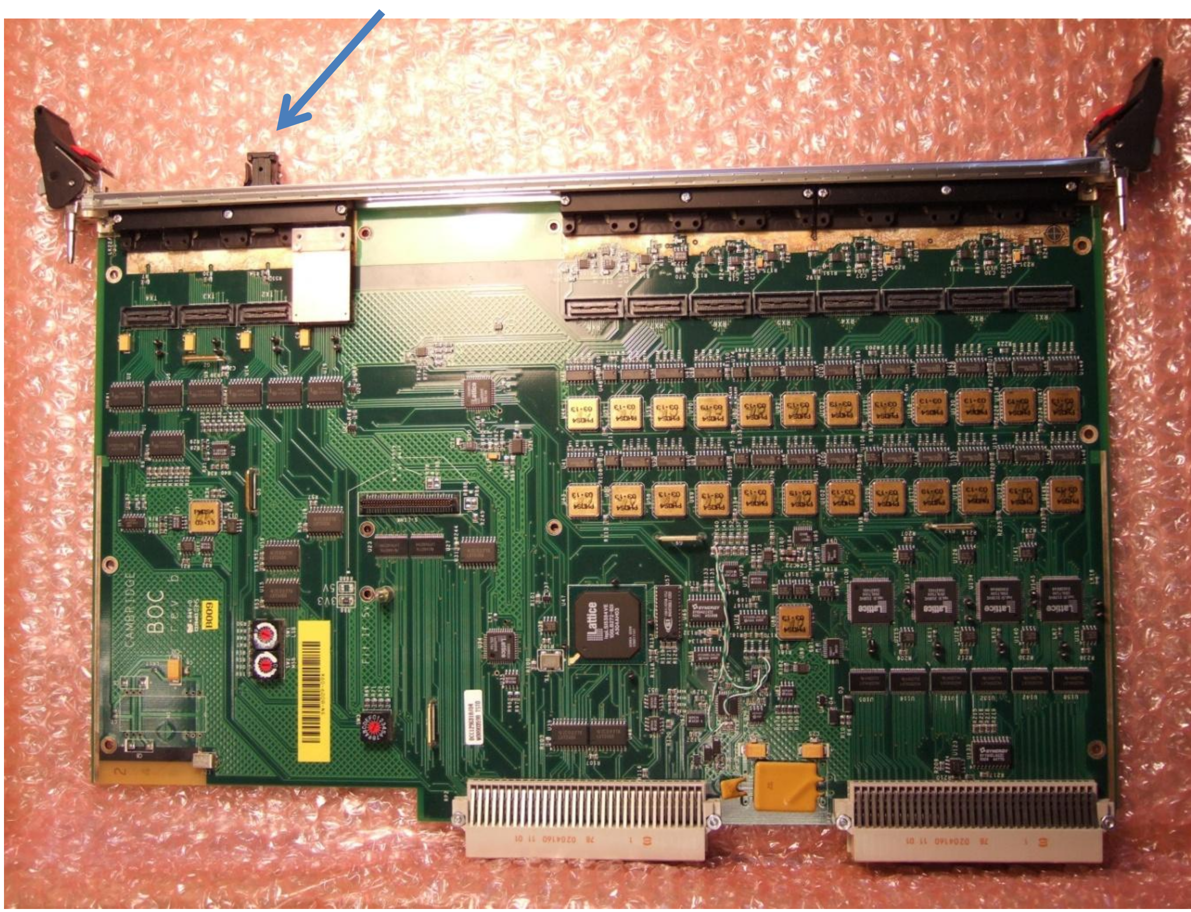
ATLAS iFlame TX

- **Short MTTF of TL VCSELs in ATLAS TX:**
  - **Humidity is a factor → replaced all TXs with similar devices with humidity resistant VCSELs from AOC**
  - **Still seeing some VCSEL deaths.**
- **Need a backup option:**
  - **Require full electrical/optical/mechanical compatibility with existing TXs.**
  - **Want a small format OSA with MT coupled VCSEL array and no laser driver.**

