Optical links for Phase I Pixel upgrade

- Project overview
- Technical achievements
  - POH prototype results
  - Receiver testing
- Summary & conclusions

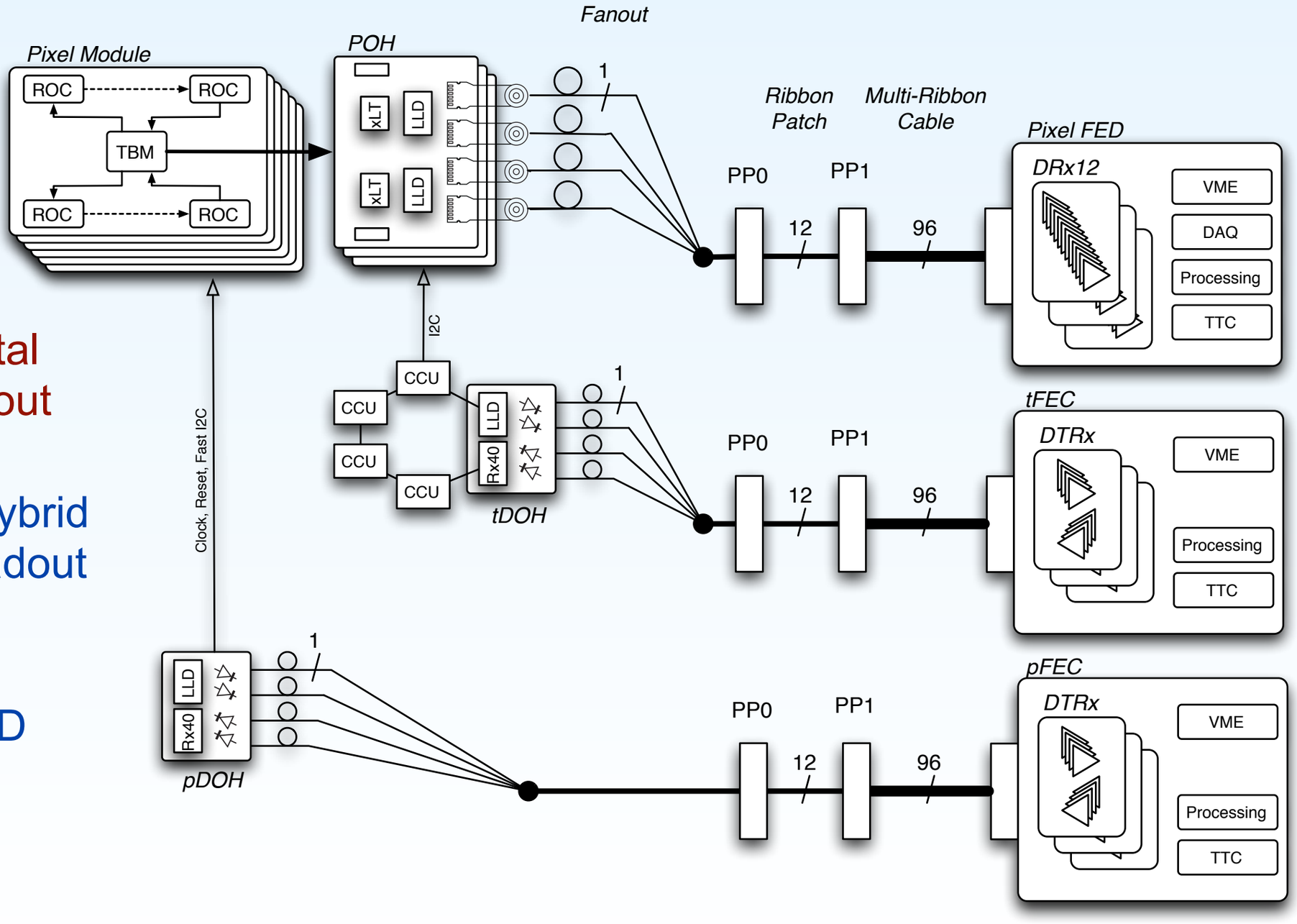
Optical link system for upgrade

- Premise: keep as much as possible from existing system
  - The installed fibres from PP0 to USC55
  - The control system (DOH & FEC)

