Opto & Power Board (OPB)

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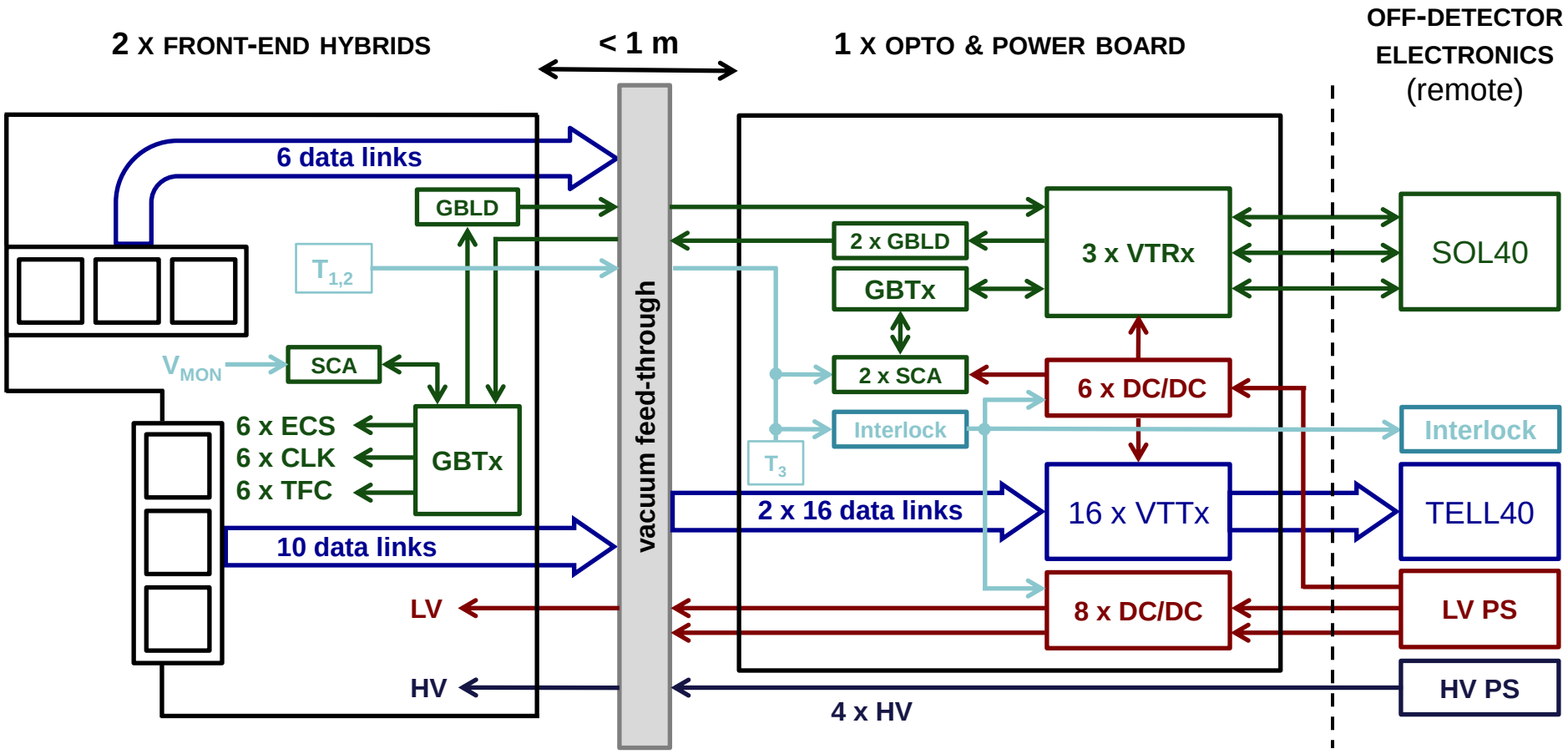
Summary of the functionality of the opto & power board

