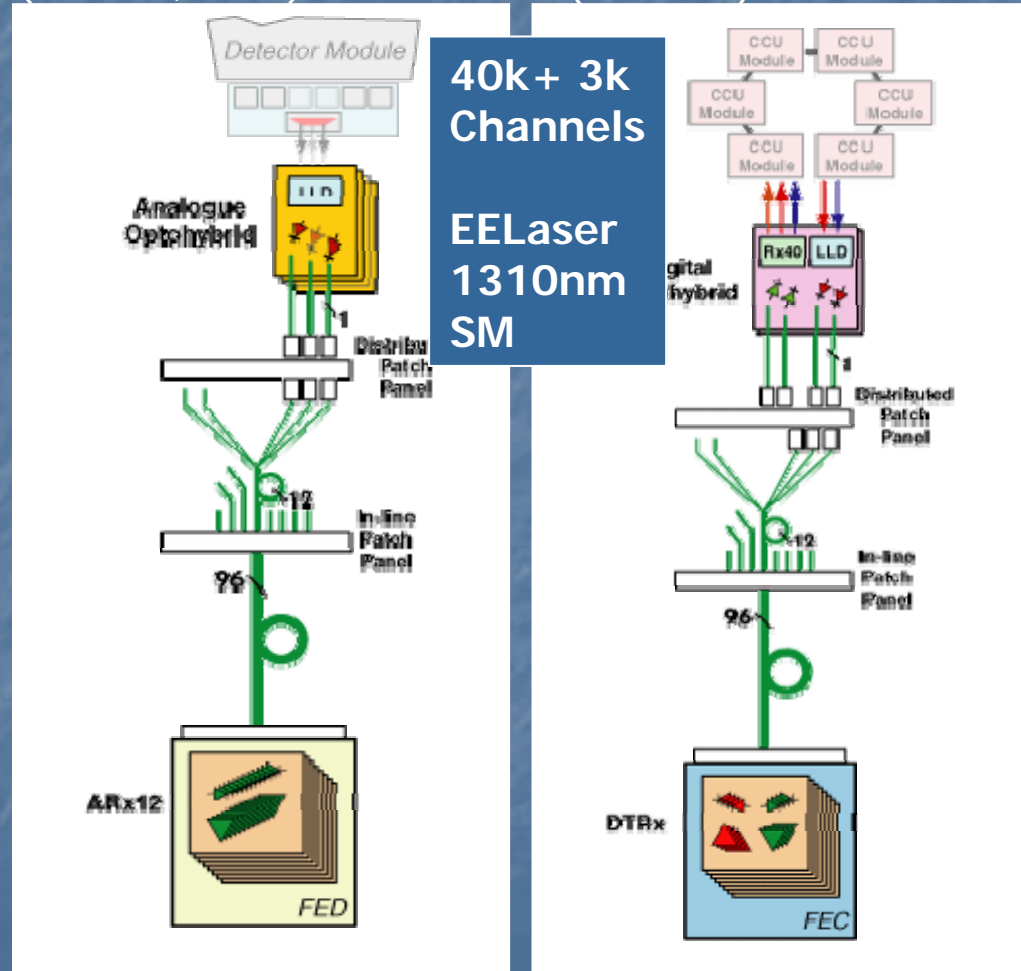
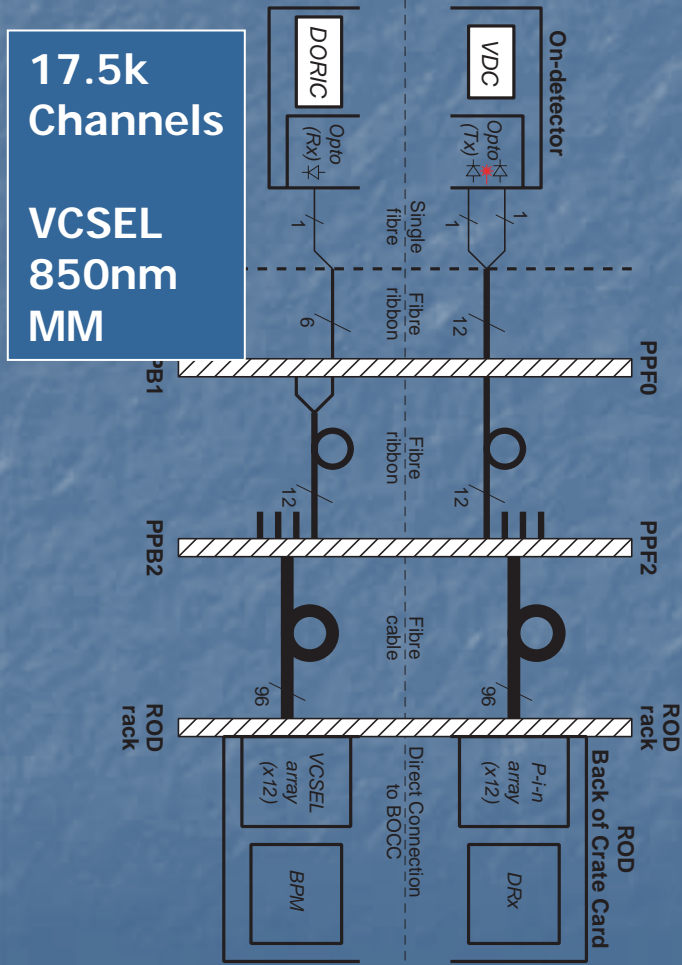
ATLAS

CMS

Digital links
(40/80Mb/s)

Analogue readout links
(40MS/s, 8bits)

Digital control links
(80 Mb/s)