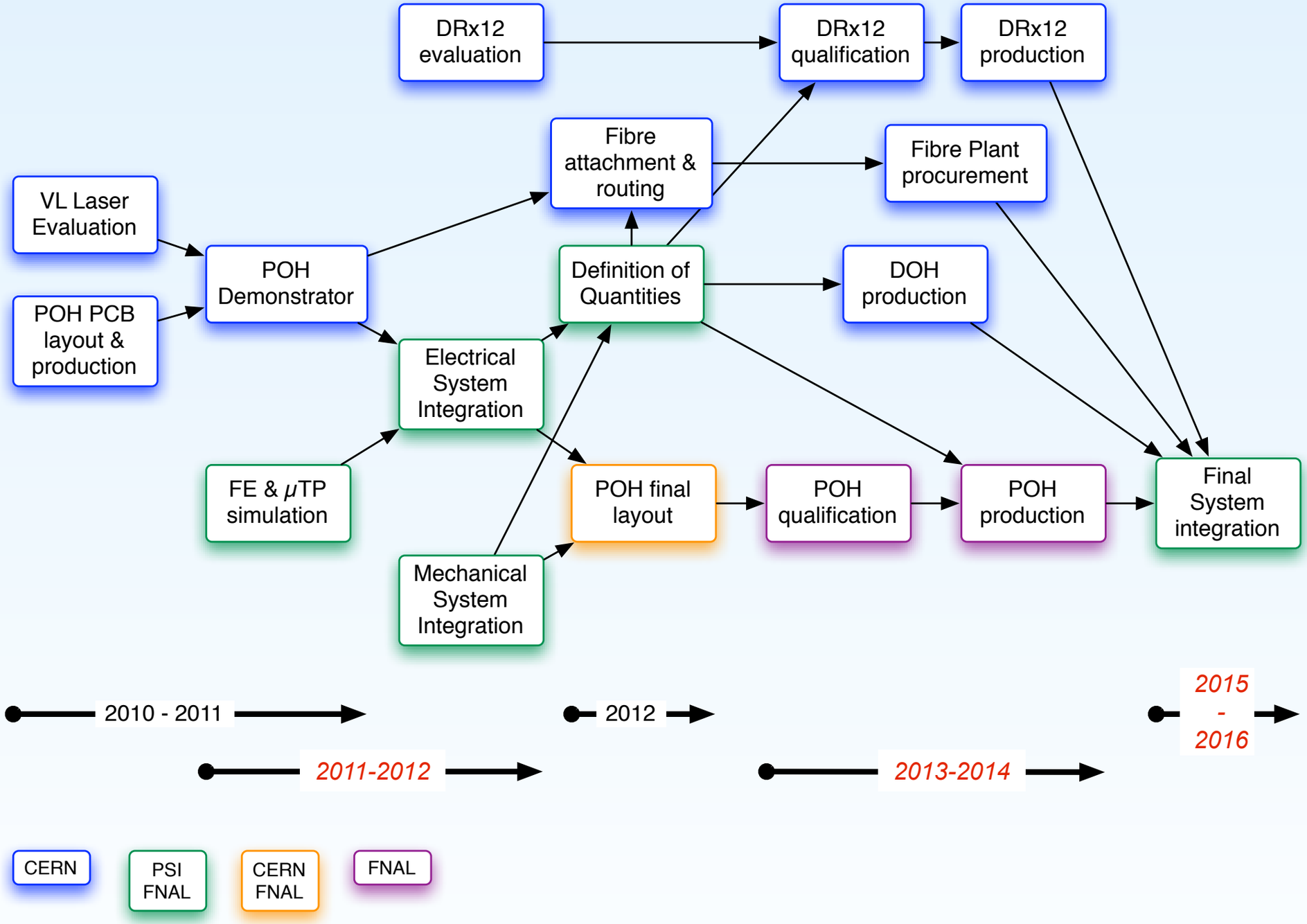
New Digital data readout

New Optohybrid for data readout (POH)

