Degradation of Calorimeter Performance at High Luminosities

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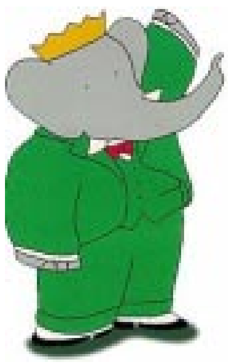


Outline

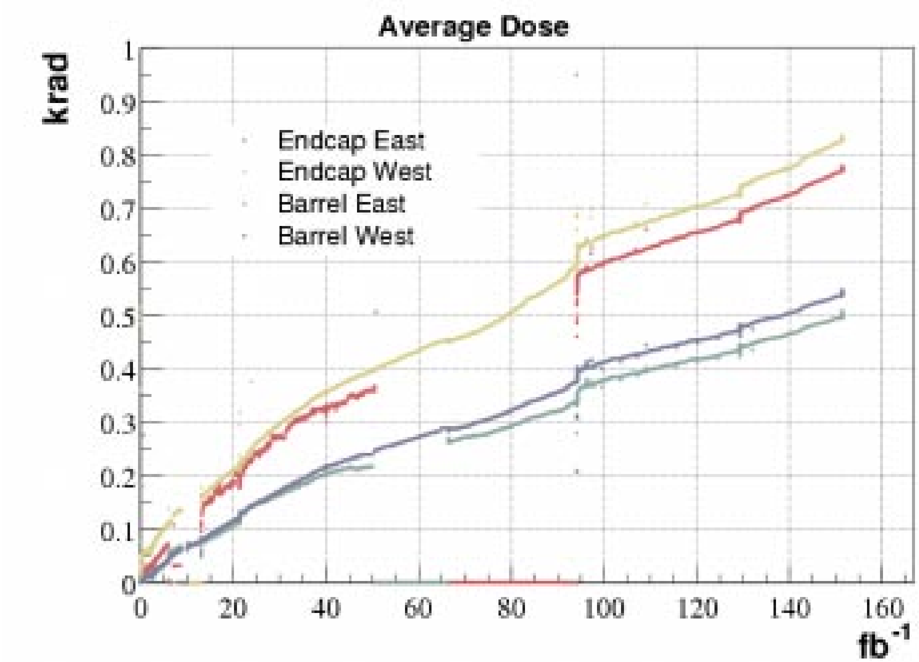
High background conditions affect calorimeter performance in several ways:

1. Radiation damage to the crystals
    - Degradation of crystal lightyield
    - Changes in crystal uniformity
2. High occupancy
    - Additional clusters
    - Additional energy

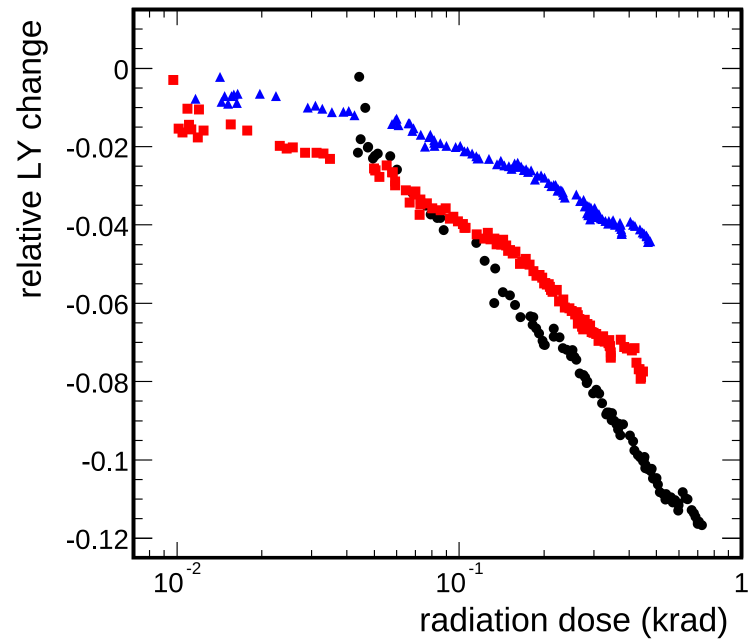
Crystal Lightyield

The present situation in the Babar calorimeter:

- Radiation dose measured by radfets in front of the calorimeter
- Lightyield measured by radioactive source calibration system
- Dose now approaches linear increase with luminosity

