Study of Opto-Box

The Ohio State University

April 20, 2016
Outline

- Radiation Length of Electrical Links
- Opto-Box with GBT
- Opto-Box with Low-Speed Downlinks
- Opto-Box with GBT Array
Radiation Length of Electrical Links

- **Up-links:** AWG30 Cu-clad Al TwinAx: $X/X_0 = 0.076\%$
- **Down-Links:** AWG36 twisted pair: $X/X_0 = 0.0086\%$
  - all smeared over 1 cm at normal incident
- If each pixel module is served by one up and one down link:
  - down link contributes 10% of the radiation length
- one down link can serve 4 FE chips
  - Layer 1: reduce wire counts by a factor of 4
  - Layer 2: reduce wire counts by a factor of 2
  - Layer 3-5: each module contains 4 FE chips
- having one down link serving more than 4 FE chips will result in large loss of solid angle if one link is broken
Opto-Box with GBT

- **Basic assumptions:**
  - up-links: use 12-channel VCSEL array operating at 5 Gb/s
  - down-links: use one GBT
    - send 160 Mb/s signal to modules
Opto-Box with GBT

GBT

VLRX

TX

12 mm

142 mm

45 mm

2 mm gap
Side View

Cooling pipe
Bottom View

60-pin Samtec high-speed coax connector
Samtec High-Speed Coax Connector
Opto-Box

10 opto-boards per side

478 mm
Opto-Box at ID Endplate

32 opto-boxes
2 x 10 opto-boards/box
640 opto-boards

315 mm

1020 mm
Opto-Box with Low-Speed Downlinks

- Basic assumptions:
  - up-links: use 12-channel VCSEL array operating at 5 Gb/s
  - down-links: send 12 channels of 8b/10b signals at 160 Mb/s from counting room to opto-box
    - not a technical challenge to program FPGA in counting room and to develop low-speed ASIC for the opto-board
    - send 160 Mb/s signal to modules
  - one opto-board flavor with up- and down-links using MTP connectors as in current opto-board
  - use relative old/proven technology
Opto-Box with Low-Speed Downlinks

TX

RX

1 mm gap

12 mm

76 mm

30 mm
Side View

Cooling pipe
Bottom View

60-pin Samtec high-speed coax connector
Opto-Box

10 opto-boards per side

320 mm
Opto-Box at ID Endplate

2 x 10 + 2 opto-boxes
2 x (13 or 16) opto-boards/box
644 opto-boards

410 mm
1090 mm
950 mm
Opto-Box with GBT Array

- Basic assumptions:
  - up-links: use 12-channel VCSEL array operating at 5 Gb/s
  - down-links: take de-serializer in GBT and layout in array format
    - send 160 Mb/s signal to modules
  - one down-link opto-board for every seven up-link opto-boards
Opto-Box with GBT Array

- **TX**
- **RX**

Dimensions:
- 12 mm
- 96 mm
- 17 mm
- 2 mm gap
Bottom View

60-pin Samtec high-speed coax connector
Opto-Box

8 opto-boards per side
Opto-Box at ID Endplate

644 opto-boards

350 mm

770 mm
Opto-Box at ID Endplate

- 2 x 8 opto-boards/box for comparison
- 5 to 7 cm of clearance on the sides for cable/fiber routing & access
- opto-box with GBT arrays is smallest
Summary

- preliminary estimate of the physical size of opto-boxes
- opto-box with GBT arrays is the smallest