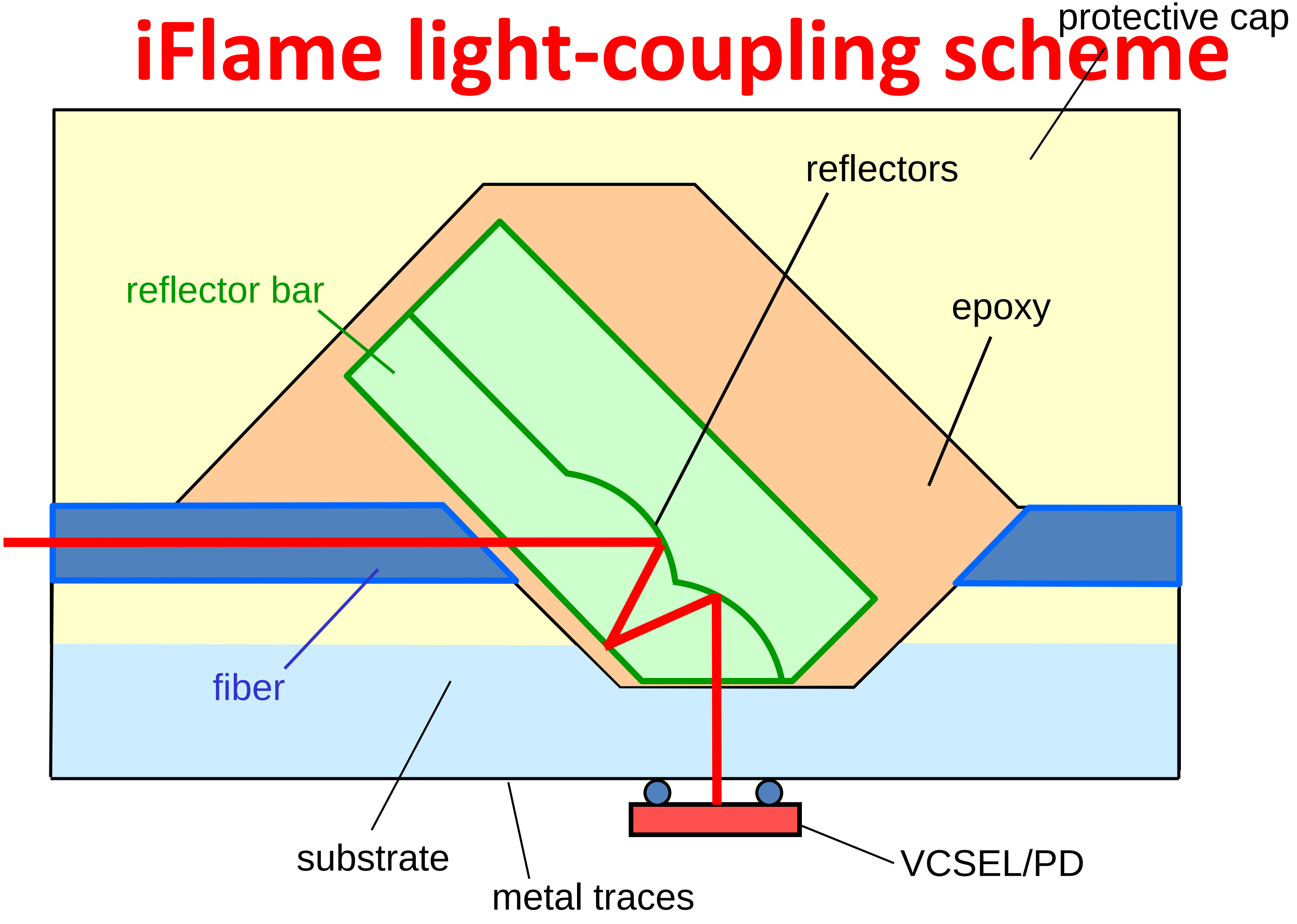
Constraints for TXs in BOC

- Backward compatibility for electrical & optical connections
- Tight space limits for width and height of TX

