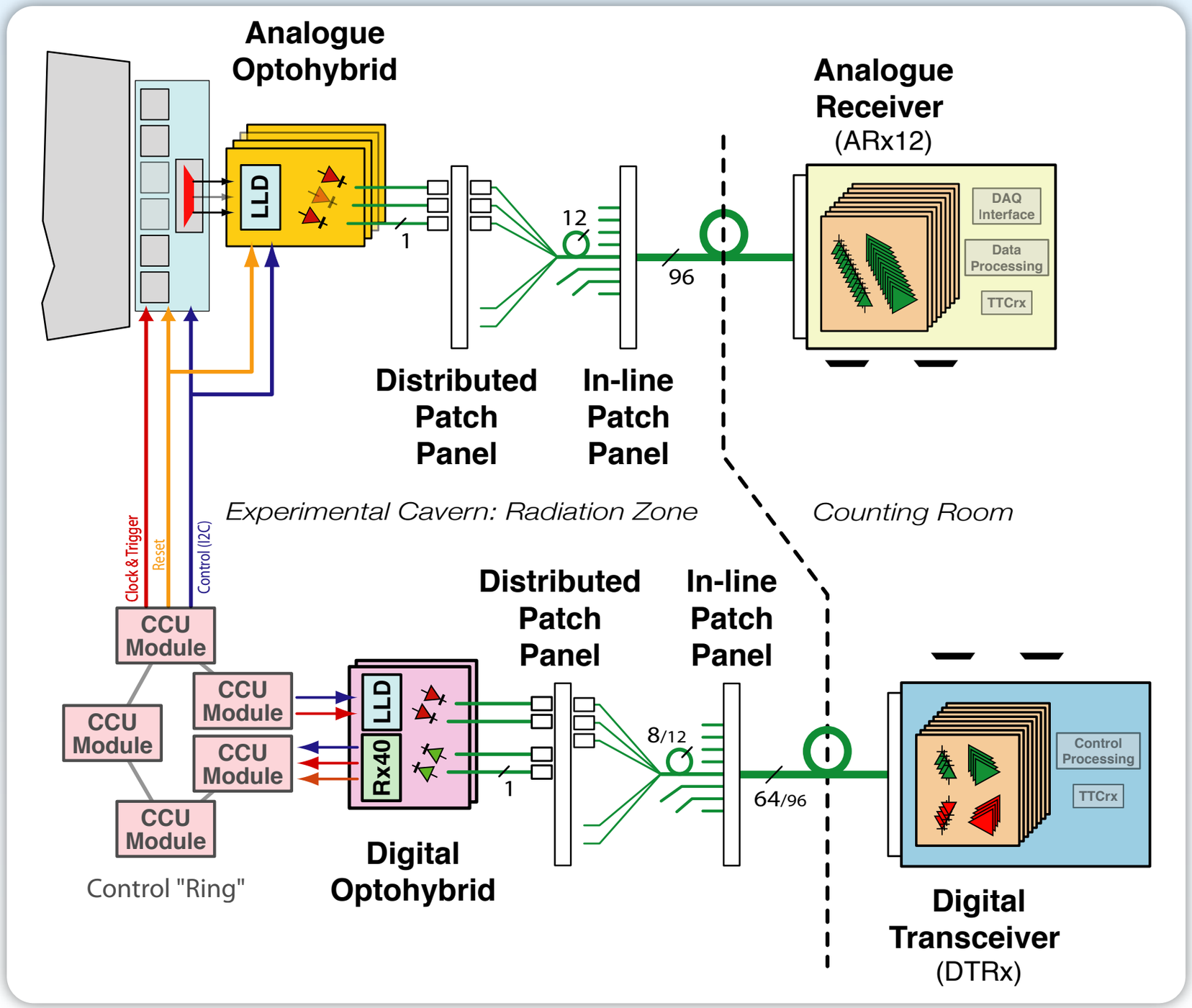
