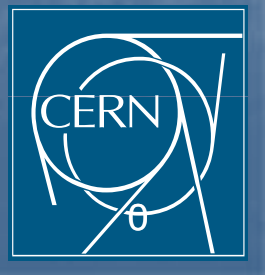
Joint Atlas CMS SLHC Optoelectronics Working Group

Francois Vasey on behalf of WG

- Opto Working Group History and Status
- Two development projects
- Conclusions and Outlook



Working Group History

- Joint WG started in 2005
- LECC-05 Heidelberg
  - Reports and discussion
- June 2006
  - Decision to move from reporting to collaborating mode
- LECC-06, Valencia:
  - WG profile established
    - 13 institutes, 23 FTE
    - 50:50 Atlas:CMS, EU+CERN:US
  - Decision to define objectives and work in small groups
  - Common link NOT an objective
- ACES-07, CERN
  - 3 sub-projects presented

3 Themes for joint projects

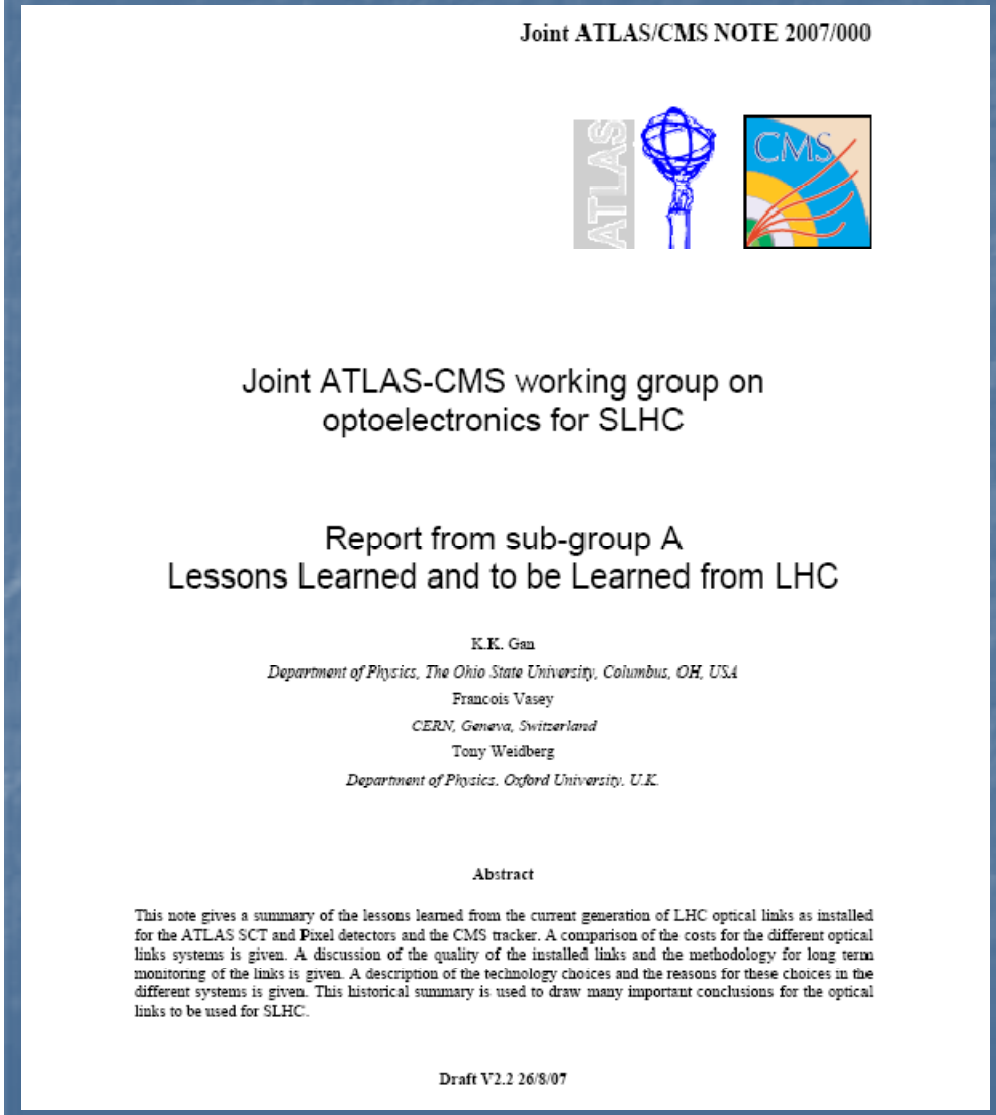
- Group a- Lessons learned and to be learned from LHC.
  - K.K. Gan (Ohio)
  - F. Vasey (CERN)
  - T. Weidberg (Oxford)
- Group b- Optical Readout System Irradiation Protocols for SLHC.
  - C. Issever, chair (Oxford)
  - K.K Gan (Ohio)
  - K. Gill, J. Troska, F. Vasey (CERN)
  - T. Huffman, T. Weidberg (Oxford)
  - P. Skubic, R. Boyd, F. Rizatdinova (Oklahoma)
  - J. Ye (SMU)

