Power Supply of Front-End Electronic in RICH/TORCH Upgrade

Rui Gao, University of Oxford
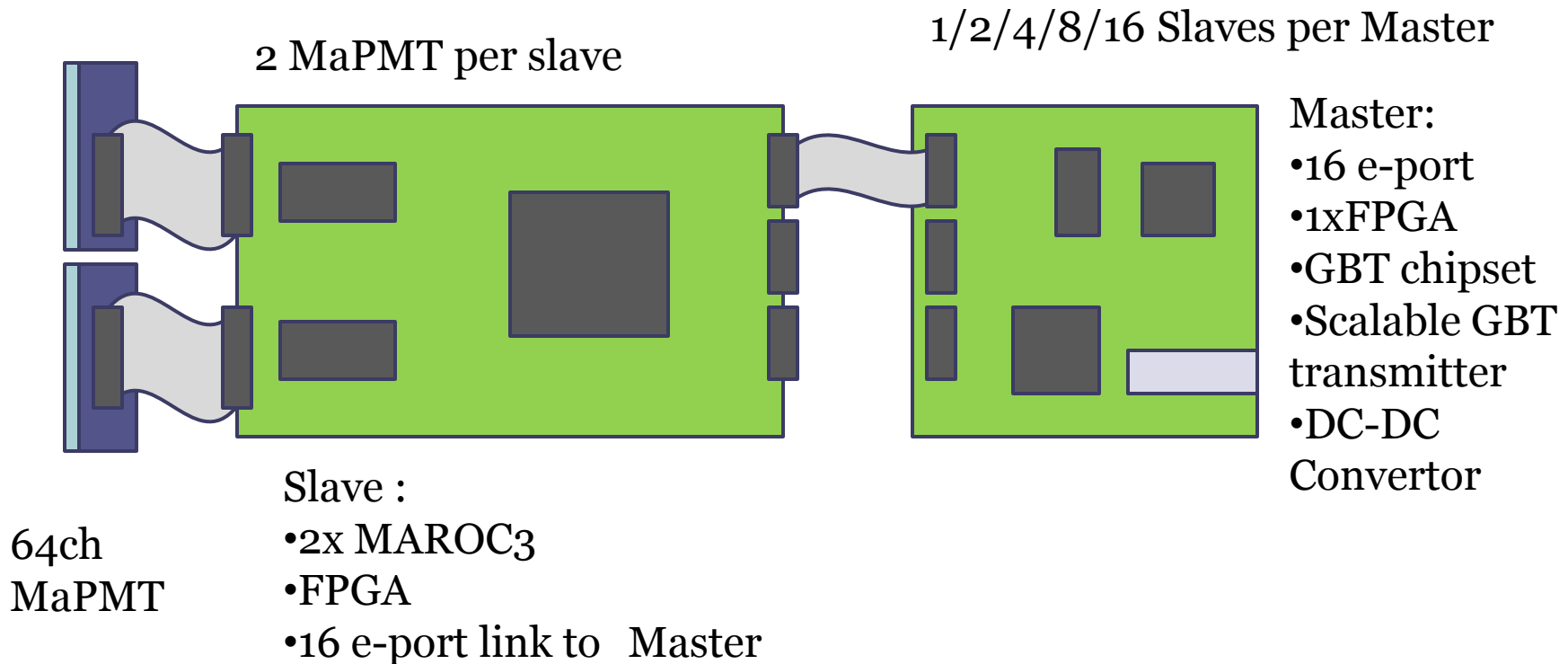
LHCb Upgrade Electronics Meeting
14th April, 2011, CERN

UNIVERSITY OF OXFORD

LHCb

RICH/TORCH Upgrade FE Electronics

- New devices: Hamamasu R7600/R11265 MaPMT, in RICH, and MCP in TORCH,
- Binary readout / TOF measurement,
- Higher readout rate, un-triggered readout,
- Use of GBT chipset,
- Use of DC-DC convertor.

- Cabling would be very similar to current RICH,
- Would re-use the current power supply module for RICH upgrade, same power supply for TORCH.

