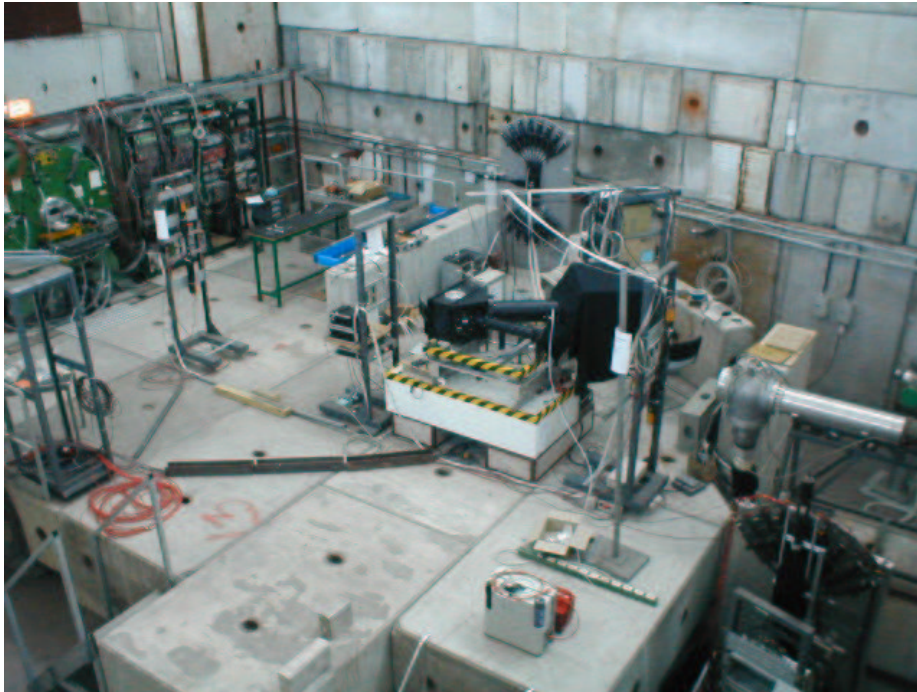


MaPMT Readout with boardBeetle

First Experiences



- Testbeam experiences:
 - boardBeetle: multichannel

Beetle User meeting, Zürich, 17.09.2003

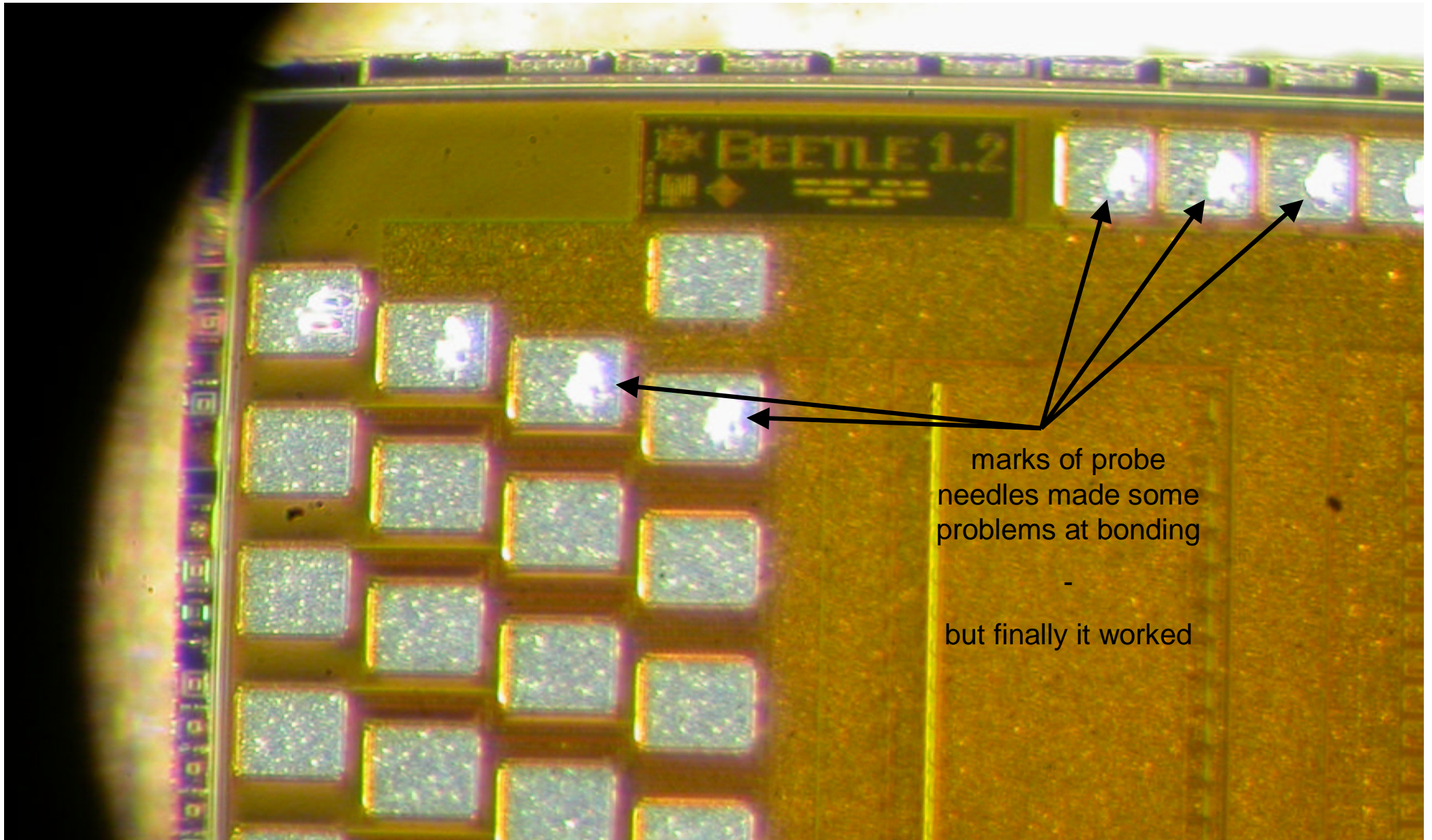
Stephan Eisenhardt
University of Edinburgh



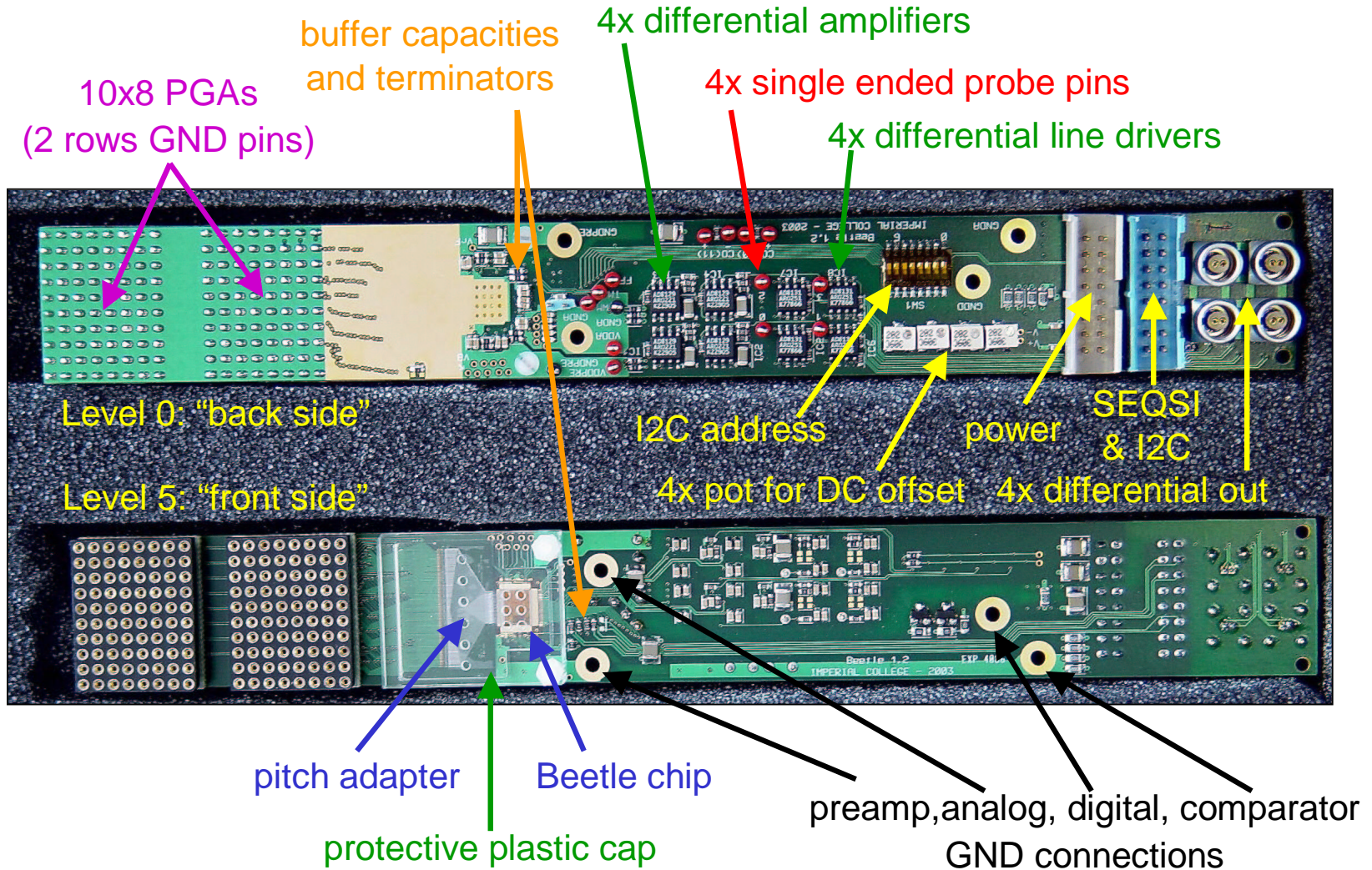
boardBeetle: Events

- Thu 14.08.: first ever boardBeetle 1.2 finished and shipped to Edinburgh
- Thu 21.08.: first ever LED light signals via DAQ chain (boardBeetle 1.2)
 ➡ success!!
- Sun 24.08.-Sun 14.09.: testbeam
- Sun 31.08.: tuning of setup for Cherenkov light &
 first Cherenkov photons with one boardBeetle 1.2
- Thu 04.09.: tuning of read-out map for right geometry match &
 first ring of Cherenkov photons ➡ success!!
- Tue 09.09.-Sat 13.09.: data taking for:
 Air, N₂, CF₄ for cluster of 9 MaPMT (Beetle 1.2)
- Sun 14.09.: mount of cluster with 6 MaPMT (Beetle 1.2MA0)
 lenses, DC-offsets,...
 ➡ ring fragments