- Group c- Optical Link Evaluation Criteria and Test Procedures
  - J. Ye, chair (SMU)
  - B. Checcucci (INFN Perrugia)
  - K.K Gan (OSU)
  - S. Hou, P.K. Teng (A. Sinica)
  - C. Issever (Oxford)
  - R. Russack, A. Singovski (UofMinnesota)
  - J. Troska, F. Vasey (CERN)

3 subgroups at work

- Each sub-group: Bi-monthly meetings/phone conferences
- 3 Reports in preparation
  - Edited by sub-group chairperson
  - Circulated to WG for comments
  - To be issued as joint ATLAS-CMS notes (???)
- WG meeting at TWEPP-07
  - 3 presentations
    - Tony
    - Cigdem
    - Jingbo
  - WG-wide discussion before freezing the documents

Joint Atlas CMS SLHC Optoelectronics Working Group
Working Group A: Lessons Learned



Joint ATLAS/CMS NOTE 2007/000

Joint ATLAS-CMS working group on optoelectronics for SLHC

Report from sub-group A
Lessons Learned and to be Learned from LHC

K.K. Gan
Department of Physics, The Ohio State University, Columbus, OH, USA
Francois Vasey
CERN, Geneva, Switzerland
Tony Weidberg
Department of Physics, Oxford University, U.K.

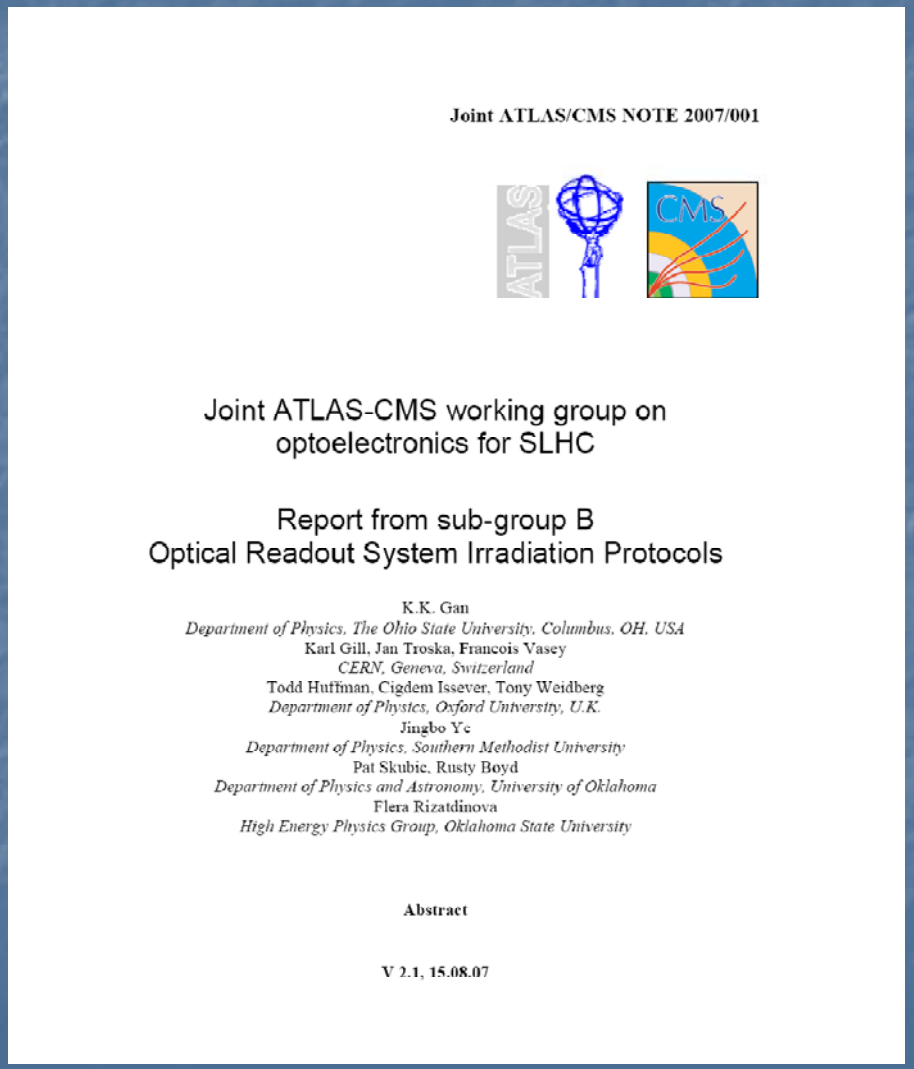
Abstract

This note gives a summary of the lessons learned from the current generation of LHC optical links as installed for the ATLAS SCT and Pixel detectors and the CMS tracker. A comparison of the costs for the different optical links systems is given. A discussion of the quality of the installed links and the methodology for long term monitoring of the links is given. A description of the technology choices and the reasons for these choices in the different systems is given. This historical summary is used to draw many important conclusions for the optical links to be used for SLHC.