RICH Front End

2 MaPMT per slave

1/2/4/8/16 Slaves per Master

Master:
- 16 e-port
- 1xFPGA
- GBT chipset
- Scalable GBT transmitter
- DC-DC Convertor

64ch MaPMT

Slave :
- 2x MAROC3
- FPGA
- 16 e-port link to Master

Detector	MaPMT	Slave	Master	GBT
RICH1	1152	504	72	72
RICH2	2560	1280	160	160

Devices and Assumptions

- Hamamatsu R7600/R11265 64ch MaPMT,
- The MAROC3 64-ch, 250mW,
- Rad-hard or tolerant FPGA, 300mW,
- Discretes, 100mW per board,
- GBT user bandwidth 2.5~3.2Gbps, GBTX-1.5W, GBLD – 380mW, GBTIA-123mW, GBTSCA – unknown.
- Scalable GBT interface, primary GBT has both trans. and recv., add-on GBT has trans. only.
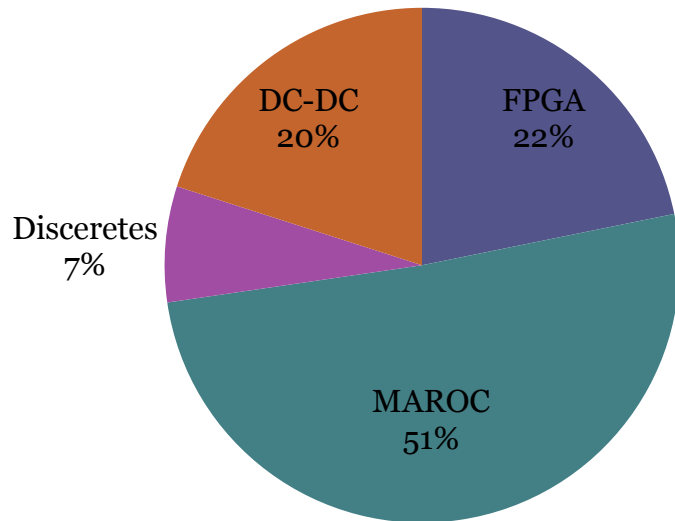- *Assumption Ave. Occupancy 1% !*

RICH Voltages and Currents

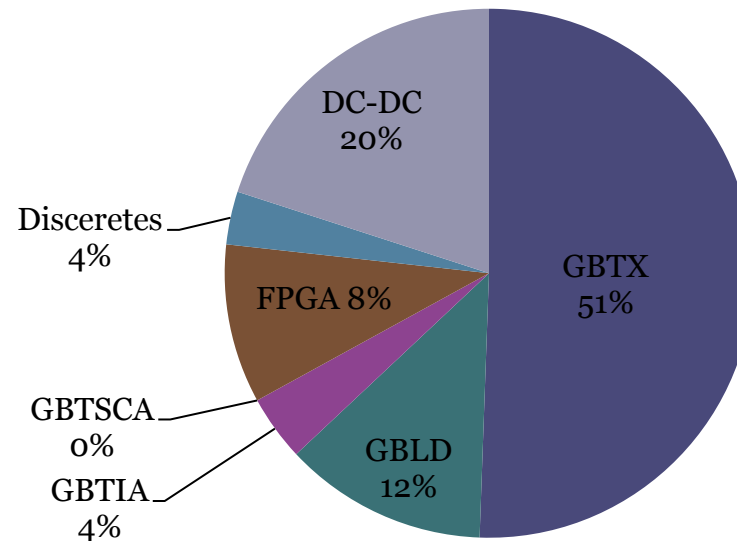| Voltage	Device	Est. Current (mA) Slave/Master
1.2v	FPGA (core), e-port drive & receiver	100 / 100
1.5v	GBTX	None / 1100
2.5v	FPGA I/O, GBTIA, GBLD, GBTSCA, Flash RAM, MAROC3	400 / 300
3.3v	"Legacy" device s, FPGA I/O	20 / 20

- Hopefully never need 3.3v,
- The Actel rad-hard *ProASIC3E* use 1.5v core voltage, no need for 1.2v,
- Radiation not so bad – comments?

