Nikhef Module 0

Module 0 objectives

0 - create a timepix4 module that can be operated to take data at high rate.

1 - investigate low material cooling substrates with < 0.5% X0, that can handle at least 2W/cm2

2 - investigate effective adhesion solutions/alternatives.

3 - investigate solutions for LV power supply that minimise material

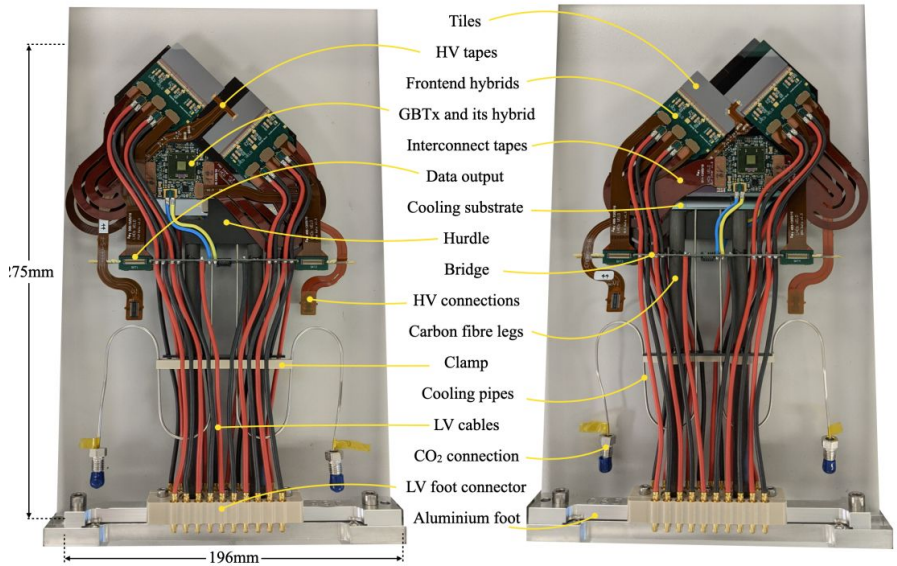
4 - Develop control firmware / software (lpGBT control)

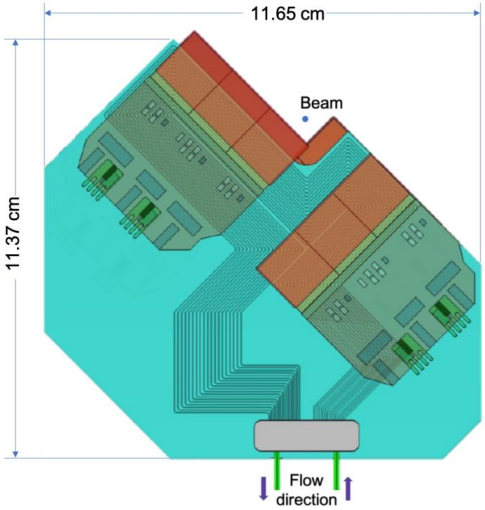
5 - Early testbed for picopix -- VeloPix2 prototype

~~4 - Try to provide stable clock distribution → TSV?~~

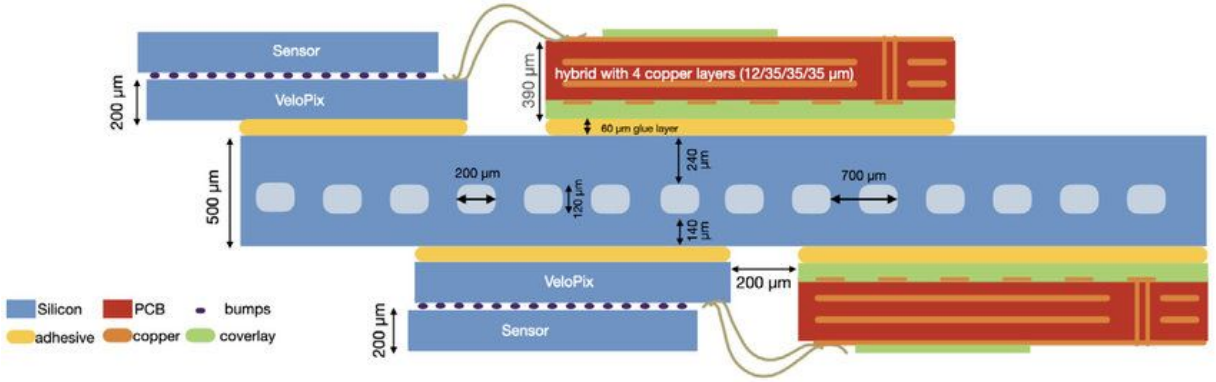
~~5 - minimise total amount of material -- combine functions in the substrate or module support.~~