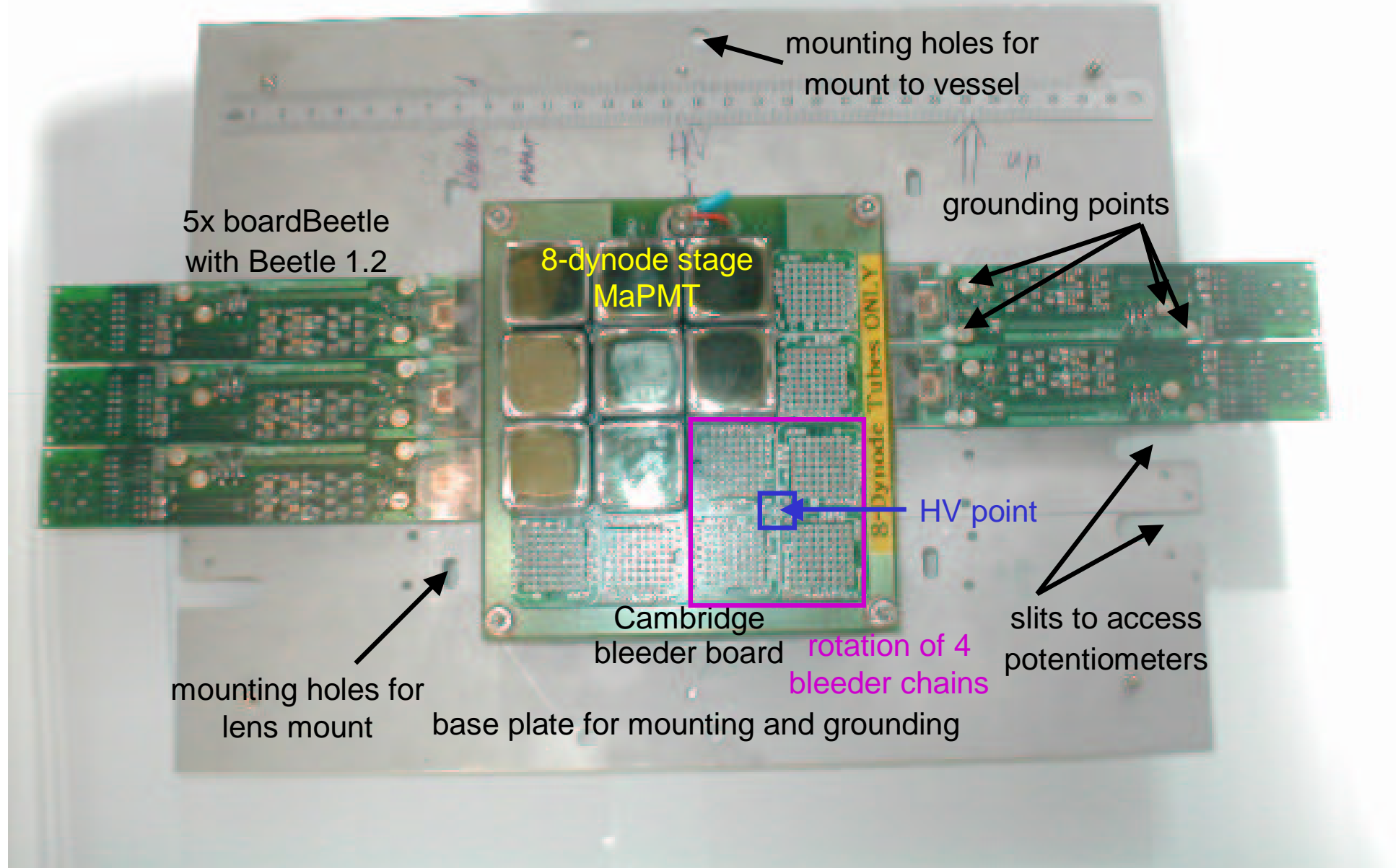
Zoom on probe-tested Chip



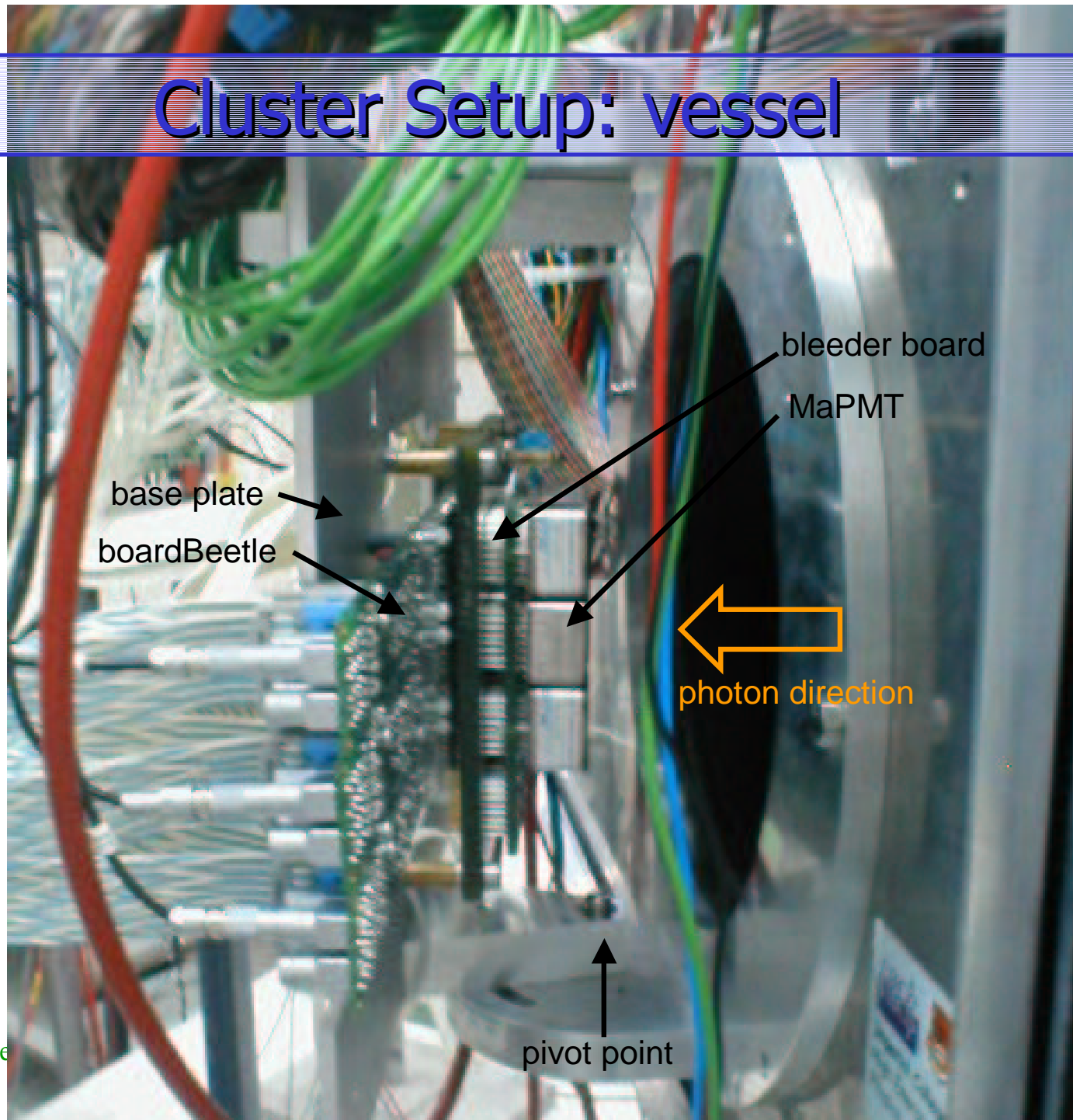
Equipped boardBeetle



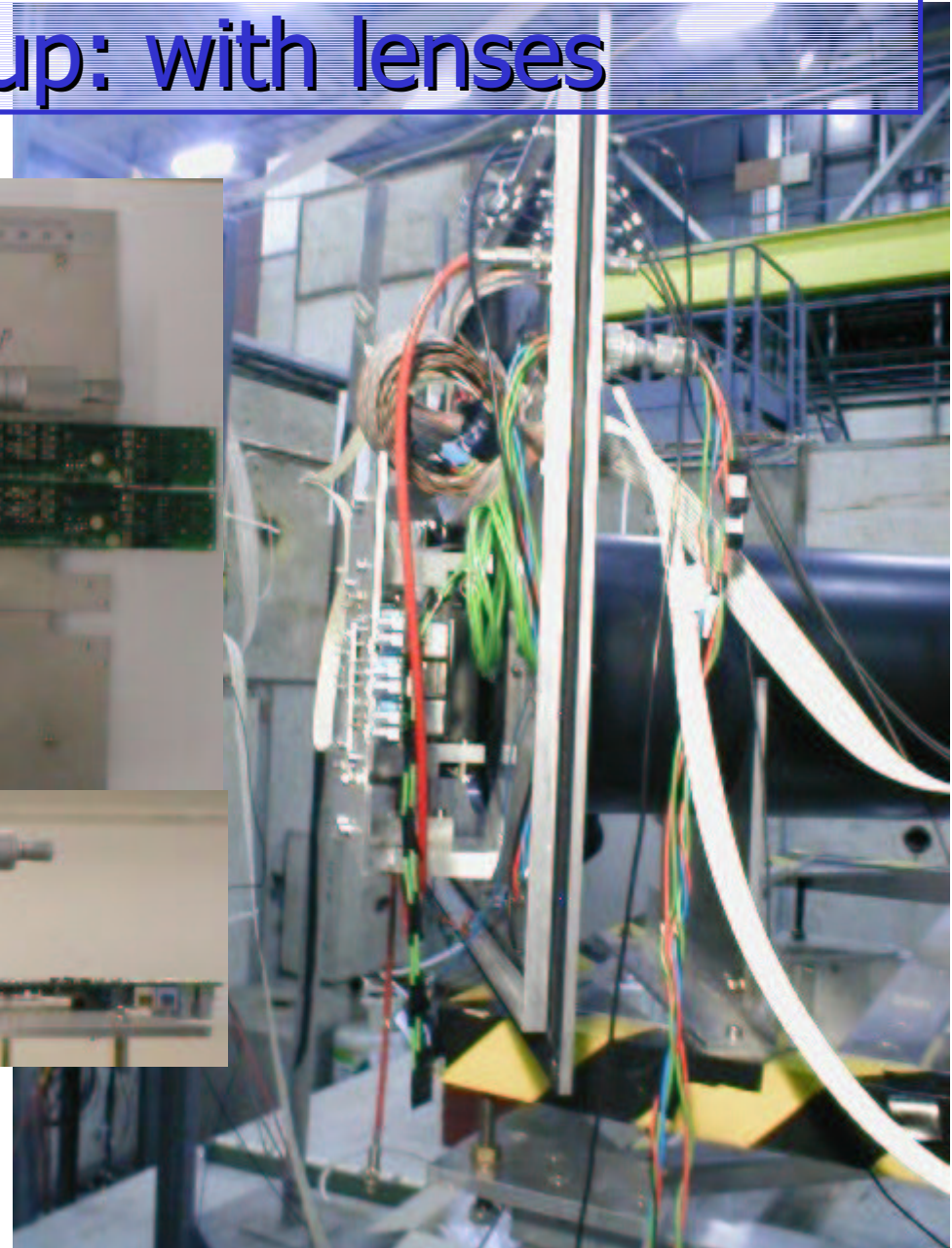
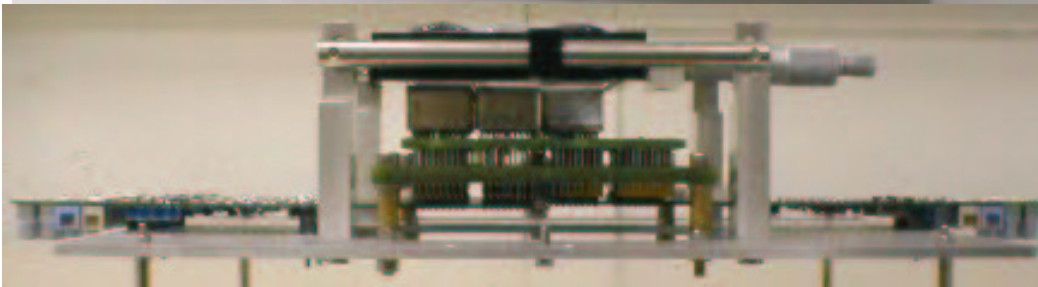
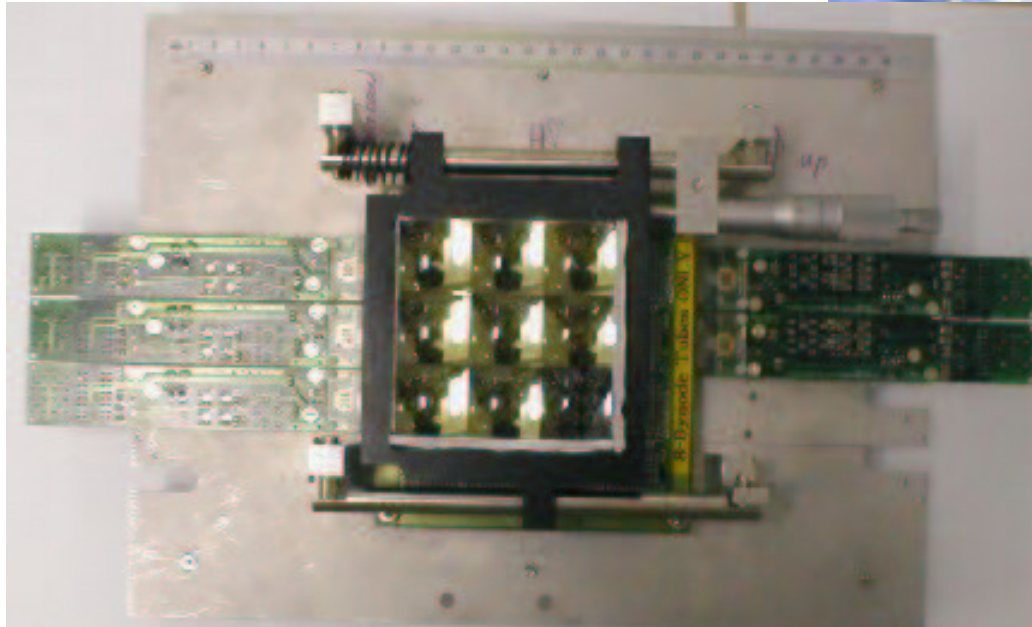
Cluster Setup



Cluster Setup: vessel



Cluster Setup: with lenses



Beetle User meeting, Zürich, 17.09.2003

Interface Board is missing...