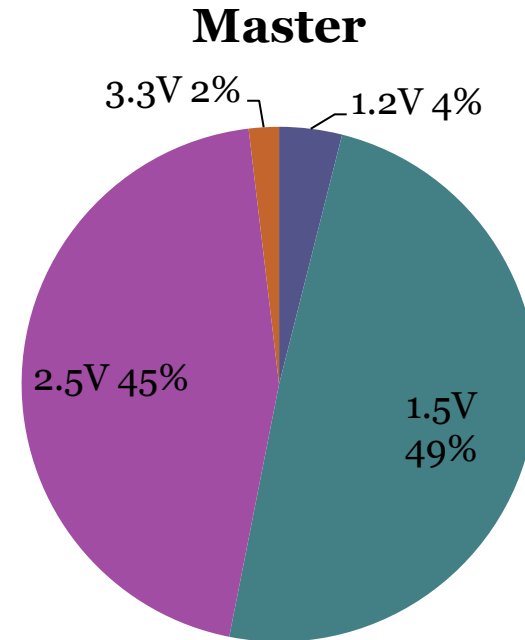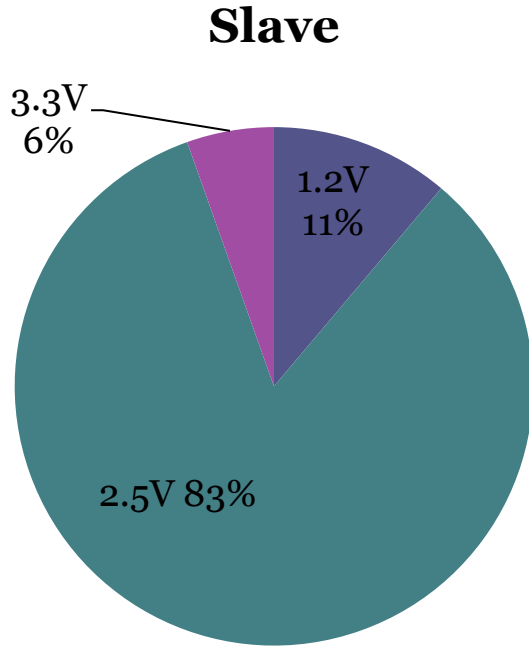# RICH Power Consumption by Device
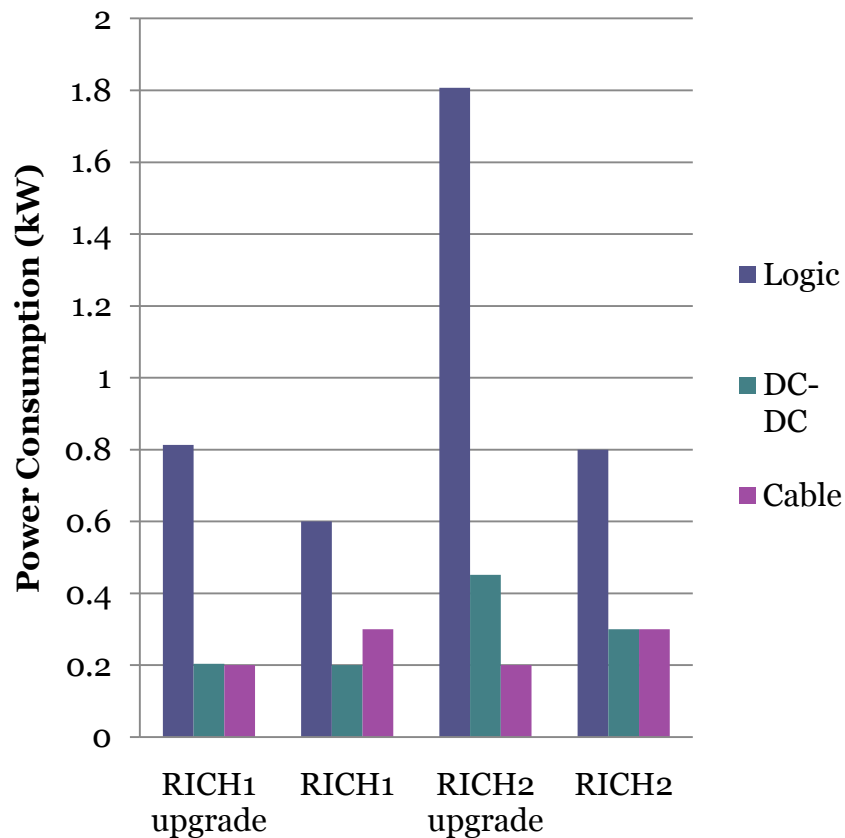
Slave