New FED



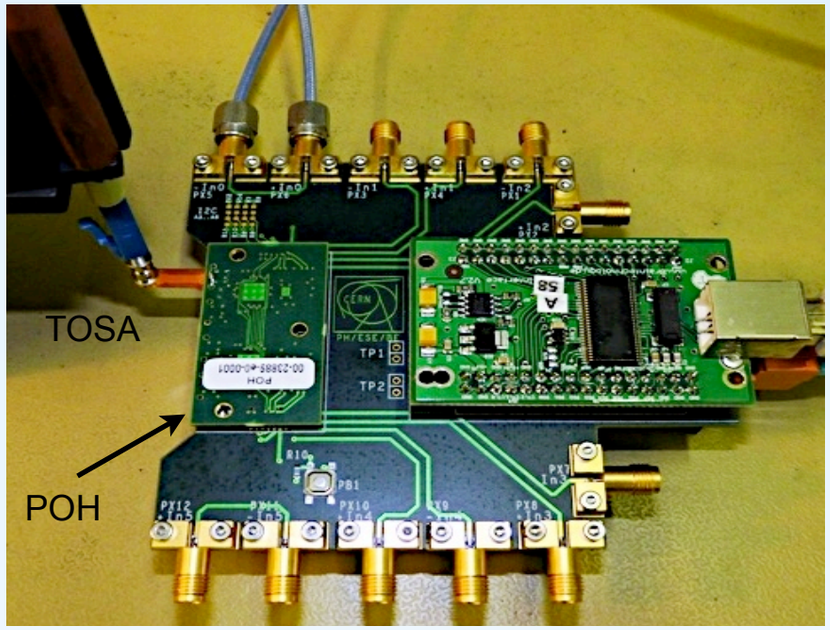
Project overview



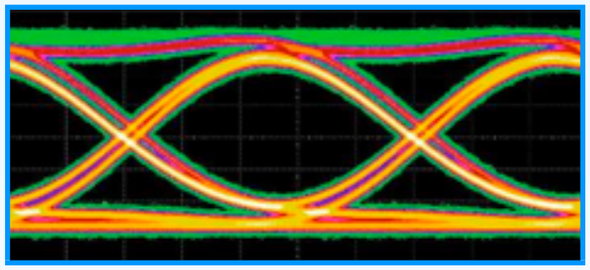
- Project Description in EDMS: CMS-TK-MG-0006

POH development

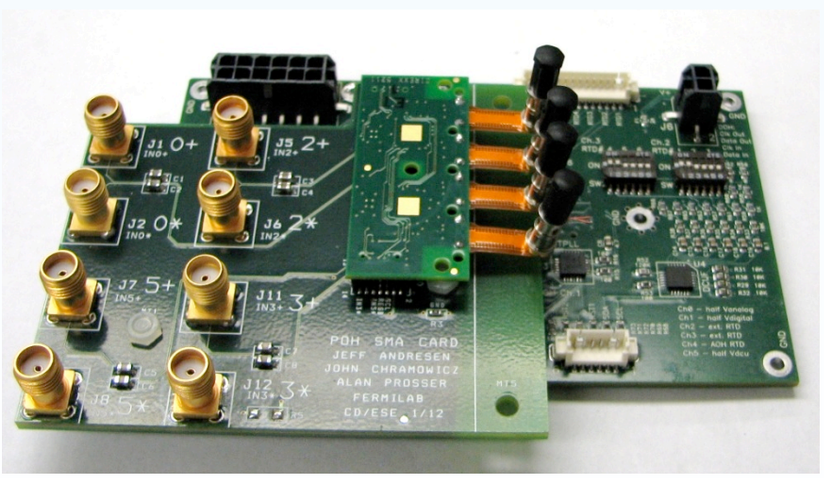
- First demonstrator PCB allowed us to connect a TOSA to the LLD and ALT
  - Design matches the dimensions given in 2010 by PSI BPIX supply tube
  - Keeps current connector and pinout for compatibility of possible test setups
  - Implements four TOSA footprints (two per LLD) to test a wide range of different devices (pinout is quite standard between devices)



- Design validated and handed-over to FNAL for fine-tuning for production
  - First prototype produced and successfully tested
  - Discussion on number of links places new dimensional constraints and requires a re-think of the design
- New (final) design by end of 2012
  - May need to go to two distinct designs for BPIX and FPIX to avoid over-constraining the layout