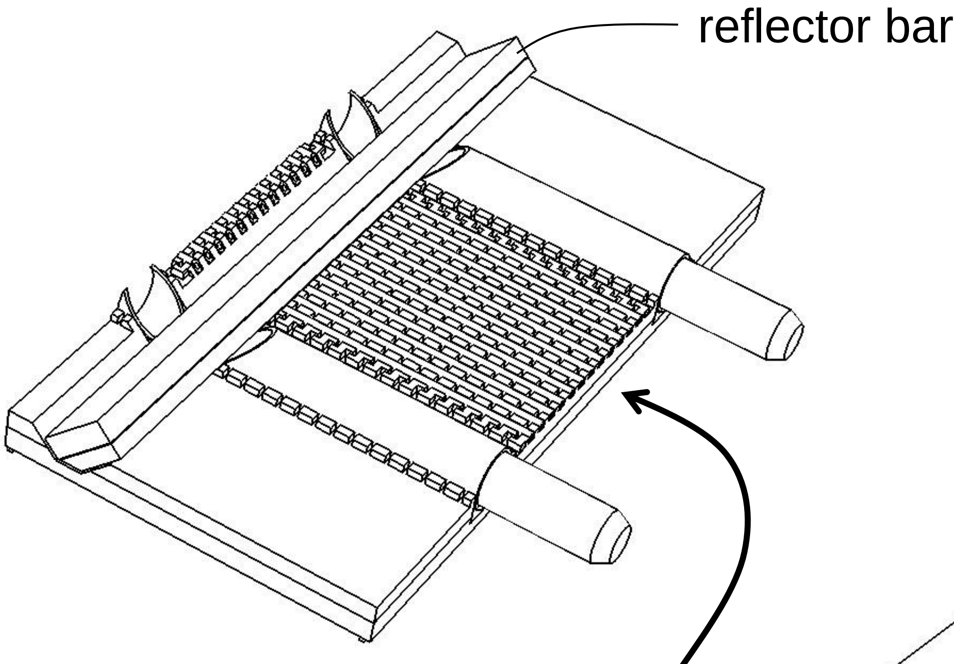
4 TX slots

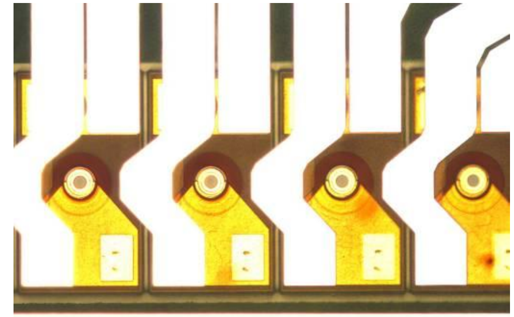


iFlame light-coupling scheme

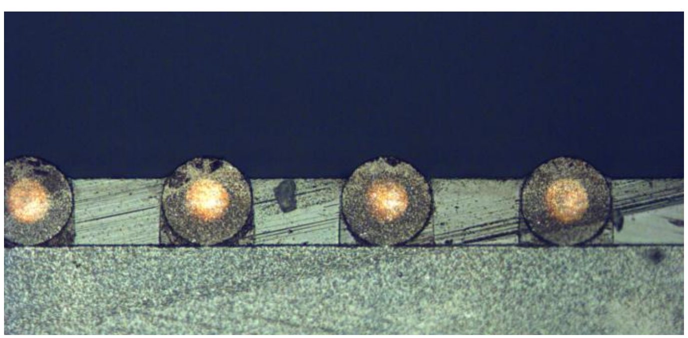


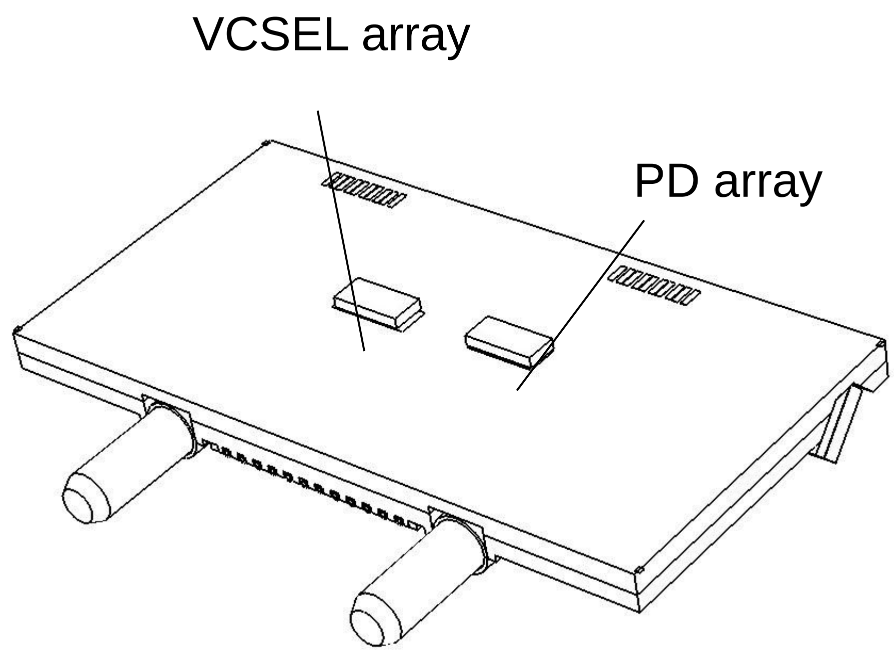
iFlame optical chip (without the cap)