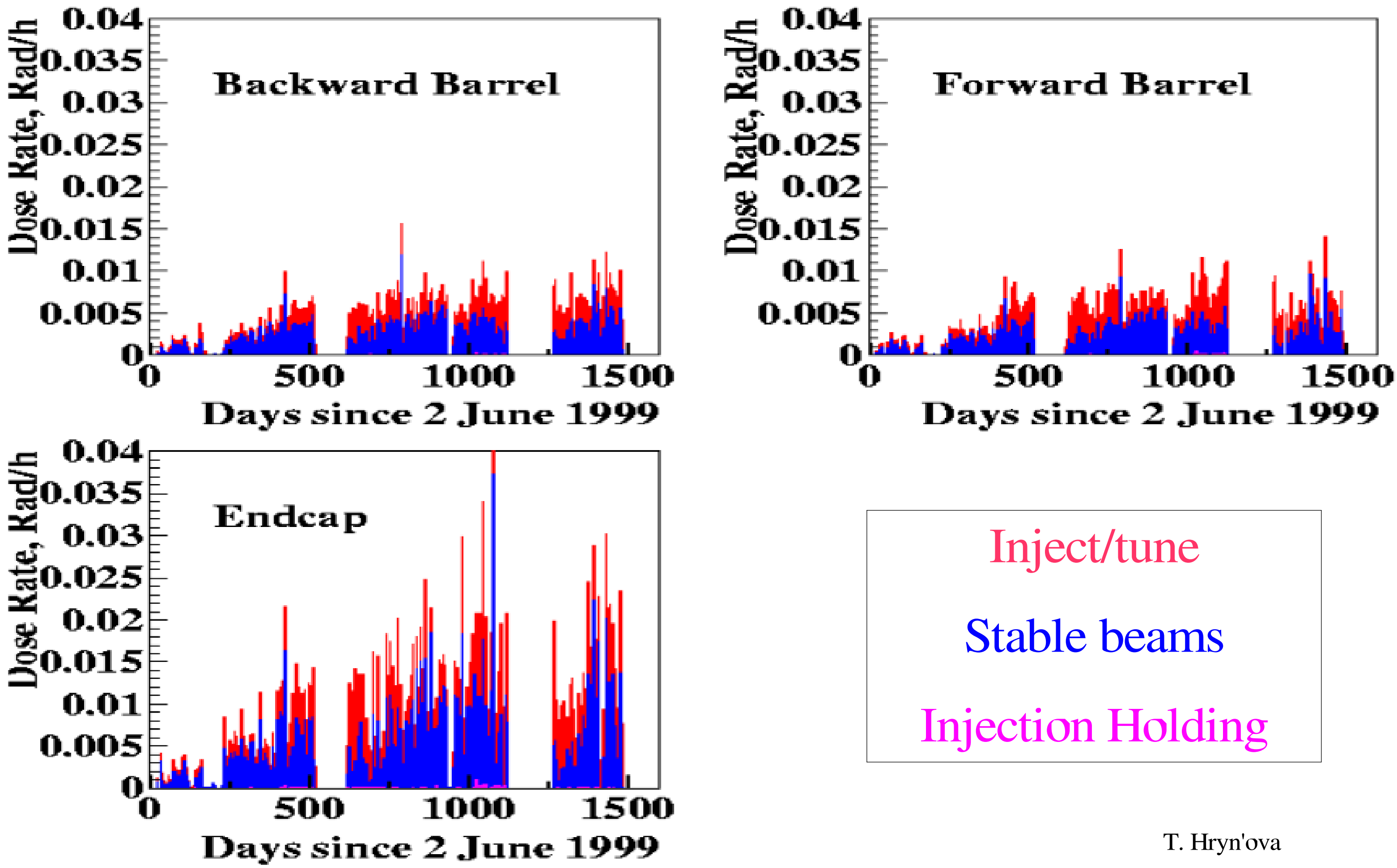


J. Stelzer



J. Bauer

Dose Accumulation



Present dose rate is about 0.01 rad/h (from leakage currents)

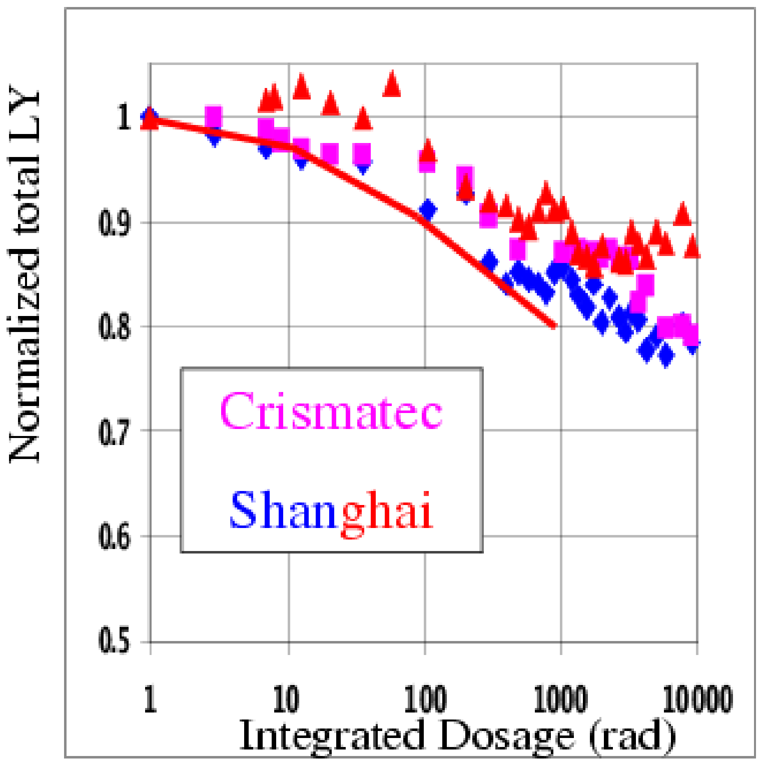
$\Rightarrow$ At 10^{36} the dose should be about 1 rad/h