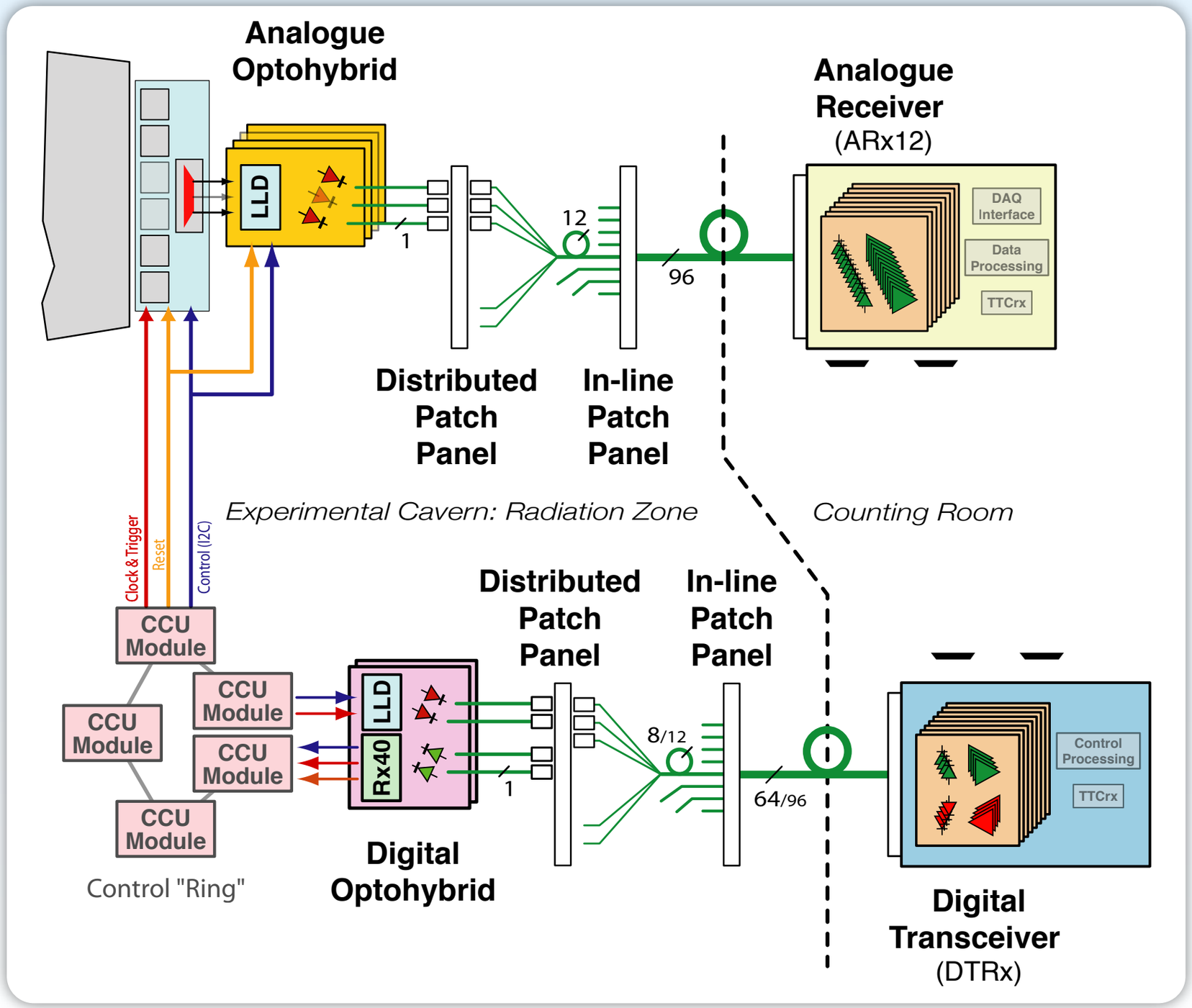
CMS Tracker Links