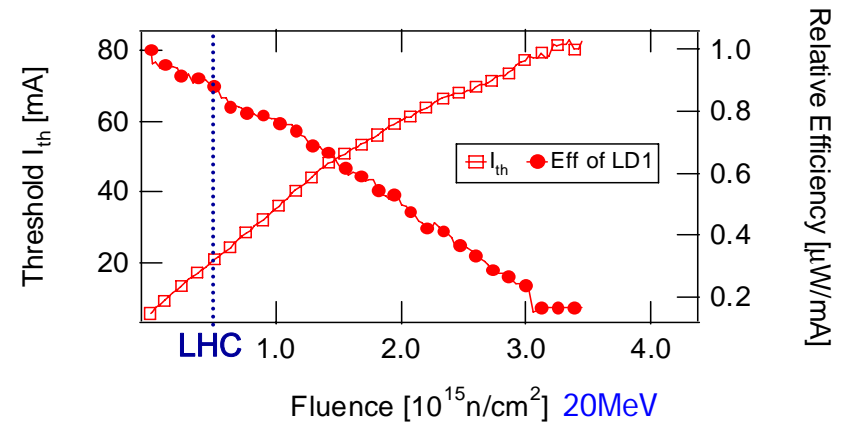
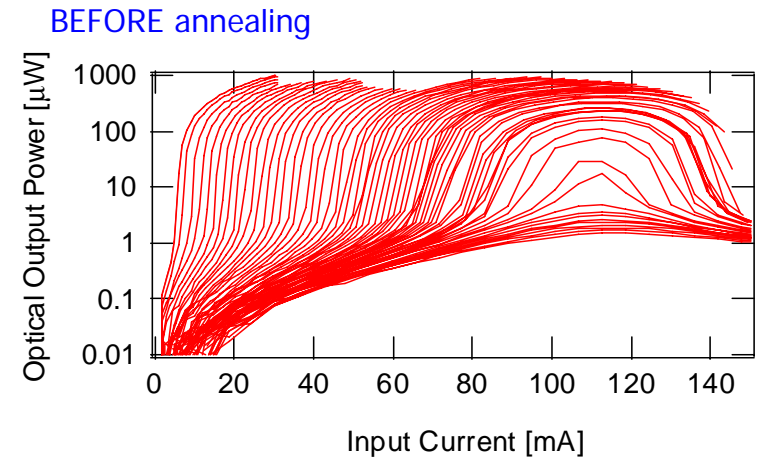
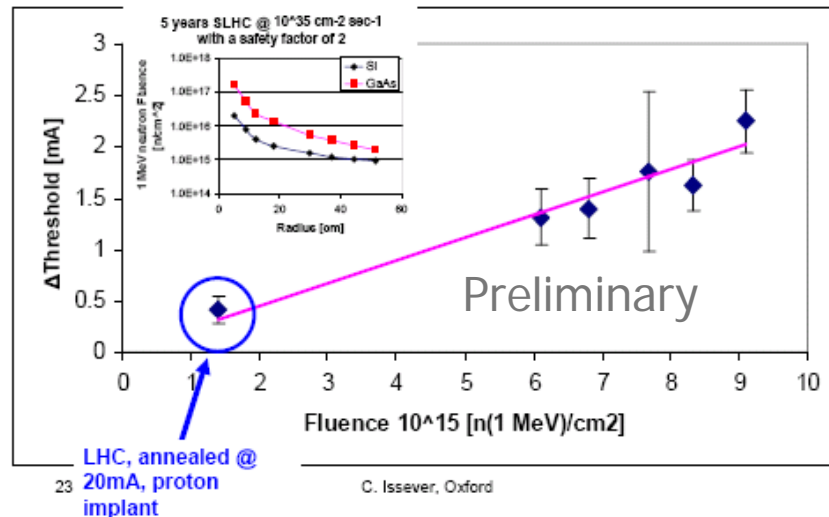


The Optical Link Margins (1: Tx)

- Tx Radiation Hardness
 - Operating point shifts
 - Thermal management becomes crucial
 - Thermal resistance
 - Annealing
 - Compliance voltage

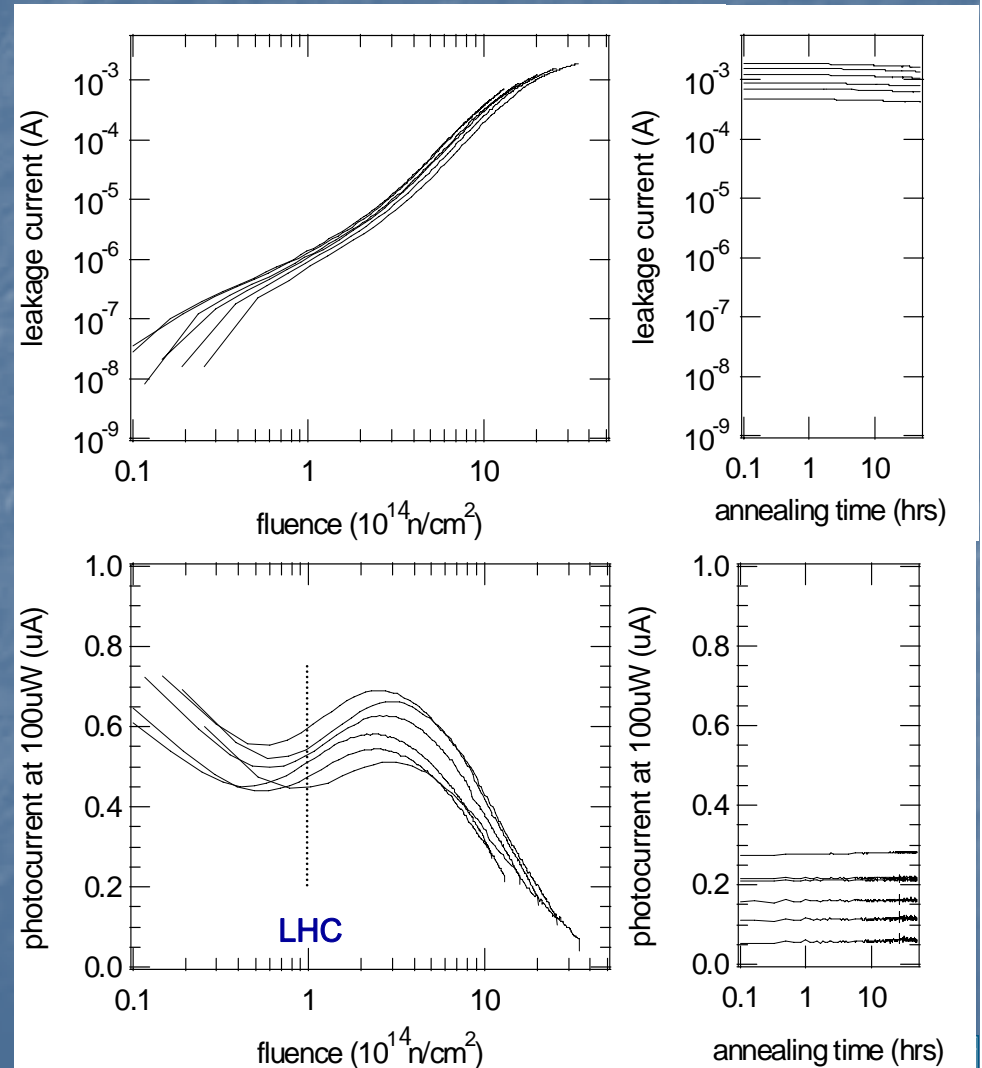
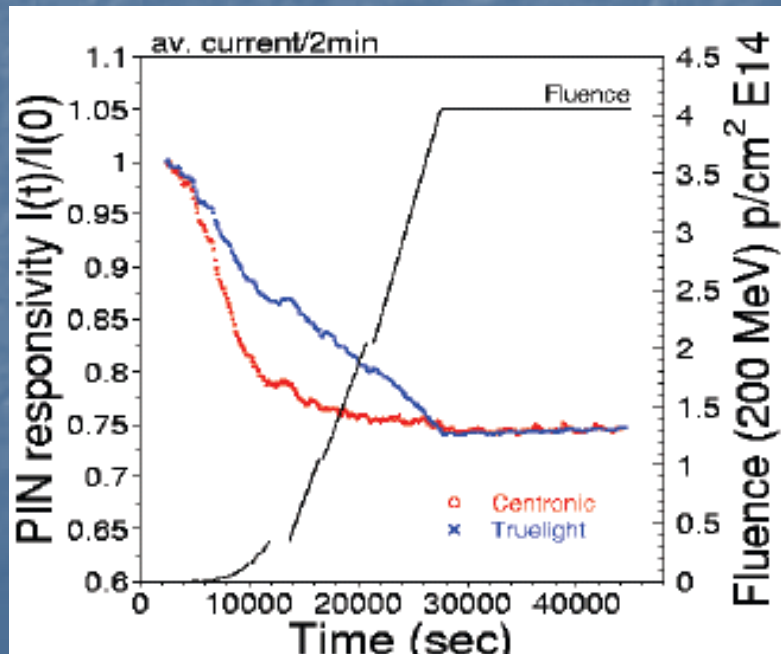
Results – Threshold Shift (After-Before)

