Study of CAL Linearity Constants

☞ Status talks held in

⇒ CAL Parallel: 22.6.98 and 19.10.98
(important mistake on 19.10.98 fixed here)

⇒ CAL Weekly: 13.1.99

☞ Purposes of this talk

⇒ Add to list of weird phenomena

⇒ Remove suspicion that these effects are related to RCAL energy scale

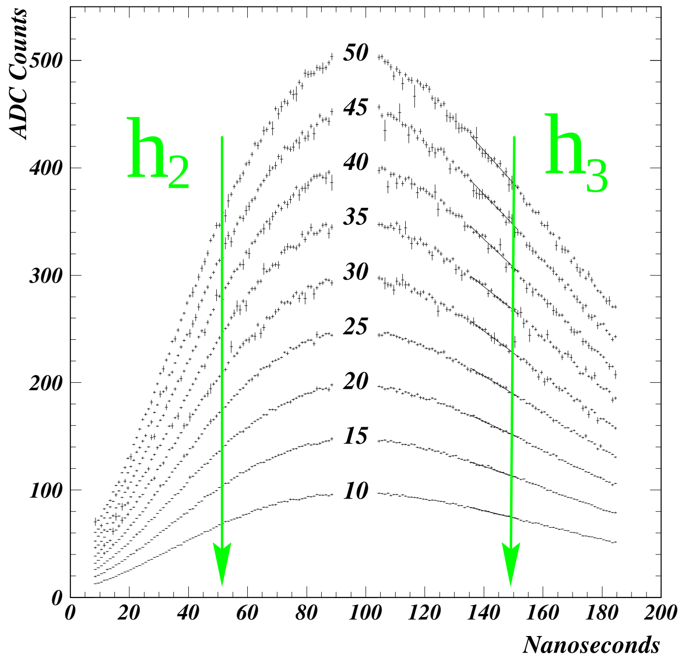
⇒ Make two recommendations

⇒ Advertise ZEUS note

J. A. Crittenden

Physikalisches Institut
Universität Bonn

What is HtoQ ?



$$H = (h_2 - h_0) + 1.8\,(h_3 - h_0)$$

- H has units of ADC counts ($H < 2.8 * 2^{12} \simeq 12000$)
- h_i have been corrected for pedestal and gain in an interesting but irrelevant way

$$Q = HtoQ \cdot H$$

- Q has units of pC ($Q < 80\,\mathrm{pC}$)
- $HtoQ$ is determined using calibrated charge injection separately for the high- and low-gain paths
  The low-gain path is chosen if *any* of the high-gain samples saturate

$$E = pCtoGeV \cdot Q$$

- $pCtoGeV$ determined from test beam calibration of 10 production modules ($pCtoGeV \simeq 10\,\mathrm{pC/GeV}$)

Charge Injection Calibration

At CERN

Since for FCAL shapers the calibrated-charge range covers only one quarter of the low-gain range, we used the "design" value of 22.22 for the ratio, together with high-gain Qinj, to obtain $HtoQ$ for low gain. Electron signals (15 GeV) in the six calibrated FCAL modules were used to verify the ratio, and the design value was reproduced with 0.1% accuracy, the channel-to-channel rms width being 0.7%. This check of the FCAL cards was also done using the four RCAL modules, again finding the design value with 0.1% accuracy, but with an rms width of 0.3% (Fig. 29 of NIM A309 (1991) 101).