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

CMS Tracker Link overview



CMS Tracker Link overview



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

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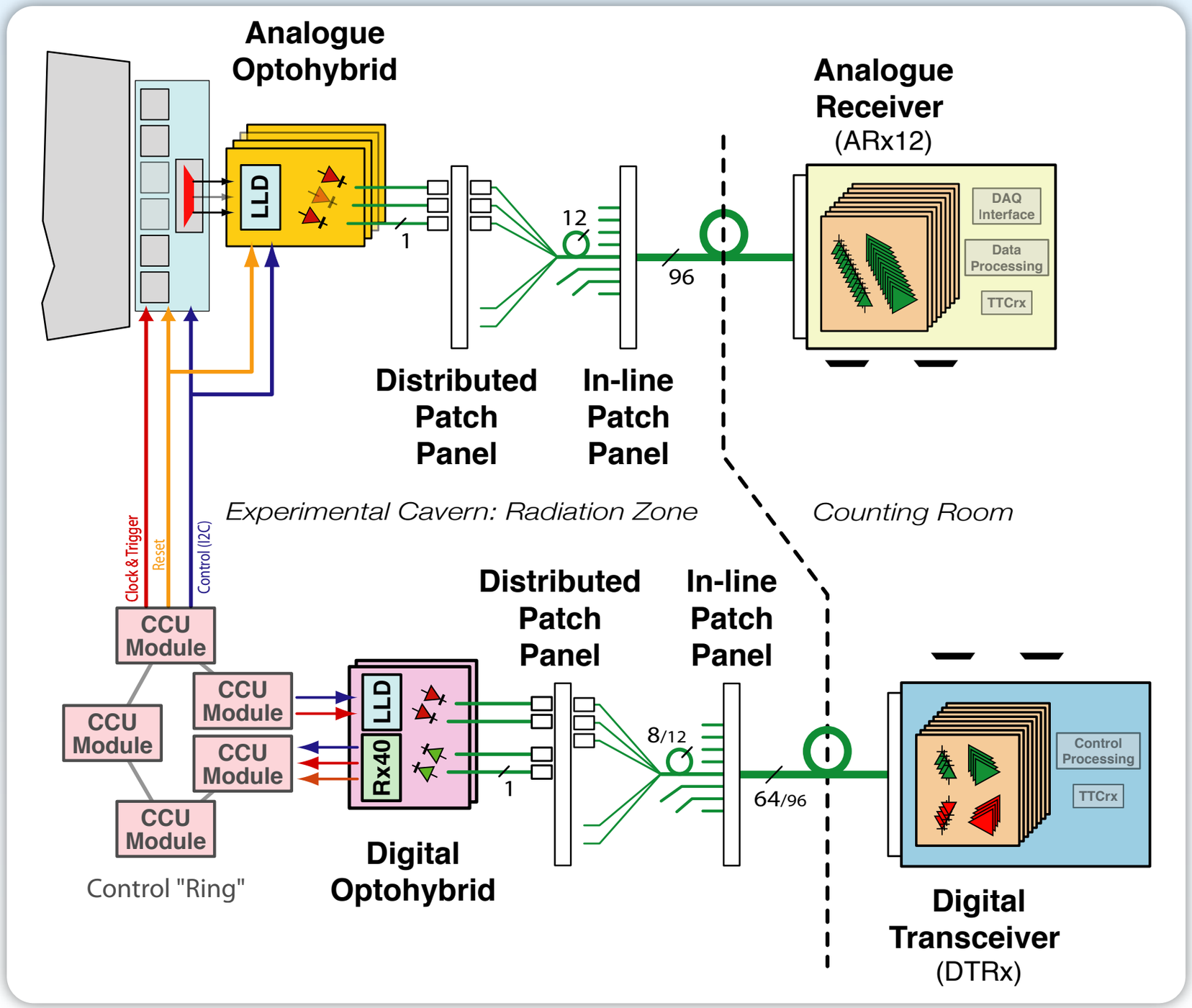