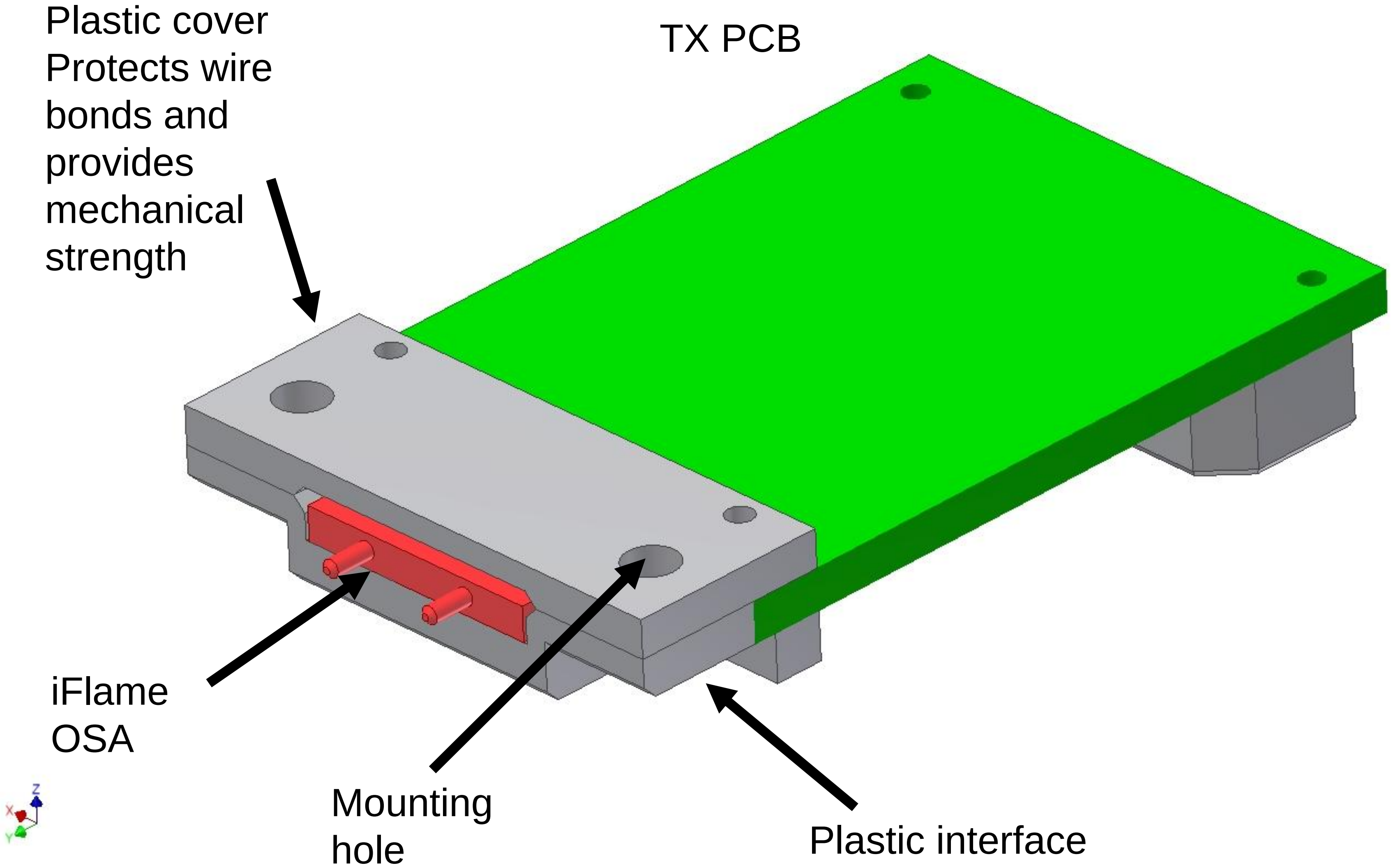


Mounted VCSELs
seen from optical side

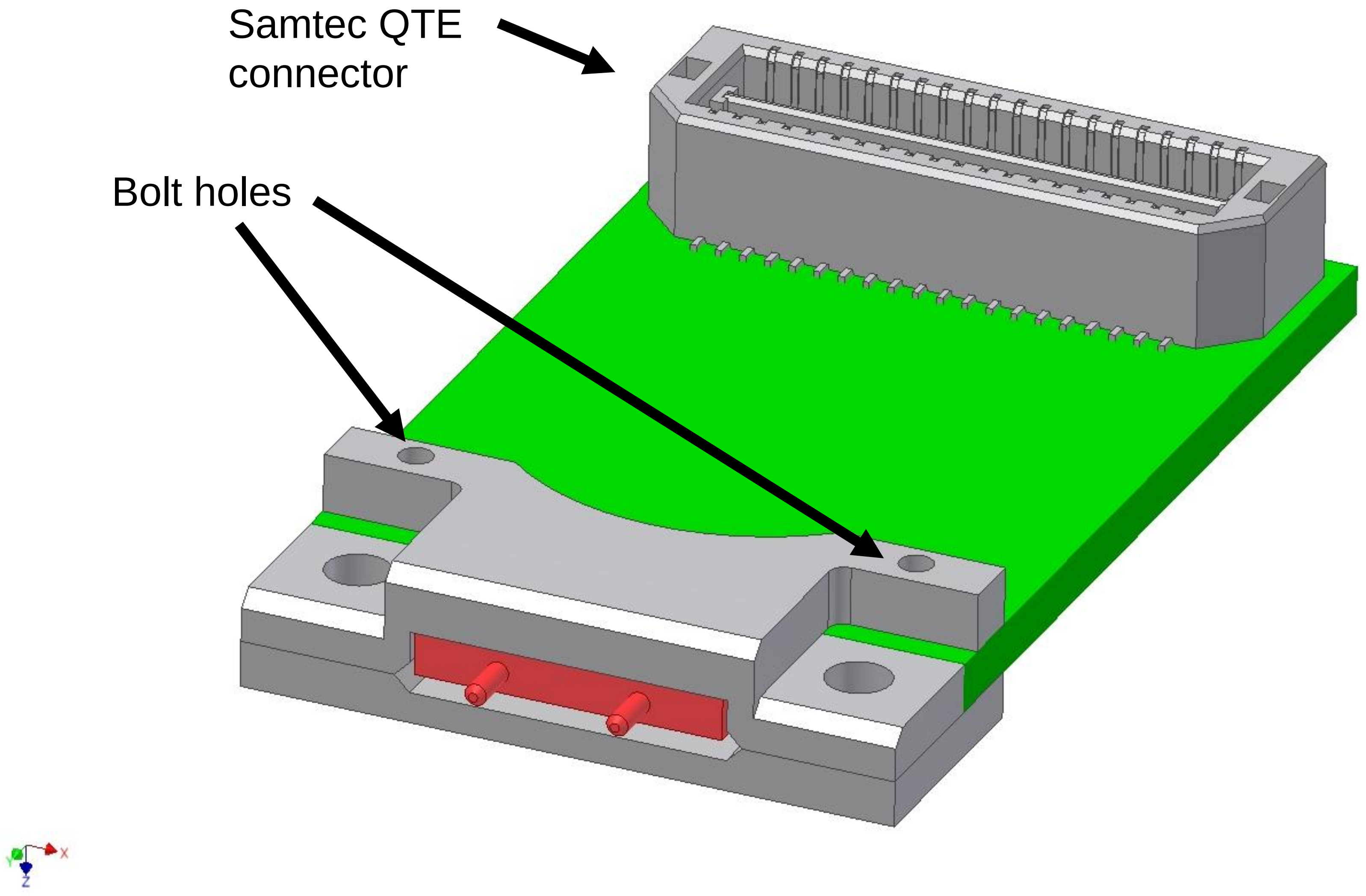




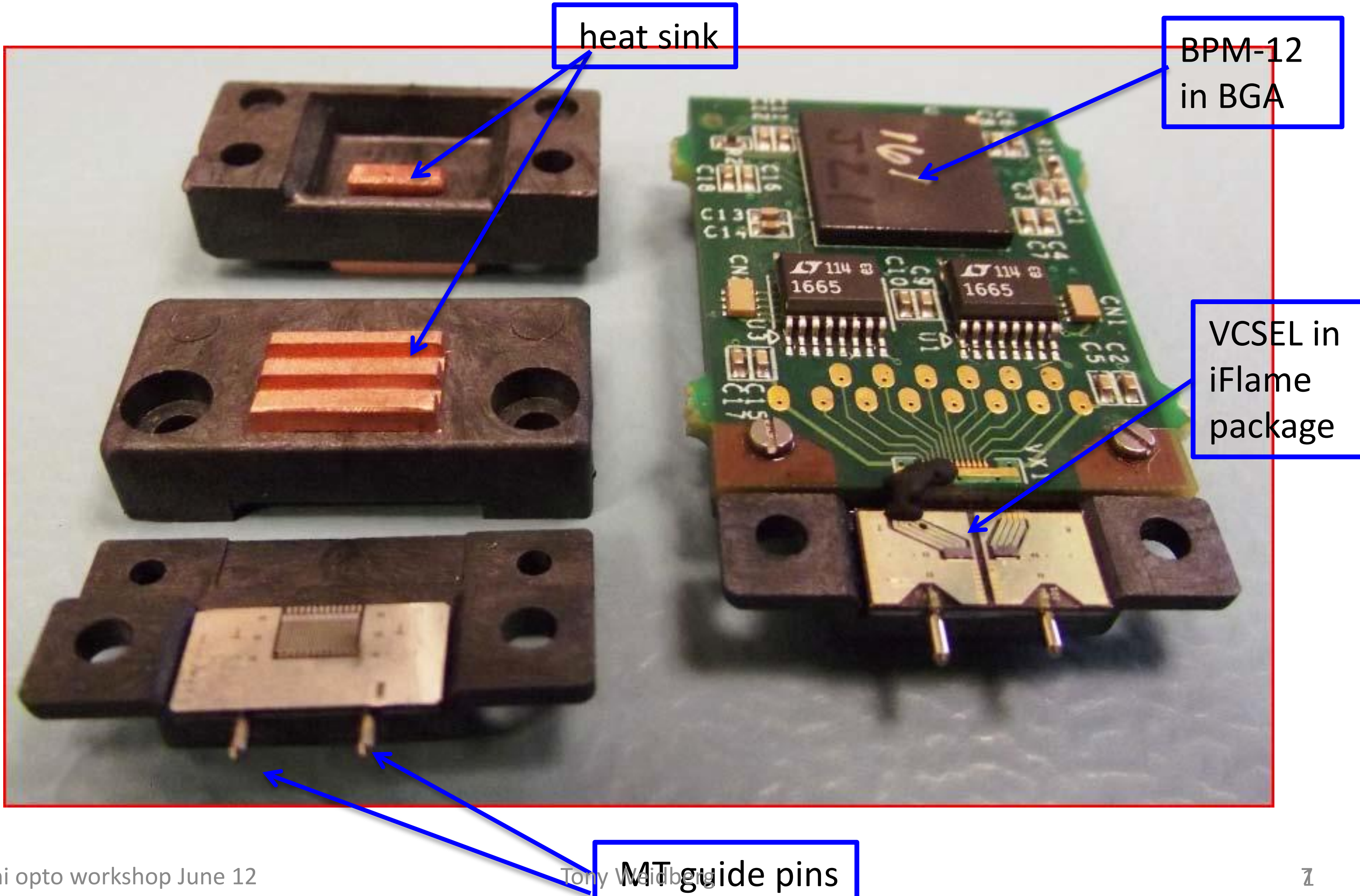
Top View


Plastic cover
Protects wire
bonds and
provides
mechanical
strength
TX PCB
iFlame
OSA
Mounting
hole
Plastic interface