Current velo module





Light cooling.
Heavy LV. Awkward HV.
Data lines independent - GWT
Control via GBT.
Awkward interconnect



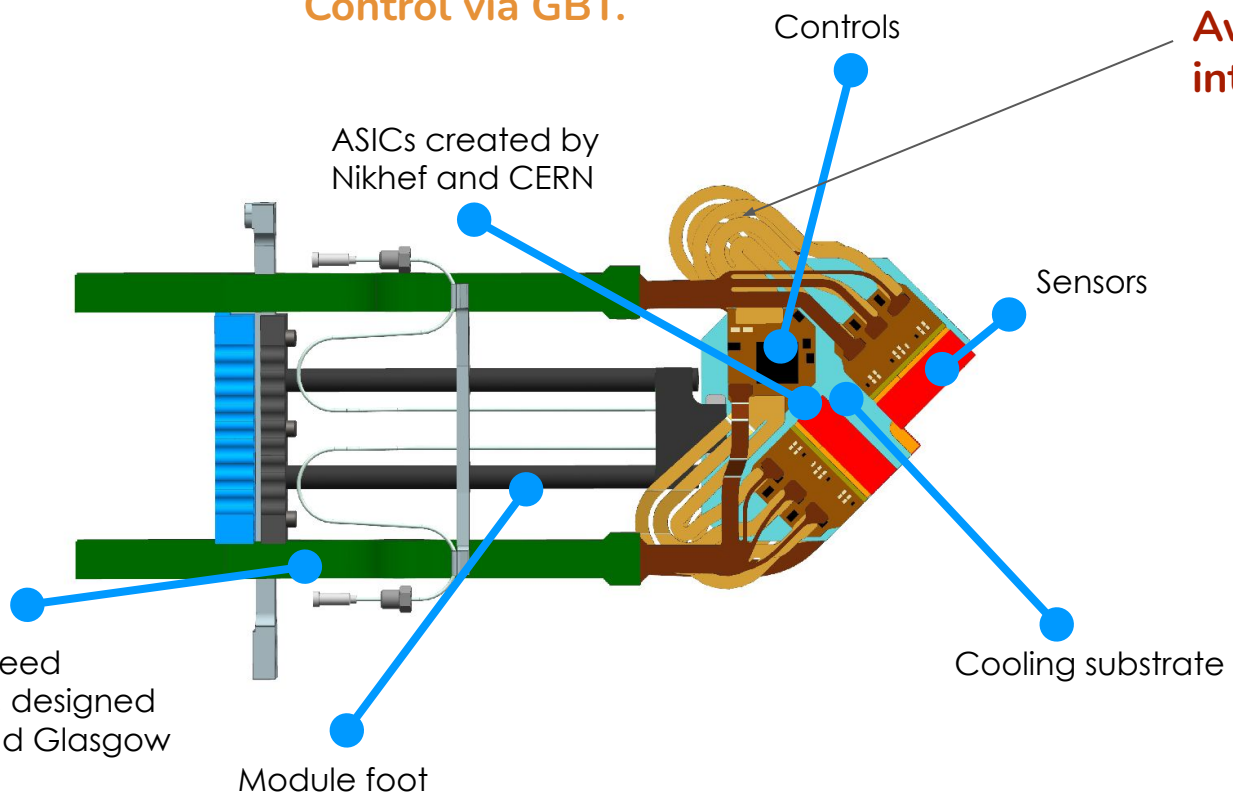
Nikhef

Current module

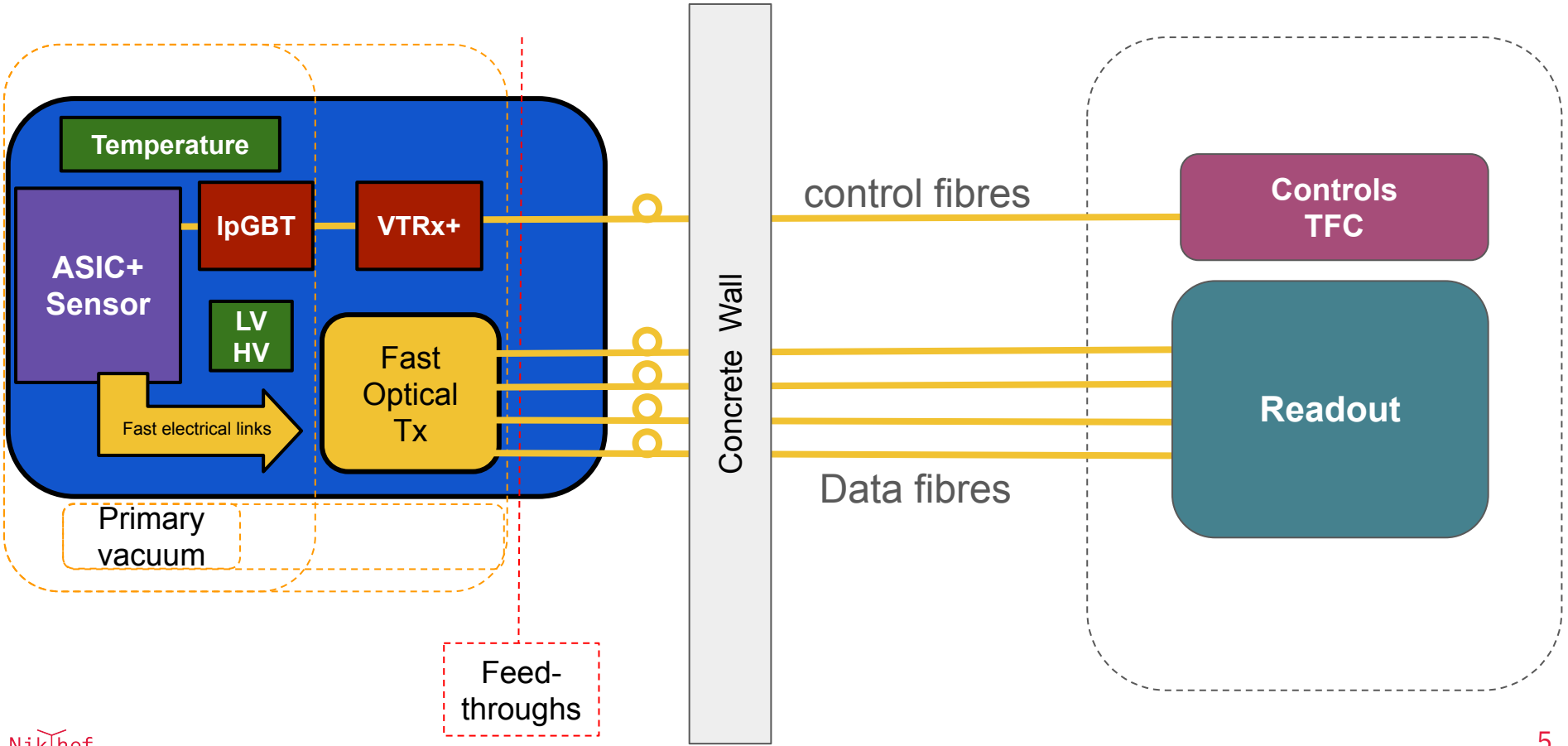
Neutral:
Data lines independent - GWT
Control via GBT.