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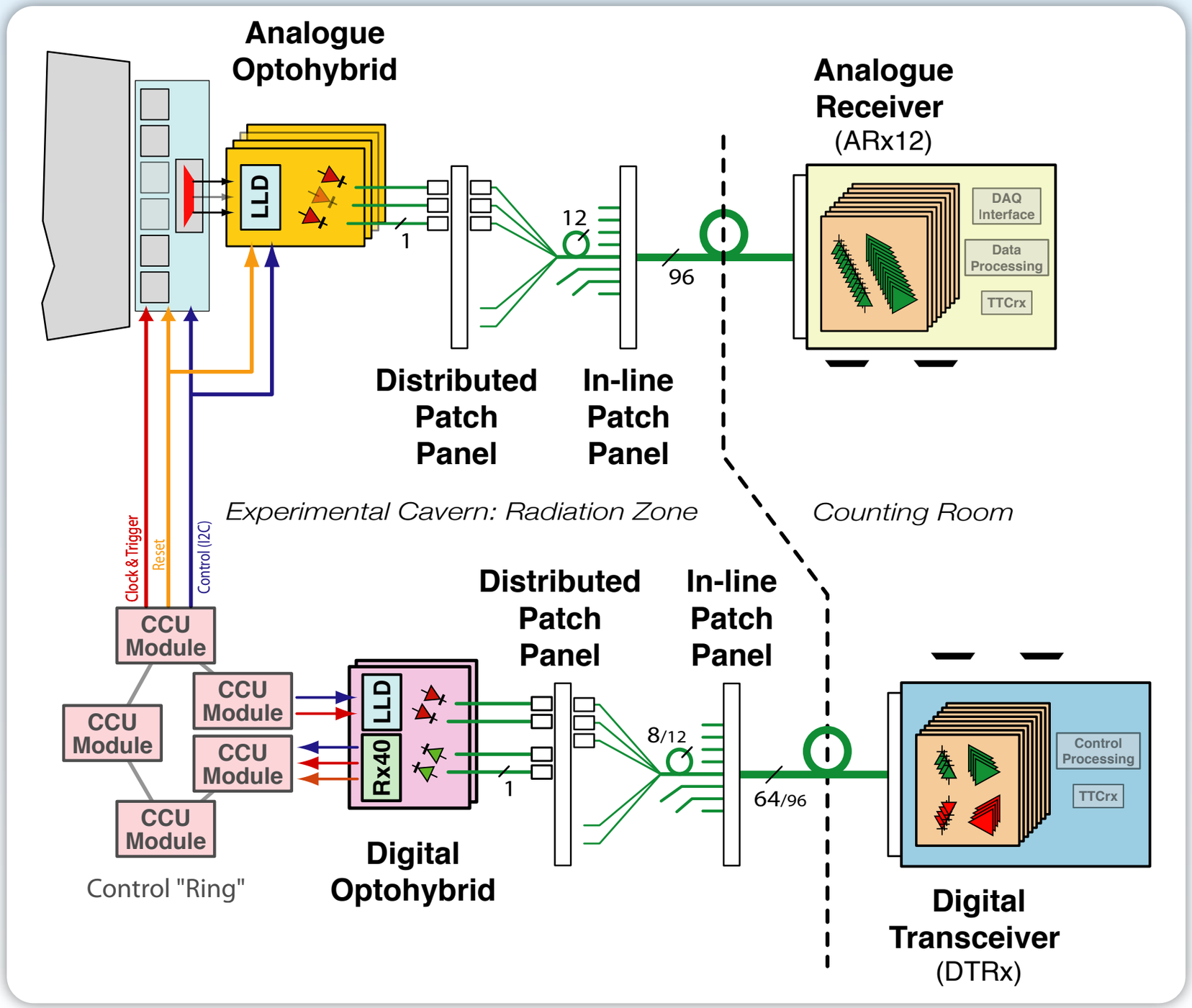

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Length: 40-65m
Low Mass & Volume
Non-Magnetic
Radiation Resistant