Bottom View



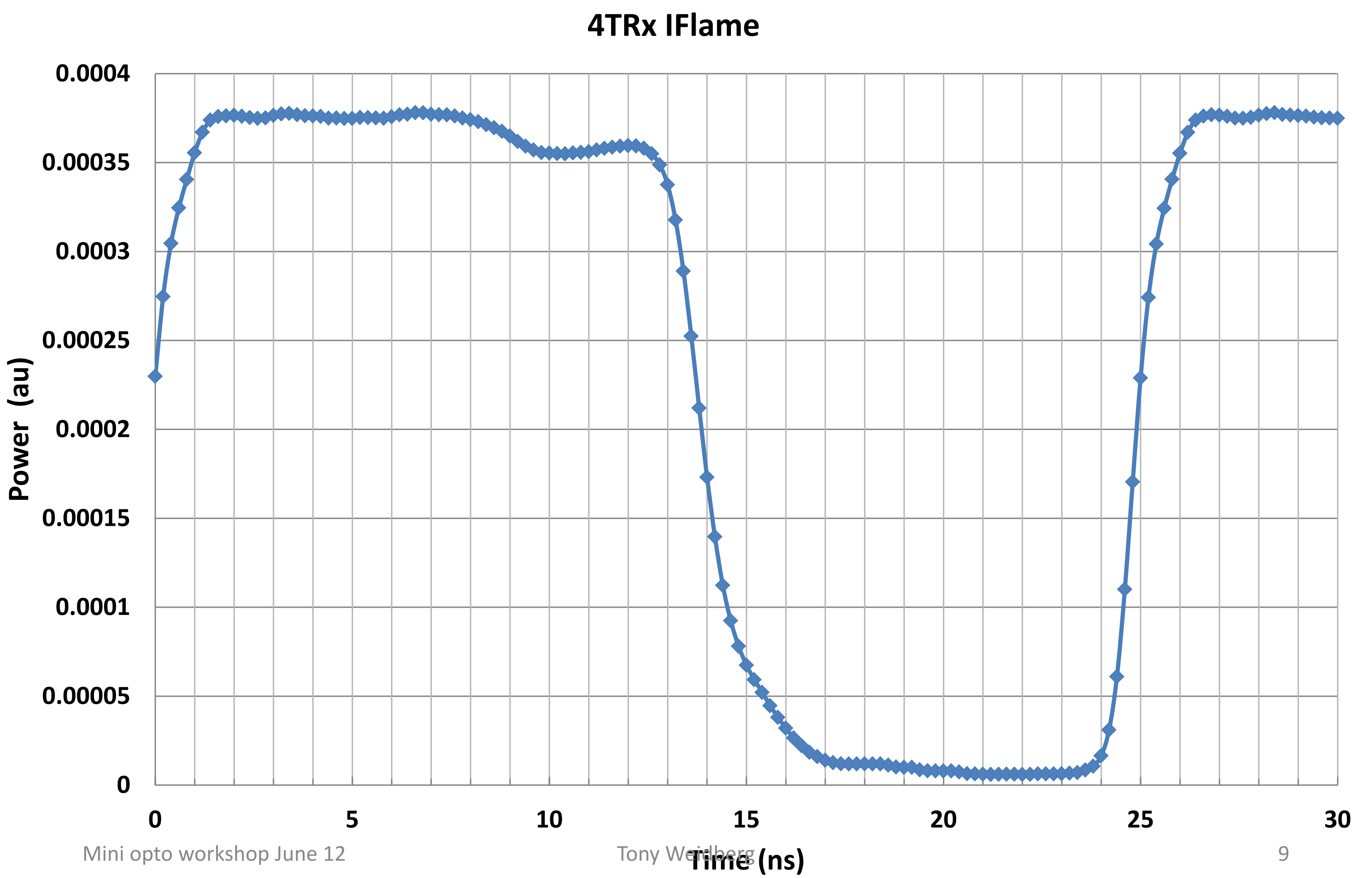
The iFLame TX



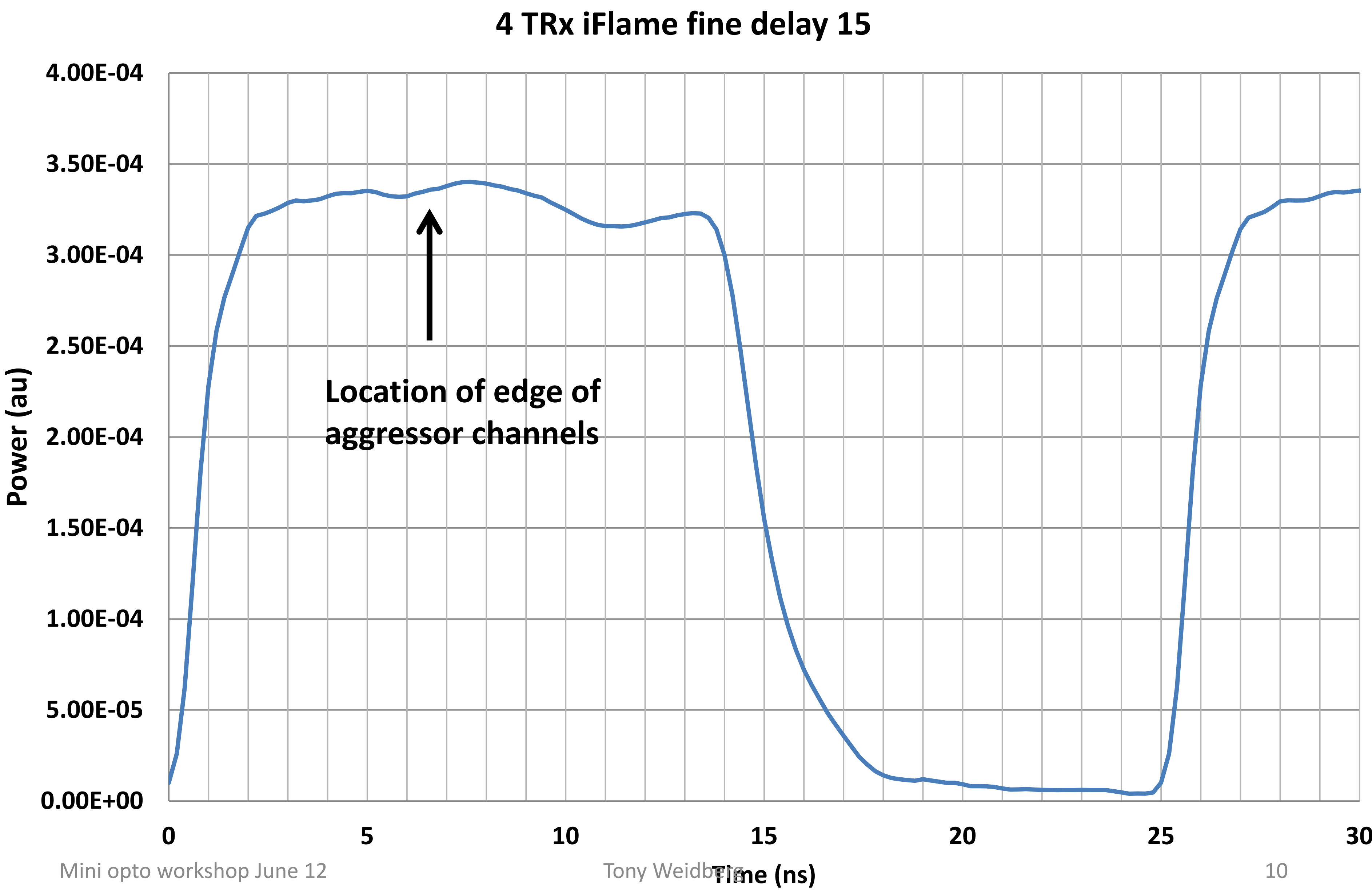
4 Channel TRx

- Used existing 4 channel TRx iFlame as proof of principle.
- Look at quality of optical signals and cross-talk (next slide).
- Used an iFlame to readout real SCT modules on the sector in SR1.
  - Worked fine.