Crystal Irradiation Experiment

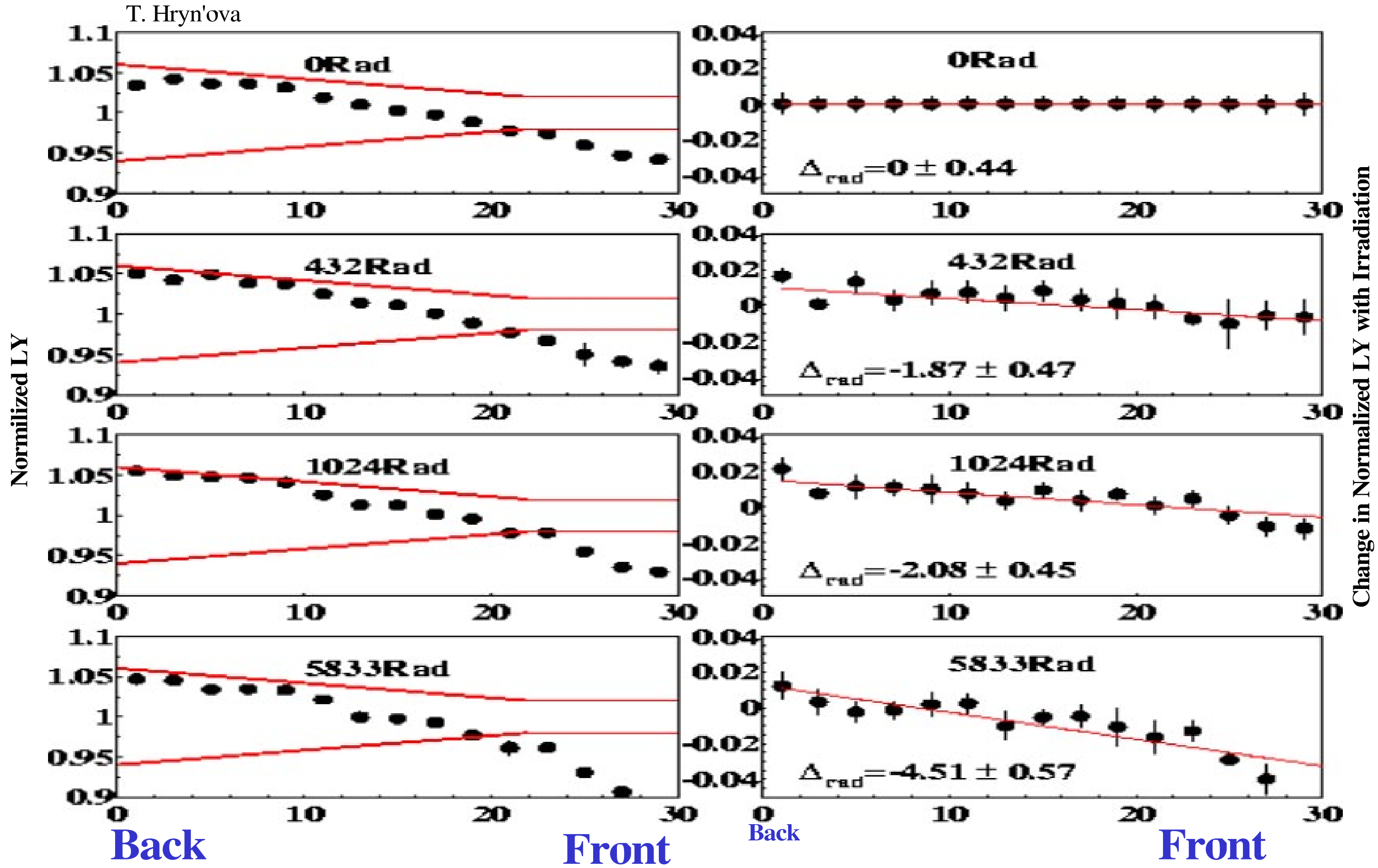
Crystal irradiation experiment by Tetiana Hryn'ova et al.