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



The Optical Link Margins (2: Rx total)

- Rx Radiation Hardness
 - Leakage current damage definitely appears to be 'saturating'
 - Responsivity going to zero
 - No significant annealing
 - Ultimate limit reached



Optical Link Margins (3: Rx SEE)

- Rx SEE cross-section
 - Bit rate dependent
 - Incidence-angle dependent

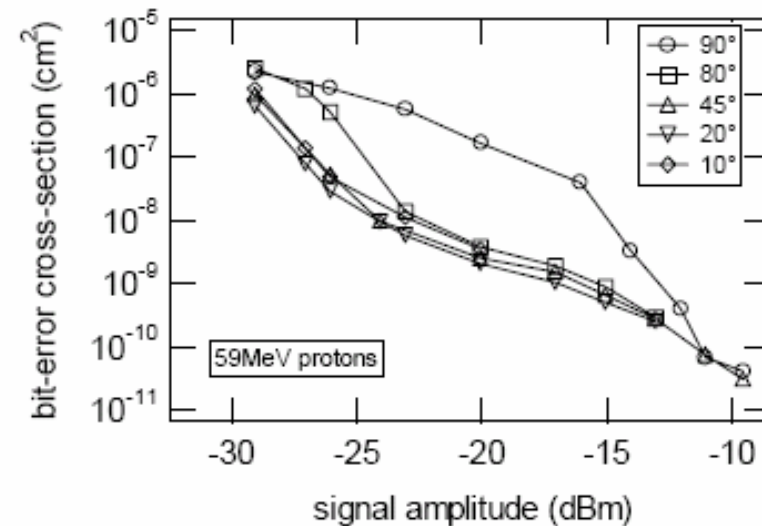
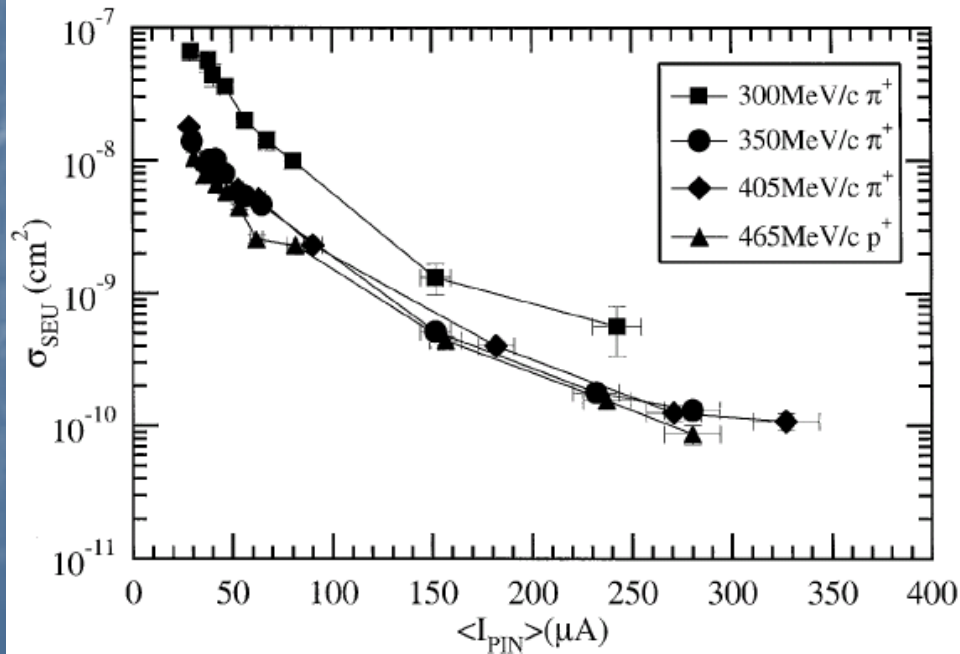
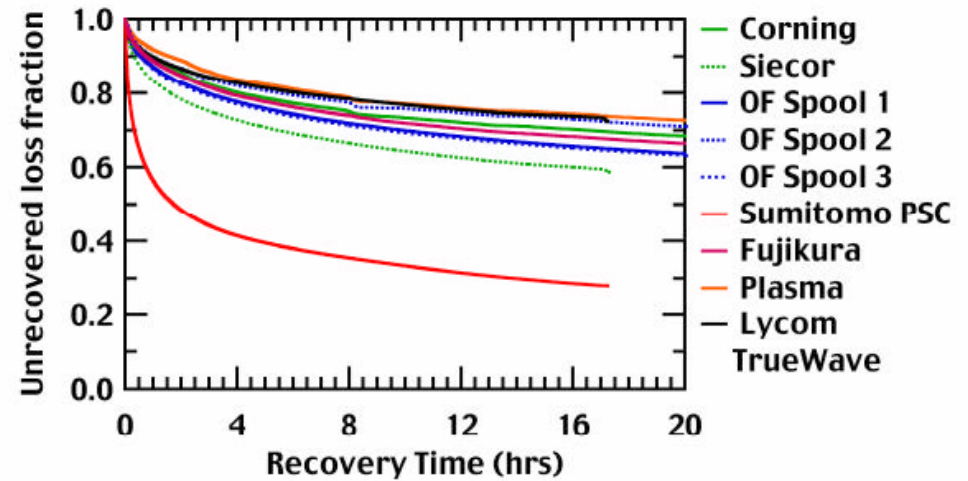
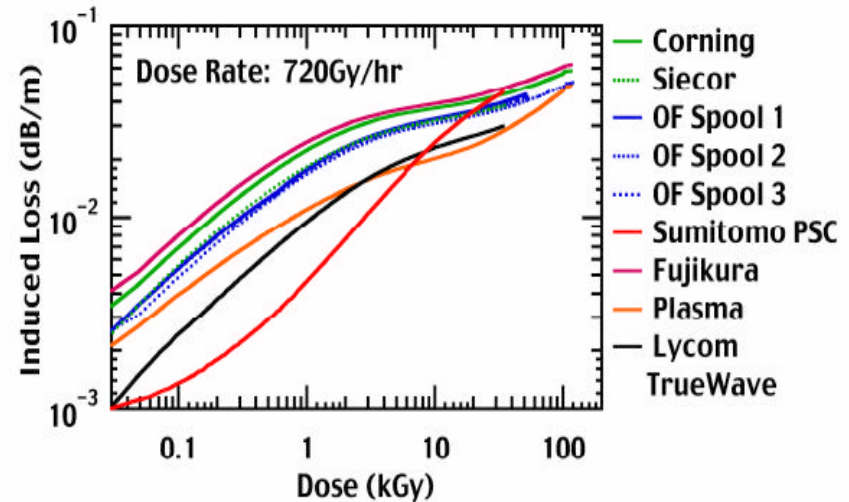
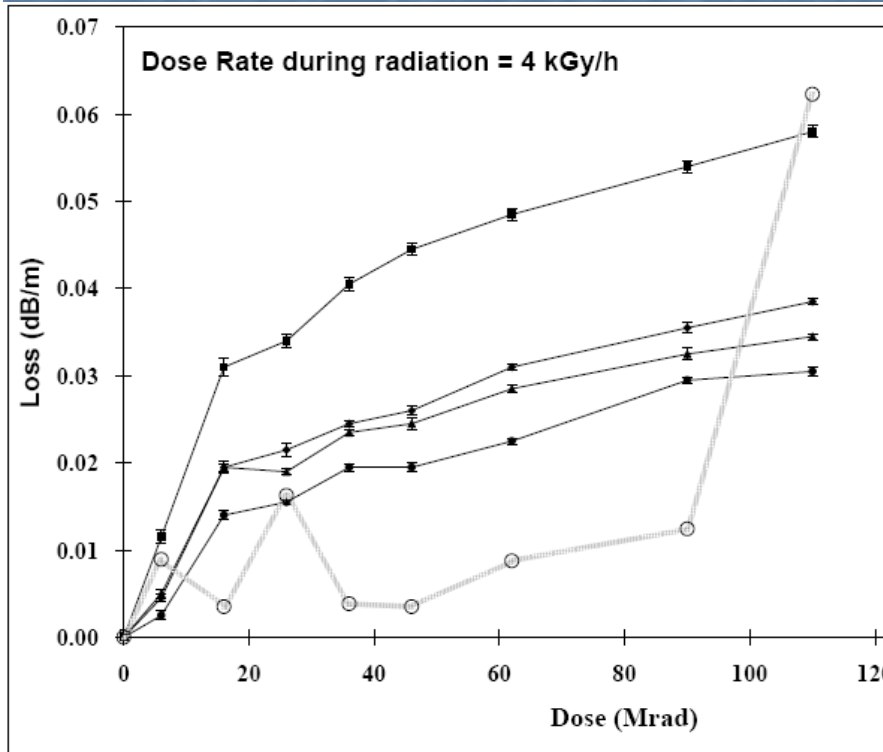