Master

Slave pie chart: FPGA 22%, MAROC 51%, Disceretes 7%, DC-DC 20%

Master pie chart: GBTX 51%, DC-DC 20%, Disceretes 4%, FPGA 8%, GBTSCA 0%, GBTIA 4%, GBLD 12%

- Slave – 1379mW, Master 3084mW

RICH Power Consumption by Voltage

Slave

3.3V 6%
1.2V 11%
2.5V 83%

Master

3.3V 2%
1.2V 4%
2.5V 45%
1.5V 49%

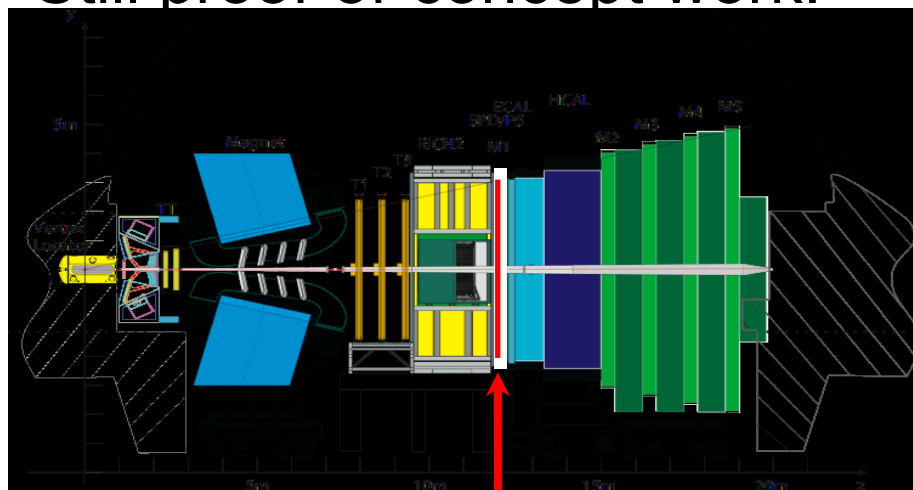- Logic power only.

RICH Summary

- 16MaPMT (1024ch)/ GBT, *need simulation results,*
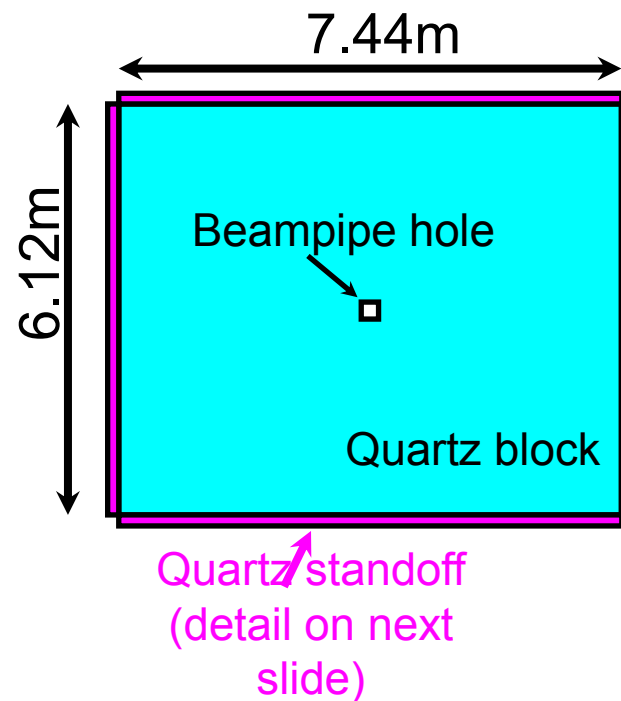- RICH1 1kW,
- RICH2 2.2kW
- 4 Supply voltages, minimum 2.