Electronics overview

One OPB serves one module = 2 hybrids

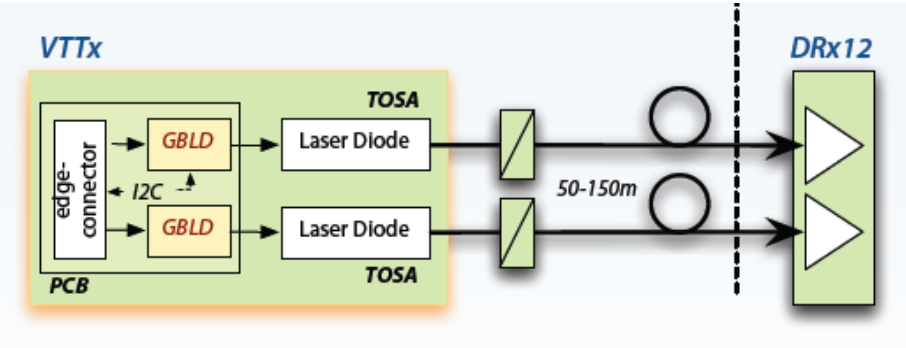


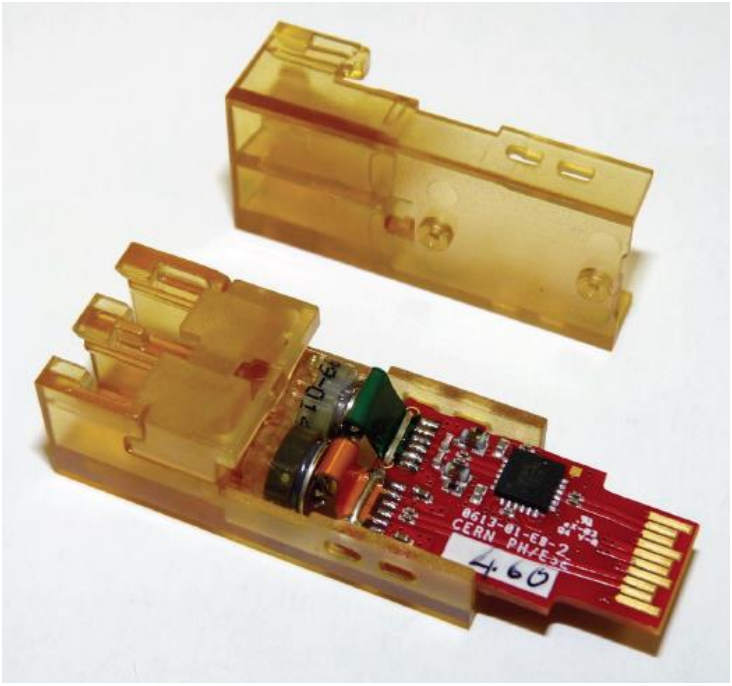
Functionality of the OPB

- Electrical-optical conversion of the 32 data links
- Optical-electrical-optical conversion of the 3 control links
- Local control of the OPB (DC/DC + opto components)
  - Also providing the control interface for the hybrid
- DC/DC conversion of voltages for the hybrids
- DC/DC conversion of voltages for the OPB itself
- Temperature monitoring of the hybrid
- Temperature interlocks for hybrid and OPB

Electrical-optical conversion of data links

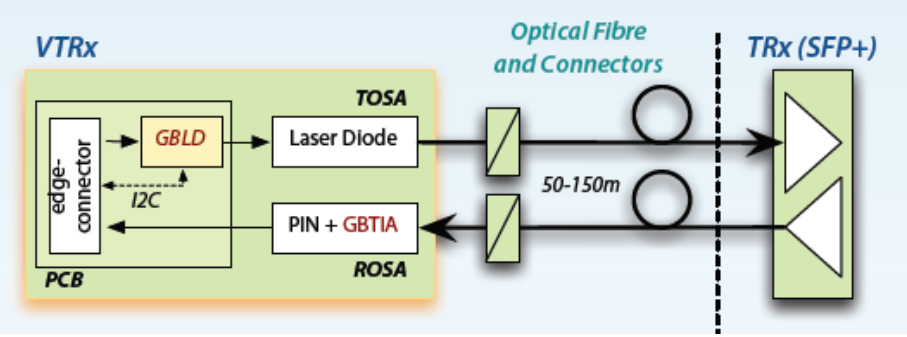
- Will use 16 VTTx modules, mounted as mezzanines
  - Edge connector brings signals from motherboard
- Supply voltage: 2.5 V, 300-400 mA
- Control: I^2C bus with 2 devices + enable signal
- Radiation qualification (according to spec)
  - 500 kGy, $5x10^{15}$ n_{eq}/cm^2
- Questions
  - Is metal housing a possibility?
  - How is the heat removed?