In ZEUS

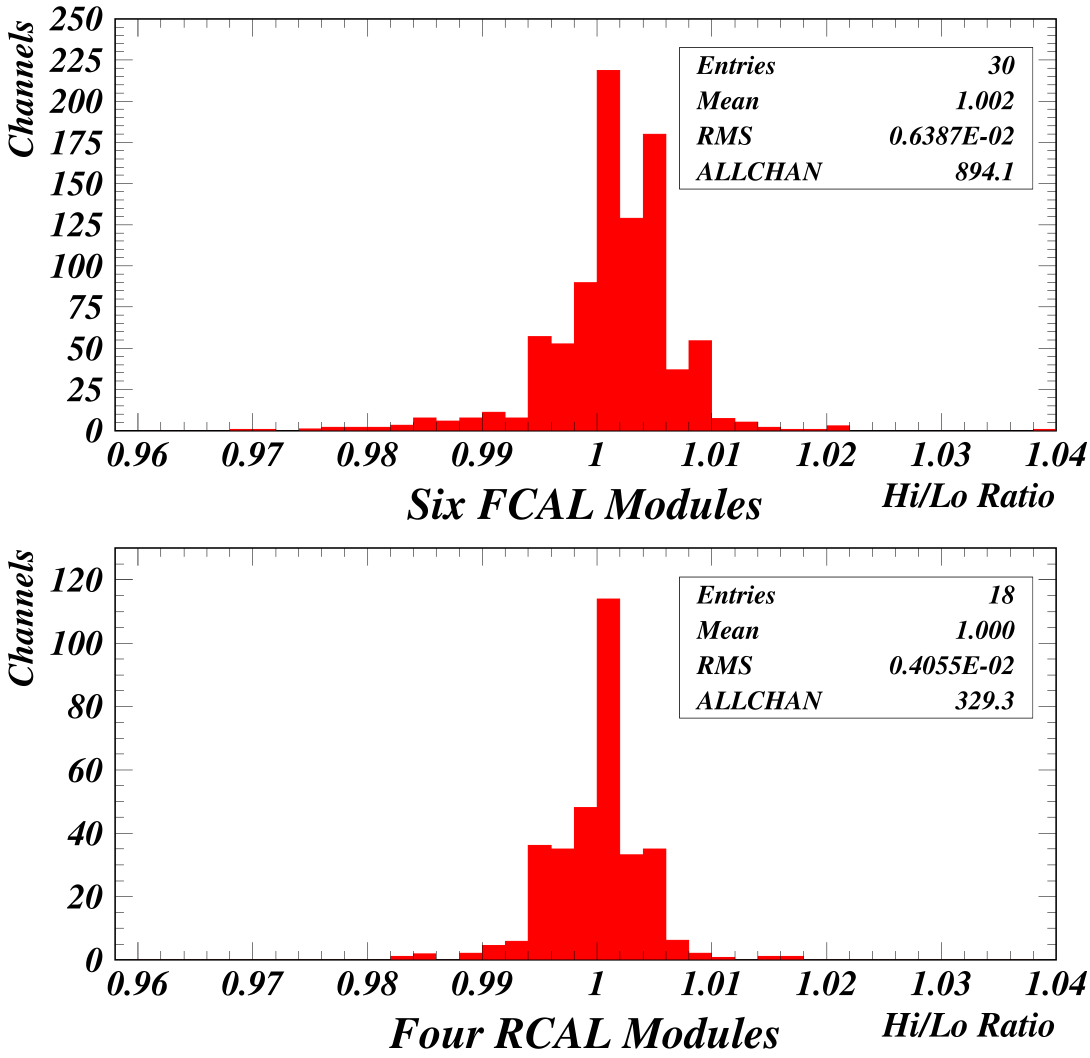
We use Qinj to obtain $HtoQ$ for both high and low gain paths. A verification of the ratio using input signals as at CERN has not been done in ZEUS.