TORCH Current baseline design

Still proof-of-concept work:

1cm-thick quartz plate at z=12m

7.44m

6.12m

Beampipe hole

Quartz block

Quartz standoff
(detail on next slide)

Rectangular quartz block:

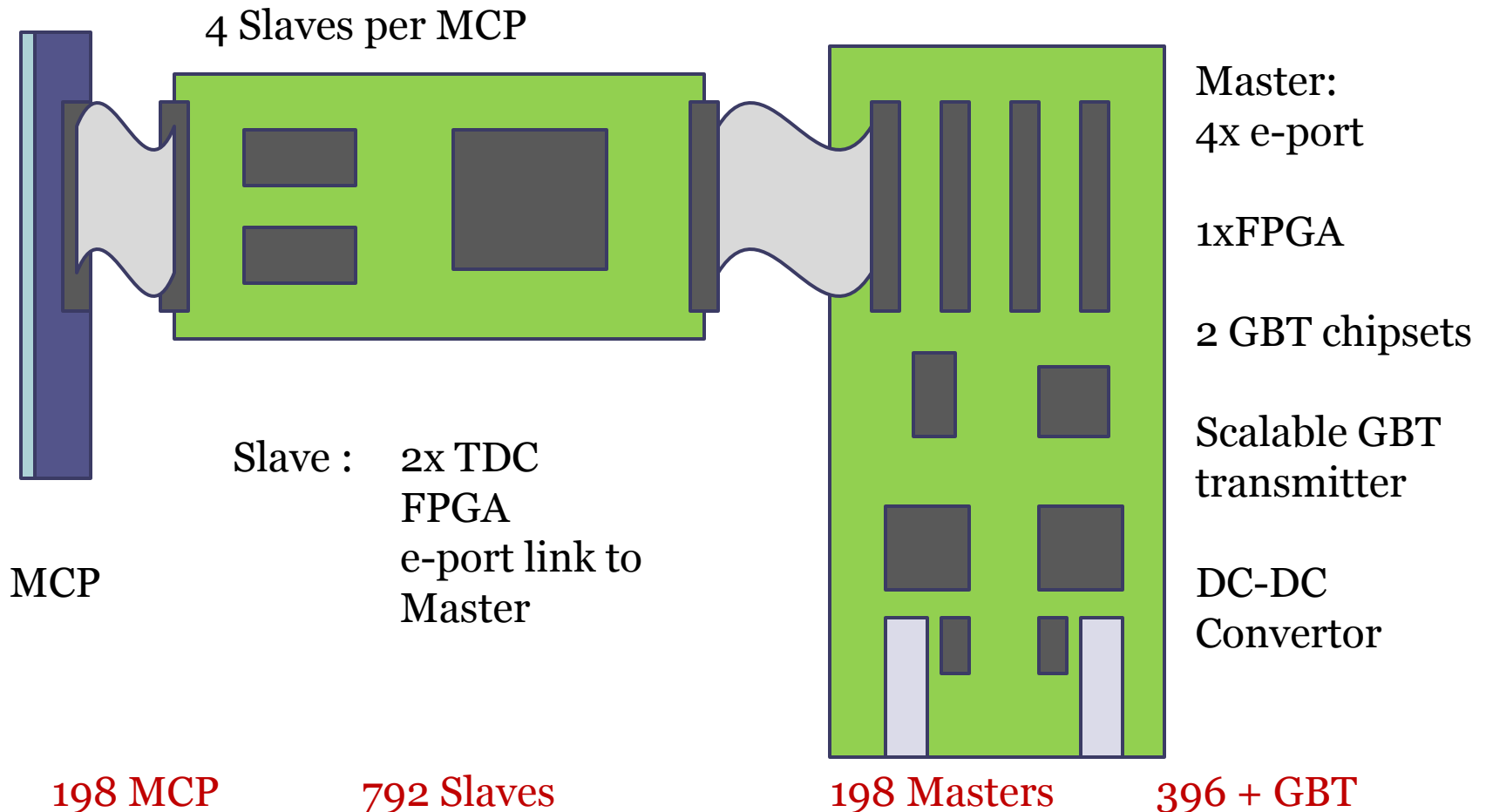7.44m wide in x (124 photodetectors each side)