- Irradiated 16 CsI(Tl) crystals at 1-2 rad/h with ^{60}Co
- Integrated dose of 10,000 rad
- Measured total lightyield and uniformity
- Plot on the right shows lightyield vs dose for 3 crystals
- The red line indicates the original Babar specification
- The irradiation test is in good agreement with Babar data

Typical Crystal Scanner crystals



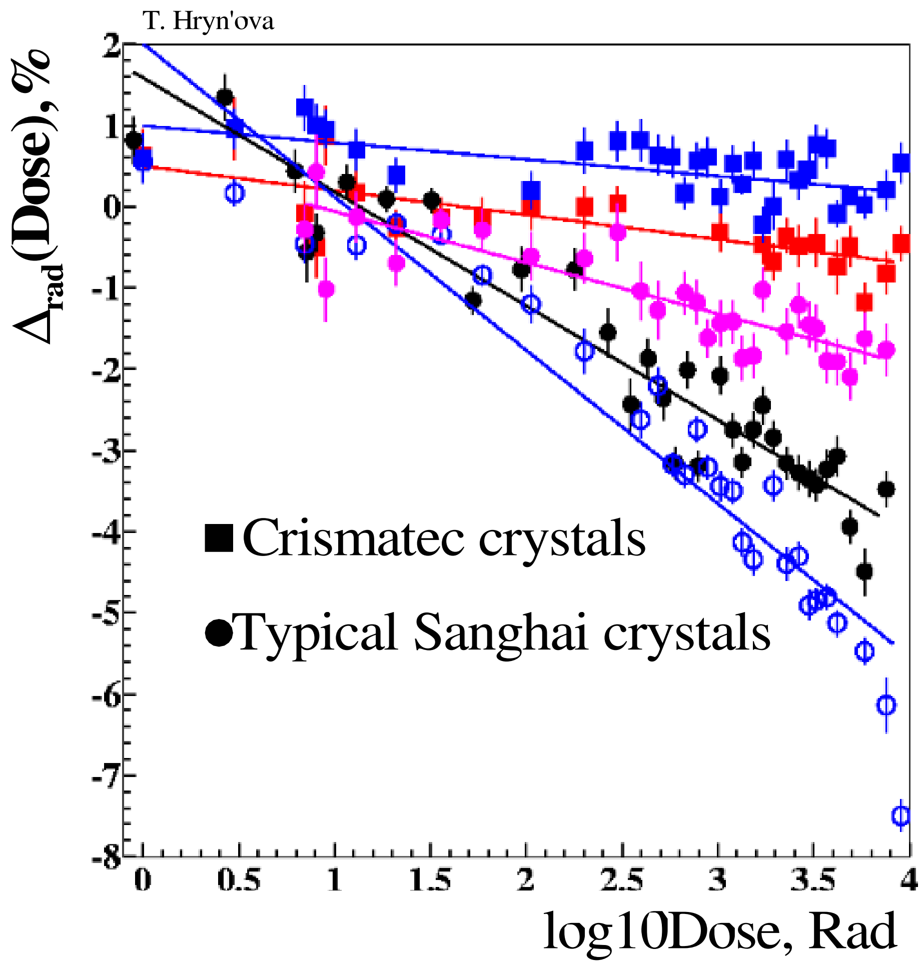
Irradiation Experiment: Uniformity



Left side: Absolute uniformity

Right side: Change with respect to initial uniformity

Dose Dependence of Uniformity

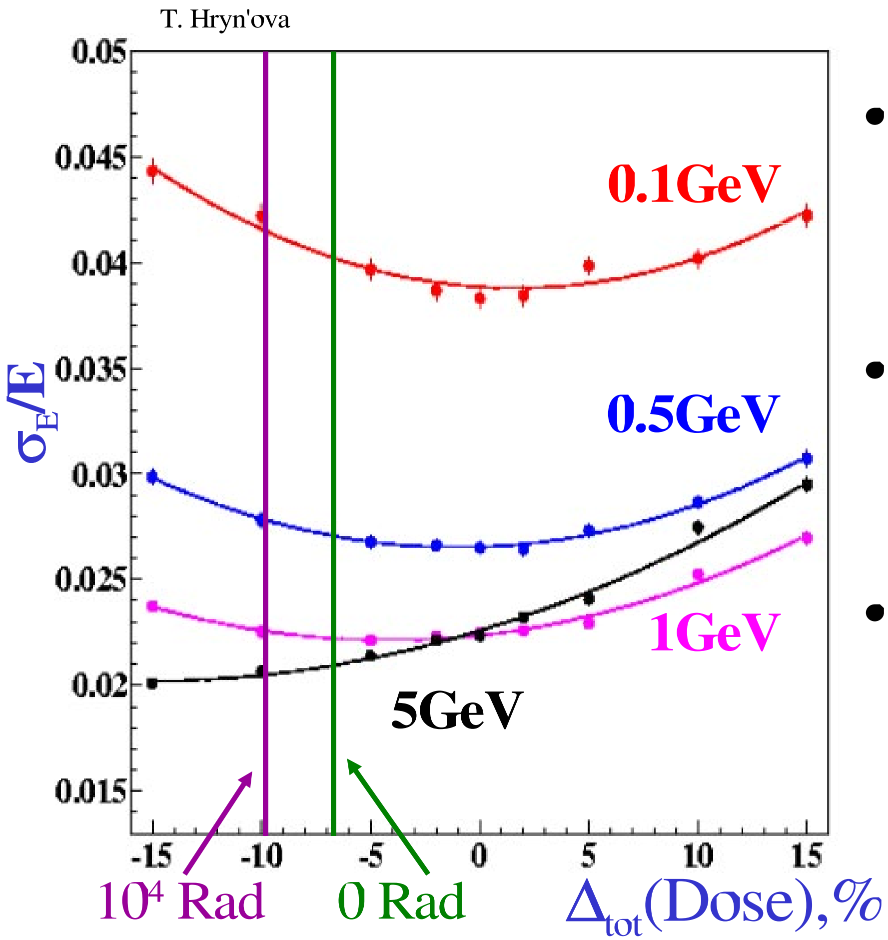


Dependence of Δ_{rad}**(Dose)** (a percentage drop in the LY from the back to the front of the crystals) on dose is:

– Negligible up to ~10 Rad

– Linear above

MC Uniformity Study



- Generate single γs of 0.1, 0.5, 1 & 5 GeV going into $|\cos\theta|<0.2$
- Weight energy in 8 sections over the length of the crystal
- $\Delta_{tot}(\text{Dose})=\Delta_0+\Delta_{rad}(\text{Dose})$

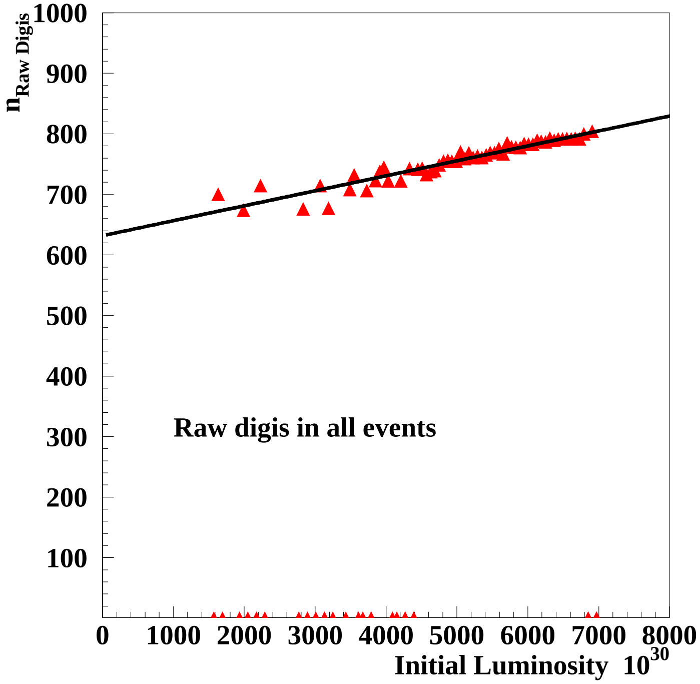
=> At 10 krad the effect of the non-uniformity is negligible

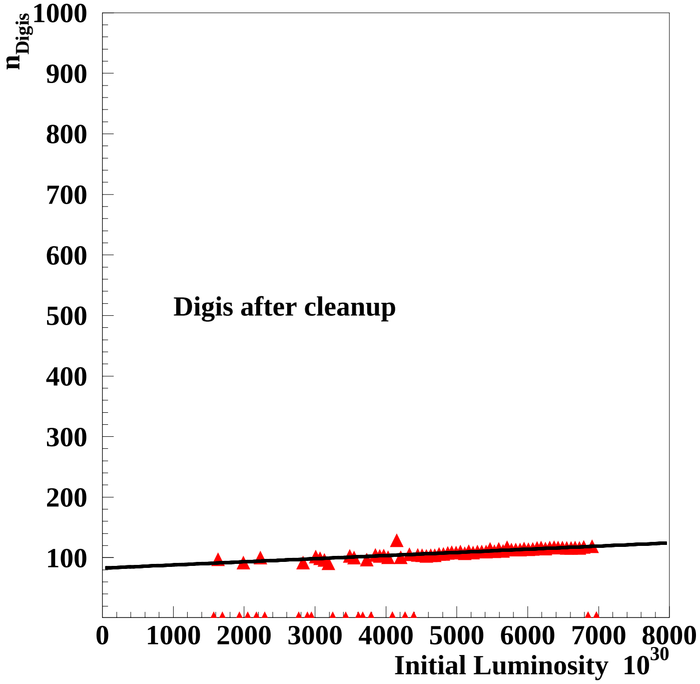
Digi Occupancy

- Raw digis: E>750 keV (filtered), within 2 μs timing window

!! New: Peak not at edge of time window

- This reduces the number of raw digis by a factor of 2
- Default digis: E>1 MeV, 120 ns timing cut, sparsification
- Data from ca. 350 runs from winter 2003