Draft V2.2 26/8/07

- Cost
  - Material
  - Personnel
- Quality
  - Today
  - Long term monitoring
- Technology
  - Components
  - Architectures
- References

Joint Atlas CMS SLHC Optoelectronics Working Group Working Group B: Irradiation Protocols



Joint ATLAS/CMS NOTE 2007/001

Joint ATLAS-CMS working group on optoelectronics for SLHC

Report from sub-group B
Optical Readout System Irradiation Protocols

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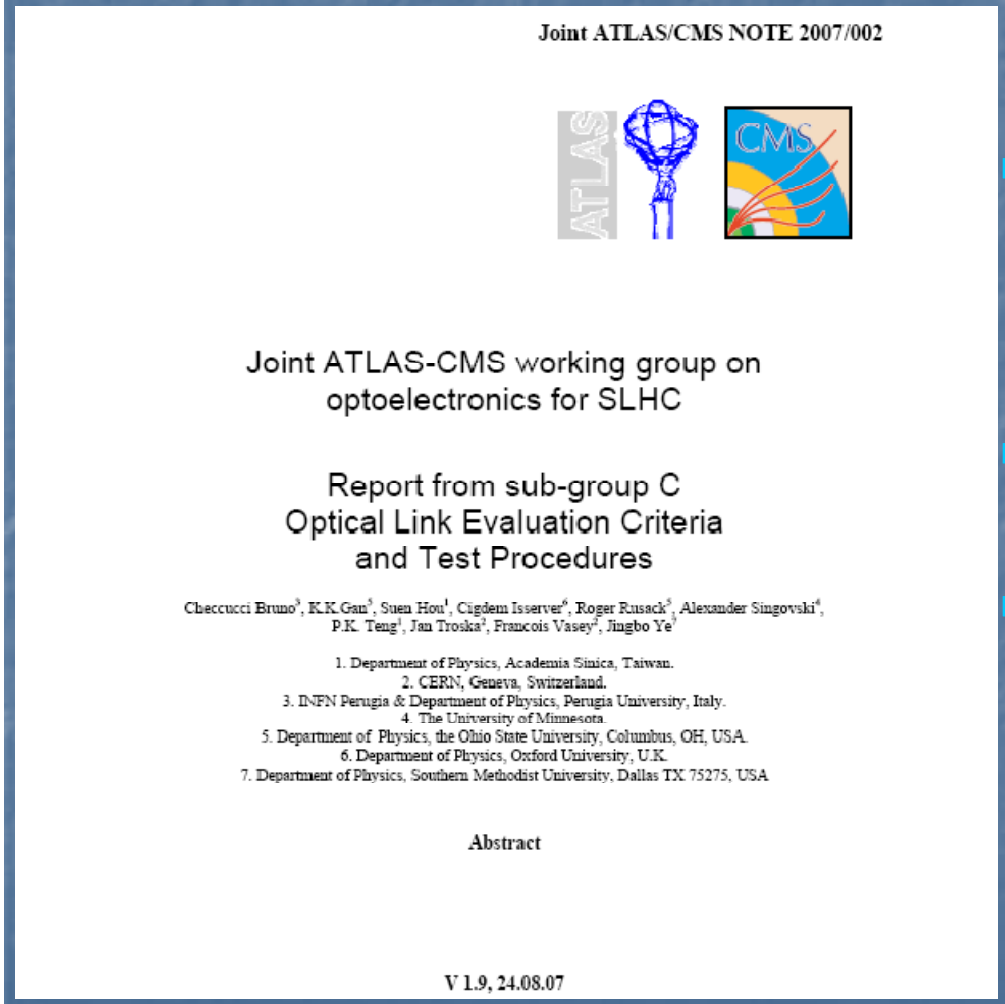
Department of Physics, The Ohio State University, Columbus, OH, USA
Karl Gill, Jan Troska, Francois Vasey
CERN, Geneva, Switzerland
Todd Huffman, Cigdem Issever, Tony Weidberg
Department of Physics, Oxford University, U.K.
Jingbo Ye
Department of Physics, Southern Methodist University
Pat Skubic, Rusty Boyd
Department of Physics and Astronomy, University of Oklahoma
Flera Rizatdinova
High Energy Physics Group, Oklahoma State University