The high/low crossover point is approximately

14 GeV per tube in FCAL and BCAL
9 GeV per tube in RCAL

CERN High/Low Ratios with 15 GeV Electrons

Fig. 29 of NIM A309 (1991) 101 and Fig. 8 of ZNote 90-111

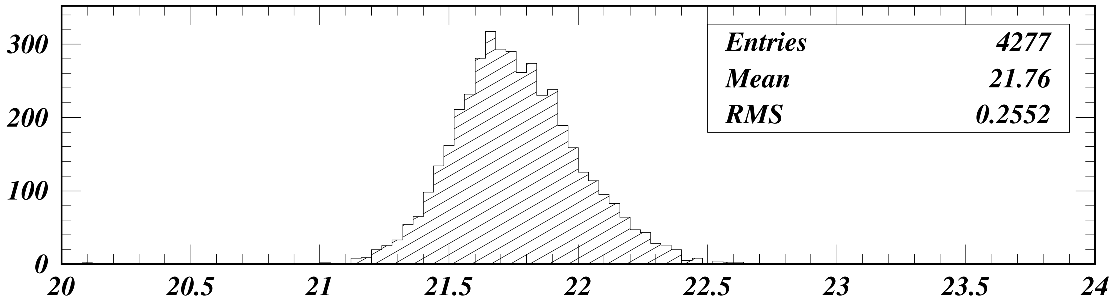


$\Longrightarrow$ Factor 22.22 accurate to $\simeq 0.1\%$

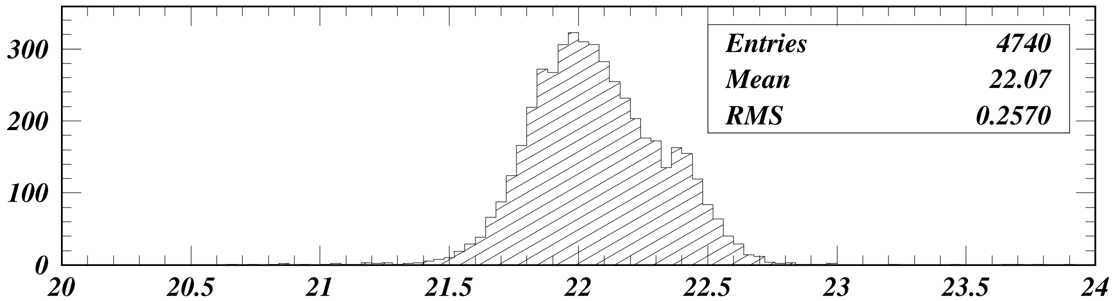
HtoQ Ratios in ZEUS

Version 1892: Last calibration in 1997

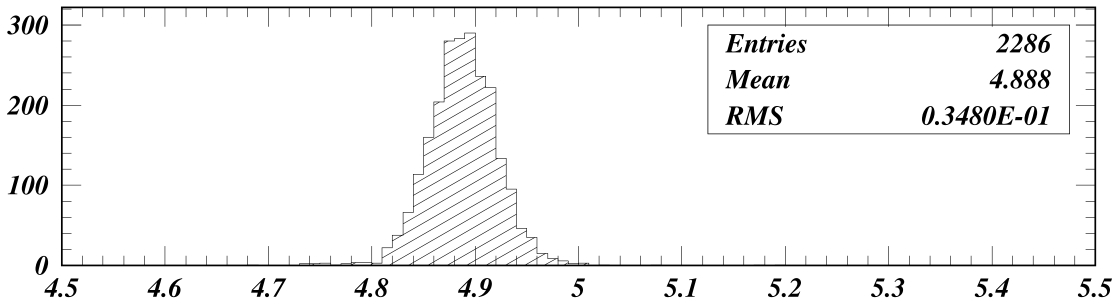
Version 1892



H to Q ratio FCal



H to Q ratio BCal



H to Q ratio RCal

$\Rightarrow$ FCAL: 2.1% lower than at CERN

Some Investigations

- ☞ Brought two of the CERN FCAL cards to DESY and calibrated them in the Mark J test stand
  Found HtoQ ratios compatible with CERN assumption

- ☞ Calibrated ten ZEUS FCAL cards in Mark J
  Found HtoQ ratios compatible with CERN FCAL cards
  $\Longrightarrow$ Qinj in ZEUS incompatible with Mark J (?!)