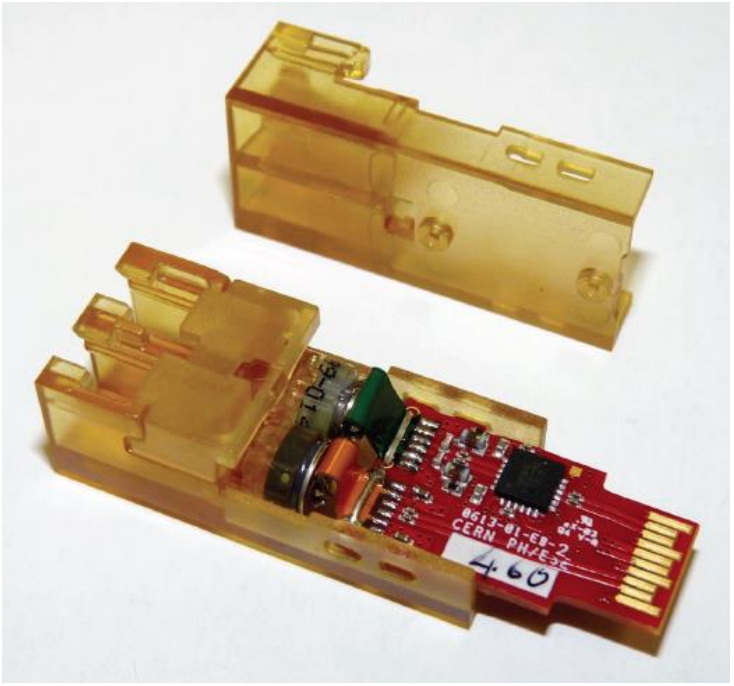




Opto-electrical conversion of control links

- Will use 3 VTRx modules, mounted as mezzanines
  - Edge connector brings signals from motherboard
- Supply voltage: 2.5 V, 200-250 mA
- Control: I^2C bus with 1 device + enable signal
- Radiation qualification (according to spec)
  - 500 kGy, $5x10^{15}$ n_{eq}/cm^2
- Questions
  - Is metal housing a possibility?
  - How is the heat removed?





Control and configuration

- Each OPB has 3 bi-directional optical control links
  - 1 for each hybrid plus 1 for local control
- Control and configuration of the hybrid
  - 1 GBTx and 1 SCA mounted on each hybrid, providing
    - 6 clocks
    - 6 or 12 e-links for configuration
    - 6 e-links for TFC commands
    - SCA used for voltage and DAC output monitoring
  - 1 High-speed electrical control link per hybrid and per direction
  - GBLD ASICs drive the electrical links
    - 1 on each hybrid, 2 on the OPB
- Control and configuration of the OPB
  - The OPB has one GBTx and two SCA for local control

OPB local control

- GBTx has a special link to configure the VTRx used for local control
- Devices controlled by the "SCA-opto"
  - 16 I^2C buses for the 16 VTTx
  - 16 digital out to disable 16 VTTx
  - 2 digital out to disable 2 VTRx for hybrid control
  - 12 ADC channels for hybrid & OPB temperature monitoring
- Devices controlled by the "SCA-power"
  - 3 ADC channels for monitoring the input voltage
  - 14 ADC channels to monitor the 14 DC/DC output voltages
  - 16 digital inputs to read V_{OK} from the 16 DC/DC converters
  - 12 digital outputs to enable 12 DC/DC converters (2 always on)
  - 2 I^2C buses to configure the 2 VTRx for hybrid control
  - 2 I^2C buses to configure the 2 GBLDs on the OPB

DC/DC for the hybrid - VeloPix

- Will use the rad-hard DC/DC modules
  - Tested to 5×10^{13} p/cm^2 @ PSI and 547 MRad with x-rays
- VeloPix power requirements
  - V = 1.5 V, $I_{digital} < 1$ A and $I_{analogue} < 1$ A per VeloPix
  - One sensor tile (3 VeloPix) share 1 analogue and 1 digital supply provided by 2 DC/DC converters
  - 4 DC/DC converters & 1 primary power supply channel (~5 V) per hybrid
- Load on the DC/DC converter (75% efficiency)
  - DC/DC conversion factor: 5 V/1.5 V = 3.3
  - 3 A @ 1.5 V output => 1.2 A @ 5 V input
- 2 hybrids & 2 PS channels per OPB
  - 2 x 4.8 A @ 5 V input
- Head dissipation
  - 36 W on the hybrid
  - 12 W on the OPB