6.12m high in y (102 photodetectors each side)
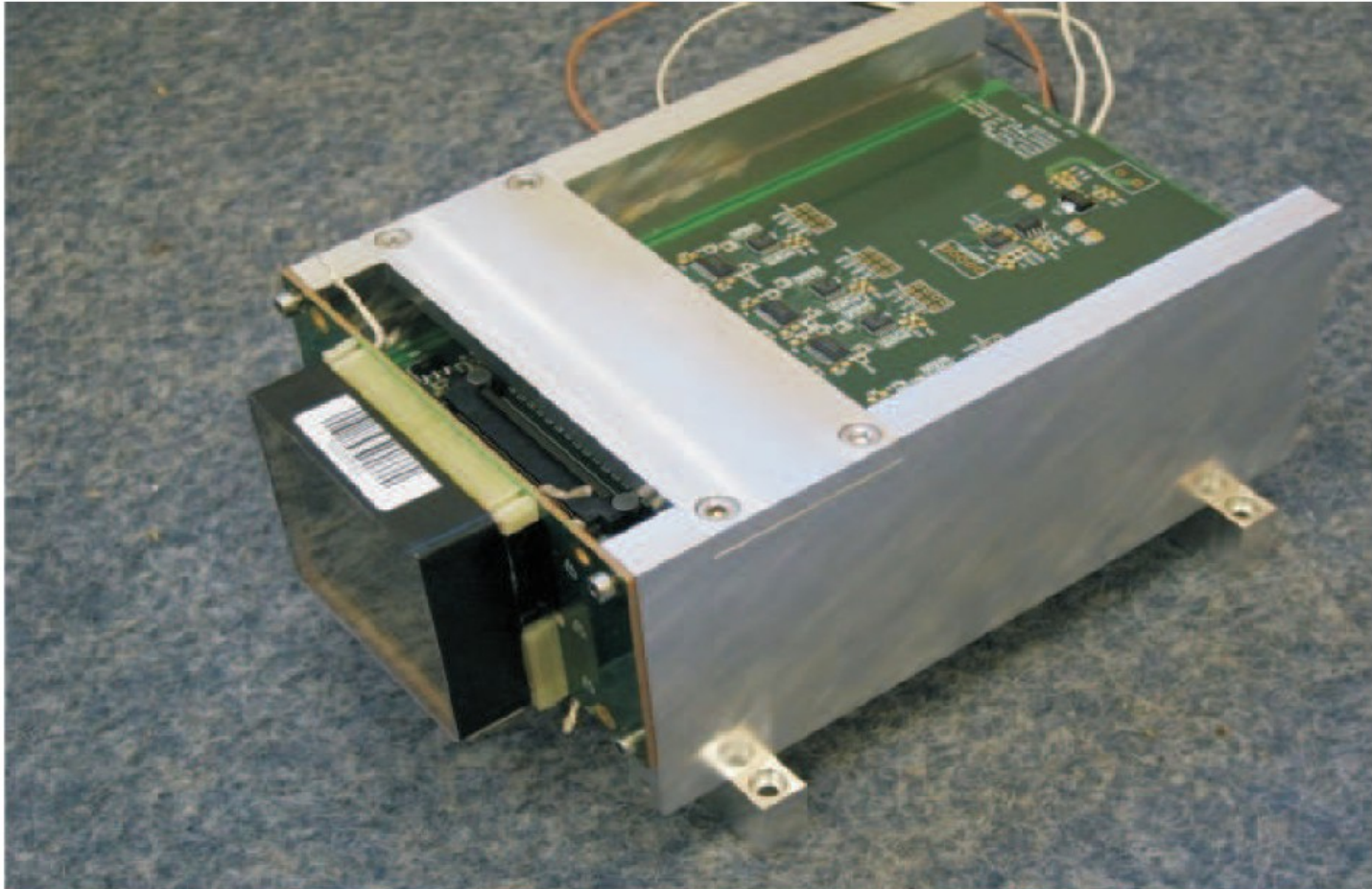
... for a total of 452 photodetectors

Square hole for beampipe in the center (26cm x 26cm) with mirrored edges

Mirrored surfaces have reflectivity 0.9

TORCH Front End

4 Slaves per MCP

Master:
4x e-port

1xFPGA

2 GBT chipsets

Scalable GBT
transmitter

Slave :   2x TDC
FPGA
e-port link to
Master

DC-DC
Convertor

MCP

198 MCP   792 Slaves   198 Masters   396 + GBT

TORCH Front End

Proof of Concept

Devices and Assumptions

- Burle-Photonis XP85022 or customised 128x8ch MCP,
- The "Perfect TDC" 128-ch with analogue input stage (amplifier and discriminator) , 6ps, 2W,
- Rad-hard or tolerant FPGA, 300mW,
- Discretes, 200mW per board,
- GBT user bandwidth 3.2Gbps, GBTX-1.5W, GBLD – 380mW, GBTIA-123mW, GBTSCA – unknow.
- Scalable GBT interface, primary GBT has both trans. and recv., add-on GBT has trans. only.
- *Assumption Ave. Occupancy 0.5% !*