Abstract

V 2.1, 15.08.07

- Radiation Environment
- Sample sizes, failure criteria
- Radiation resistance tests
  - fibers
  - Lasers
  - Pin diodes
  - ASICs
  - Packaged modules

Joint Atlas CMS SLHC Optoelectronics Working Group
Working Group C: Evaluation and test



Joint ATLAS/CMS NOTE 2007/002

Joint ATLAS-CMS working group on optoelectronics for SLHC

Report from sub-group C
Optical Link Evaluation Criteria and Test Procedures

Checcucci Bruno[3], K.K.Gan[5], Suen Hou[1], Cigdem Isserver[6], Roger Rusack[5], Alexander Singovski[4], P.K. Teng[1], Jan Troska[2], Francois Vasey[2], Jingbo Ye[3]

1. Department of Physics, Academia Sinica, Taiwan.
2. CERN, Geneva, Switzerland.
3. INFN Perugia & Department of Physics, Perugia University, Italy.
4. The University of Minnesota
5. Department of Physics, the Ohio State University, Columbus, OH, USA.
6. Department of Physics, Oxford University, U.K.
7. Department of Physics, Southern Methodist University, Dallas TX 75275, USA

Abstract

V 1.9, 24.08.07

- Lab testing
  - Parameters
  - Instruments
- Reference optical link
- Standardized test setup

What Next?

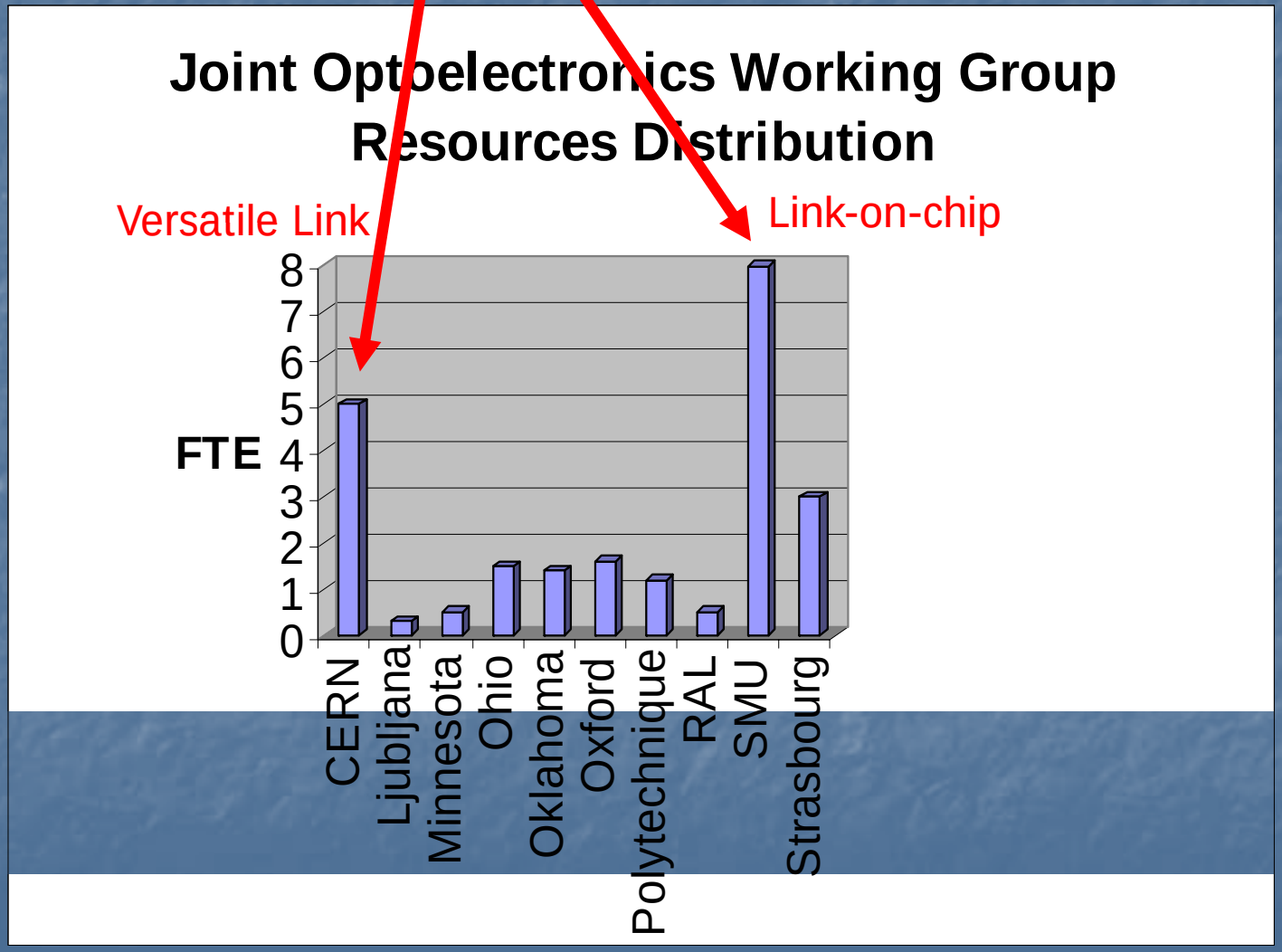
- Group a- monitors quality status and updates lessons learned accordingly
- Group b- plans and coordinates irradiation tests, discusses and updates procedures
- Group c- builds reference link, discusses and updates procedures