DC/DC for the hybrid – support electronics

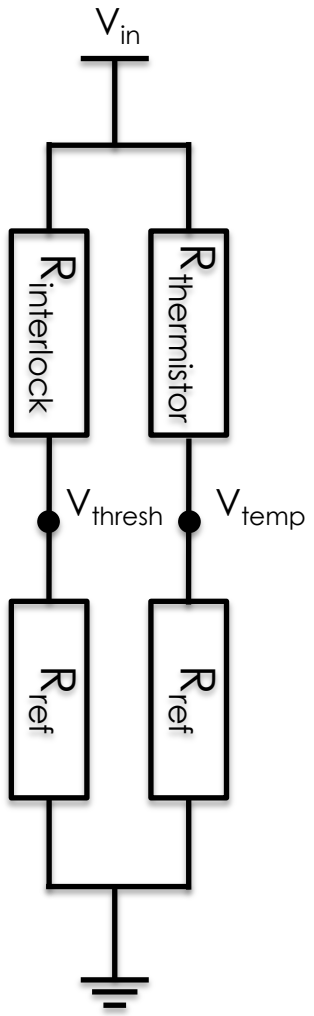
- Support electronics power requirements
  - GBTx: 1.5 V, 1 A ?
  - SCA: 1.5 V, 300 mA ?
  - GBLD: 2.5 V (1.5 V possible?), 150 mA?
- Total estimated power
  - 1.3 A @ 1.5 V and 0.3 A @ 2.5 V
  - 1.6 A @ 1.5 V (if GBLD can be powered with 1.5 V)
- Supplied by rad-hard DC/DC converters
  - GBTx powered from the digital supply of the 'far' pixel tile
    - SCA from the 'near' tile digital supply?
    - Digital consumption depend on occupancy
  - Separate supply, both 1.5 and 2.5 V?
- Control signals
  - Enable (input), power good (output)

DC/DC for the OPB

- 16 VTTx powered by 2 DC/DC converters (75% efficient)
  - 8 x 400 mA @ 2.5 V per DC/DC
  - Input 2.1 A @ 5 V
- 1 always enabled 2.5 V DC/DC (75% efficient)
  - 3 VTRx consuming 3 x 300 mA
  - 2 GBLD consuming 2 x 150 mA
  - 1.2 A @ 2.5 V => 800 mA @ 5 V
- 1 always enabled 1.5 V DC/DC (75% efficient)
  - 2 SCA consuming 2 x 300 mA
  - 1 GBTx consuming 1 A
  - 1.6 A @ 1.5 V => 650 mA @ 5 V
- Total: 4 DC/DC converters
  - One 5 V power supply channel with 3.6 A
  - 18 W dissipated on the OPB