TORCH – Voltage and Current

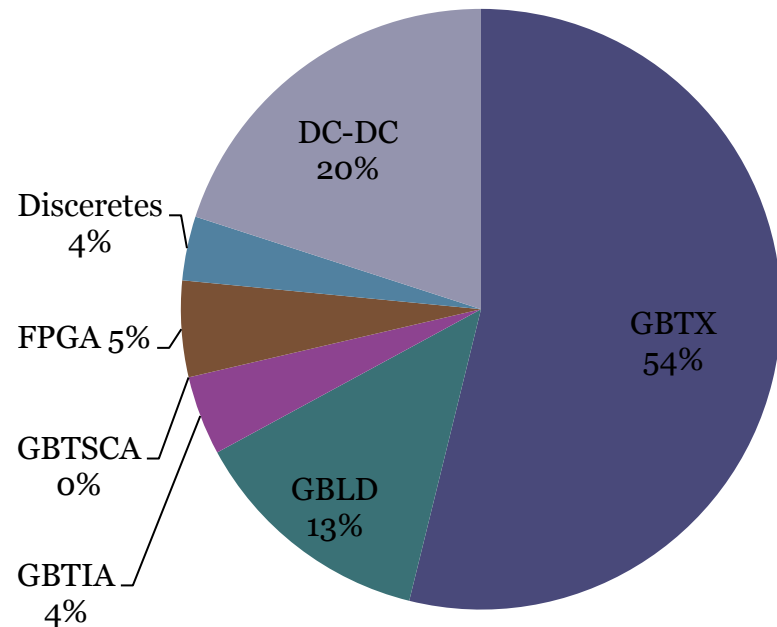| Voltage	Device	Est. Current (mA) Slave/Master
1.2v	FPGA (core), e-port drive & receiver	100 / 100
1.5v	GBTX x 2	None / 2100
2.5v	FPGA I/O, GBTIA, GBLD, GBTSCA, Flash RAM, TDC	1750/ 550
3.3v	"Legacy" device s, FPGA I/O	20 / 20

- Hopefully never need 3.3v,
- TDC may need "clean" analogue 2.5v,
- The Actel rad-hard *ProASIC3E* use 1.5v core voltage.
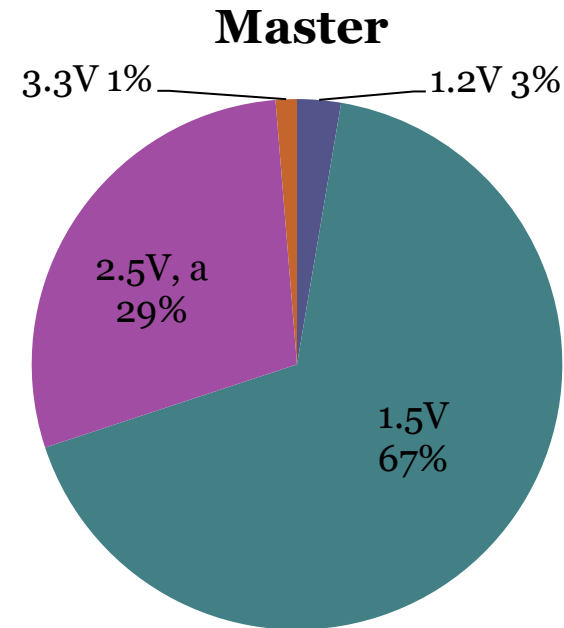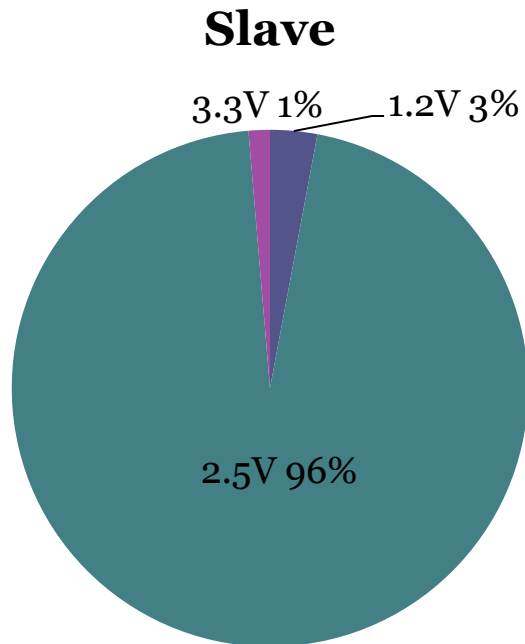
Power Consumption – by Device
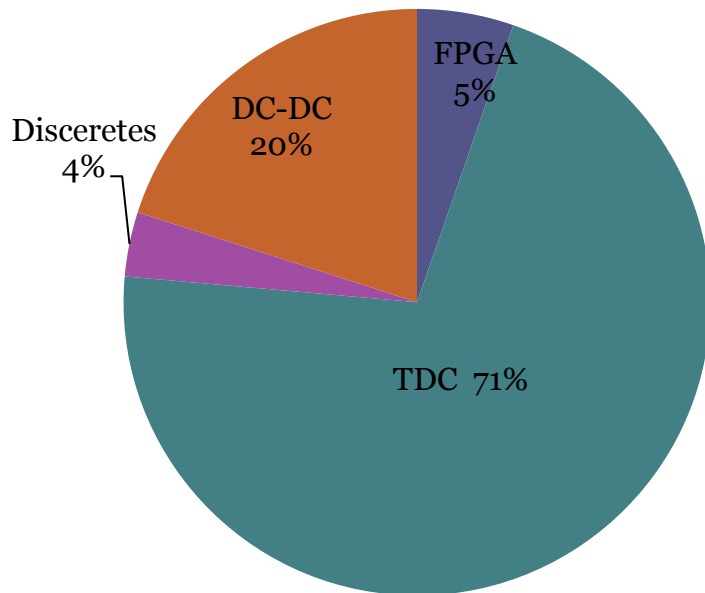
Slave