Figure 5: Cross-section measured with 59MeV protons for various incident angles.

Optical Link Margins (4: fiber)

■ Fiber Radiation Hardness

- (0.05-0.1dB/m)
- To be reconfirmed



Optical Link Margins (5: link)

■ Fiber Capacity

- ATLAS SIMM: 50-80 MHz·km
- ATLAS GRIN: 1000 MHz·km
- CMS SISIM: >>10GHz·km

■ Electronics

- Binary 40/80MBps
- Analogue 100MHz
- Digital 80MBps

■ Geometry

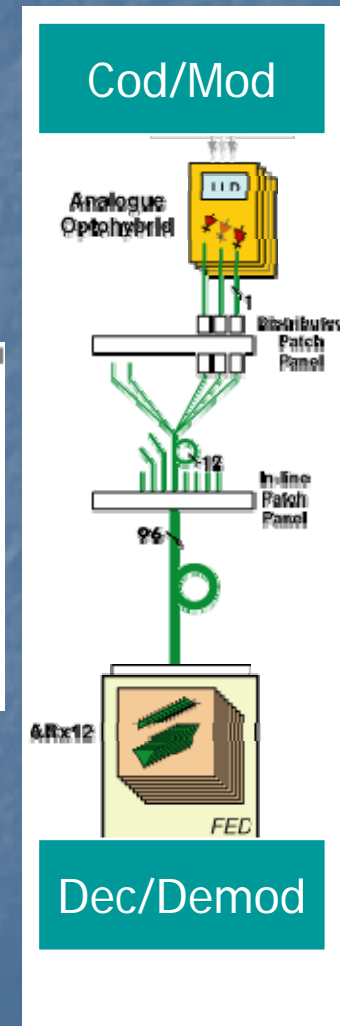
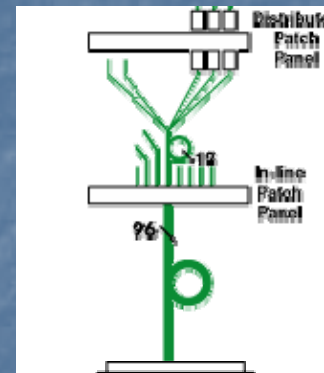
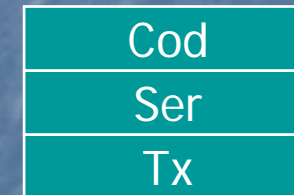
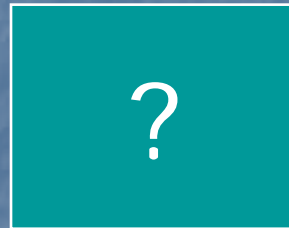
- 18cm from beam axis
- 20cm from beam axis