I2C bus

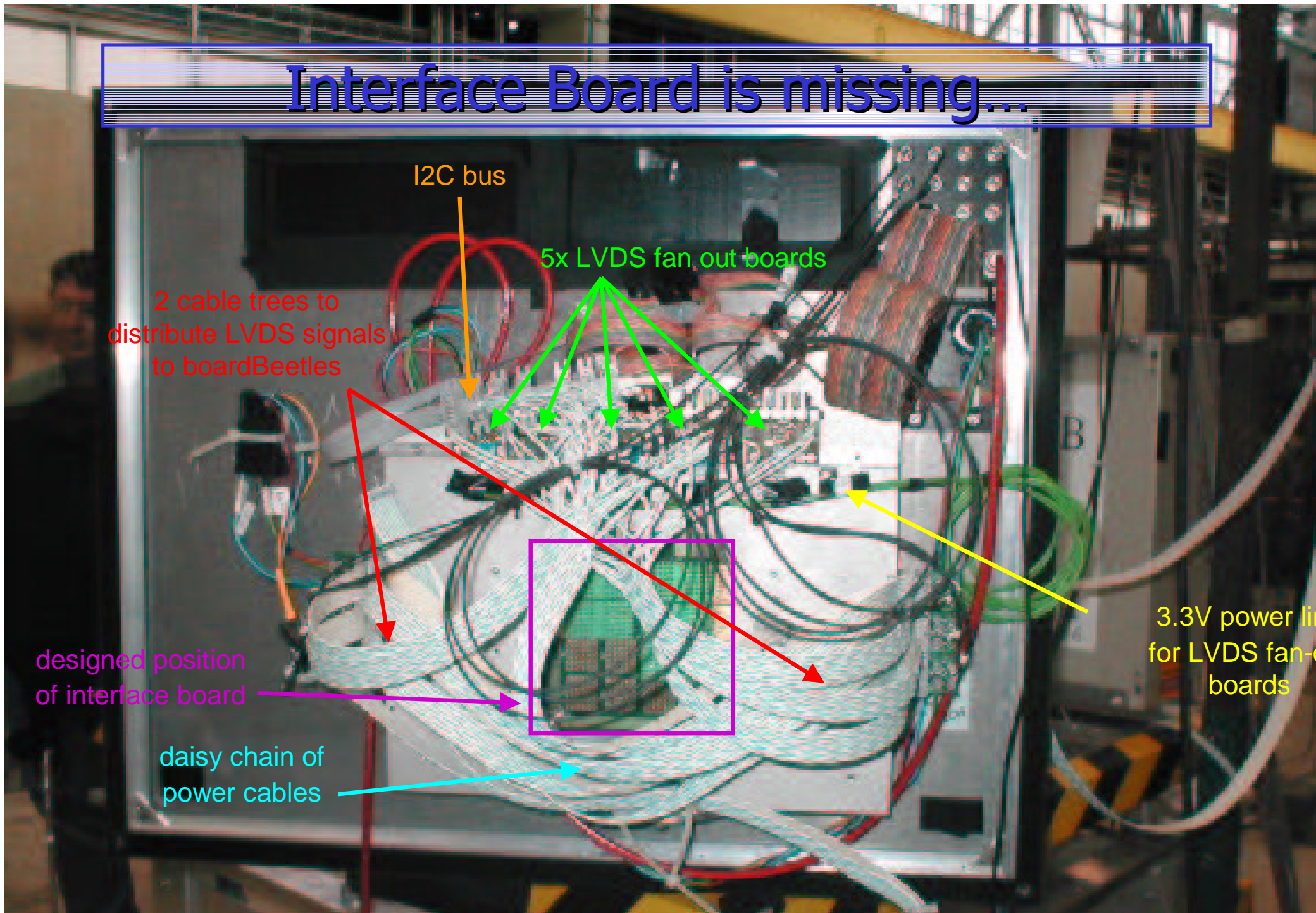
5x LVDS fan out boards

2 cable trees to distribute LVDS signals to boardBeetles

designed position of interface board

daisy chain of power cables

3.3V power line for LVDS fan-out boards



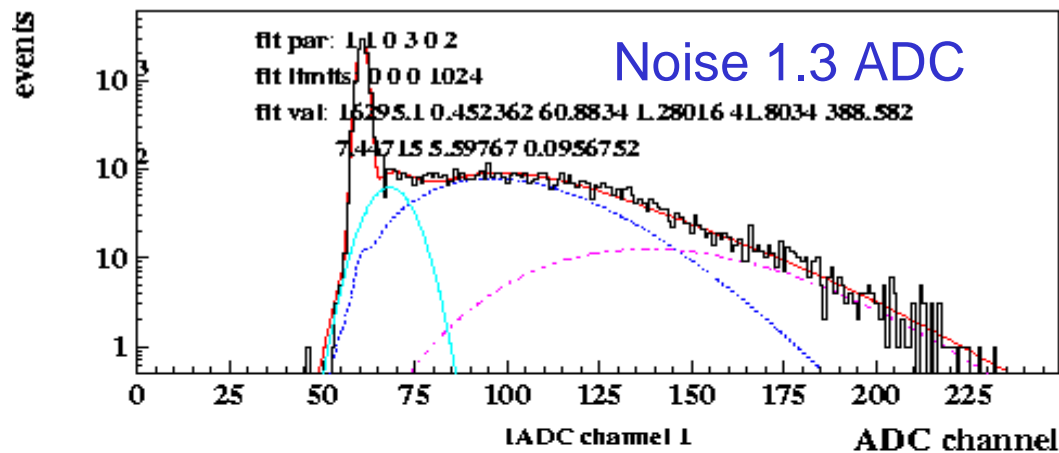
Pre-Testbeam Results

- using Heidelberg board at Edinburgh
 - noise
 - signal loss
 - comparison Beetle 1.2 / Beetle 1.2 MA0
- using boardBeetle at Edinburgh
 - first spectra
 - comparison Beetle 1.2 / Beetle 1.2 MA0
 - saturation

Comparison using Heidelberg Board

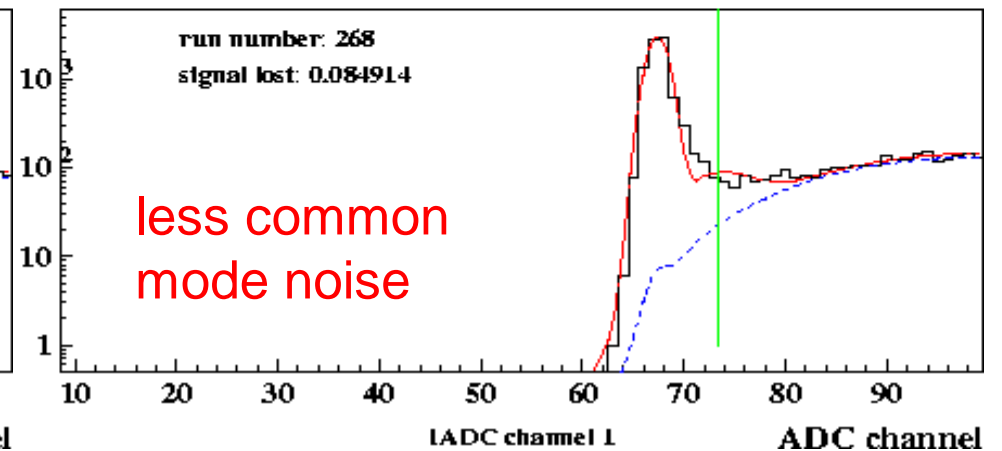
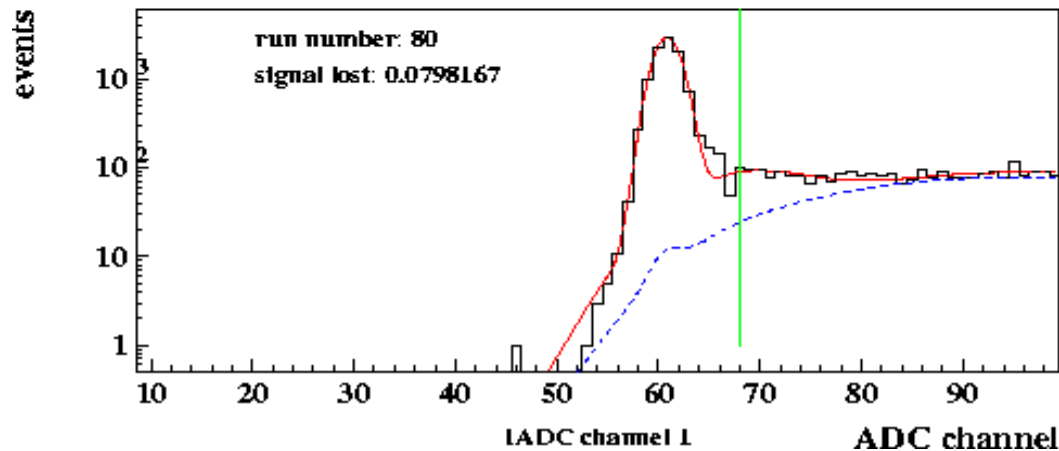
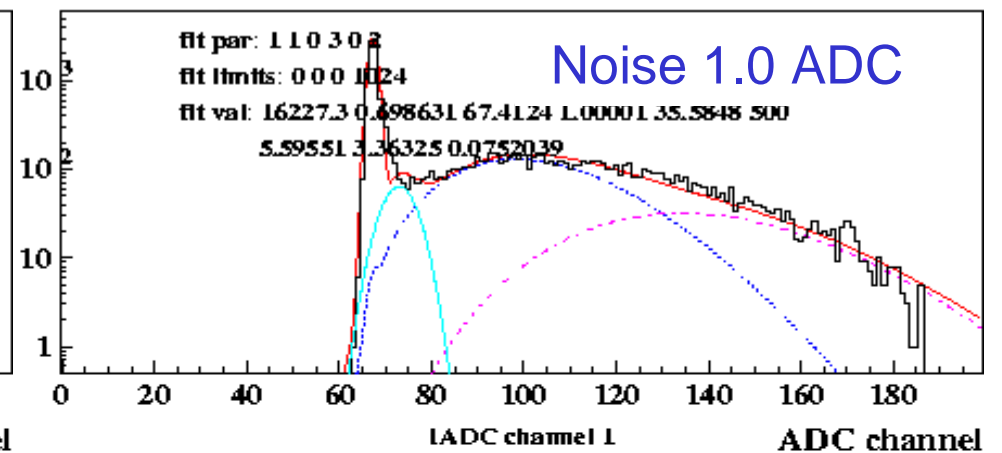
8-dynode/Beetle1.2