- ☞ Calibrated five BCAL and six RCAL cards in Mark J
  Found HtoQ ratios compatible with Qinj in ZEUS
  $\Longrightarrow$ Unrelated to KP scale in RCAL

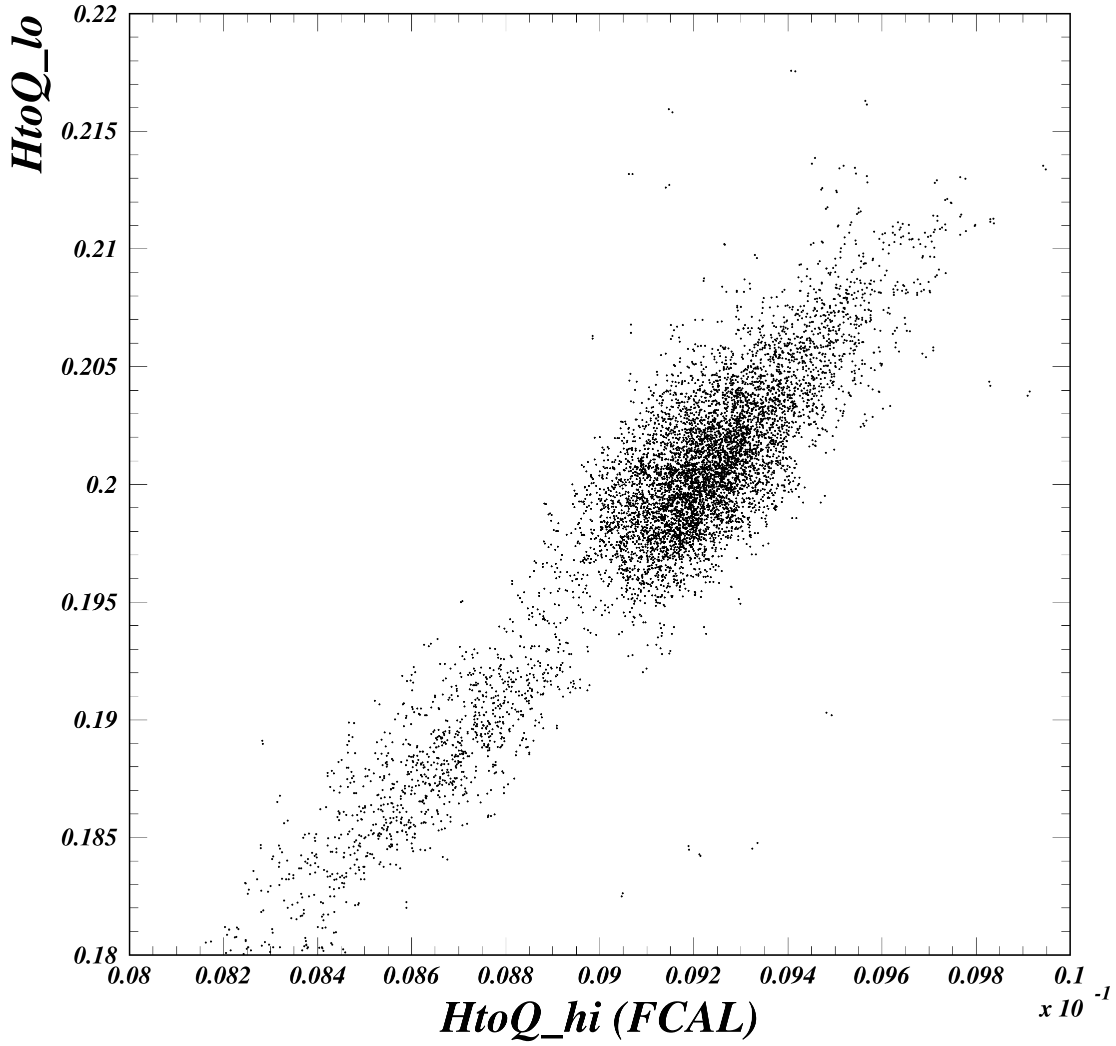
- ☞ Looked at ZEUS HtoQ ratios for unused FCAL channels (not connected to PM)
  No different than those connected to PM

- ☞ Compared HtoQ ratios to measured resistor values
  Distribution in resistance ratios narrower than Qinj (?)

- ☞ Investigated HtoQ distributions in ZEUS for high and low gain separately
  Found some amazing effects ...