- Collaborate not only on documents, but also on projects

Overlap between working group and projects

Working Group / Project	Subgroup a Lessons learned	Subgroup b Rad Resistance and reliability	Subgroup c Reference link	
	-Cost -Quality -Technology -Monitoring	-Procedures -Facilities	-Procedures -Equipment	
Project	-Requirements -QA	-Validation Tests -Total Dose -Total Fluence -SEE -Reliability	-Validation Tests -Functionality -System level -Margins	-Packaging -Specification -Market survey -Procurement -System

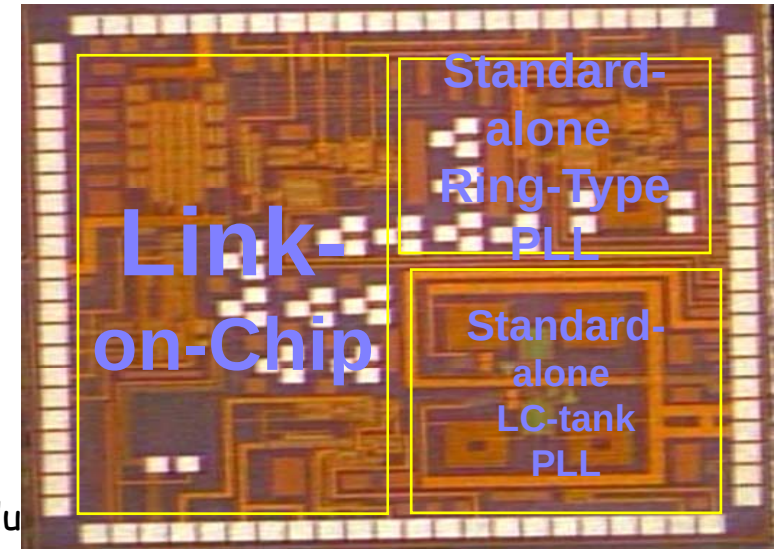
Two development projects



Link on Chip Project (LOC): Technology Evaluation

J. Ye et al., SMU

- Peregrine 0.25 μm UltraCMOSTM SOS has been evaluated and is found to be suitable for radiation tolerant ASIC development for LHC upgrade. No special layout technique (ELT, guard ring) is needed.
- Technology Advantages:
  - Low power, low cross talk, good for mixed signal ASIC designs.
  - Economical for small to medium scale ASIC development.
- TID on transistors with gamma (Co-60):
  - With a floating substrate, leakage current increase is observed but saturates after ~ 100 krad. This increase anneals back at room temperature in a few weeks.
  - With a grounded substrate during irradiation, there is no measurable leakage current and threshold voltage change in both NMOS and PMOS
- SEE using shift registers with 230 MeV proton:
  - No SEE was observed with flux < 1×109 proton/cm2/sec.



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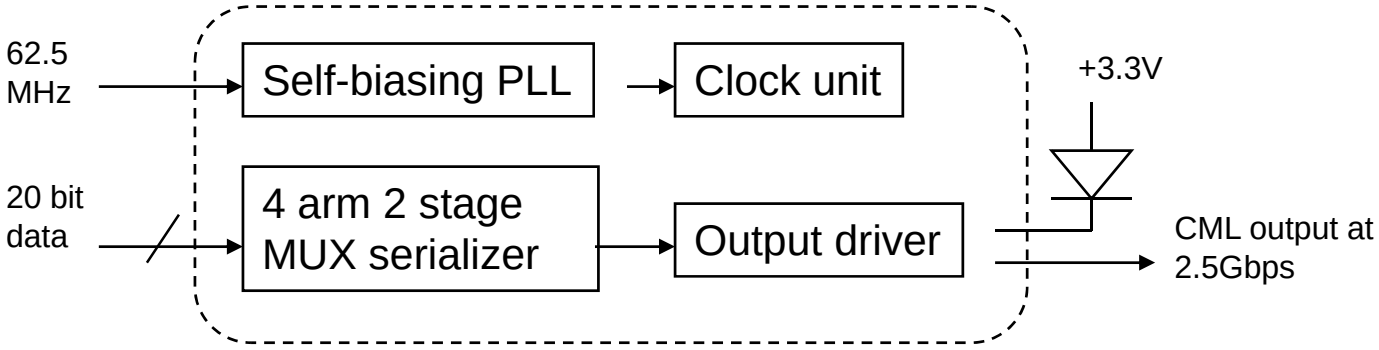
Link-On-Chip (LOC) project, 1st Prototype