Margins for operation at SLHC (6: summary)

- Tx and Rx need careful study
 - Are we reaching the limit?
 - Rx SEE sensitivity to be mitigated
- Fiber
 - Radiation tolerance probably OK
 - Capacity increase OK in SM, NOT OK in SIMM, OK in GRIN
- Electronics
 - Generalized Bottleneck
- Geometry
 - Possibility to move away from beam axis to gain margin against radiation damage
- Good overall agreement between ATLAS and CMS observations

The Options for an Upgrade (1)

- Reuse the existing system
 - Check margins carefully
 - Boost analog link capacity by developing CODEC and MODEM
 - See paper by S. Dris
- Reuse the fiber plant only
 - Develop TRx, SERDES and CODEC
 - See paper by P. Moreira
 - Check compatibility and margins of legacy fiber and connectors
- Start from scratch
 - Possibly using components identical to existing ones
- A combination of the above
 - Geometry dependent system implementation

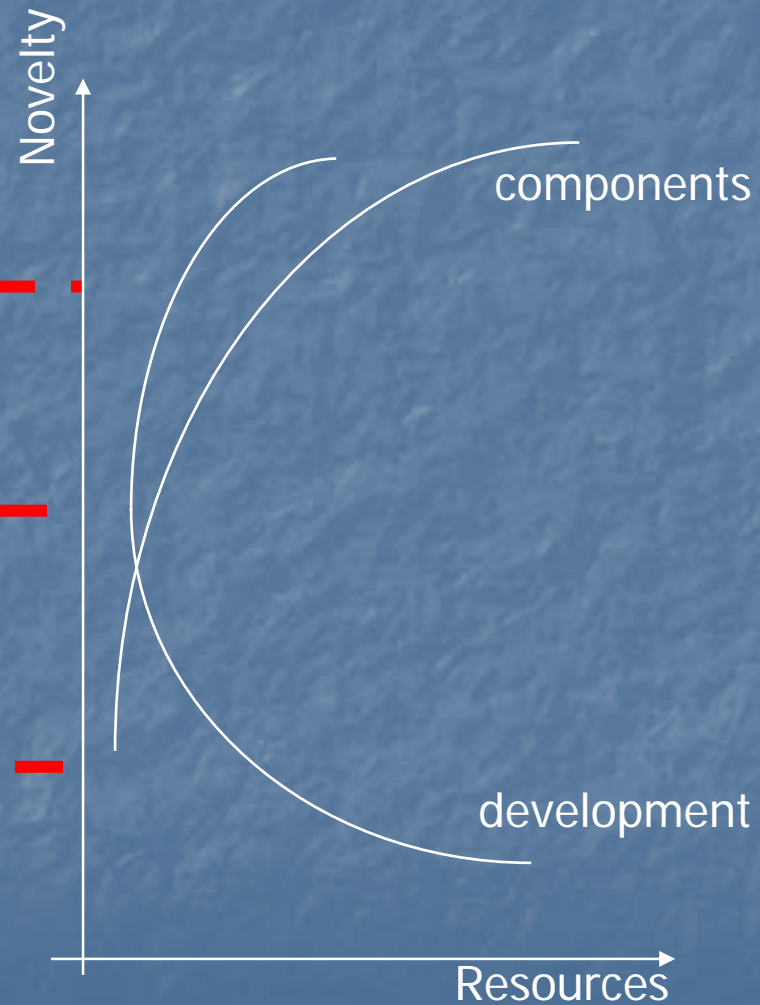


The Options for an Upgrade (2)

