



Study of Opto-Box

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Outline

- Reliability of Opto-Links
- Use of Electrical Repeater?
- Radiation Level at ID Endplate
- Opto-Box with High-Speed Downlinks
- Opto-Box with Low-Speed Downlinks



Reliability of Opto-Links

- Best data on reliability of opto-links are from the pixel detector
 - ◆ 1st generation on-detector opto-links built by OSU had failure rate of $\sim 0.1\%$
 - ◆ no failure so far for 2nd generation on-detector opto-links
 - ◆ proposed ITK-Pixel links are similar to 2nd generation links
 - ⇒ expect similar reliability
 - opto-links will be installed at a location that can be accessed for the first few years
- opto-links of ITK-Stripe will be installed at inaccessible locations
 - ◆ no need to build ITK-Pixel if opto-links are unreliable



Radiation Level

- Radiation level at ID endplate ($Z = 335$ cm) is acceptable for opto-link operation
 - ◆ safety factor not included in table below
 - ◆ radiation tolerance needs to be verified

R (cm)	1 MeV neq ($10^{14}/\text{cm}^2$)	TID (MGy)
35	10.41	0.464
50	7.73	0.231
75	5.24	0.102



Repeater Box vs Opto-Box

Repeater Box	Opto-Box	Comment
ASIC	ASIC	Non trivial to develop high-speed repeater ASIC. Need programmable pre-emphasis.
	VCSELs + PINs	No opto failure
Messy input cables	Messy input cables	Same mess
Messy output cables	Messy output cables	Need dimensions of opto vs elec. cables
Services: +V, NTC	Services: +V, -V, VPIN, NTC	Opto needs more services. Need dimensions

- Repeater box is as messy as opto-box
- Development of repeater ASIC is non trivial
- ⇒ No clear gain in replacing opto-box by repeater box?



Opto-Box with High-Speed Downlinks

- Basic assumptions:
 - ◆ up-links: use 12-channel VCSEL array operating at 5 Gb/s
 - ◆ down-links: use two GBTs for redundancy
 - prevent lost of half stave with a broken down-link
 - ☹ need to develop redundancy ASIC
 - send 160 Mb/s signal to 1 or 2 modules
 - ☹ need two favors of opto-boards and opto-boxes
 - ☹ down-link opto-board is 3x larger than up-link opto-board
- work in progress to estimate the size of two kinds of opto-boxes



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 ASIC for the opto-board
 - send 160 Mb/s signal to 1 or 2 modules
 - ☺ one opto-board flavor with up- and down-links on same opto-board using MTP connectors as in current opto-board
- ☺ use relative old/proven technology
- work in progress to estimate the size of opto-box