J. Ye et al., SMU

•The LOC1 chip was sent to Peregrine for fabrication mid Feb. 2007.

•The design speed of LOC1 is 2.5 Gbps. The block diagram is as follows:



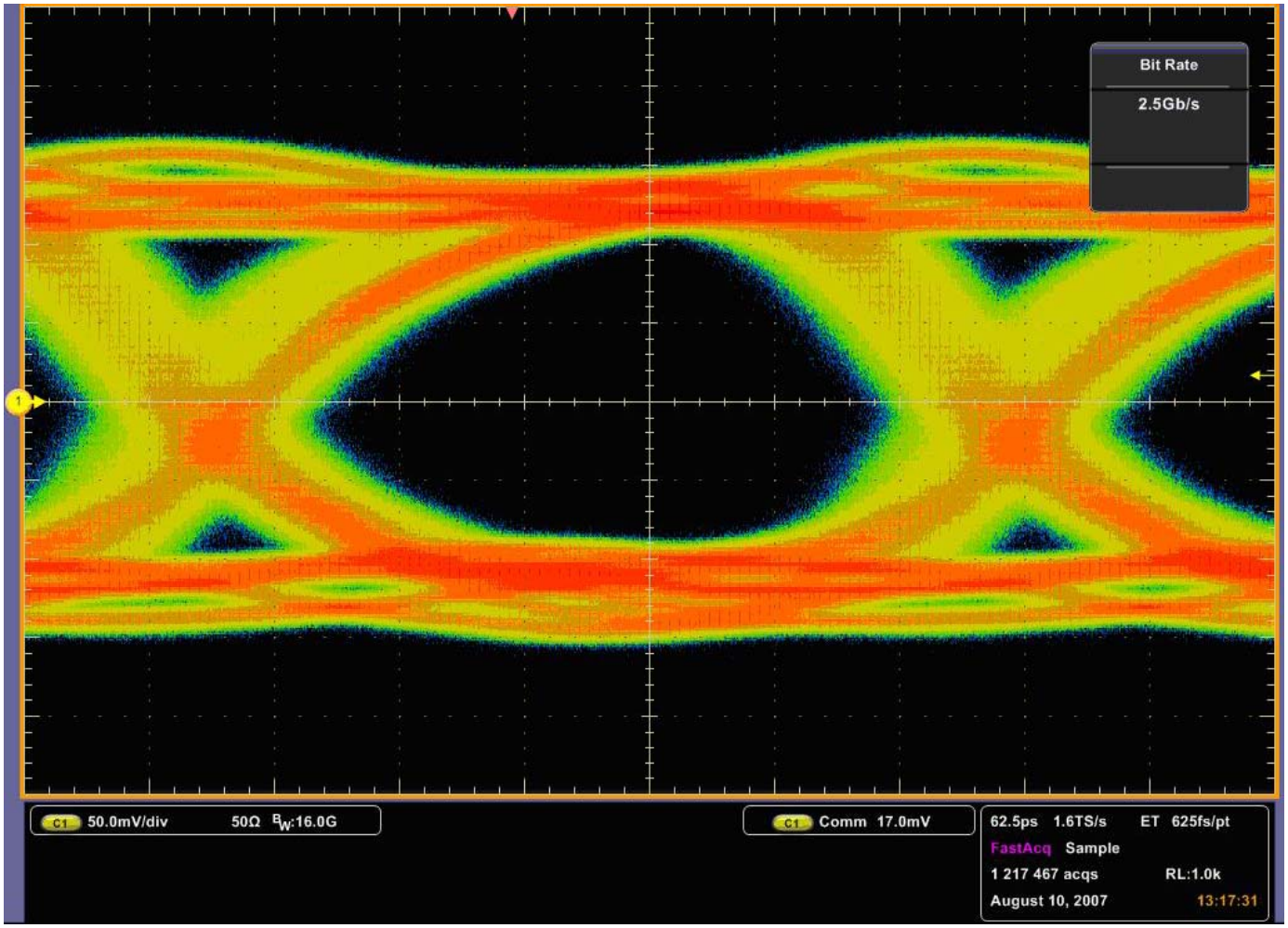
•The framing encoder and other configuring circuits are not yet included.