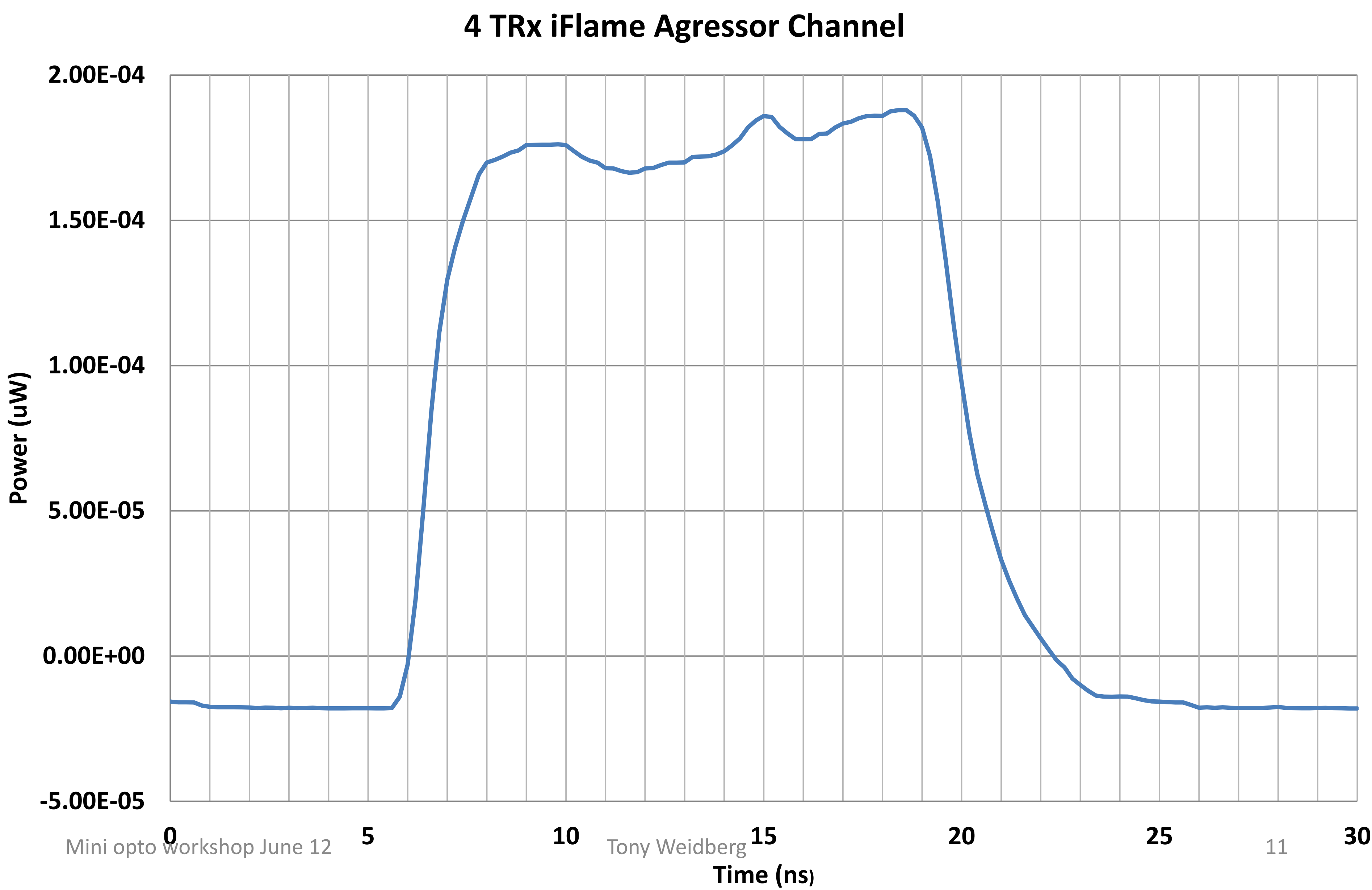
Optical Signal



Fine Delay 15



Aggressor Channel



4TRx Performance Summary

- **Clean optical signals despite very long wire bonds.**
- **Rise/fall times ok for 40 MHz**
- **No evidence for any cross talk**
- **Optical power above ATLAS spec for all channels.**

Thermal Management

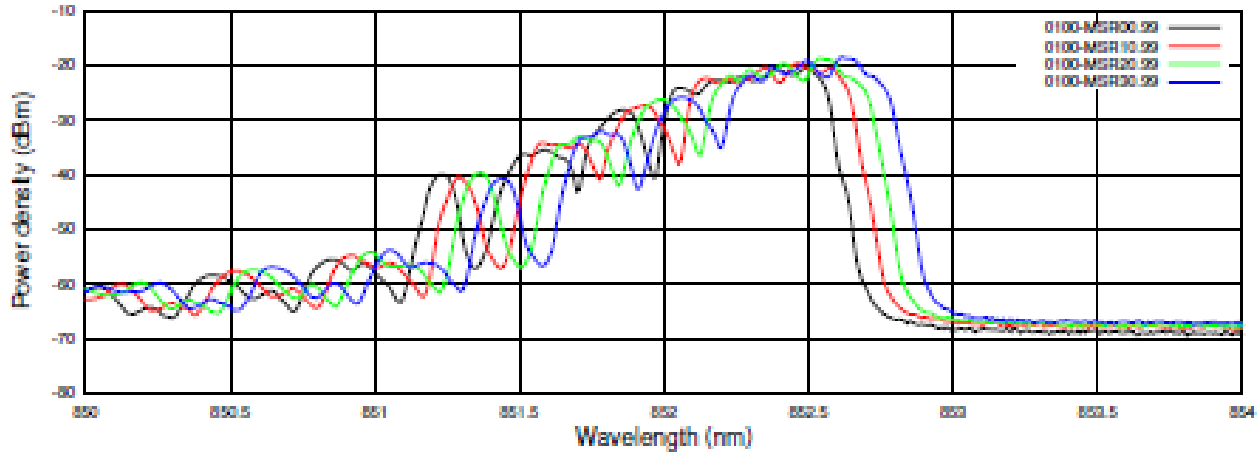
- Can't take heat out through iFlame to PCB because thermal conductivity of glass too low.
- Take heat out from the top:
  - Thermal putty
  - Cu heat spreader
  - Forced air flow over fins of heat spreader
- FEA checked with thermal measurements using OSA.