MaPMT Spectrum Fit with Poisson and 1st Dynode Effects

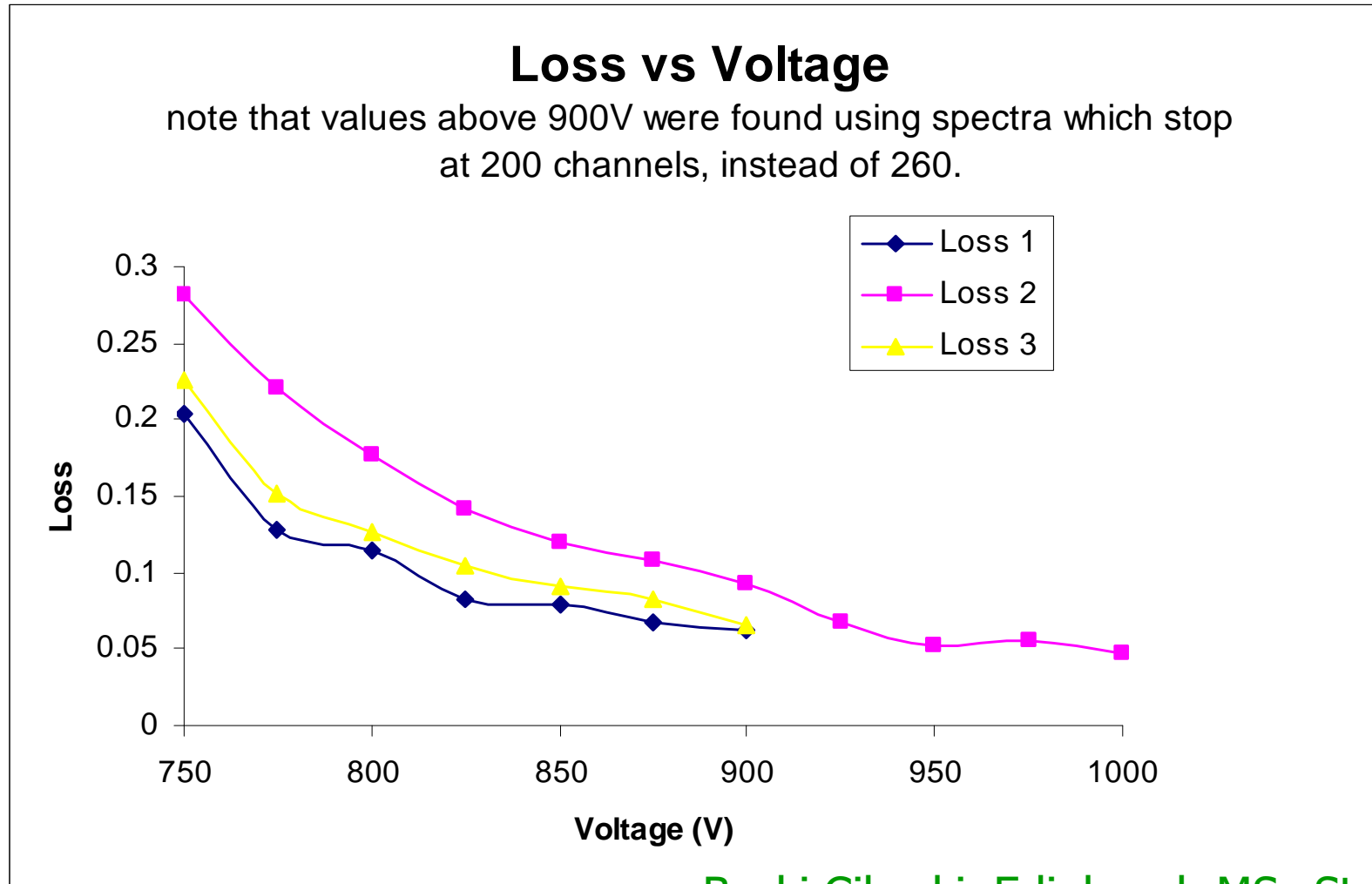


12-dynode/BeetleMA0

MaPMT Spectrum Fit with Poisson and 1st Dynode Effects



Signal Loss Study

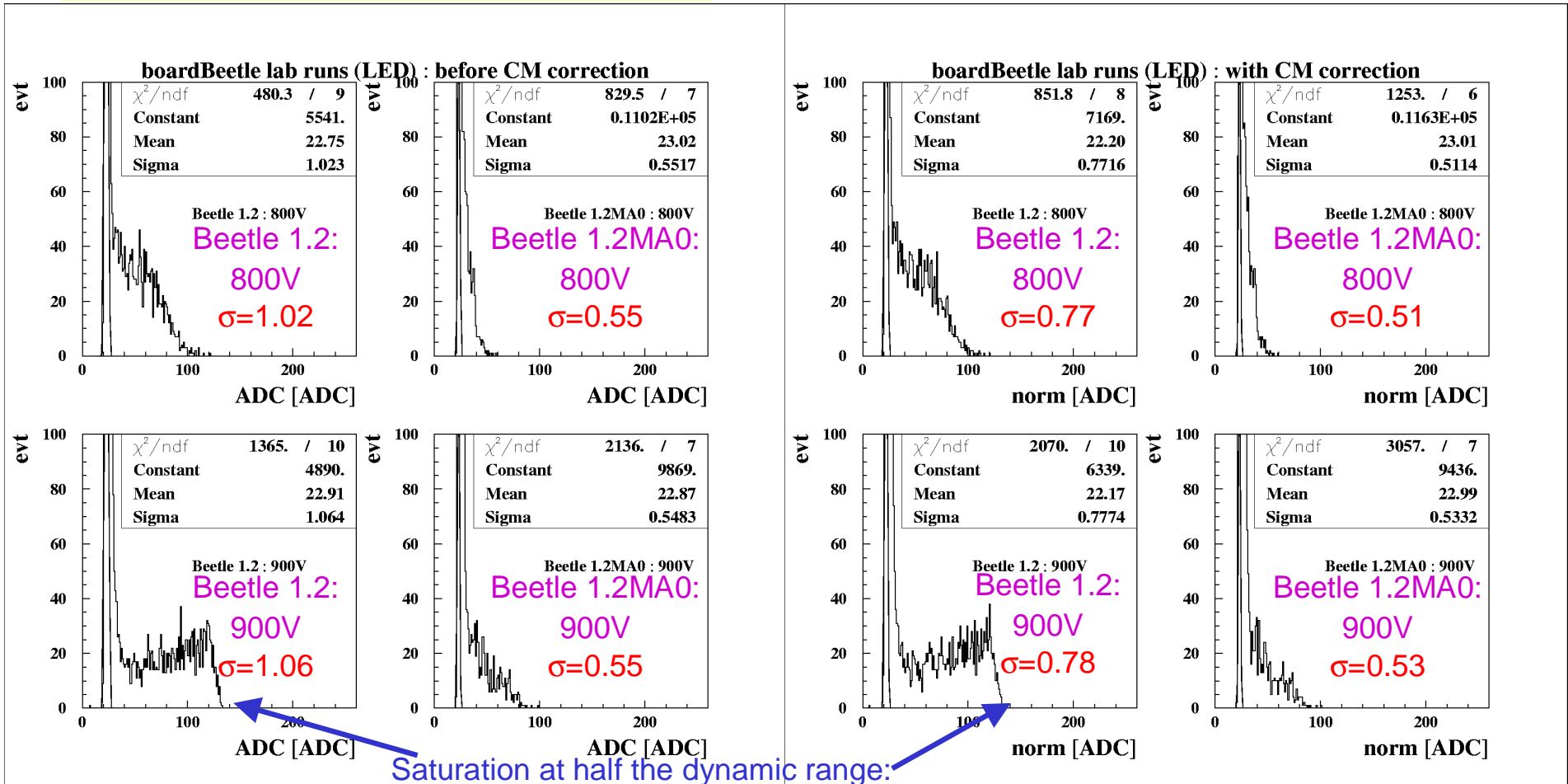


Becki Cikoski, Edinburgh MSc Student

First Spectra with boardBeetle

before CM correction

after CM correction



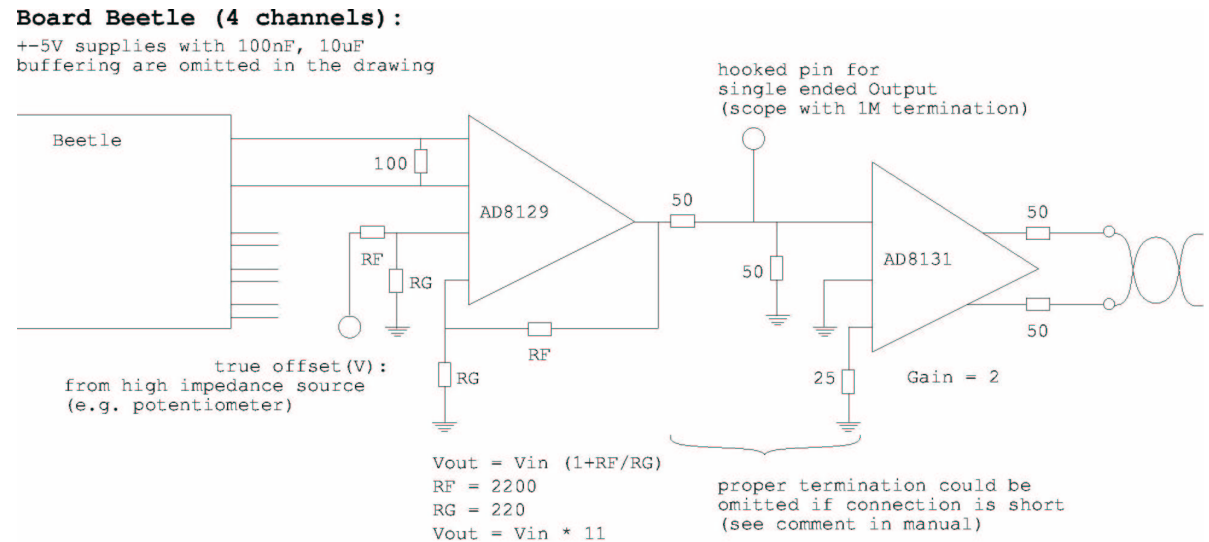
Saturation

□ A) differential amplifier

– gain 10 seems too much for our signals

– easy fix:

- gain 5
- remove serial 50Ω
- ➔ total gain maintained
- ➔ dynamic range doubled



□ B) FED

- Edinburgh FED was configured **single-ended, unipolar**
- conversion to **differential OK**, but still **unipolar (no level shifters)**,
 i.e. **0...0.75V** instead of **-0.75...0.75V** ➔ **8-bit** ➔ **7-bit reduction**