HtoQ Values in ZEUS
(Version 1892)

FCAL

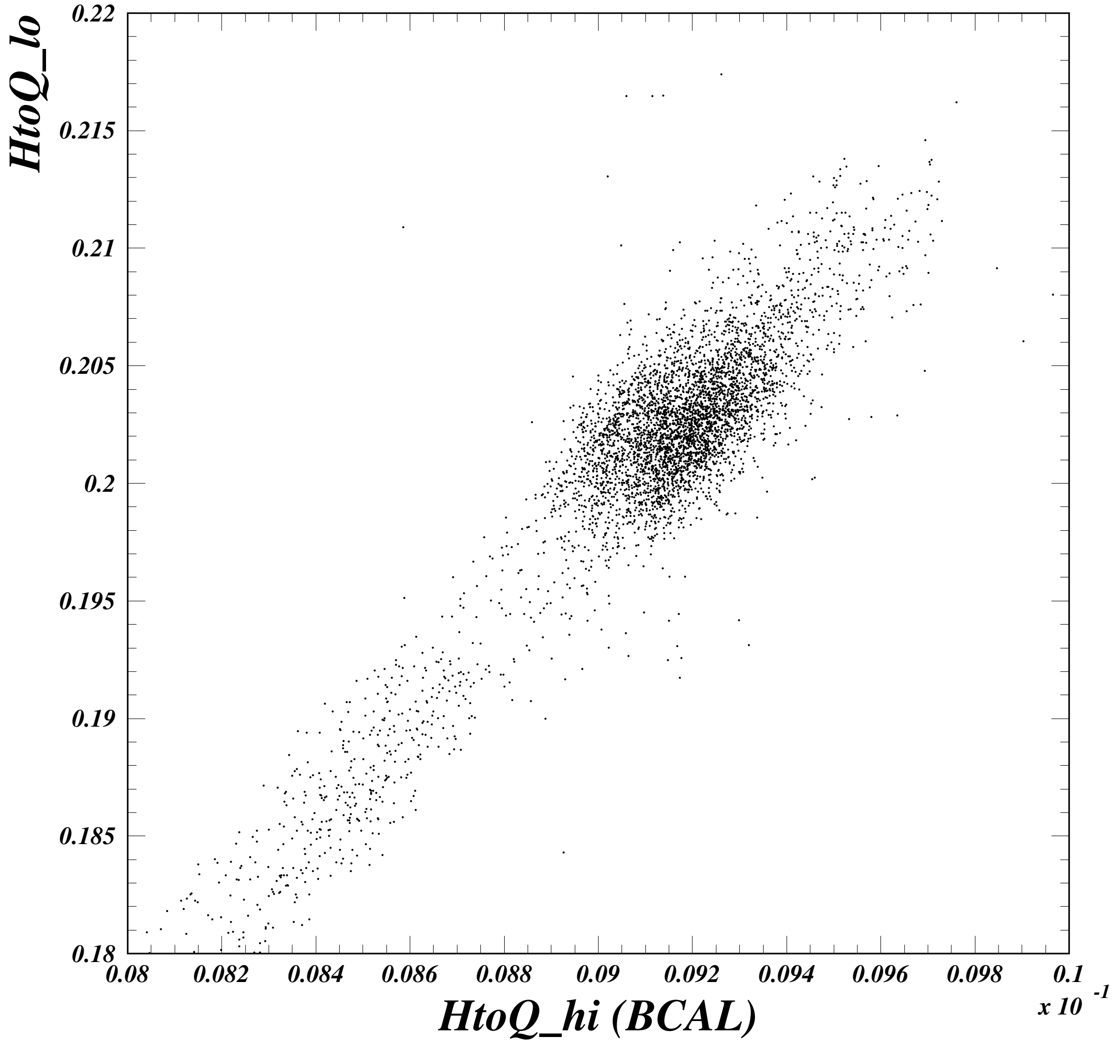


⇒ About 15% of channels show HtoQ values low by roughly 10%

HtoQ Values in ZEUS

(Version 1892)