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

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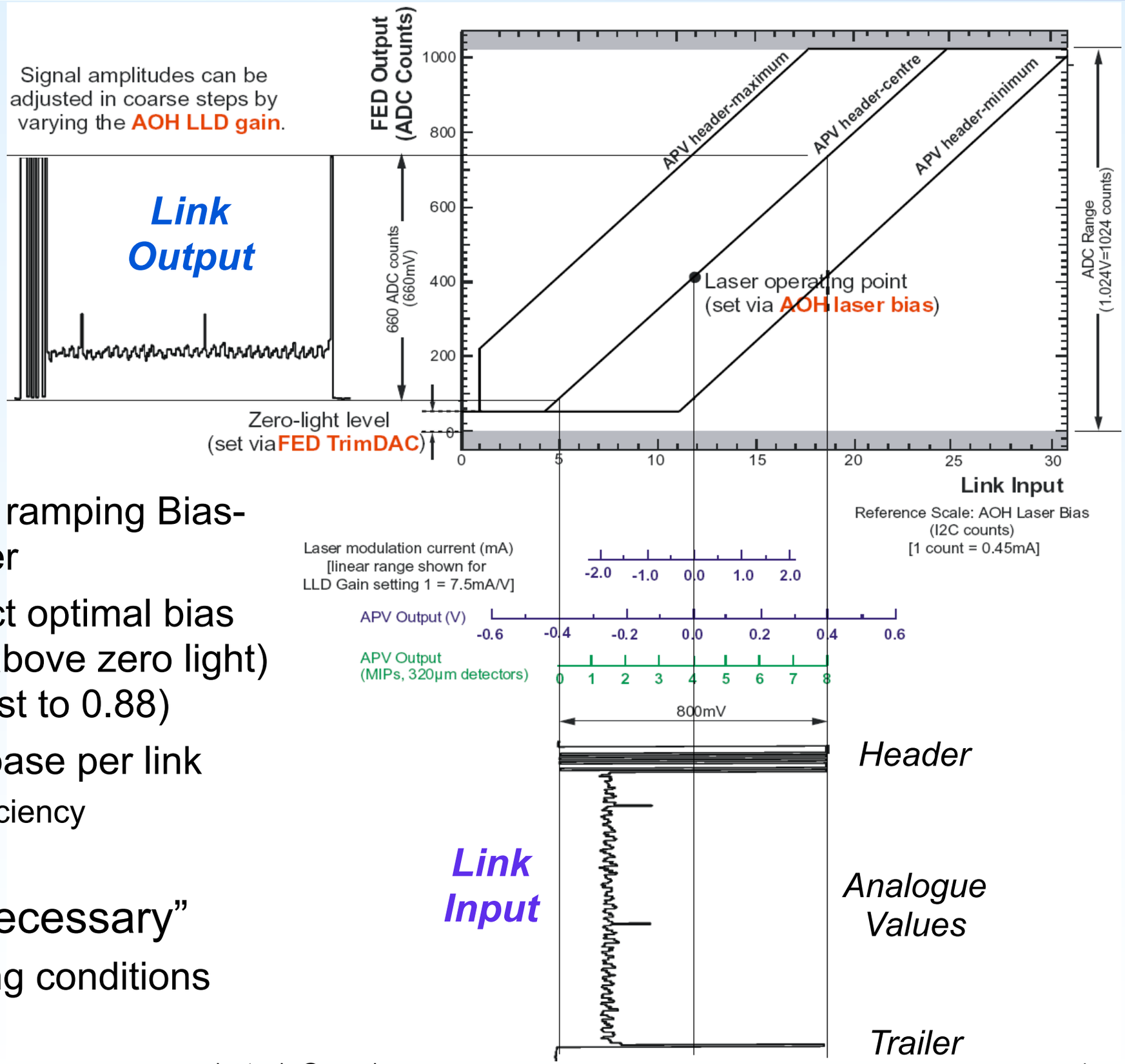
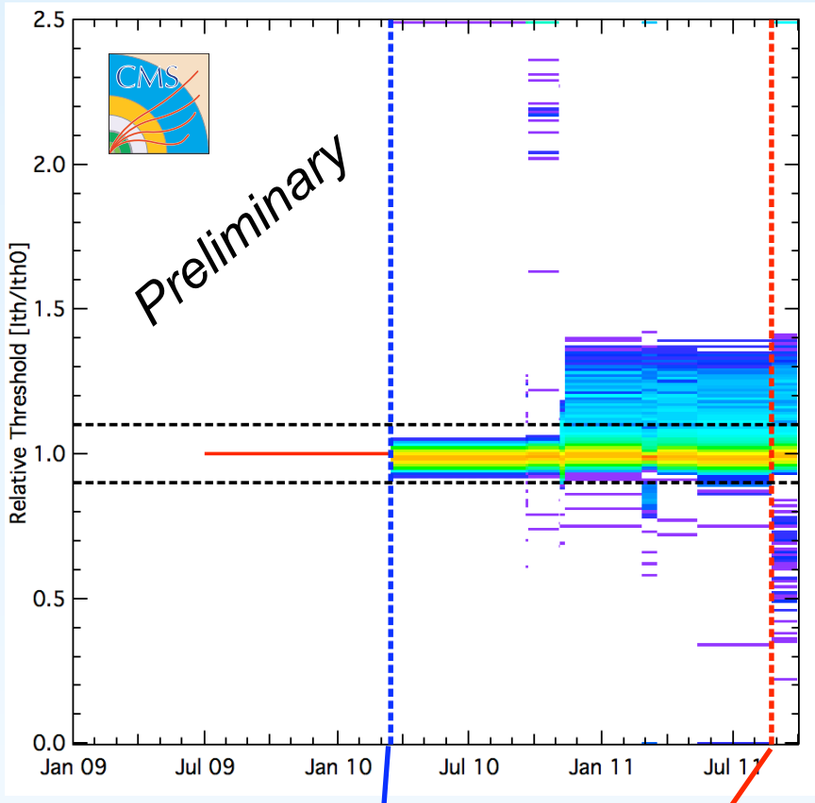
Link Setup: OptoScan procedure