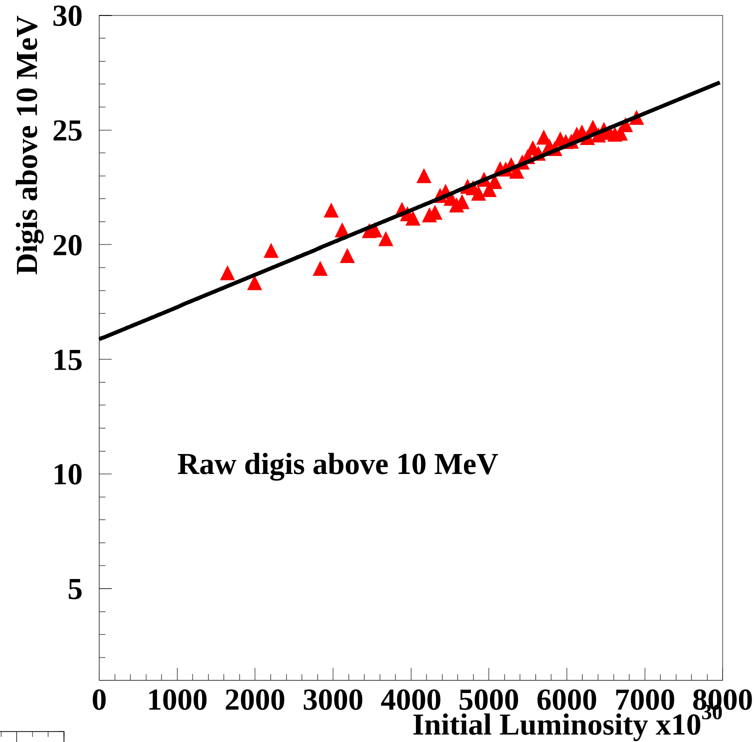


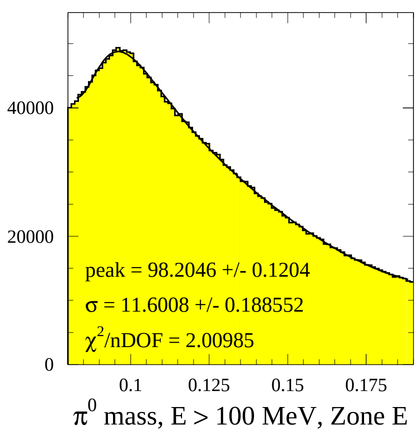
Digi Occupancy II

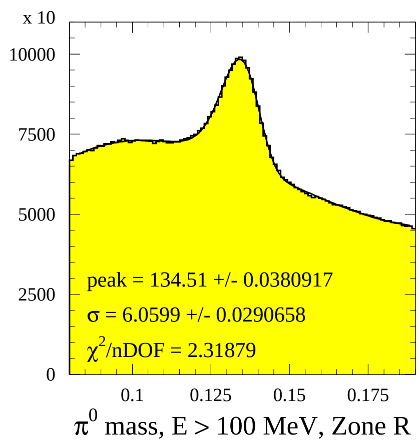
Extrapolation of the numbers to 10^{36}:

- Raw digis: "25000"
- Sparsified digis: 5000
- Raw digis, E>10 MeV: 1400
- Reconstructed clusters: 200

!! These numbers are too high for reconstruction



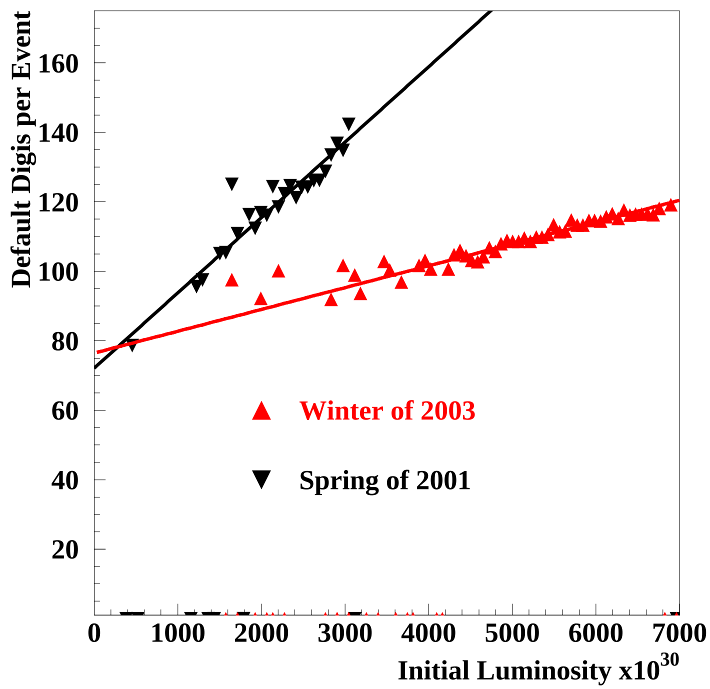




Left: $N_{digi} > 2000$, Right: Normal backgrounds (N. Barlow)