BCAL

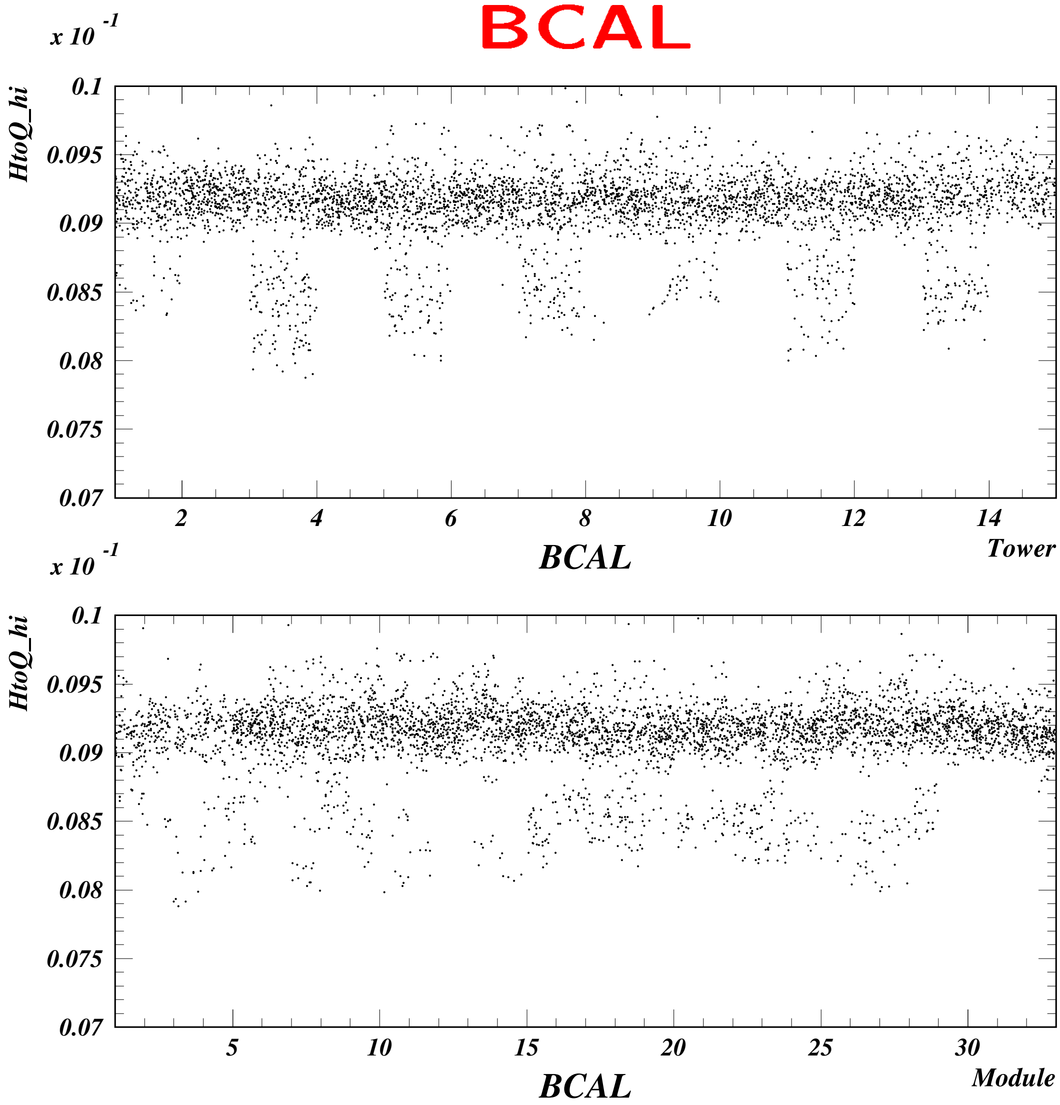


⇒ About 10% of BCAL channels are anomalous

HtoQ Values in ZEUS

(Version 1892)