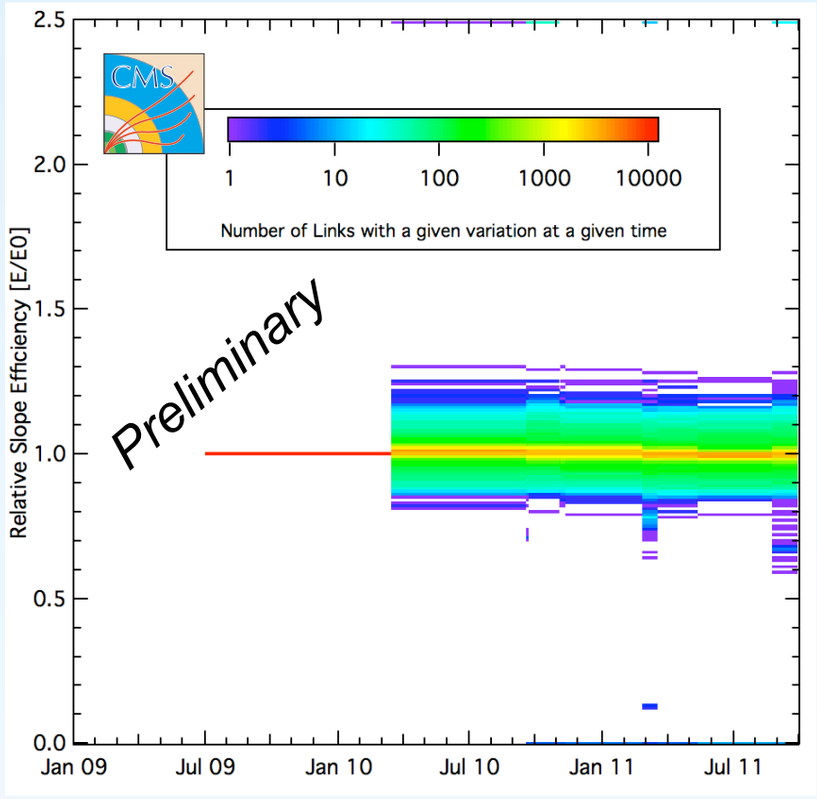
- Analogue optohybrid settings:
  - Bias-point (0-127)
    - 0.45 mA/setting unit
  - Gain settings (0-3)
    - (‘0’) 5, (‘1’) 7.5, (‘2’) 10, (‘3’) 12.5 mA/V
- Calibration procedure
  - Loop over gains 0 to 3, ramping Bias-point 0-50 for each laser
  - Check output and select optimal bias point (+2 setting 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