Temperature monitoring & interlock

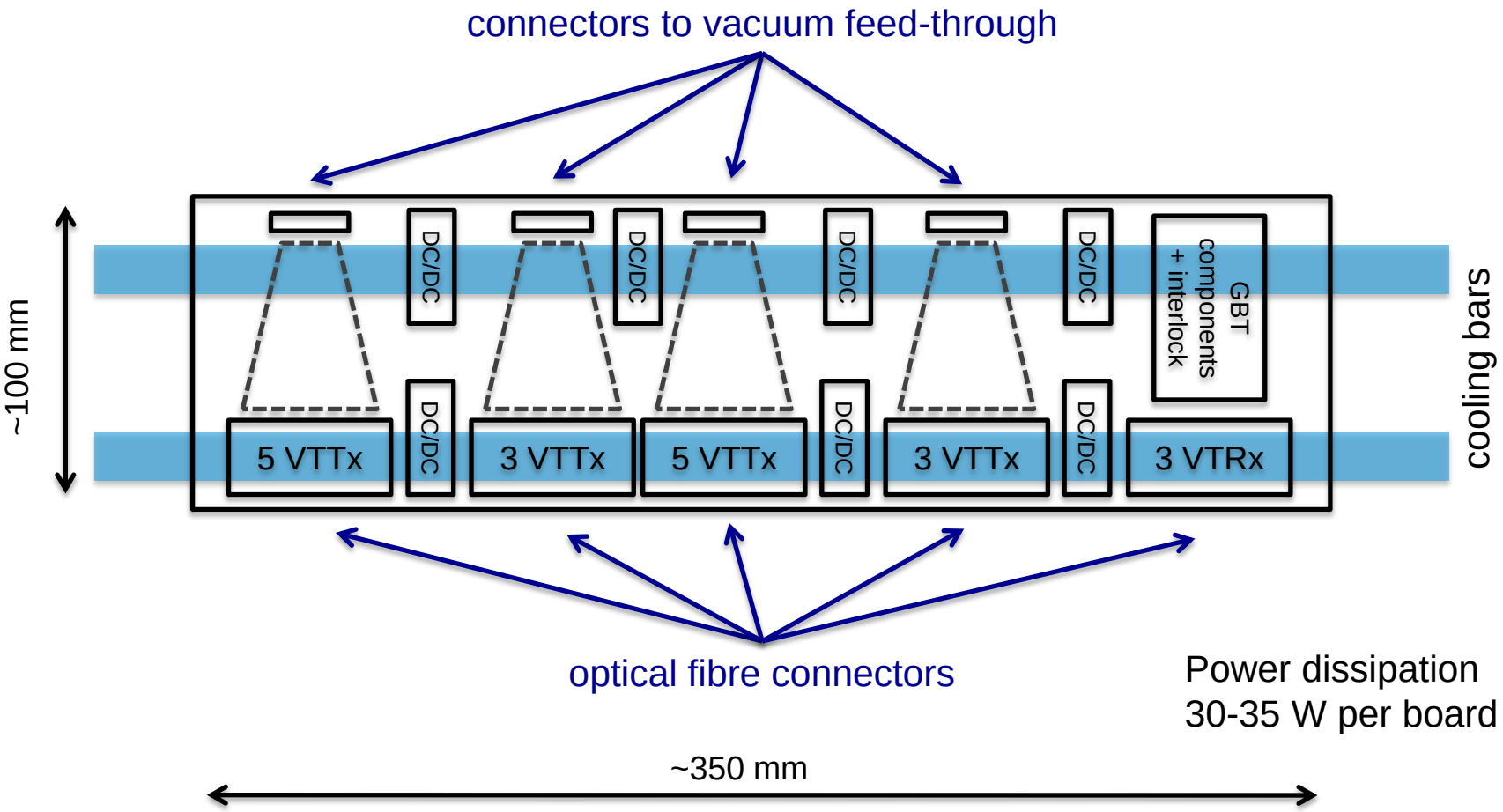
- 2 thermistors on each hybrid and 2 on the OPB
  - Connected with voltage divider located on the OPB
- Measured with two ADC channels
  - Vin and Vtemp
- H/W interlock circuit comparing voltages V_{thres} & V_{temp}
  - $R_{interlock}$ sets the shooting point
- DC/DC converters are enabled by local AND between enable from SCA and the interlock signal
  - Interlock signal sent off-detector as well
- Interlock signals collected by the Interlock Box
  - From all OPBs, vacuum, cooling and from beam conditions.
  - Enables LV and HV power supplies
  - Provides monitoring of the interlock states



Component count (preliminary)

Item	per module	VELO total
Data links	32	1664
Control links	3	156
VTTx units	16	832
VTRx units	3	156
VeloPix	12	624
GBTx	3	156
SCA	3	156
GBLD	4	208
DC/DC modules	14	728
LV channels	3	156
HV channels	4	208

Cartoon layout (first guess)



Summary

- The Opto & Power Board (OPB) provides the electrical interface to the front-end module
- It fulfils the following purposes
  - Opto-electrical conversion of data & control
  - DC/DC conversion of supply voltages
  - Local control and monitoring
  - Temperature monitoring & interlock
- It can be build almost completely with versatile link and DC/DC project components
  - Only COTS components on in the interlock circuit
- Functionality fits on one PCB
  - But active cooling will be required