CMS Tracker Links

- Link overview/reminder
- Link monitoring tools
- Status update
CMS Tracker Link overview

Clock & Trigger

Control "Ring"

Opto WG@TWEPP – September 2011

jan.troska@cern.ch
**CMS Tracker Link overview**

**Readout System**

- **INL**: 1%
- **SpNR**: 48 dB
- **BWtyp**: 70 MHz
- **Gain**: 0.8 V/V
- **~40000 Fibres**

---

Opto WG@TWEPP – September 2011

jan.troska@cern.ch
CMS Tracker Link overview

Readout System
- INL: 1%
- SpNR: 48 dB
- BWtyp: 70 MHz
- Gain: 0.8 V/V
- ~40000 Fibres

Control System
- Data-Rate: 80Mb/s
- BER: 10-12
- ~2500 Fibres
CMS Tracker Link overview

**Readout System**
- **INL**: 1%
- **SpNR**: 48 dB
- **BWtyp**: 70 MHz
- **Gain**: 0.8 V/V

**Control System**
- **Data-Rate**: 80 Mb/s
- **BER**: 10-12

**Features**
- Non-Magnetic
- Low Mass & Volume
- Radiation Resistant

~40000 Fibres
~2500 Fibres
Length: 40-65m

---

Opto WG@TWEPP – September 2011

jan.troska@cern.ch
Link Monitoring tools

- Based upon system commissioning/calibration
  - Setup of analogue readout link operating point (infrequent)
    - Measure/track laser threshold
    - Measure/track link gain (~ laser slope efficiency changes)
    - Measure noise
  - “Spy channel” event-by-event monitoring (quasi-online)
    - Measure signal and noise amplitudes
    - Track deterioration

- Independent
  - Fibre loopback inside Tracker
    - Monitor level of returned light
    - Measure losses over time

- No monitoring of digital links at present
  - Handled by hand when control ring fails

Opto WG@TWEPP – September 2011

jan.troska@cern.ch
Based upon system commissioning/calibration

- Setup of analogue readout link operating point (infrequent)
  - Measure/track laser threshold
  - Measure/track link gain (~ laser slope efficiency changes)
  - Measure noise

- “Spy channel” event-by-event monitoring (quasi-online)
  - Measure signal and noise amplitudes
  - Track deterioration

Independent

- Fibre loopback inside Tracker
  - Monitor level of returned light
  - Measure losses over time

No monitoring of digital links at present

- Handled by hand when control ring fails
Link Setup: OptoScan procedure

- Analogue optohybrid settings:
  - Bias-point (0-127)
    - 0.45 mA/setting unit
  - Gain settings (0-3)
    - (‘0’) 5, (‘1’) 7.5, (‘2’) 10, (‘3’) 12.5 mA/V

- Calibration procedure
  - Loop over gains 0 to 3, ramping Bias-point 0-50 for each laser
  - Check output and select optimal bias point (+2 setting units above zero light) and gain setting (nearest to 0.88)
  - Outputs stored in database per link
    - Laser threshold and efficiency
    - Noise at pedestal value

- Procedure is run “as necessary”
  - Typically when operating conditions change
OptoScan Data TOB

- Plots show the number of links showing a variation in either threshold current or efficiency as a function of time.

- Long-term increase in threshold due to one of:
  - temperature increase (the case for the outliers here),
  - radiation damage (what we want to monitor)

- No evidence yet of radiation damage, good to get baseline for “normal” variability of these quantities.
Summary, Conclusions, Future

- Link systems functioning well
- Analogue Link monitoring tools are maturing
  - Synergy with monitoring other detector parameters
    - Temperature, leakage currents, HV
  - Still lots to understand
    - Methods and analysis
    - Sensitivity and errors
- Digital link monitoring tools still under development
  - All “offline” right now, require intervention on the physical link
- Getting ready to observe radiation-induced changes in long running this year
  - Subject to obtaining the required sensitivity
  - Understanding temperature effects