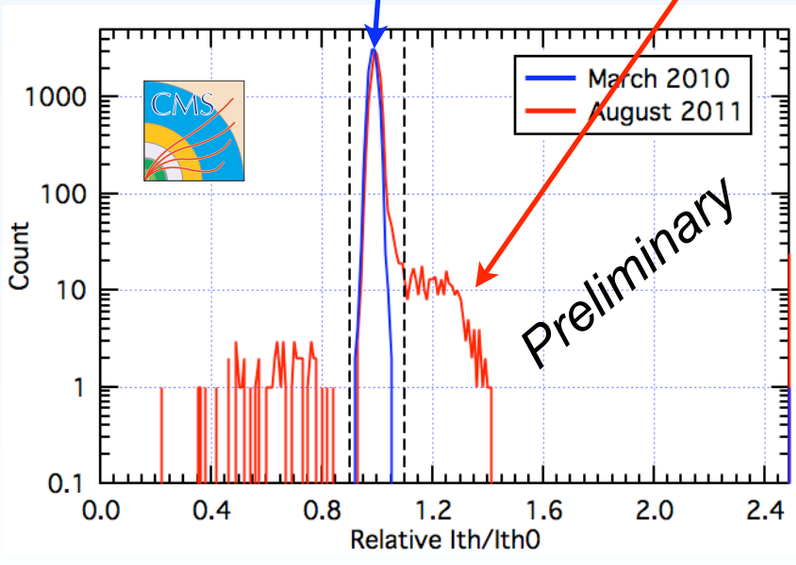
OptoScan Data TOB

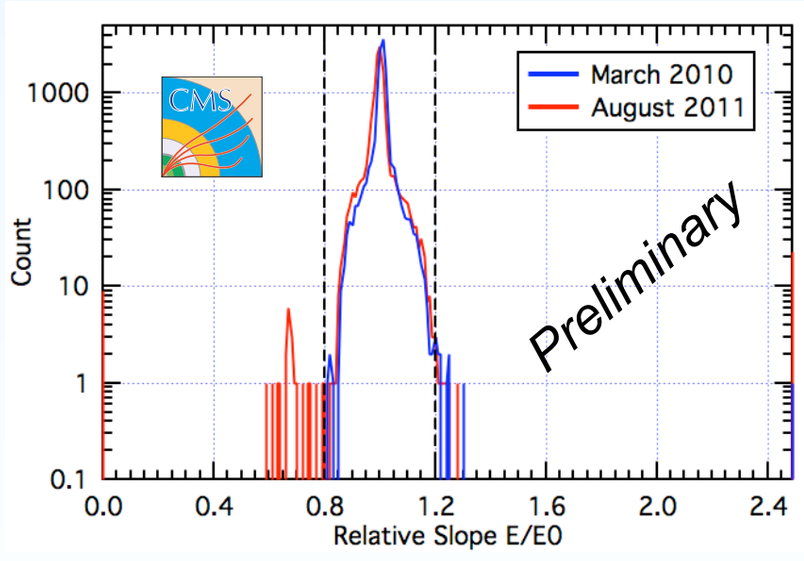
- Plots show the number of links showing a variation in either threshold current or efficiency as a function of time
- Long-term increase in threshold due to one of:
  - temperature increase (the case for the outliers here),
  - radiation damage (what we want to monitor)
- No evidence yet of radiation damage, good to get baseline for “normal” variability of these quantities





Cut through distribution at two times to observe variations





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