- Start from scratch

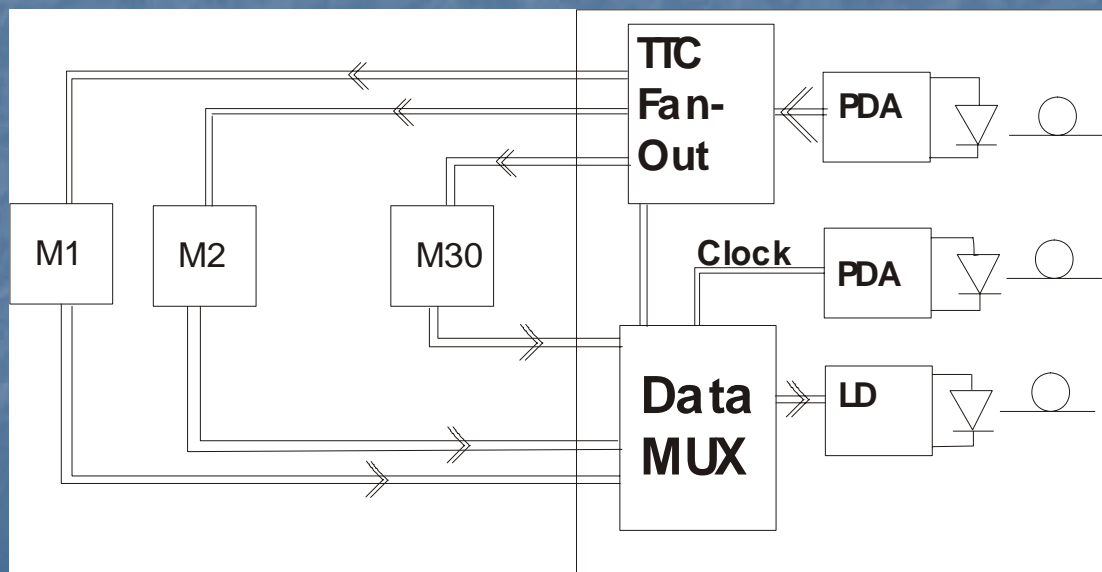
- Reuse the fiber plant only

- Reuse the existing system



Proposal 1: The ATLAS SCT Straw-Link

- (T. Weidberg, Oxford, Oct 05)
 - 2500 links
 - 2.5Gbps
 - Start from scratch

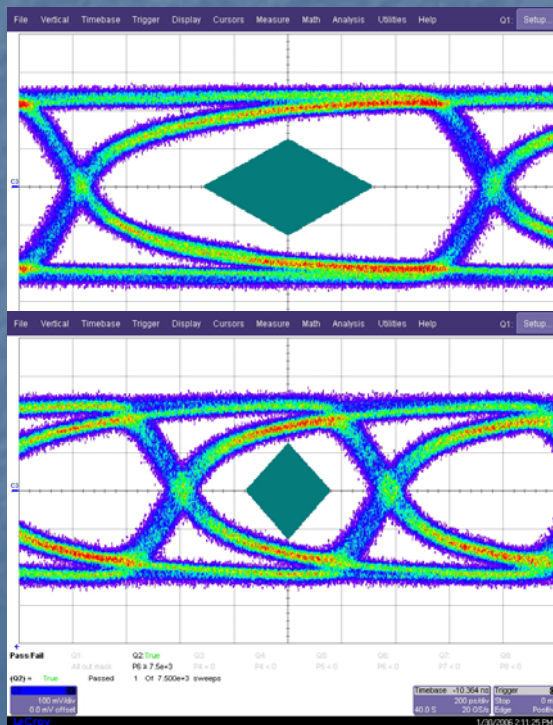


Proposal 2: ATLAS Pixels

- K.K. Gan, Ohio State University
- Reuse existing cable plant
 - 1m micro twisted pair, 8m SIMM fiber, 70m GRIN fiber, 1Gbps

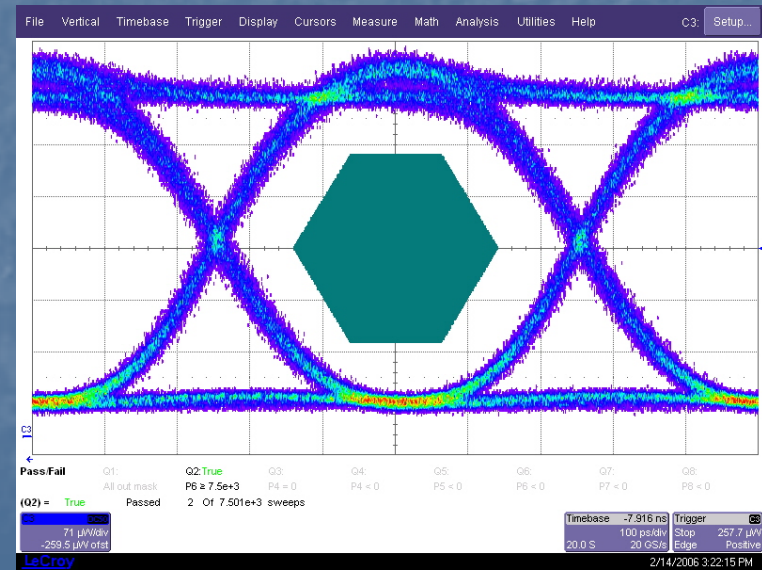
1m40 μ TP

0.65Gbps



1.3 Gbps

2Gbps 9m SIMM + 20m GRIN



Proposal 3: The versatile bi-directional digital link

- S. Marchioro, P. Moreira, CERN,
 - 3-6Gbps
 - Start from scratch or reuse fiber plant

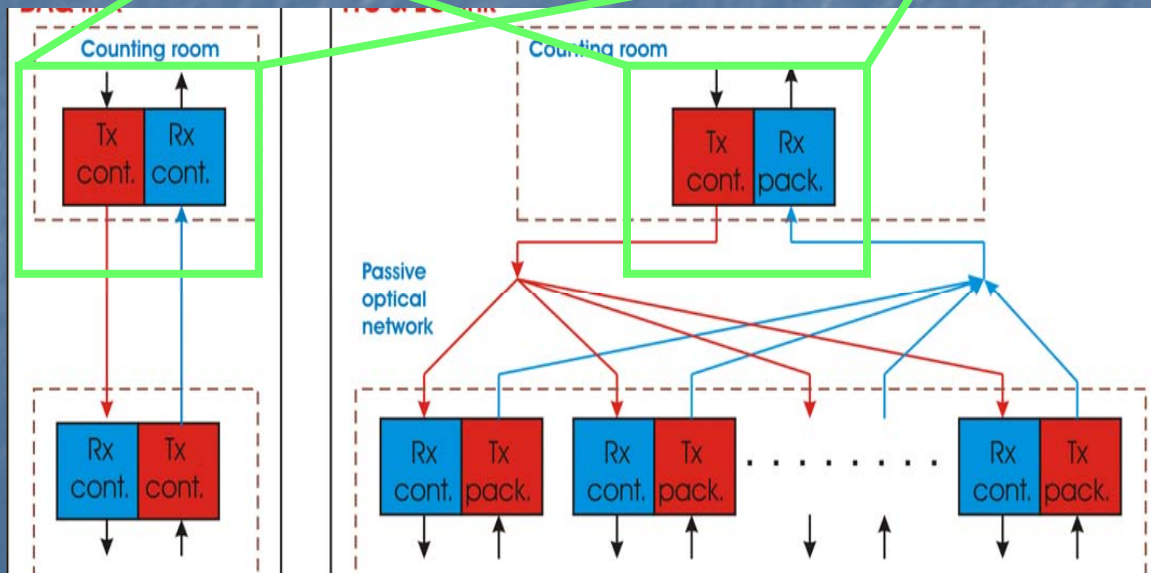
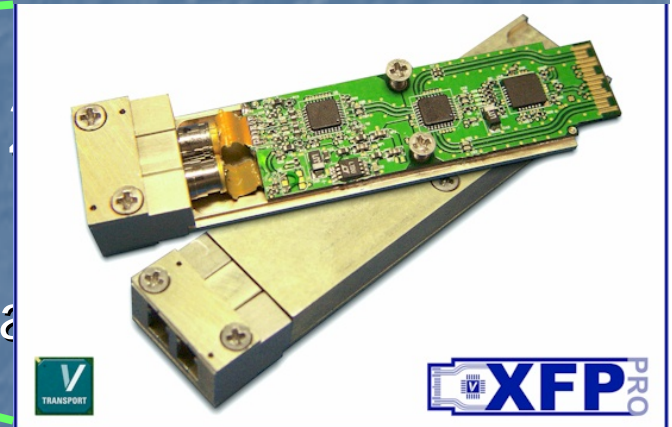
GBT Chipset