Master
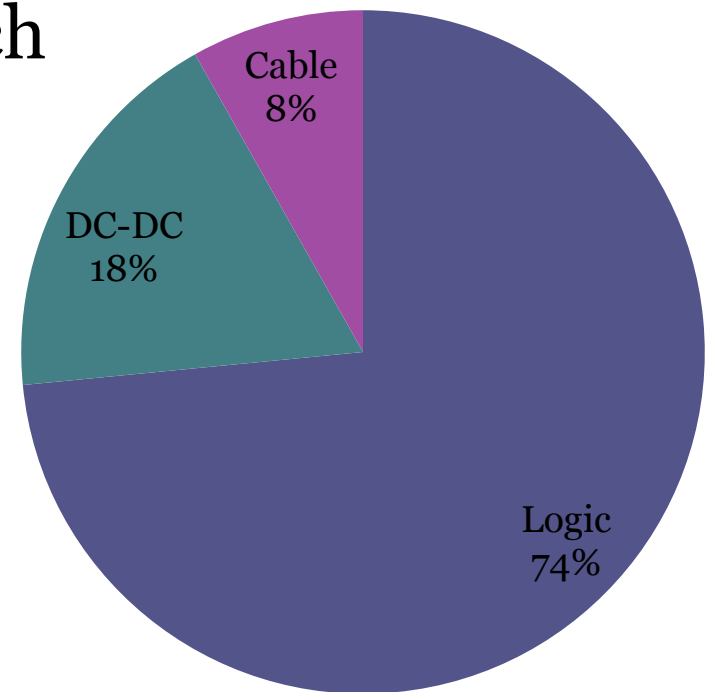

- Slave – 5641mW, Master – 5794mW

Power Consumption – by Voltage

Slave

3.3V 1%   1.2V 3%

2.5V 96%

Master

3.3V 1%   1.2V 3%

2.5V, a 29%

1.5V 67%

- Logic power only

Summary - TORCH

- 198 MCP – FE assembly, each gives 30W, 6.1kW in total
- 400 GBT,
- 4 Supply voltages, min 2.
- *Simulation needed,*
- *According to Mat's simulation result: 9GBT/MCP , 50W/ MCP, 1800 GBTs, 10kW.*

Cable
8%

DC-DC
18%

Logic
74%

Thanks!

Backup Slides

Commercial Rad Hard DC-DC Module

- An example: VPT-0510S
  - 3.5-7v input 0.8-3.4 output, 33w max
  - 84-94% efficiency
  - 100krads