Bad points:
Heavy LV.
Awkward HV.
Awkward interconnect

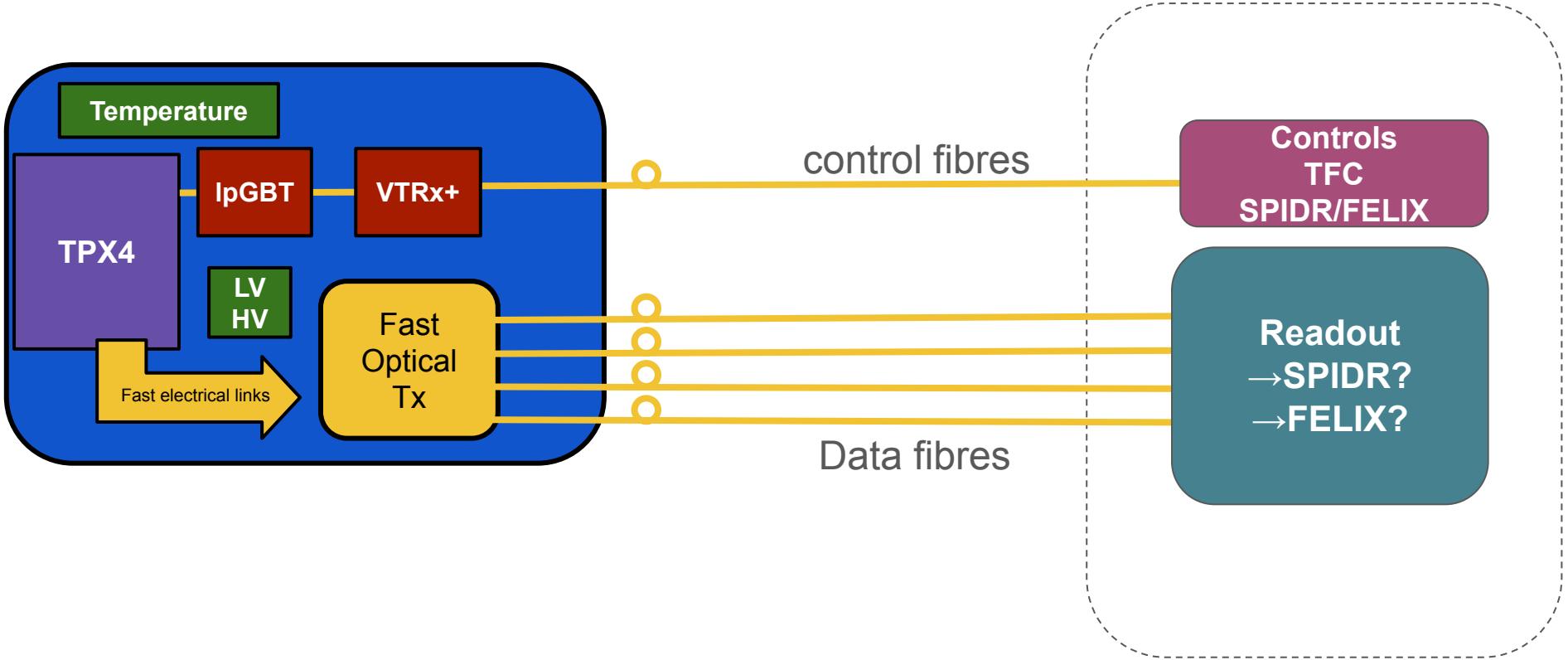
Good points:
Light cooling.
Light support.