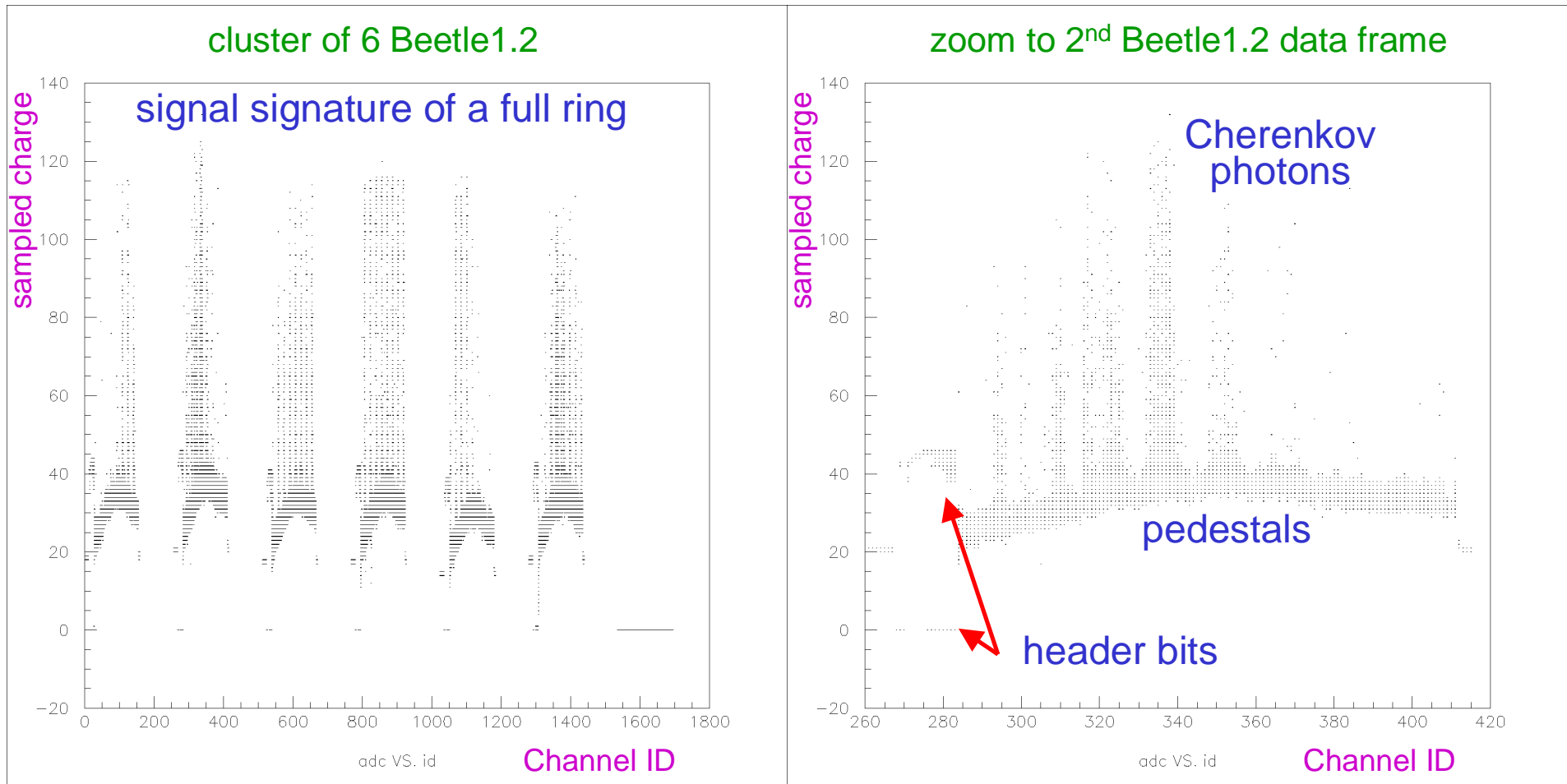
□ ... at least the two devices match...

Preliminary Testbeam Results

- first measurements with cluster: 8 8-dynode MaPMT & 5 Beetle1.2
 - data frames, LED light, adjustment of pixel map, first Cherenkov ring
- timing optimisation
- noise level and CM suppression
 - cluster of 8-dynode MaPMT & Beetle1.2
 - half cluster of 12-dynode MaPMT & Beetle1.2MA0
- study of cross-talk from header to first channel

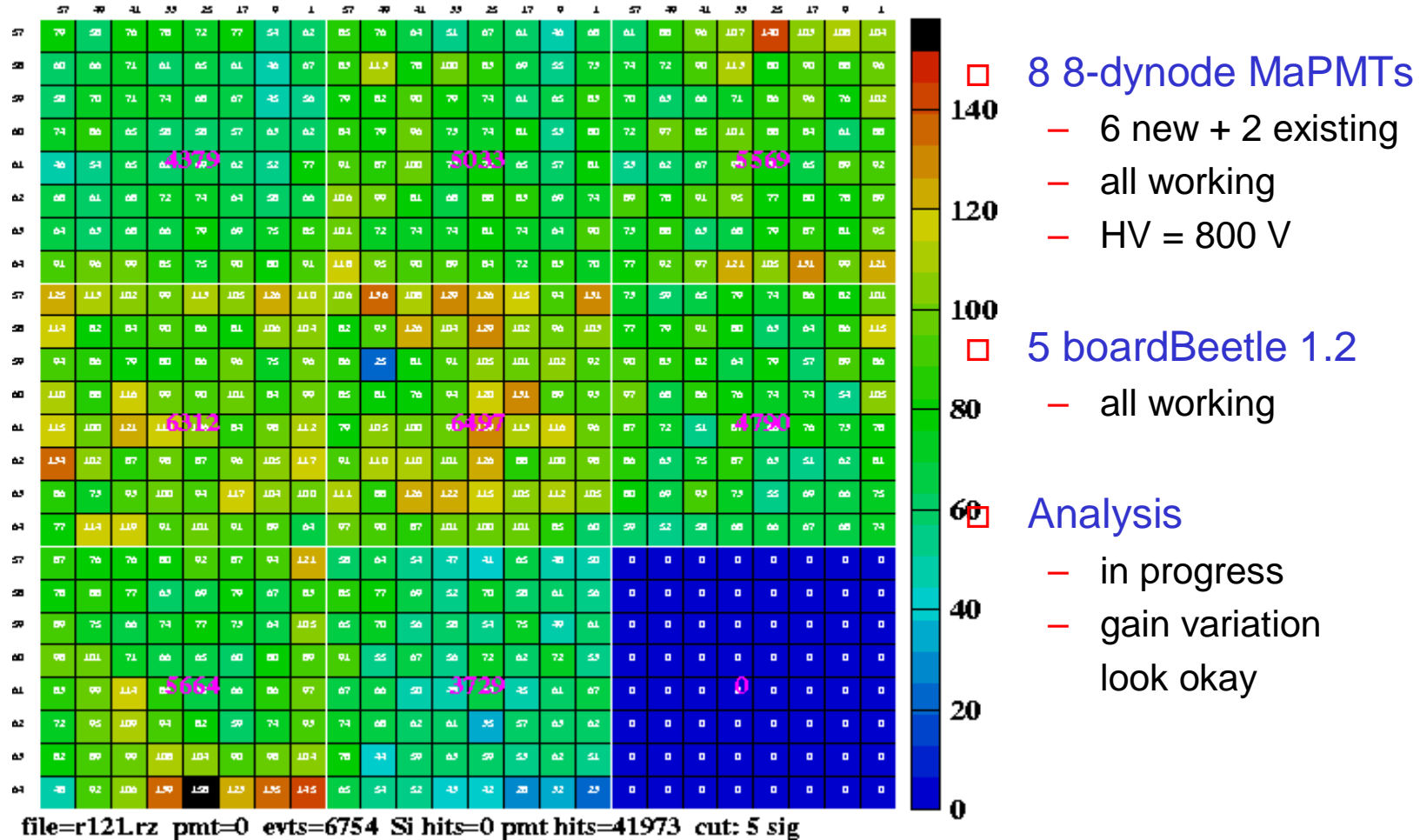
- application in RICH: photon yields:
 - Air: 960 mbar
 - N₂: 960 mbar
 - CF₄: 80 mbar , 800 mbar