BCAL

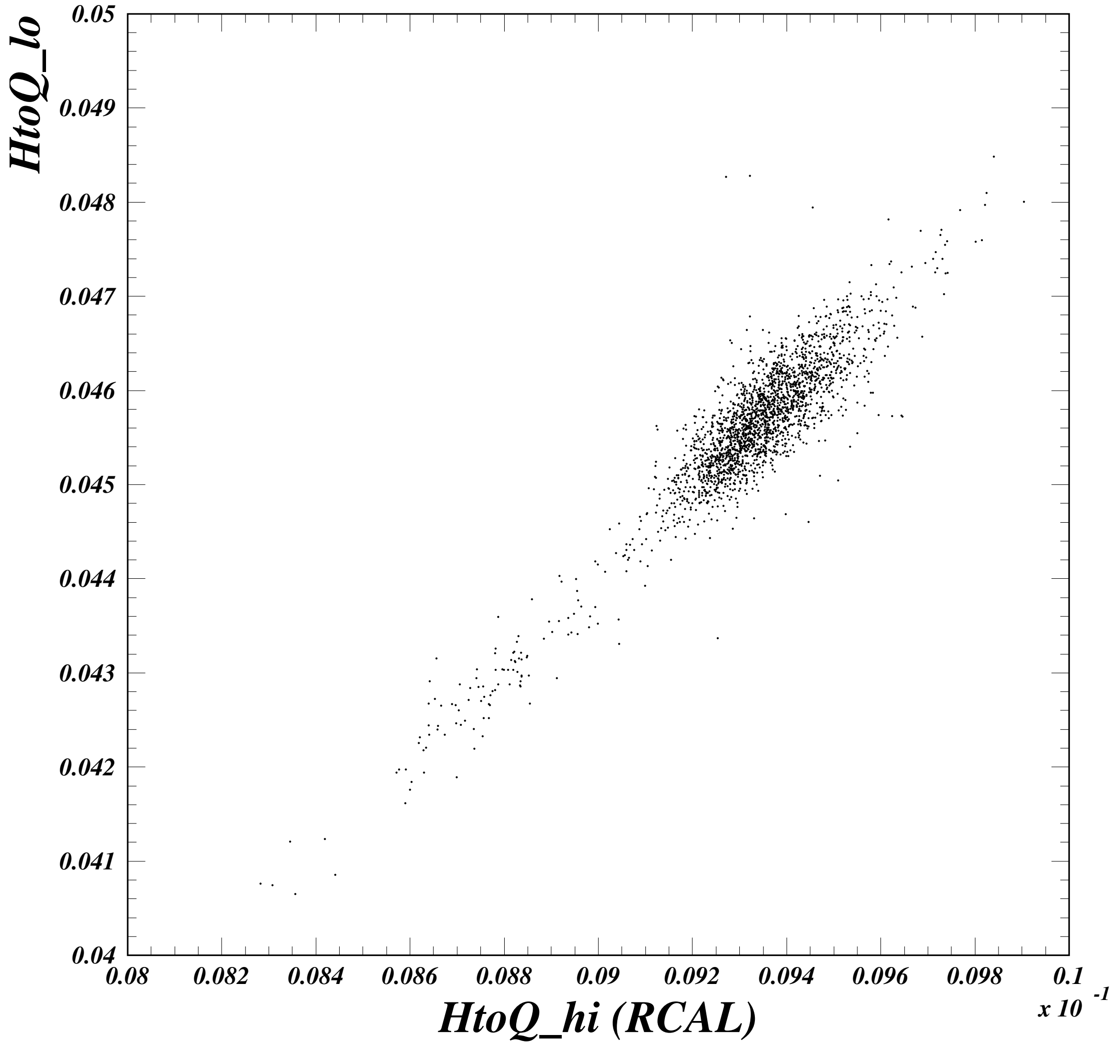


$\Rightarrow$ Anomalous channels only in odd-numbered BCAL towers !

HtoQ Values in ZEUS

(Version 1892)

RCAL



⇒ About 5% of RCAL channels (but only HAC0 and HAC1 !)

Two Recommendations

Perform CERN-type high/low gain verification with ZEUS data

(Requires DSP-calibration offline)

Check offline data for effects of anomalous HtoQ values

(Imbalances, ...)

ZEUS note in progress