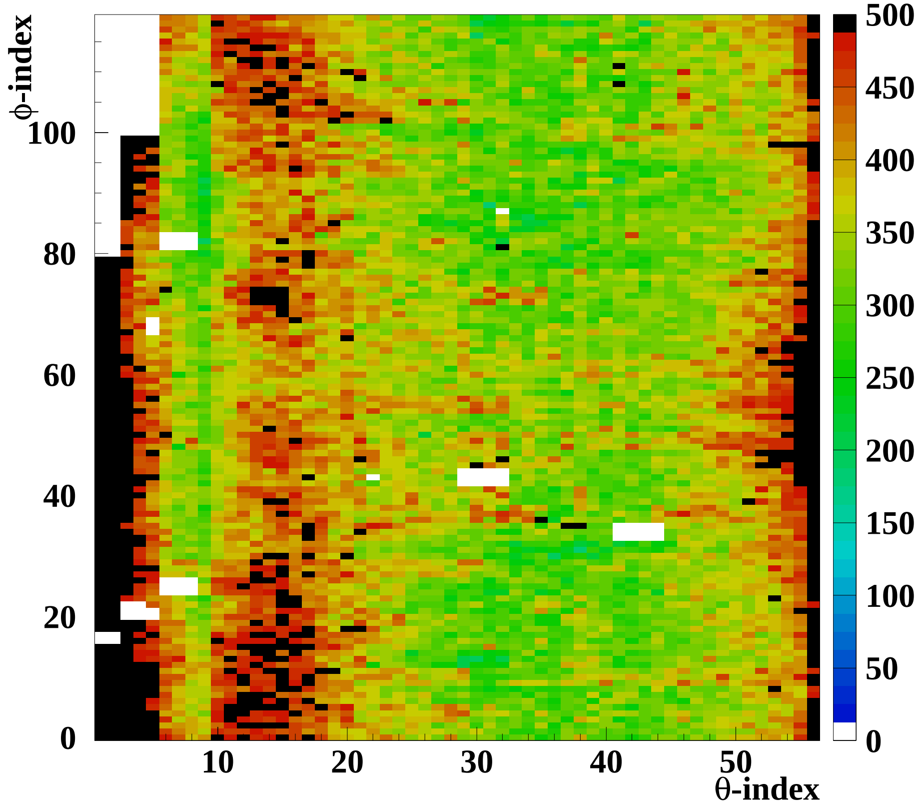
Improvements

- Have backgrounds improved over time?
- Compare early 2001 (400 runs) with late 2003 (350 runs)



- Significant improvement for 2 reasons
  1. Better machine performance
  2. Improved background rejection in Emc code

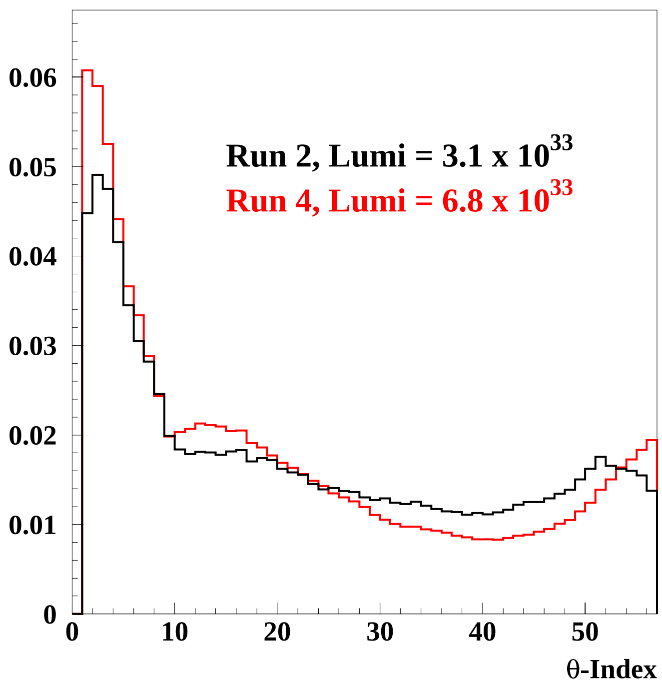
Angular Distribution

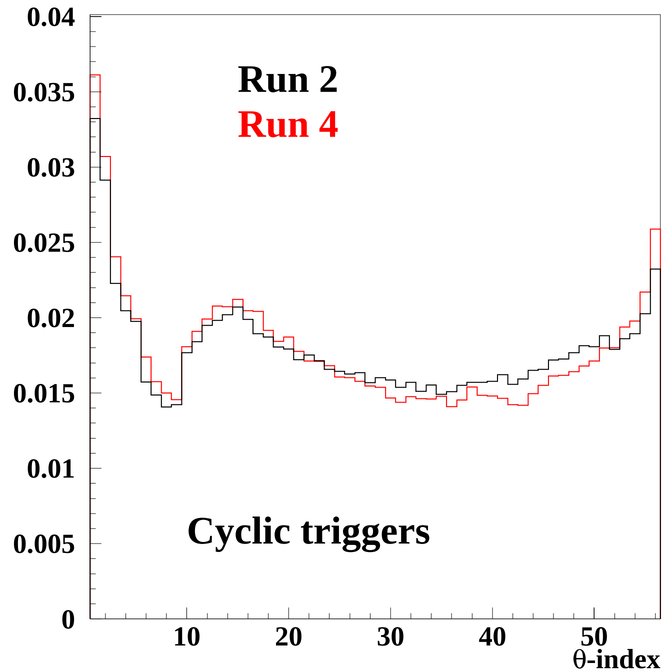


- Cyclic triggers (backgrounds only)
- Clear structure in θ
- Slightly increased backgrounds on the inside of the ring