Data Frames



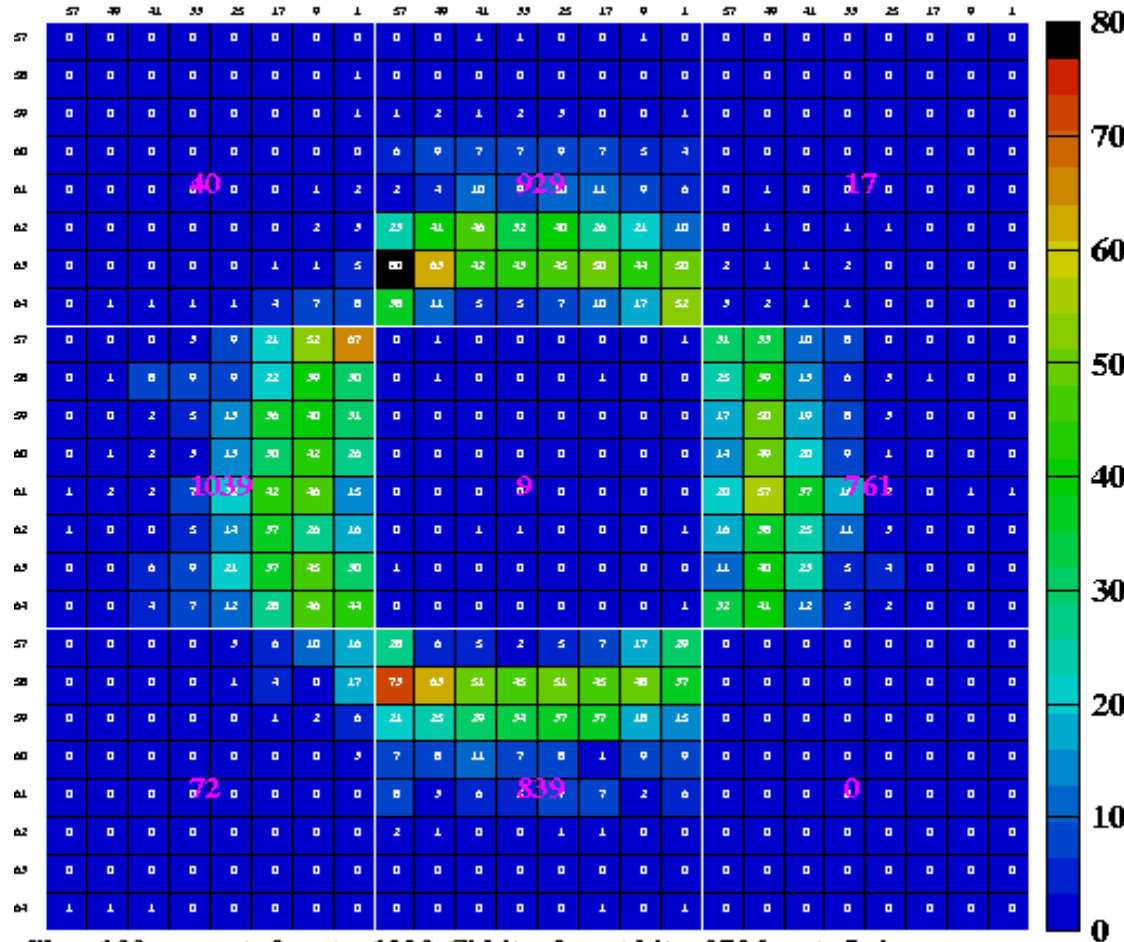
LED Light

2003/09/05 00.05



First Cherenkov Light

2003/09/04 19.28

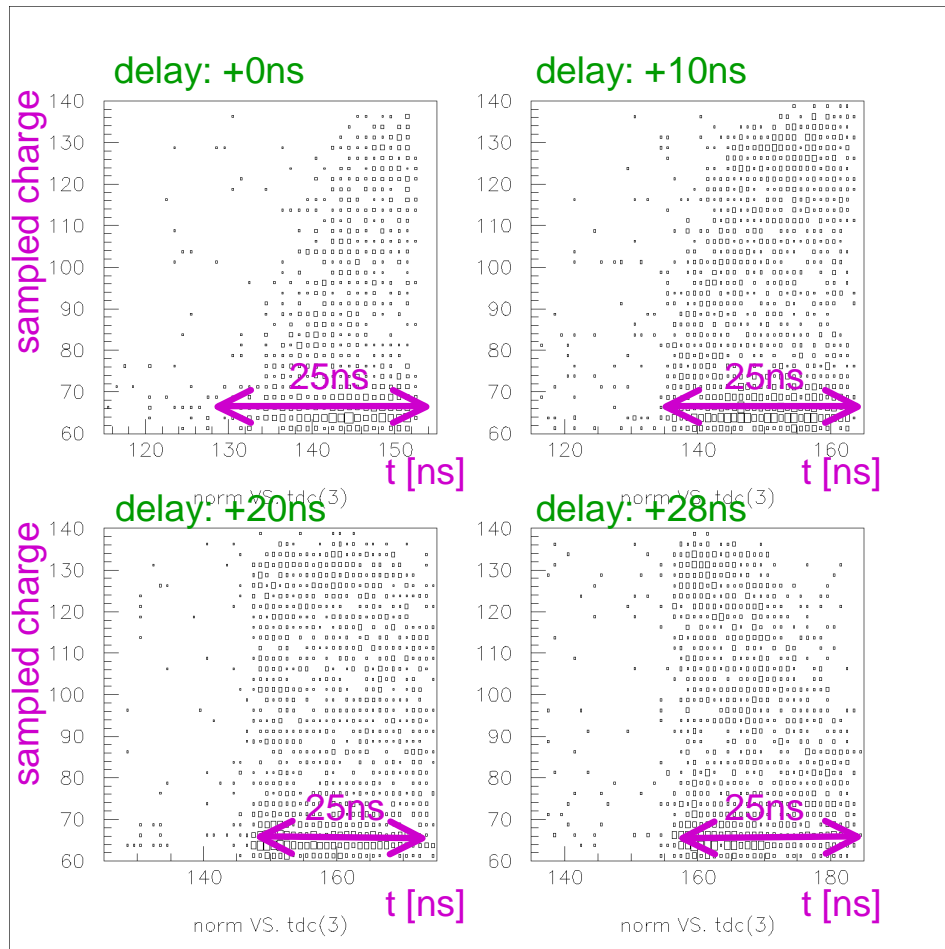


file=r133.rz pmt=0 evts=1223 Si hits=0 pmt hits=3706 cut: 5 sig

- 8 MaPMTs
 - no lenses
 - HV = 800 V

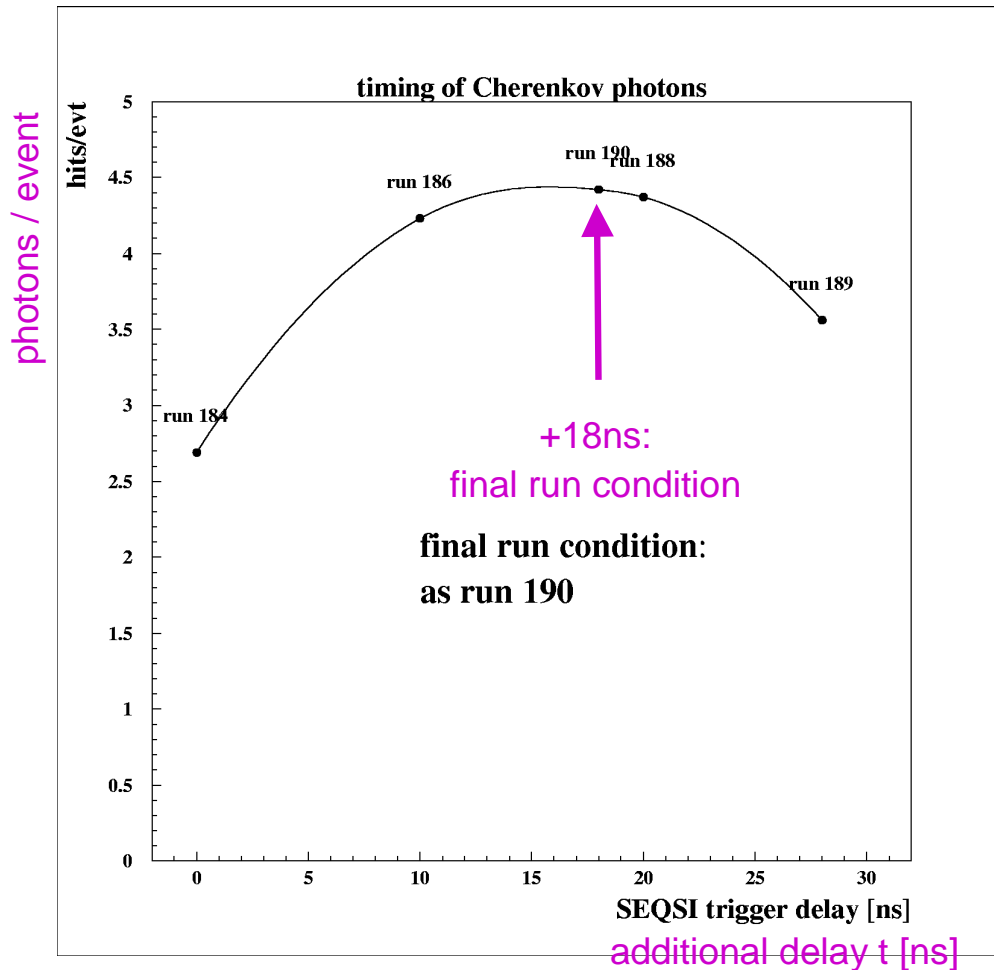
- Cherenkov Ring
 - Air 960 mbar
 - 3.6 pixels / event with 5 sigma cut
 - from raw data

Timing of Beam Photons



- adjusted average timing between beam photons and Beetle clock
 - 25ns jitter
 - measured by TDC
- aim to sample at peak of signal
 - adjustment for average by cable delay

Result of Timing Optimisation



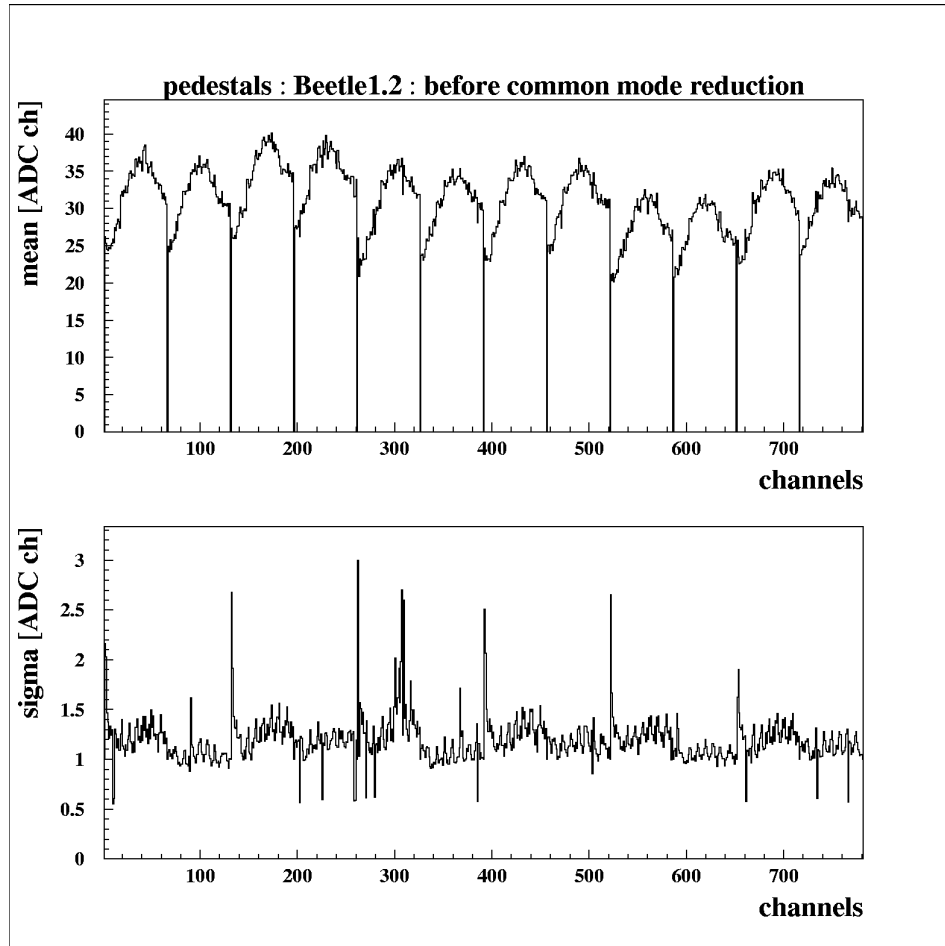
□ made from Cherenkov Ring

- Air 960 mbar
- no lenses
- HV = 800 V
- 8 8-stage MaPMTs
- 5 Beetle 1.2

□ narrow distribution

- as one expects
- indicates shape of analog pulse signals at sampler in the Beetle
(in average)

Noise in Beetle1.2



- final noise level
 - after DC-offset tuning
 - after tuning of timing

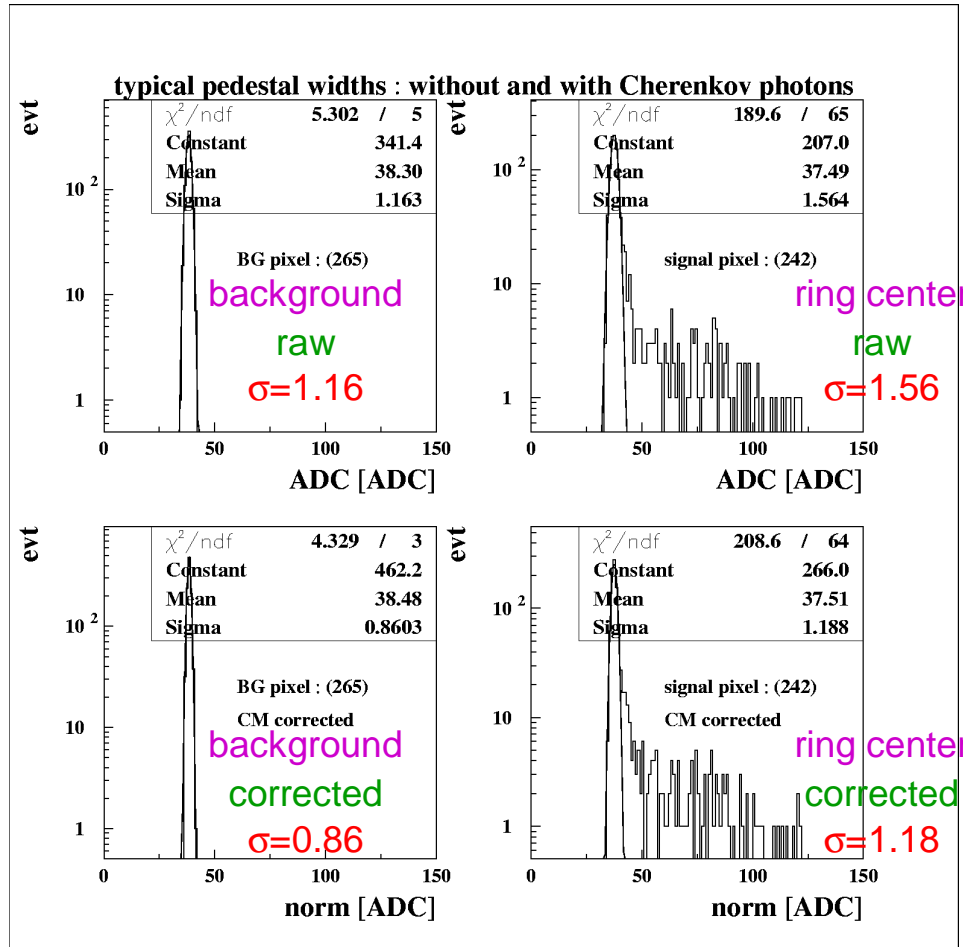
- full cluster
 - 6 boardBeetle1.2
 - 9 8-stage MaPMT