Opto 1

Opto 2

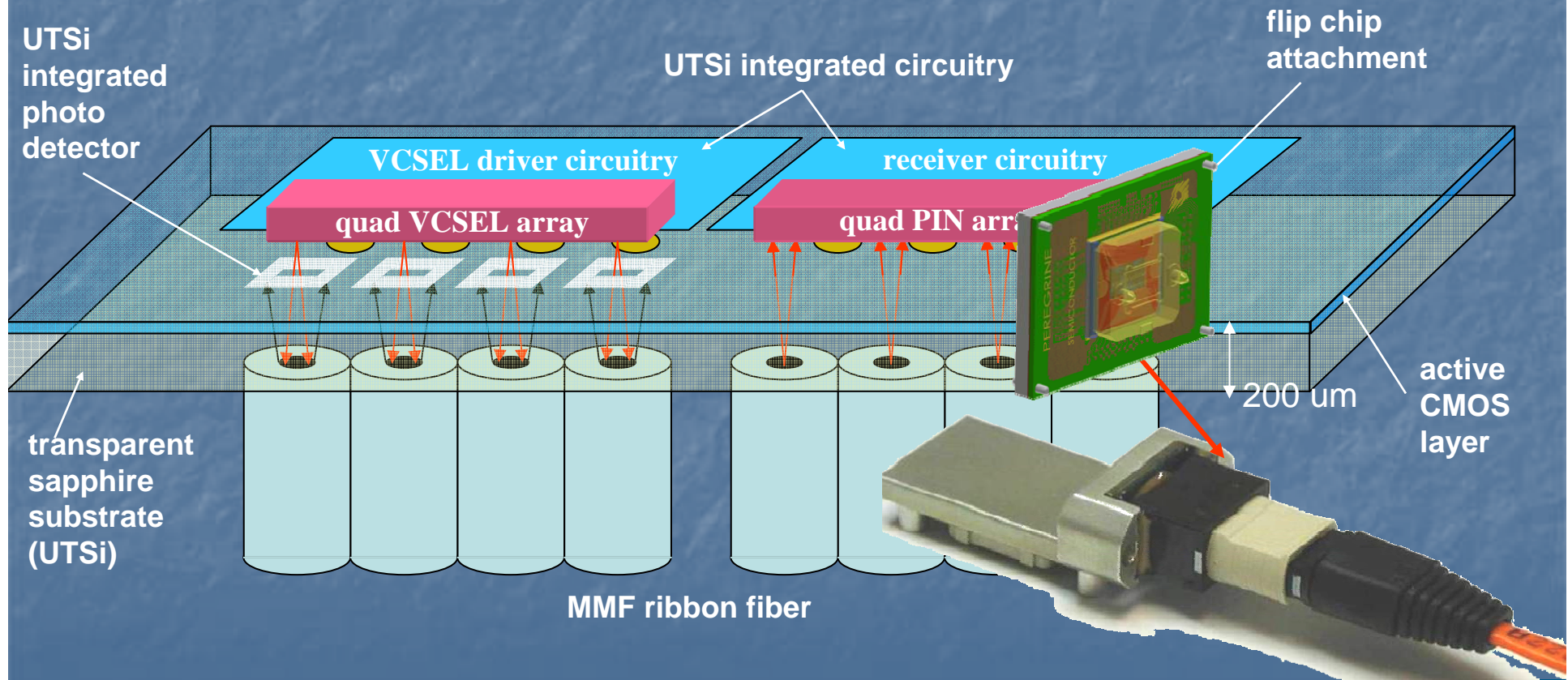
Opto 3

Versatile
bit/Tx

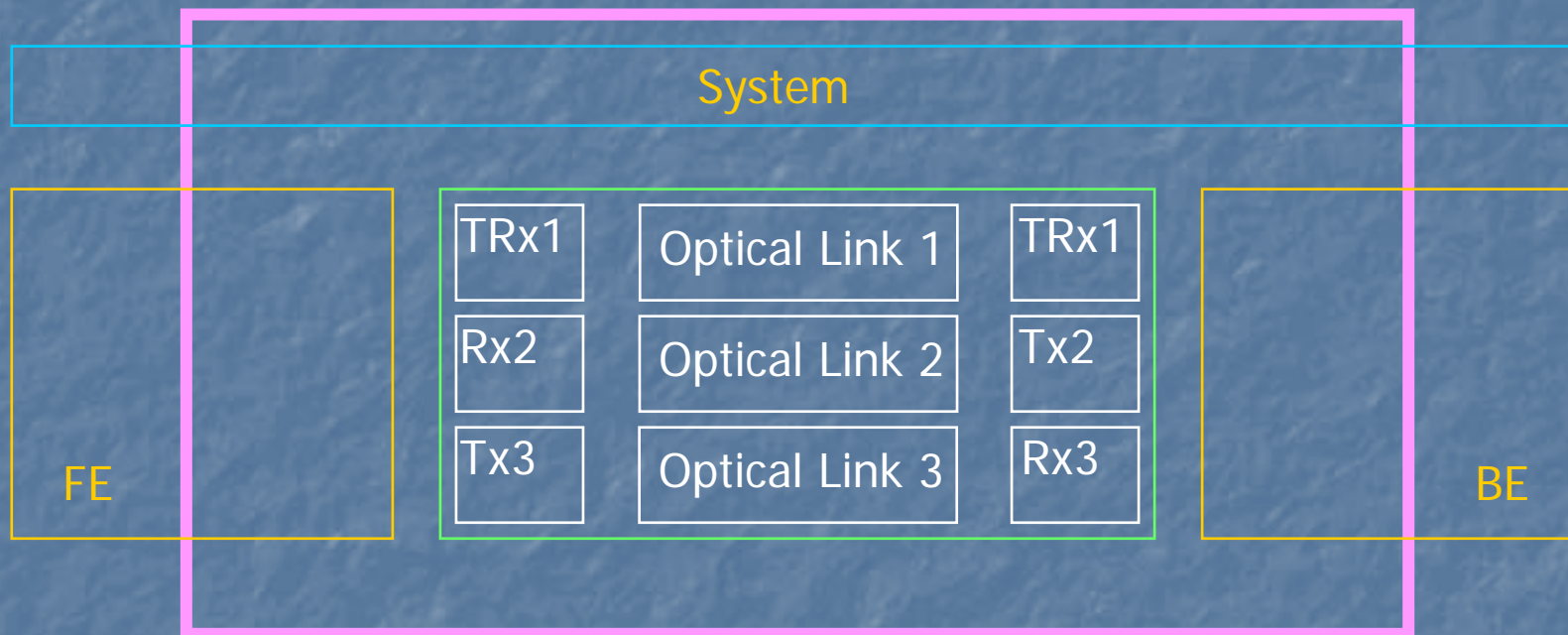


Proposal 4: Flipped OE devices on SoS substrate

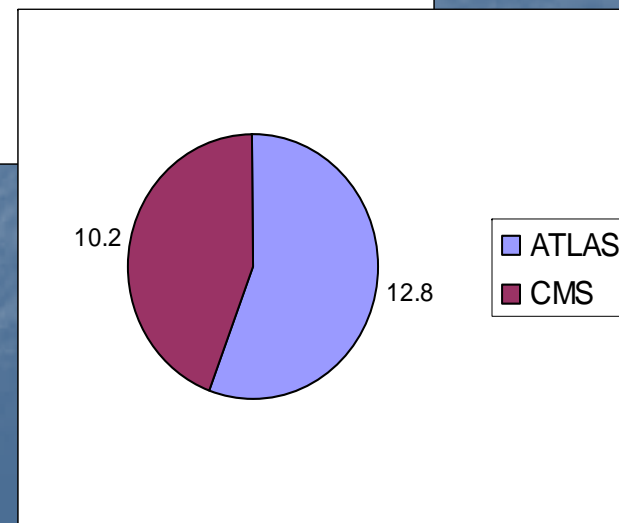
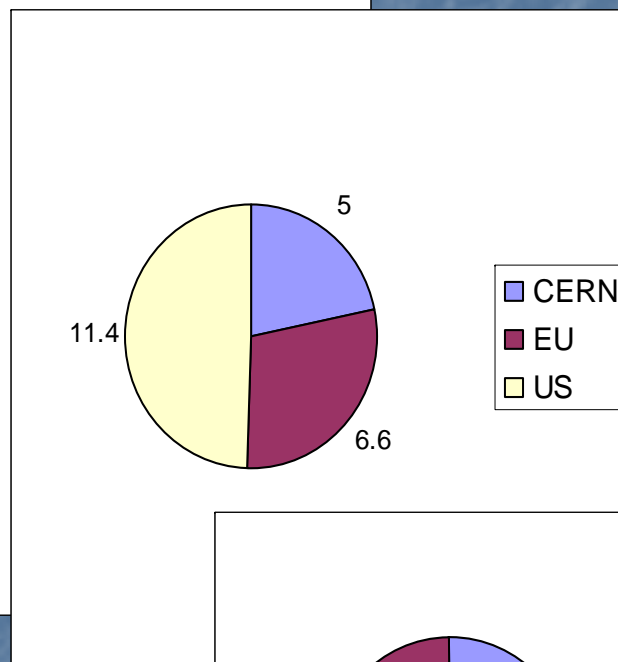
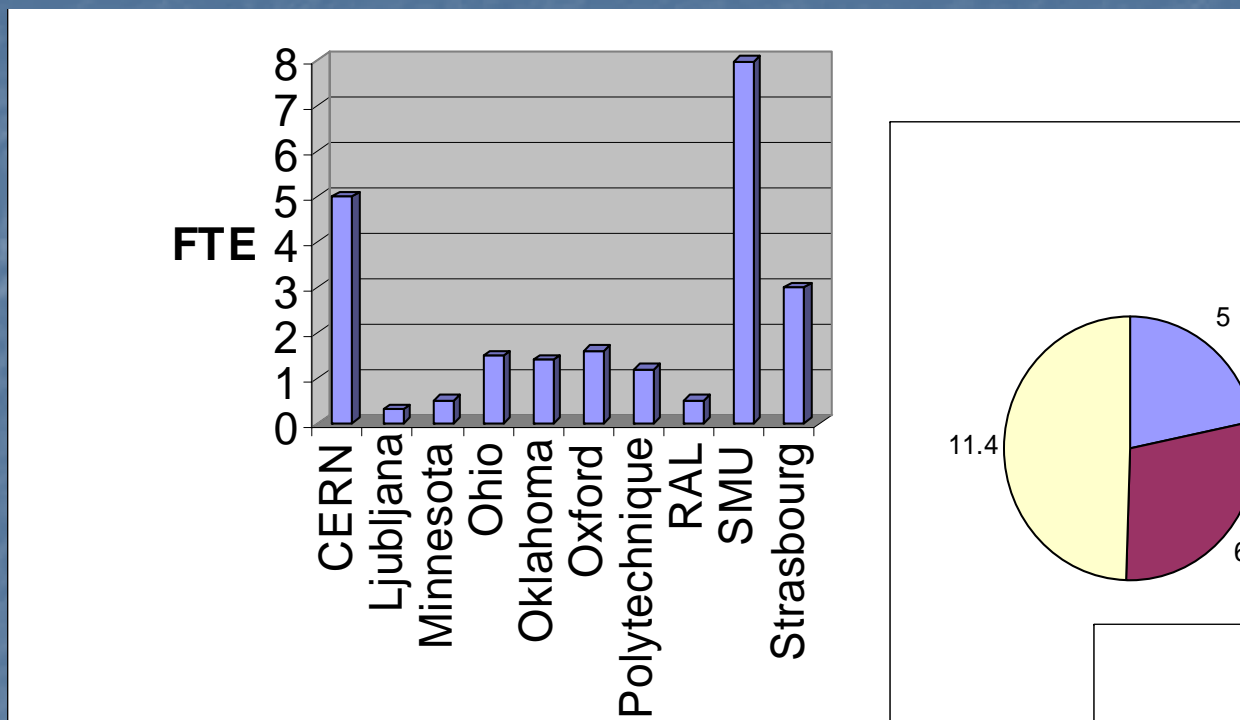
- Ping Gui, Jingbo Ye, SMU, 2005
- Start from scratch or reuse fiber plant



The Joint Optoelectronics Working Group



Joint Optoelectronics Working Group Survey Result



- 13 institutes, 23FTE
- 2 development projects (SMU, CERN)
- Collaborative proposals in preparation

Conclusions

- Options for Optical Links at SLHC are:
 - Reuse existing system (open to CMS only)
 - Reuse fiber plant only (open to CMS and ATLAS Pixels)
 - Start from scratch (possibly using components identical to existing ones).

- Check margins of existing components thoroughly
 - Investigate Laser and PIN diodes in depth
 - Will we reach the total dose limit at SLHC?
 - Draw a line of usability at SLHC, with safety margin.
 - Investigate electronic mitigation techniques (total dose and SEE).

- For new components, concentrate on only very few options.
 - Generic and versatile
 - The joint optoelectronics working group has the potential to coordinate a few parallel projects across experiments.
 - System level aspects to be addressed by the experiments.