Angular Distribution

- Spring 2001 / Winter 2003 at peak luminosity
- 2001: LER = 1570 mA HER = 860 mA lumi = $3.1 \cdot 10^{33}$
- 2003: LER = 1920 mA HER = 1250 mA lumi = $6.9 \cdot 10^{33}$

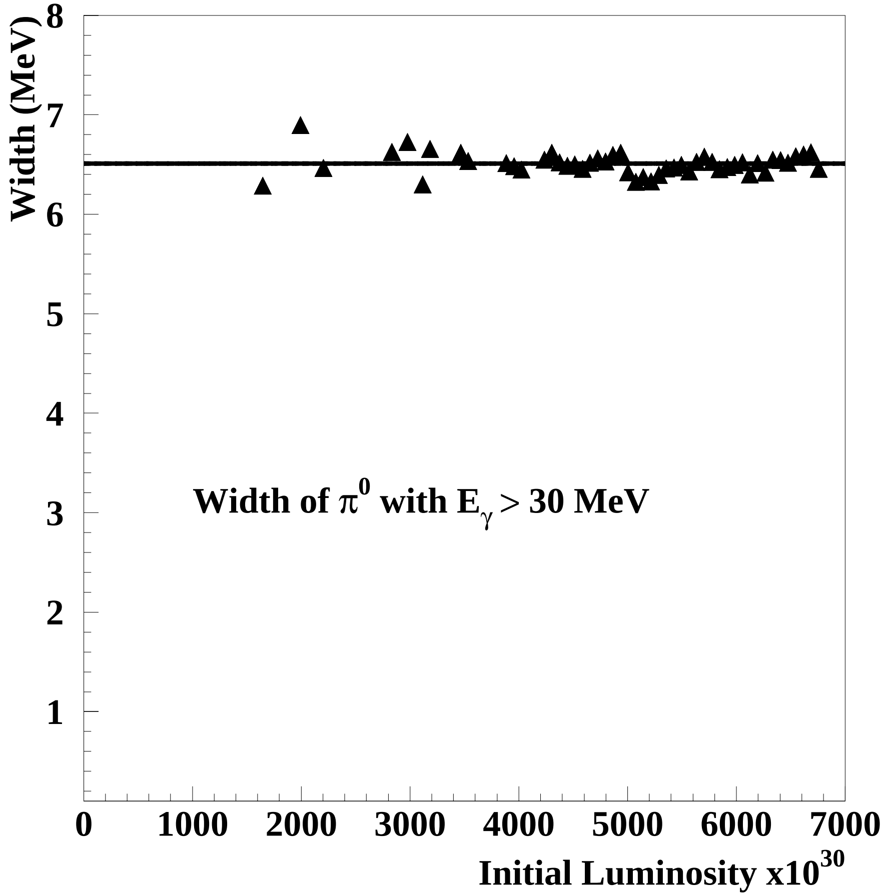


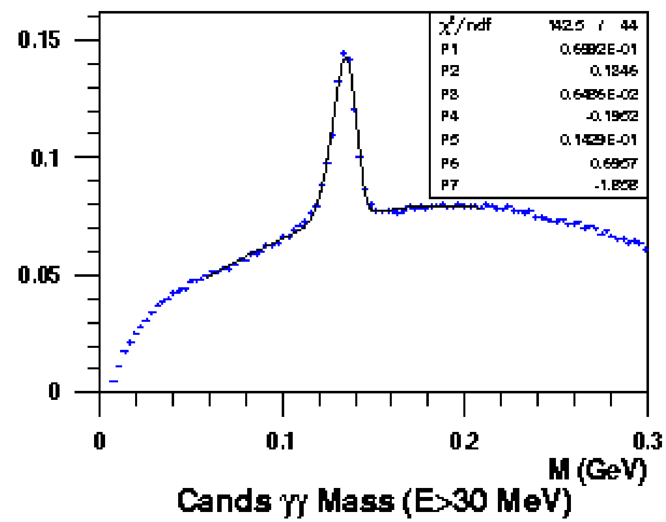


- Higher backgrounds in far forward/backward direction than before

π^0 Resolution

- How sensitive is the π^0-resolution to increased backgrounds?





- Look at 350 runs from late 2003

⇒ So far no deterioration of the π^0-width is observed

Conclusions

- An experiment was performed to understand radiation damage to CsI(Tl) crystals
- Uniformity degradation does not constitute a major problem at 10 krad
- Background occupancy in the Babar calorimeter is improved
- π^0 resolution shows no degradation so far

Related topics:

- Work is being done on the TURTLE simulation to understand machine backgrounds
- A new round of runs taken with one beam only and with beams out of collision would be useful to understand how these factors contribute to the total background (last time this was done in February 2002).