- from pedestal run
 - before CM correction

- low σ (1.0...1.5 ADC)
 - no CM problem

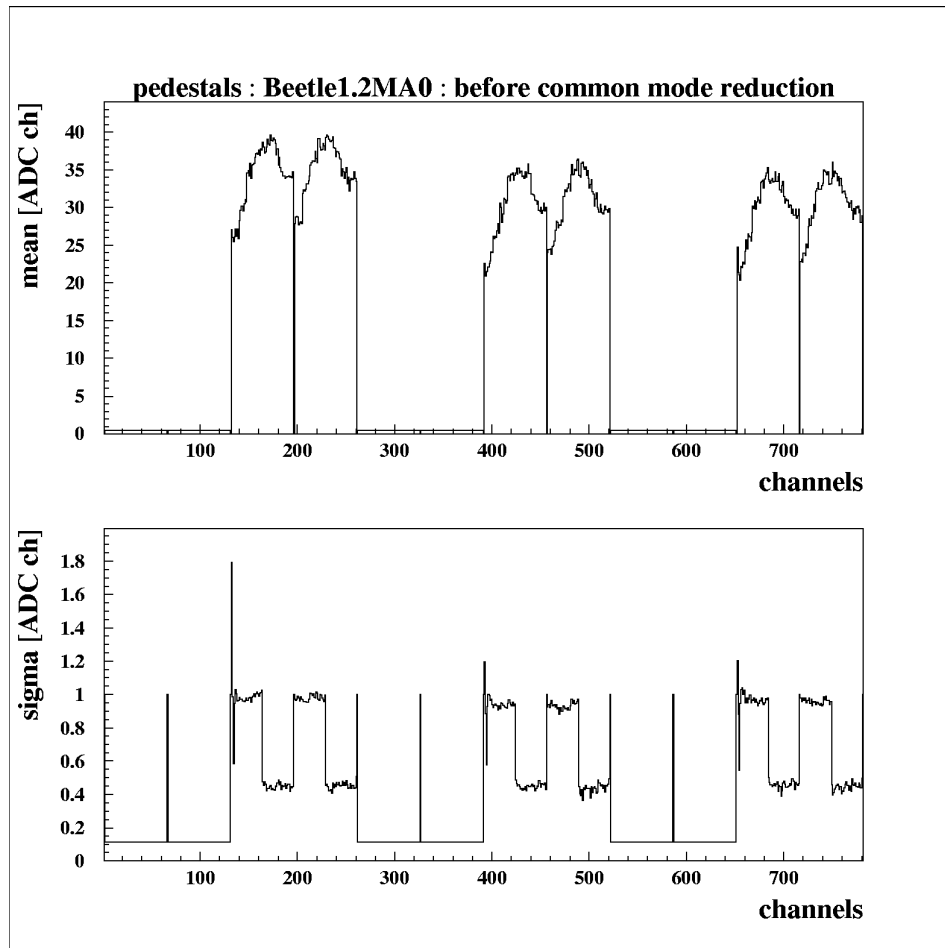
- uniform offsets

CM Suppression in Beam Run



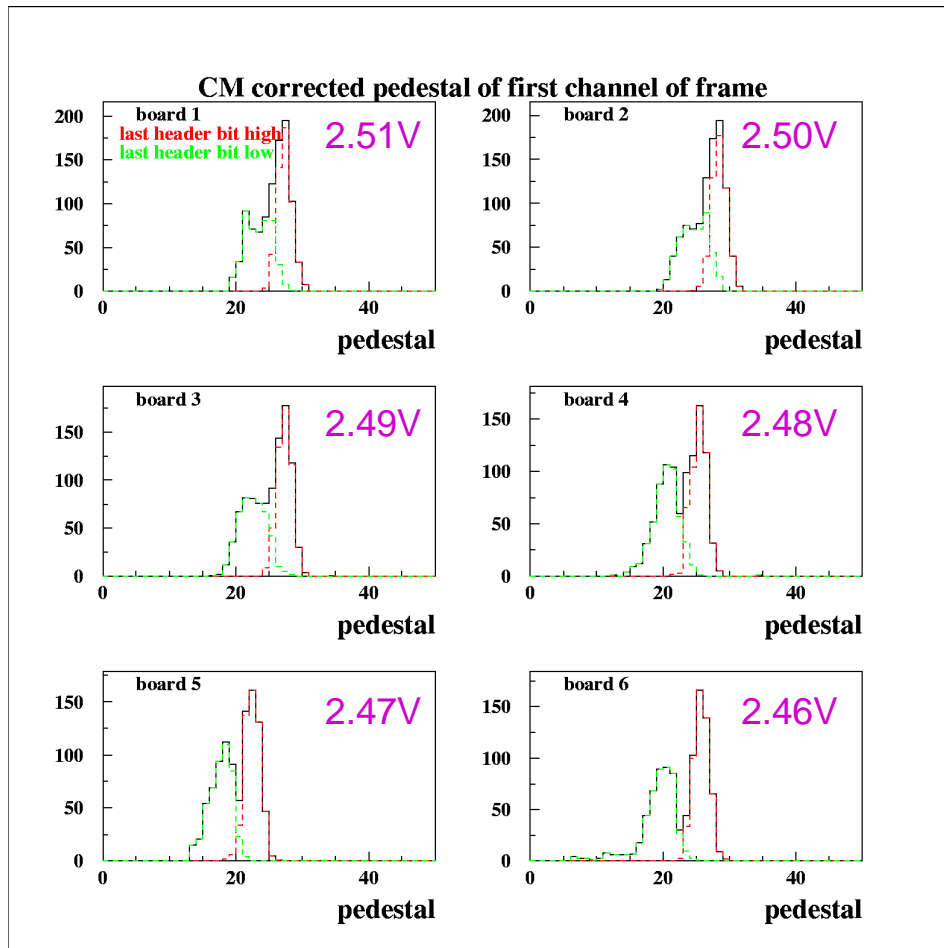
- from CF_4 beam run
 - HV= 800V
 - cluster of 8-stage MaPMT with Beetle1.2
- without cross-talk suppression
 - pedestals of ring pixels broadened

Noise in Beetle1.2MA0



- final noise level
 - after DC-offset tuning
 - after tuning of timing
- half cluster
 - 3 boardBeetle1.2MA0
 - 6 12-stage MaPMT
- from pedestal run
 - before CM correction
- lower σ for charge divider (1.0 ADC)
- even lower σ for attenuator (0.5 ADC)
- uniform offsets

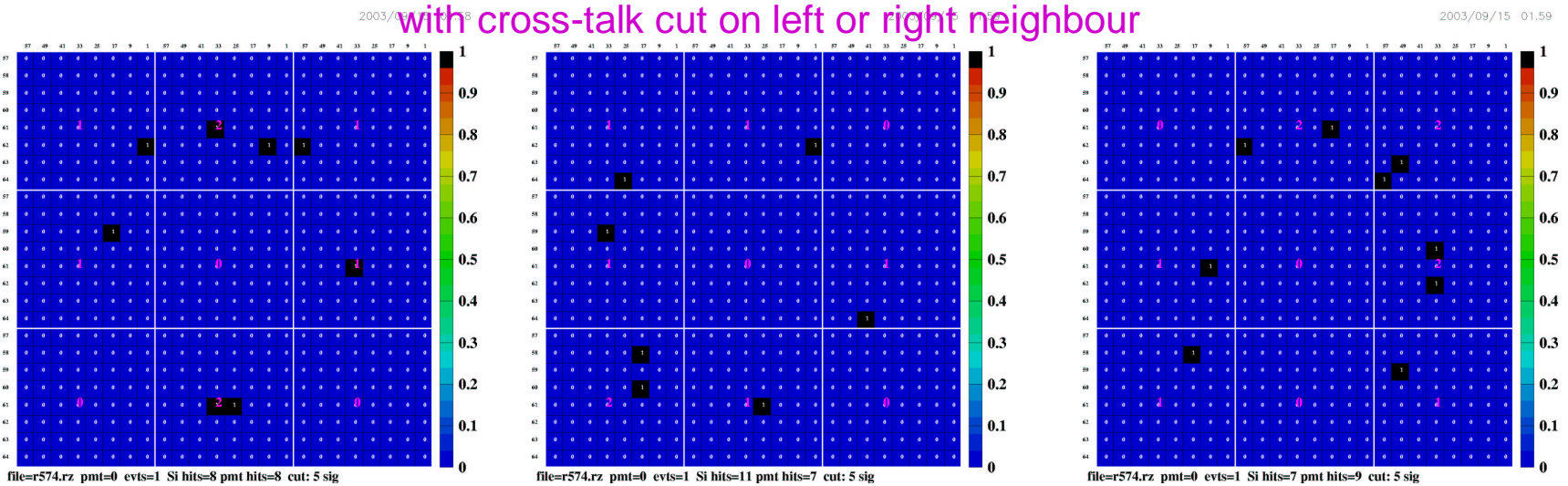
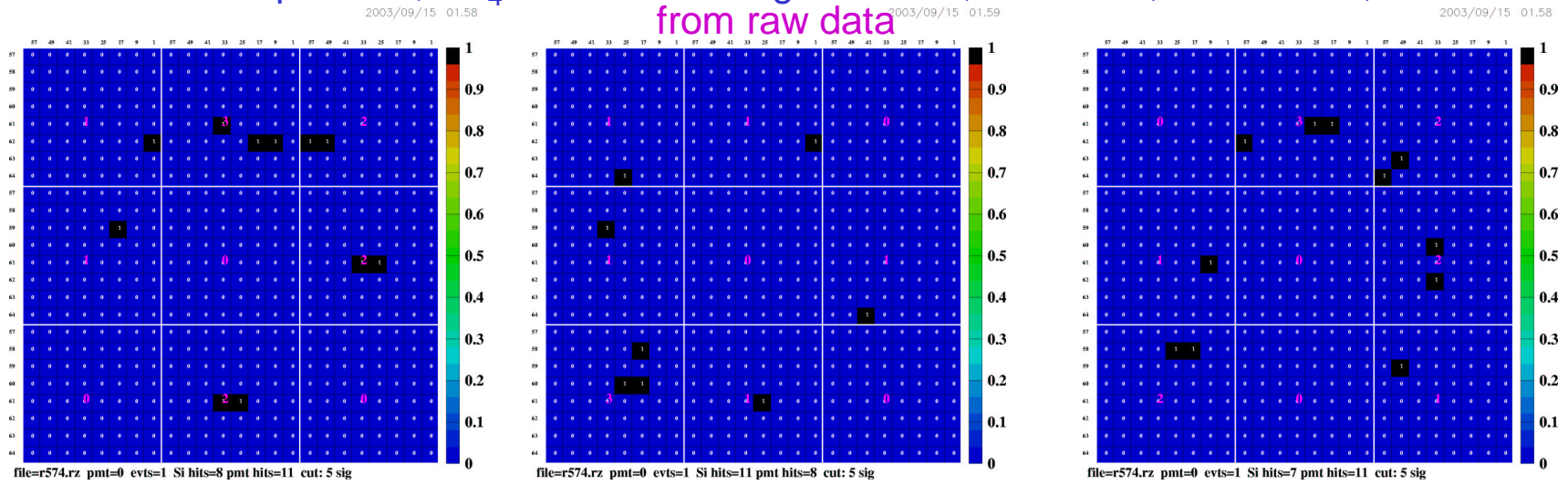
Cross-talk from Header to First Channel



- clear correlation of pedestal of first channel with state of last header bit:
 - header high
 - header low
- due to daisy chain of power cables:
 - voltage drop along chain
 - ➔ the lower the voltage, the more pronounced the sensitivity to the header