Electronics Slice -- to be adapted and finished



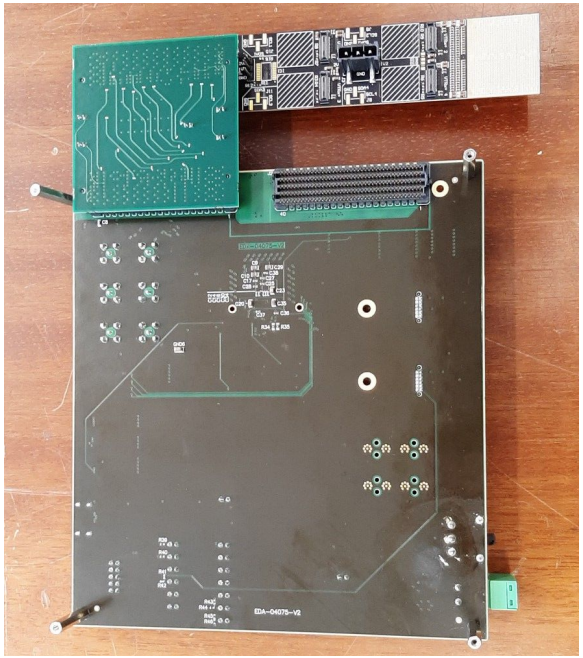
Idea of the Module 0 Slice

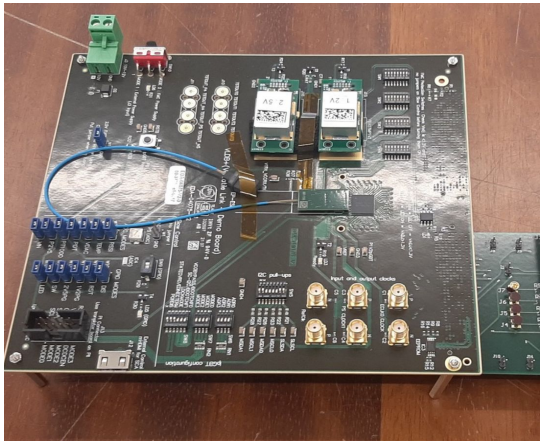


Module 0 Requirements

- Single Timepix4 plane controlled with a lbGBT
- Thin cooling substrate using prototype substrates
  - Can use CO2 or liquid.
  - Must be able to cool down to -40 C to test irradiated prototypes
  - Estimated power 1.5-2 W/cm2
- DAQ speed → 10 MHz over whole detector area
- Material → Minimise amount of material only behind the ASIC/sensor
  - → Can we have a cutout?
- Material → radiation hard to 1 Grad or 5e16 neq
  - This is for best effort only.

Ongoing work





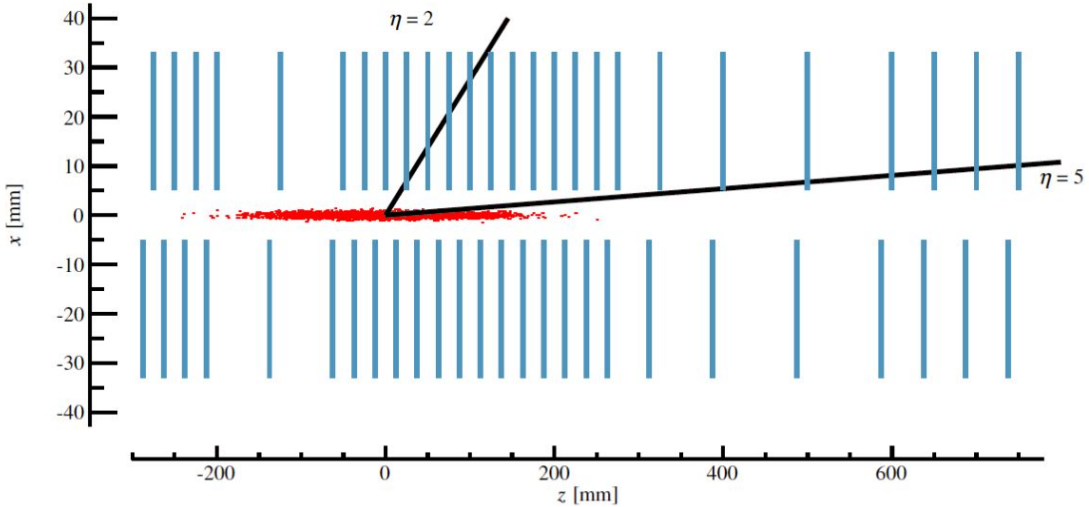
LpGBT demo board
+ FMC adaptor

Compatible with Nikhef spidr

Module development Timeline

- Module production to start by end of 2029.
- VELO U2 specific Module design ready by end of 2028.
- Module pre-production expected in 2028
- VELO U2 specific Module design ready by end of 2027.
- Single Picopix based module by end of 2026.
- Ideally we would like to have a prototype using timepix4 by end 2025.

General Physics requirements



Amount of material before the 2nd hit should be smaller than upgrade 1 ⇒

Sensor + ASIC < 400 μm silicon,

Cooling substrate < 500 μm Silicon (~0.5%X0)

Modules should present an angular coverage from about 15 mrad to 270 mrad.

Closest distance chosen to be 7.2 mm instead of 5.1 mm.

Z arrangement under discussion