•The first prototype chip arrived at SMU beginning of June, with one fabrication problem: the wafer failed the PCM (Process Control Monitor) test. Peregrine's measurements show that SN (lightly doped N+) resistively ranges 0.6% to 22% higher than the upper spec limit, and P+ resistively ranges from 19% to 22% higher than the upper spec limit. Peregrine started a backup run immediately, but that backup run has the same problem. Peregrine is investigating this problem and a second backup run will be started soon.

•While waiting for the fully Peregrine qualified chips, we started our tests on the chips we have.

Link-On-Chip (LOC) project, 1st Prototype

J. Ye et al., SMU



Link-On-Chip (LOC) project, 1st Prototype

J. Ye et al., SMU

1. A full testing chain with LOC1 as transmitter has been constructed. The input data generator with parallel PRBS and the 8B/10B framing encoder are now implemented in a FPGA. TLK2501 is used as the receiver chip. Error detection has been implemented in the FPGA with PC interface (USB) for data logging during BER and irradiation tests.
2. The PLL frequency range is measured to be 0.8 – 2.2 GHz. Jitter at 1.25 GHz is measured to be: DJ (what is this) = 47ps, RJ (what is this) = 7.4ps. These measurements are made on a stand-alone PLL, with the same design, on the same chip.
3. The logic of the serializer is checked to be correct with fixed pattern input data.
4. We see a large jitter in the output serial bit stream (electrical output). There the DJ is about 200ps. Most part of this DJ is understood and may be eliminated in future designs. The number for RJ is about 12ps and is still under investigation.
5. The rise and fall times of the serial bit stream are measured to be 154±19ps and 152±14ps. These are boarder line for 2.5 Gbps data rate. The limits on the output driver bandwidth will be investigated.
6. A lot of measurements and tests, including those with optics, are still on-going or have to be started. These tests will be repeated with fully Peregrine qualified chips when they become available. An ATLAS/RD note will be generated with the final results. These results will be useful for the design of LOC2, our next version of this ASIC.

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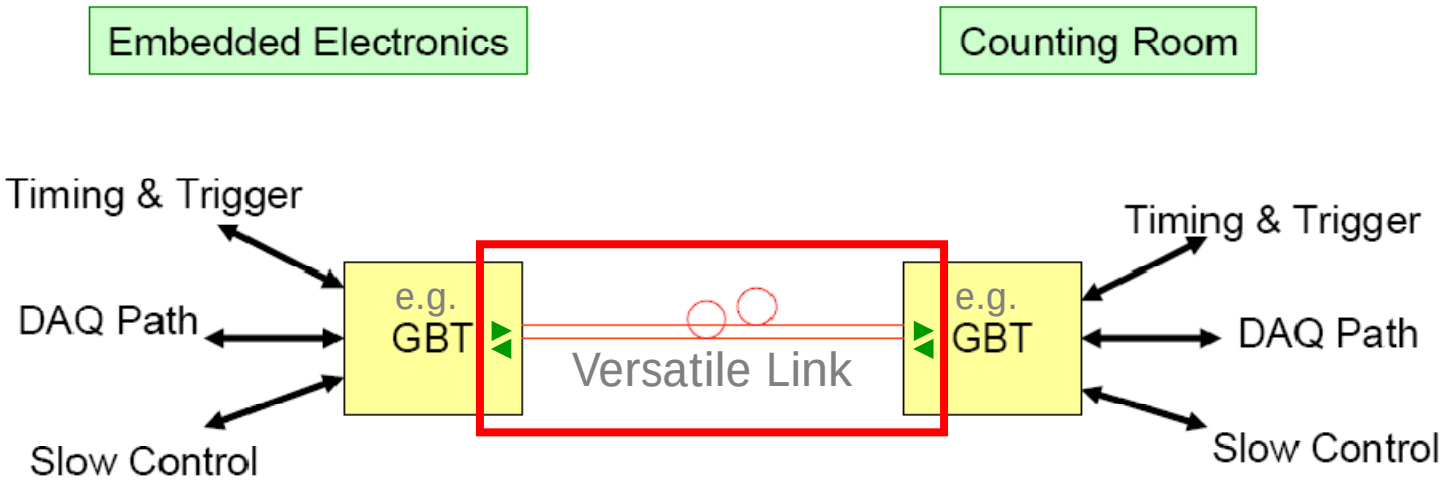
Versatile link common project