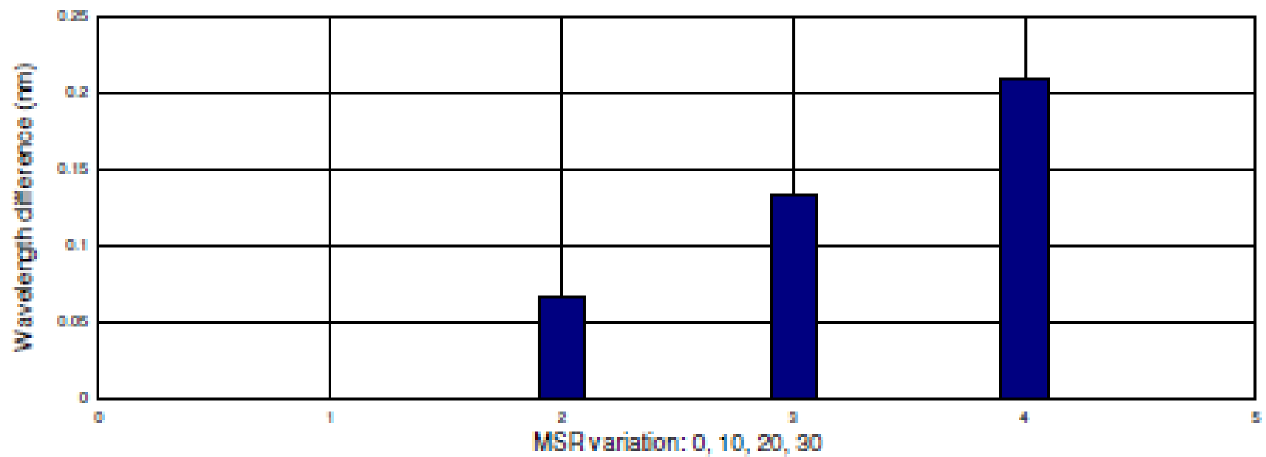
Thermal Measurements

- ULM data sheet: $d\lambda/dT$=0.007 nm/K for these VCSELs ➔ use OSA as a junction thermometer.
- However, λ also changes with I, so difficult to deconvolute effects of I and T if we vary I.
- Tobias's idea:
  - Vary duty cycle (change MSR setting in BPM-12 chip) and measure OSA.
  - Measure gradient of λ vs <power>
  - Gives thermal impedance of package.

Thermal Measurements

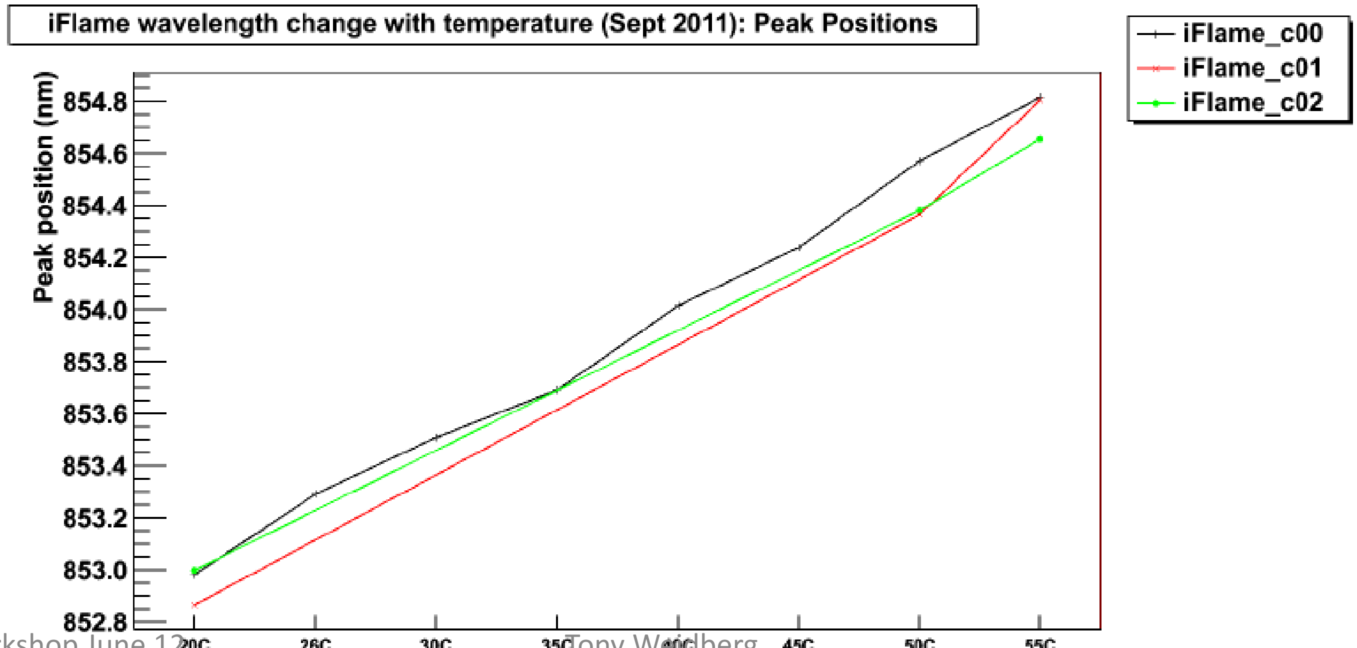
- **OSA for different MSR (0,10,20,30)**
- **Plot dλ for different MSR**





Calibration of OSA

- Measure peak l vs T and fit slopes → dλ/dT.
- Average value dλ/dT=0.061 nm/K (cf ULM data sheet: 0.07)



Thermal Impedance

- Assuming our measured value for dλ/dT we get values for thermal resistance:
  - 1050 ± 30 K/W.
  - For typical ATLAS operation <I>=5.5 mA, V=2V → ΔT ~ 10K which is acceptable.

Manufacture 12x

- Simple change to mask for Al tracks but …
- Incoming material: SoI wafer anodically bonded to borofloat glass (CTE match).
- Wafer processing includes:

1. Al deposition tracks
2. Plasma deposition SiO2 and SiN (moisture protection)
3. Openings for optical path through wafer for VCSELs
4. UBM & solder reflow

- Xloom steps include
  - Fibre attach
  - Lens (mirror)
  - VCSEL flip chip
- Wafer processing for 4TRx iFlame was done by Israeli military company but they no longer wish to do this work ➔ new manufacturer found but long delays … hope to see first 12x in ~ 2 weeks …

Outlook

- **iFlame/TX PCB integration demonstrated functionality with 4 channel TRx**
- **Long delays with 12x but hope to see devices soon …**
- **Need for lifetime tests with 12x devices (very limited testing with 4TRx).**