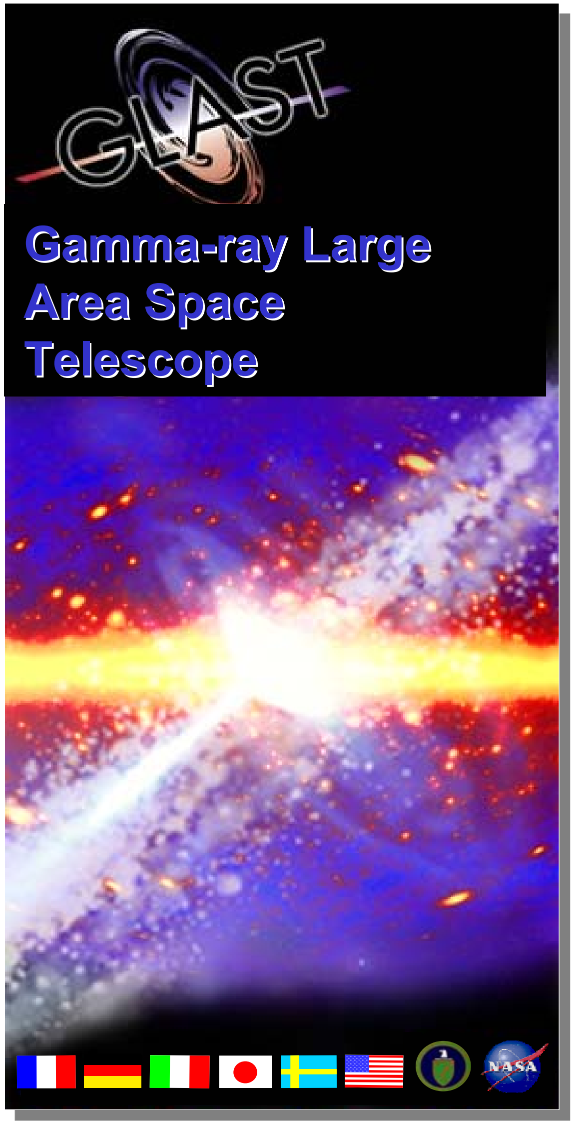

CsI afterglow - possible explaination of pedestal drift and excess of energy.

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Unexpected CAL problems in beam test data

- We see significant negative pedestal drift
  - increases to event rate and energy deposition in the crystal
  - Two components:
    1. Exponentially decreasing as a function of GemDeltaEventTime with ~150 μs time constant
       - Normal discharge of preamp feedback capacitor after previous event
    2. Increasing as function of time since the start of spill with time constant ~0.2 s
       - Pile up of slow scintillation signals ("CsI afterglow") from many consecutive events
- Energy measured by CAL at high energies (100-200 GeV) in 10-15% bigger than expected
  - Similar problem was at PS energies in LEX1 range, but it was corrected after HEX8-LEX1 range intercalibration procedure
- Position along a crystal measured by asymmetry at high energies has significant systematic bias (up to 2 cm) varying from crystal to crystal
  - Probably it is secondary effect of energy excess – when it is different for two ends of the same crystal

There no pedestal drift with charge injection

- Pedestal drift in SPS data has been seen at rather small event rate:
  - Run 2031: pedestal drift in HEX8 range ~30 adc units
  - rate is ~400 events/second, so the mean time between events is 2.5 ms, which is 15 times large than capacitor discharge time constant – we should not see pile up effect.
- Direct test with charge injection pulses shows no pedestal drift
  - similar rate (500 events/second) and
  - Different amplitudes (ciDAC=512-4095 corresponding to 10 - 70 GeV per crystal in HE diode)
  - 1000 consecutive pulses sent during 2 seconds followed by 2 seconds without pulses
- The natural conclusion – pedestal drift is related to scintillation

CsI afterglow

- http://www.scionixusa.com/pages/navbar/scin_crystals.html:
  - Afterglow is defined as the fraction of scintillation light still present for a certain time after the X-ray excitation stops. Afterglow originates from the presence of millisecond to even hour long decay time components. Afterglow in most halide scintillation crystals can be as high as a few percent after 3 ms. The long duration afterglow in e.g. CsI(Tl) can be a problem for many applications. Afterglow in halides is believed to be intrinsic and correlated to certain lattice defects.
- http://www.crystalsland.com/csitl.html:
  - Afterglow (after 6ms)   0.5%-5.0%

Pedestal drift and nonlinearity curve

- CAL electronics contains:
  - charge integrating preamp
    - It integrates the input signal with time constant ~150 μs, so at the output we have contribution from all components, even from very slow light emission
    - The nonlinearity curve of the preamp depends on total output signal, including slow components
    - There is preamp reset circuit in both LE and HE preamps, which discharges the feedback capacitor through the small resistor if preamp output signal exceeds ¼ of full dynamic range. The discharge starts in 10 μs after threshold is reached.
    - At high event rates and high energies the pileup of afterglow signals produce the DC bias at preamp output, which modifies the starting point of nonlinearity curve.
  - CRRC shaper with time constant ~3.5μs
    - It differentiates the input signal first, so we do not see any DC component at the shaper output
    - The exponential discharge of the feedback capacitor produce the negative pedestal drift at the shaper output
    - At sufficiently high event rates and high energies, when preamp reset circuit starts to work, the pedestal bias disappears, while nonlinearity curve is still modified with respect to low rate functionning

Conclusion

- There is possible explaination of CAL calibration effects seen in PS and SPS beam test data
- I'm now implementing the model and trying to extract parameters from beam test data.
- Once it will be done, it will be possible to make appropriate correction of pedestals and nonlinearity curve.
- I hope to prepare next week more detailed presentation with all plots.