F. Vasey et al. CERN

- Optical Physical layer linking front- to back-end, protocol-agnostic
- Bidirectional, ~5 Gbps, serial in/out
- Versatile
  - Multimode (850nm) and Singlemode (1310nm) versions
  - Point to Point and Point to Multipoint architectures
  - Rad-resistant and Standard
- Phase 1: Proof of Concept based on tentative specifications (18m)

- Phase 2: Feasibility (18m)
- Phase 3: Pre-production Readiness (18m)

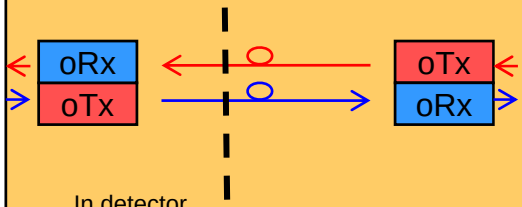


Versatile link project: Workpackages

Project Management

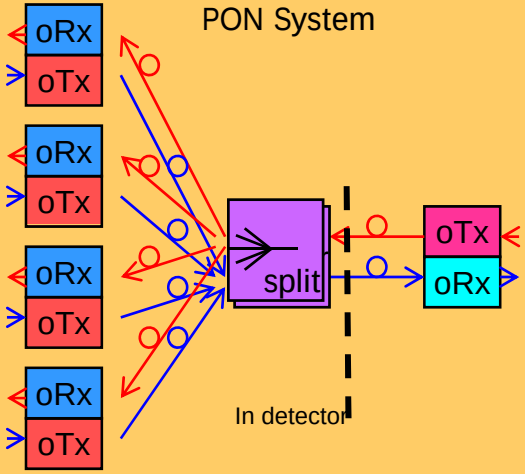
WP1.1

P2P System



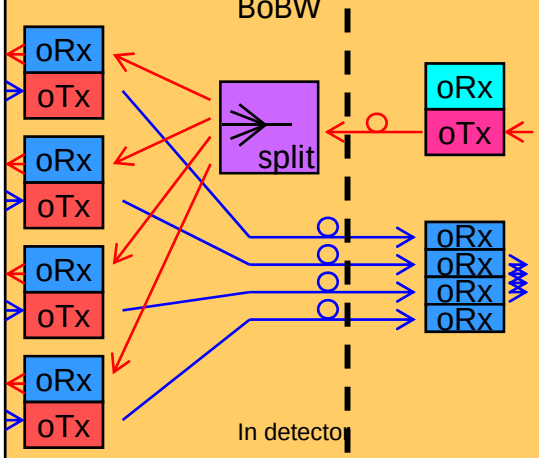
WP1.2

PON System



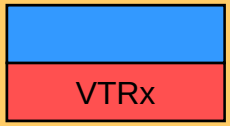
WP1.3

BoBW



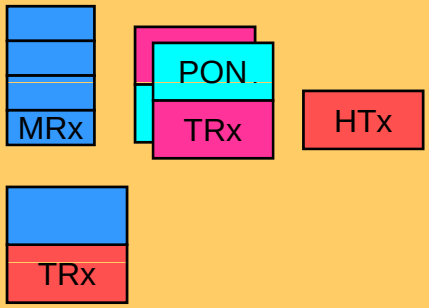
WP2.1

Front End Components



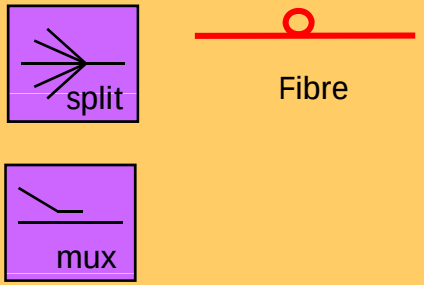
WP2.2

Back End Components



WP2.3

Passive Components



Versatile link project: Status

- Concept discussed with selected partners within joint ATLAS-CMS optoelectronics WG
- 5/6 Workpackages subscribed to
  - 2xFR, UK, US, CERN
  - 2x ex-ATLAS, 3x ex-CMS
  - 3x ex-TK, 2x ex-CAL
- Proposal for phase 1 drafted
  - In circulation

  - Blessing by ATLAS-CMS common project review board in autumn?

- Circulation to funding agencies for approval in winter 07/08

- Start work in early 08

Conclusion and Outlook

- Joint ATLAS CMS SLHC Optoelectronics WG exists and is well alive
- 3 subgroups active
  - 3 reports in draft state
  - Key players identified
  - Common work-base established
- In future: important to maintain dynamics
  - Regularly meet and update all 3 reports
  - Coordinate testing, share facilities and instruments
  - Common projects
- Diversity in common framework
  - Joint ATLAS-CMS review structure is still missing