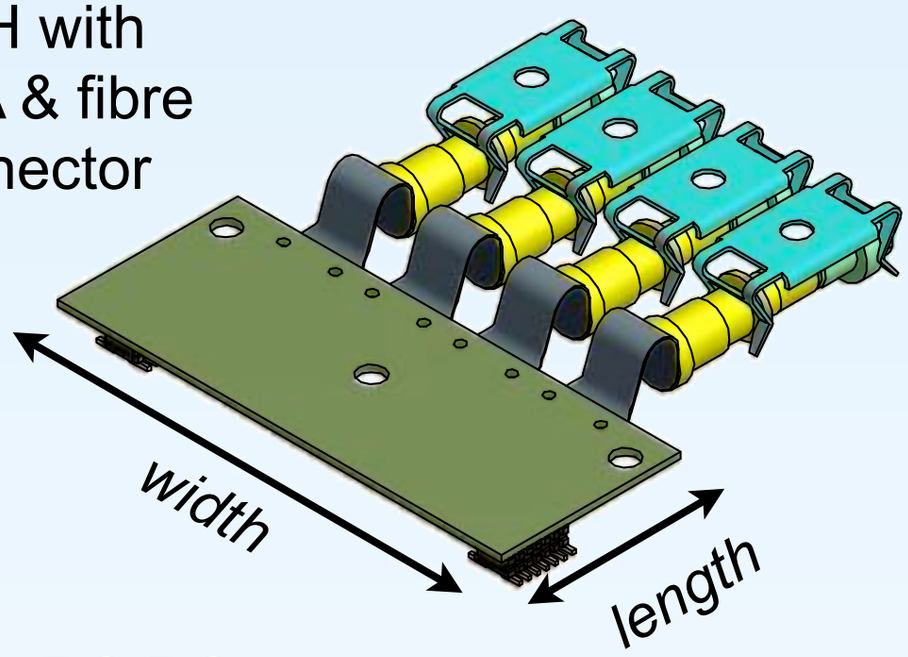


POH 4B/5B NRZI 400 Mb/s

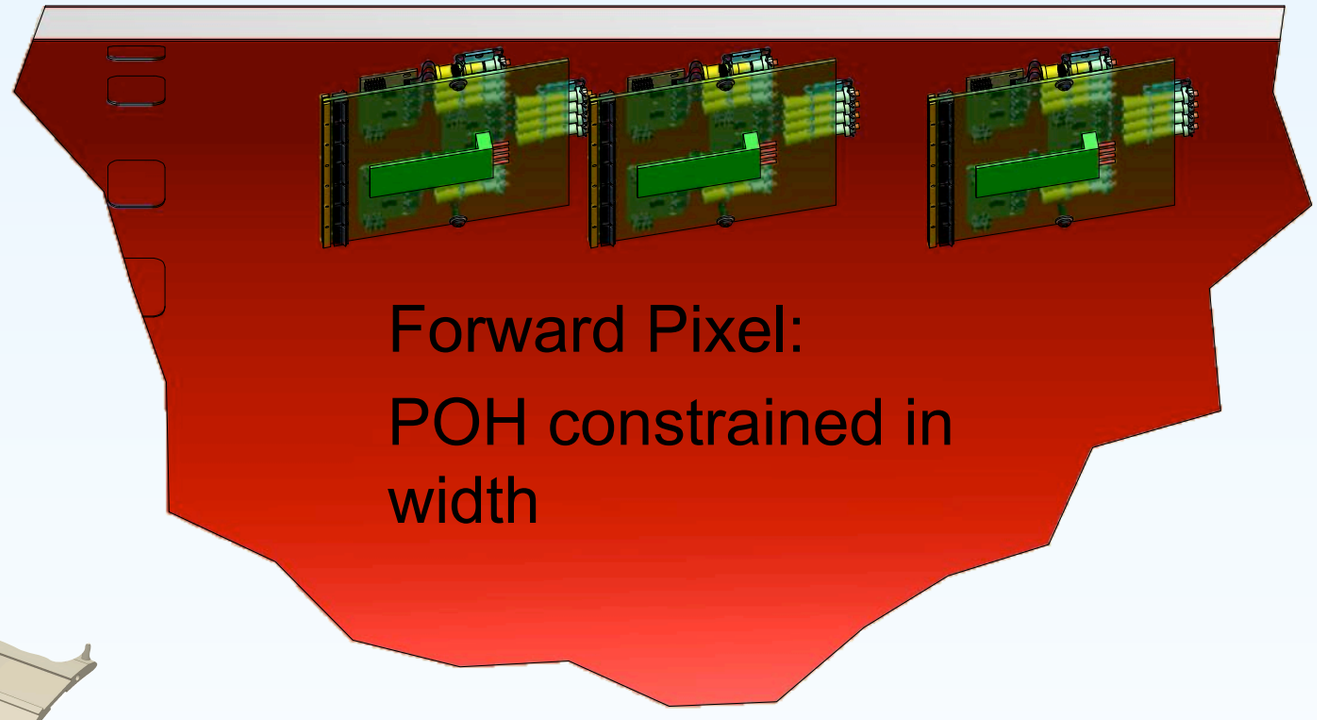


Mechanical Constraints

POH with TOSA & fibre connector



DETAIL E
SCALE 1 / 2

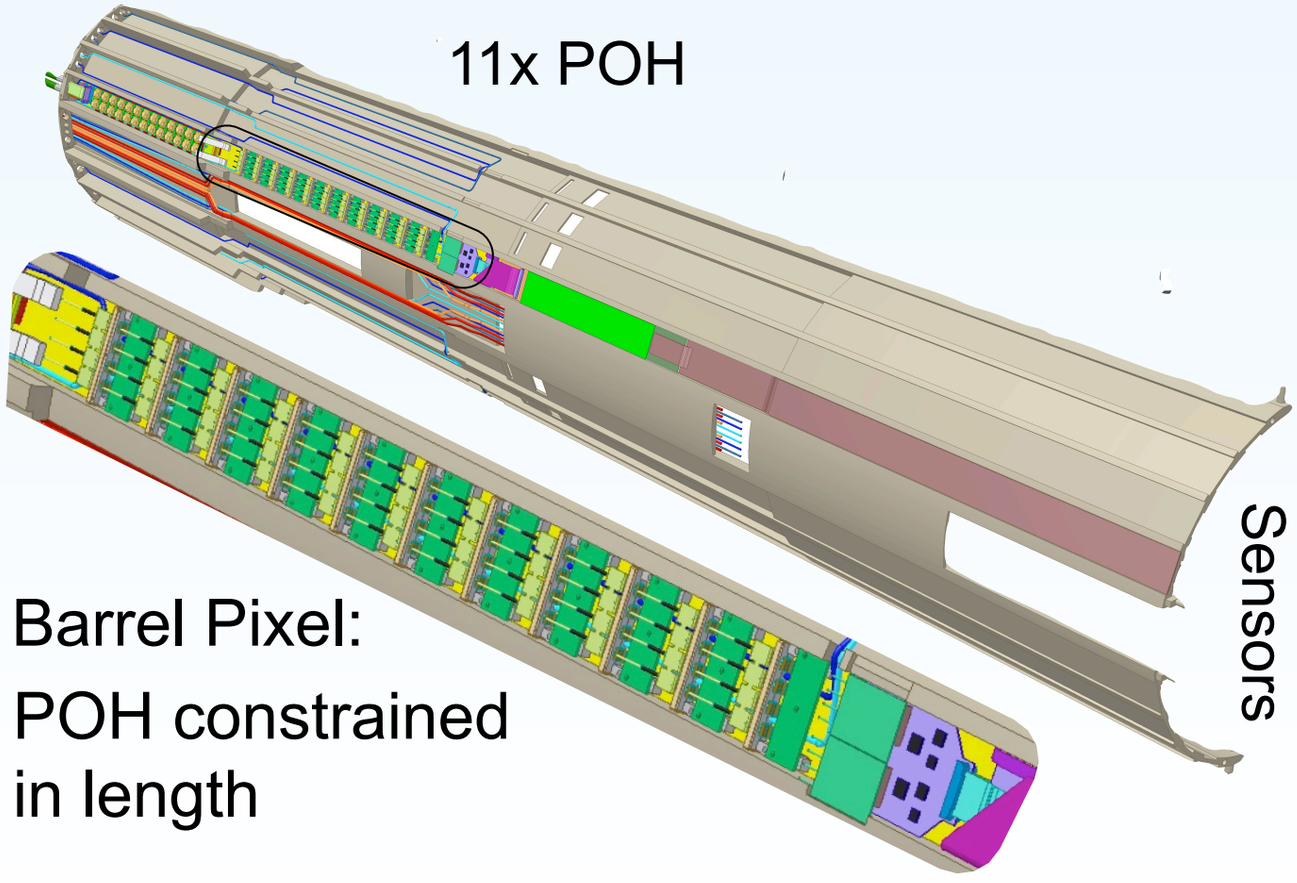


Forward Pixel:

POH constrained in width

DC-DC

11x POH



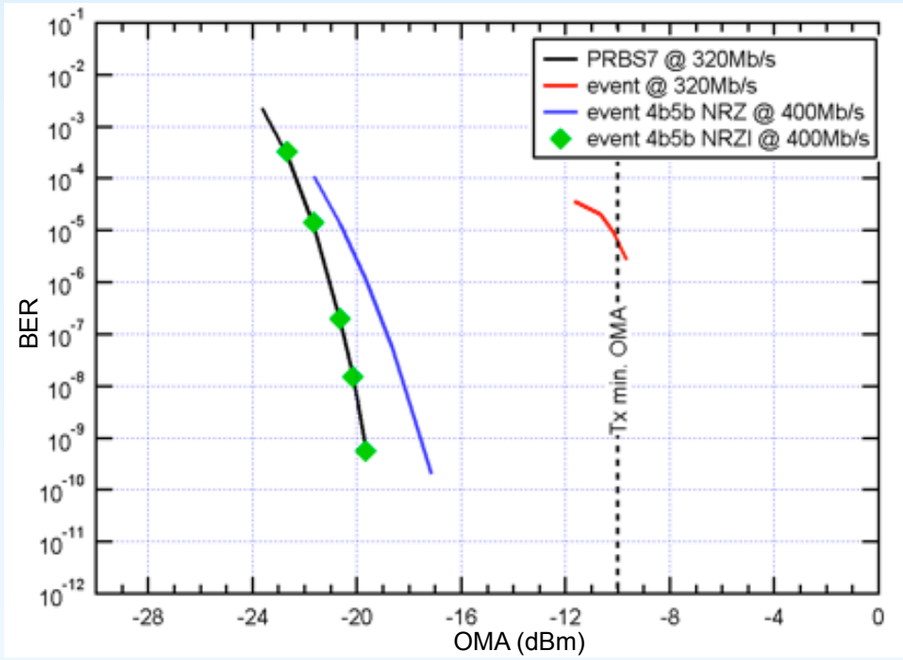
Barrel Pixel:

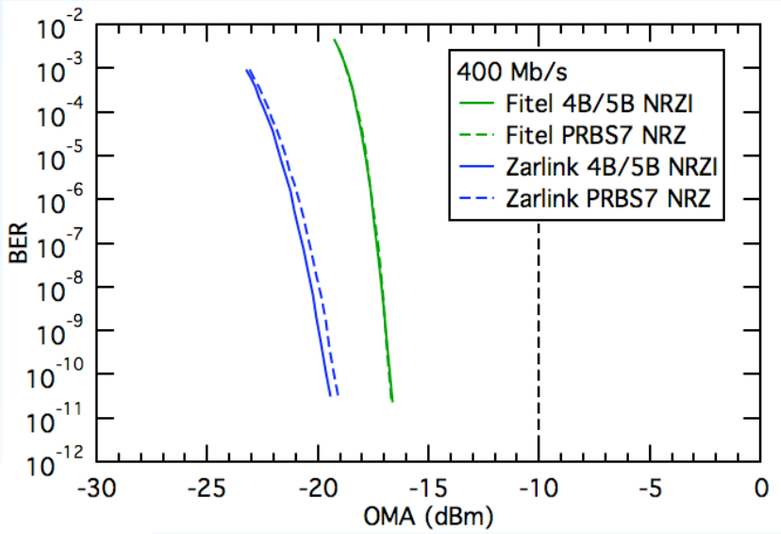
POH constrained in length

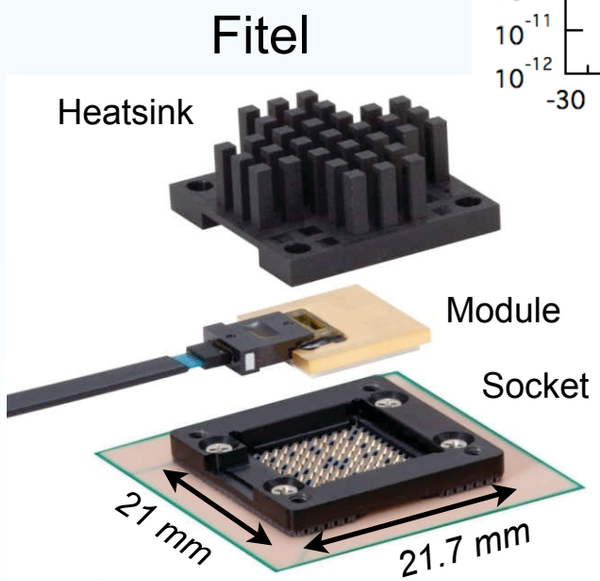
Conflicting dimensional constraints in Barrel & Forward make single POH design challenging

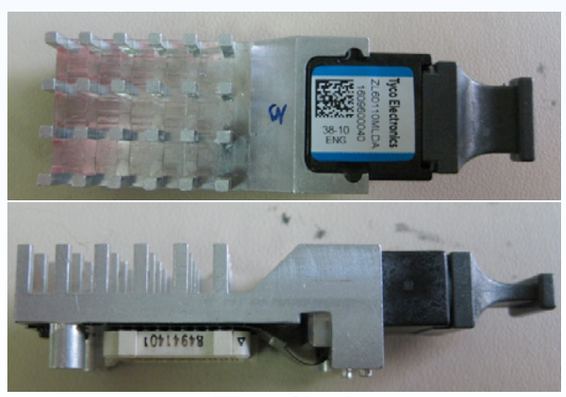
Validation of Receiver

- Measured POH (LLD only) connected to Zarlink/TYCO Receiver module on evaluation board
  - Using PRBS7 pattern plus simulated physics event pattern
    - Event data not able to be transmitted error-free at 320 Mb/s due to low-frequency content of data-stream
- Proposed and validated line-balancing with 4B/5B NRZI encoding
  - To be implemented in TBM
- Two vendors identified for supply of receiver modules









Optical Power Budget

From CMS-TK-ER-0030

Table 2: Calculated Power Budgets for the Zarlink Receiver

	Scenario 1 120 mV input	Scenario 1 60 mV input	Scenario 2 800 mV diff. input to LLD	Scenario 2 1400 mV diff. input to LLD
Tx min. OMA	-8.3 dBm	-11.3dBm	-7.7 dBm	-5.7 dBm[‡]
Irrad. Penalty	0.5 dB	0.5 dB	0.5 dB	0.5 dB
Connector Losses	2.4 dB	2.4 dB	2.4 dB	2.4 dB
Rx sensitivity	-14.2 dBm	-14.2 dBm	-14.2 dBm	-14.2 dBm
Margin	3 dB	0 dB	3.6 dB	5.6 dB

Table 3: Calculated Power Budgets for the Fitel Receiver

	Scenario 1 120 mV input	Scenario 1 60 mV input	Scenario 2 800 mV input to LLD	Scenario 2 1400 mV input to LLD
Tx min. OMA	-8.3 dBm	-11.3dBm	-7.7 dBm	-5.7 dBm[§]
Irrad. Penalty	0.5 dB	0.5 dB	0.5 dB	0.5 dB
Connector Losses	2.4 dB	2.4 dB	2.4 dB	2.4 dB
Rx sensitivity[**]	-13.0 dBm	-13.0 dBm	-13.0 dBm	-13.0 dBm
Margin	1.8 dB	-1.2 dB	2.4 dB	4.4 dB

Margin sufficient for either receiver

Scenario 2 with new Digital Level Translator on POH, could be used to over-drive the LLD input. However there is a trade-off with a signal distortion penalty (not accounted for in table)

Summary & Conclusion

- Proof of concept prototypes exist for all new parts of upgraded optical link
  - POH, DRx12, fibre connector clip
- Integration issues pending
  - BPIX clearances and POH dimensions
  - Electrical system tests – with new ASICs (DLT, TBM)
  - Laser TOSAs to be purchased in 2012
  - Production 2013-2015 for installation in LS1.5 (Jan.17) or LS2 (2018) if LS1.5 cancelled