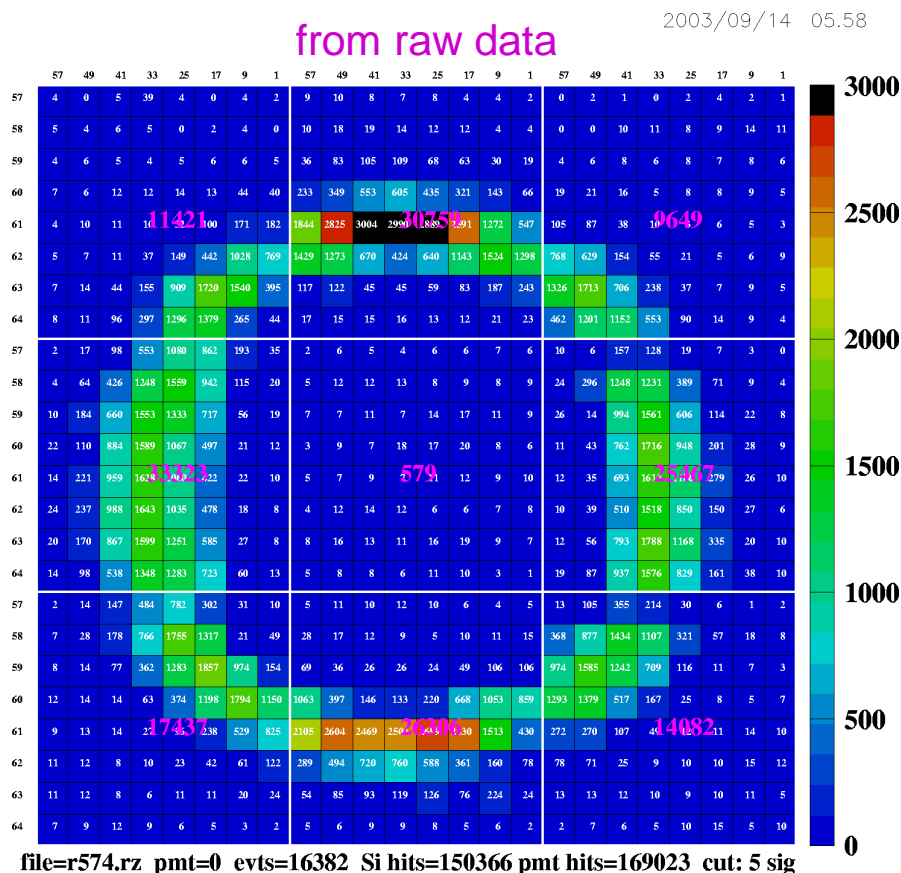
Single Events

- Cherenkov photons, CF₄ 800mbar: 8-stage MaPMT, Beetle1.2; with lenses, -900V



Cherenkov Rings I

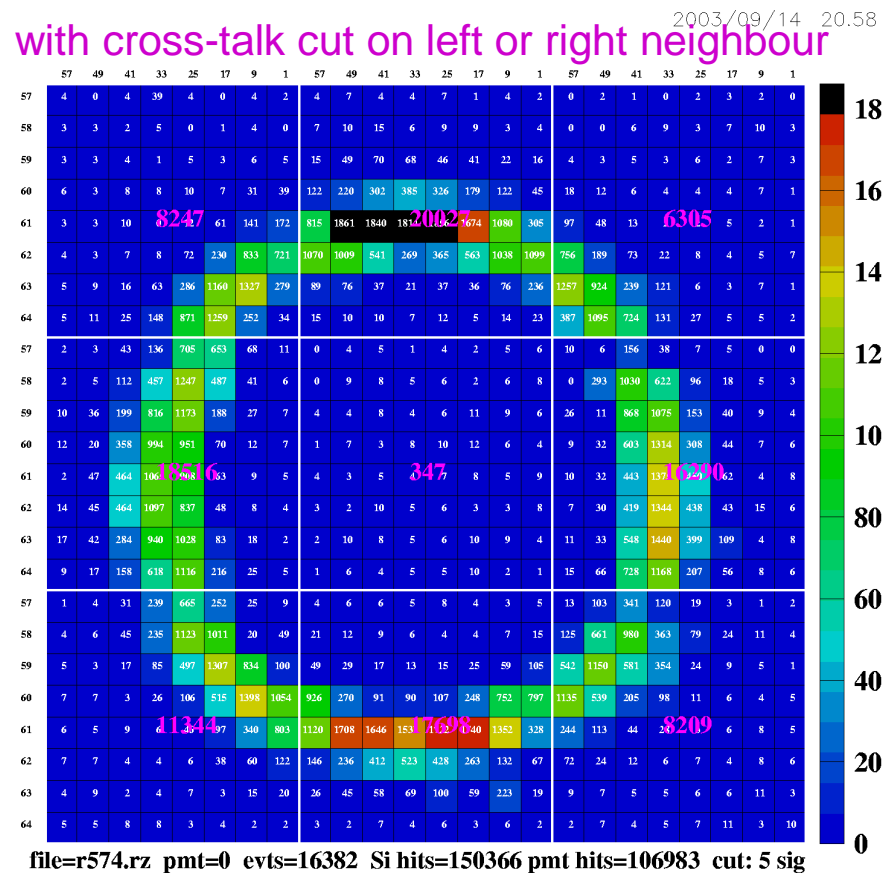
- Cherenkov photons, CF₄ 800mbar: 8-stage MaPMT, Beetle1.2; with lenses, -900V



10.3 photons/evt

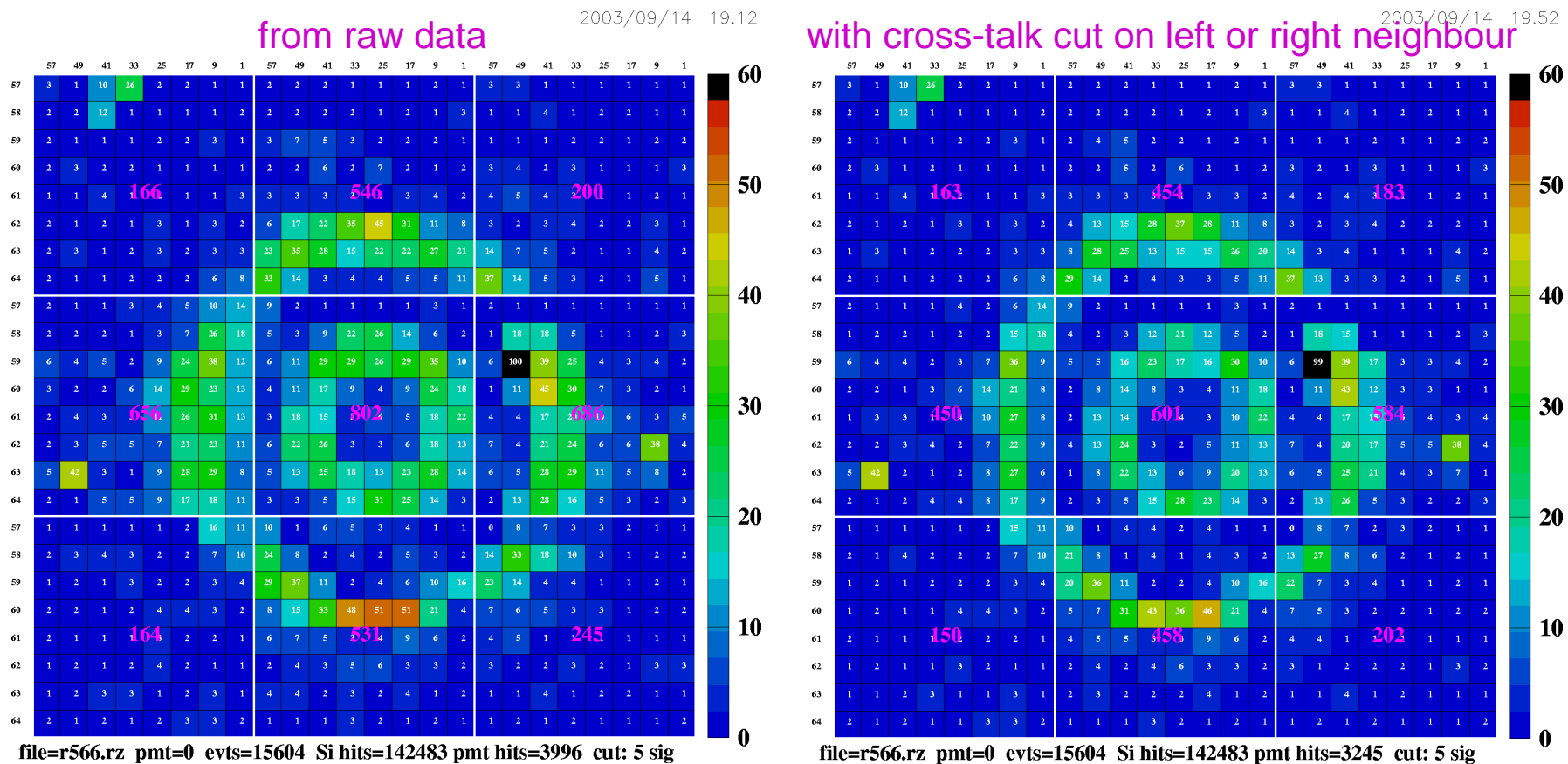
beam: -10 GeV \Rightarrow mostly π^-

6.5 photons/evt



Cherenkov Rings II

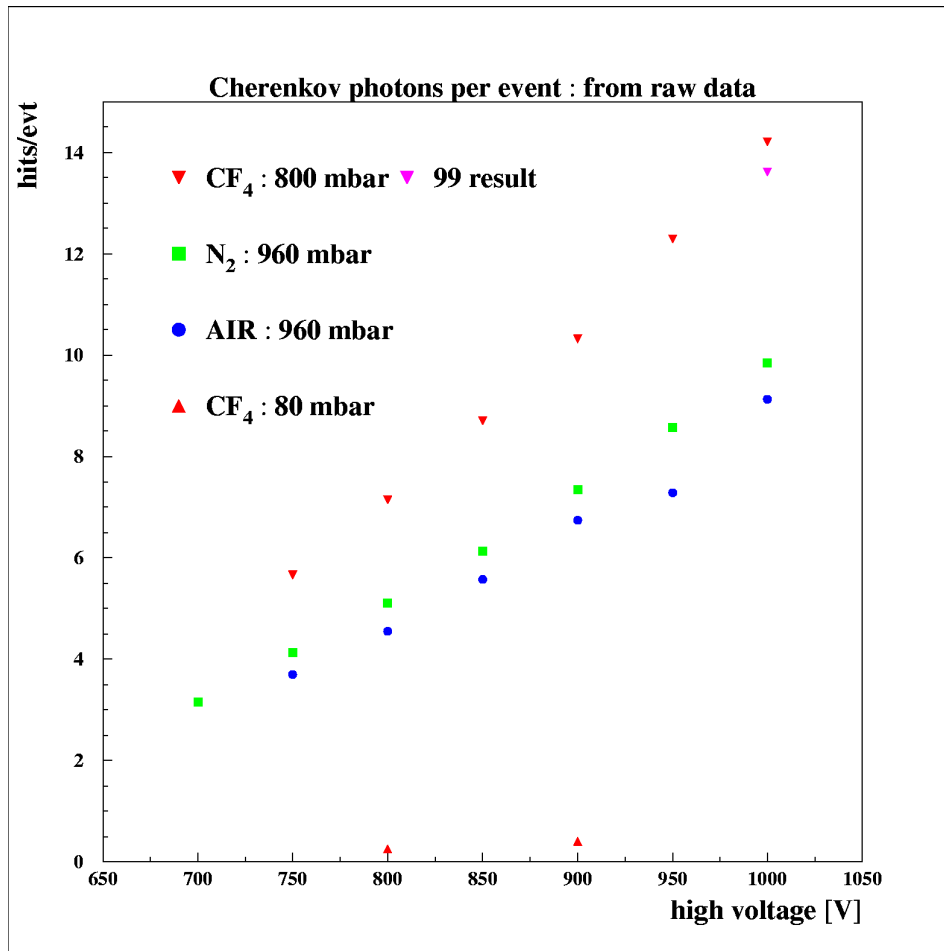
- Cherenkov photons, CF₄ 80mbar: 8-stage MaPMT, Beetle1.2; with lenses, -900V



0.26 photons/evt

beam: -10 GeV $\rightarrow \pi^-$ and e^- 0.21 photons/evt

Preliminary Photon Yield



- photon yields from raw data:
 - no CM correction
 - no cross-talk correction
 - 9 8-stage MaPMT – full ring (N₂: only 8 tubes)
 - Beetle1.2
 - with lenses
 - '99 result CM corrected

Conclusions

□ the testbeam was a success:

- Beetle1.2 & 8-stage MaPMT work
- noise excellent, almost no CM
- preliminary photon yields look OK
- further analysis is ongoing

□ issues:

- Beetle1.2MA0 not fully tested
- binary readout only started
- source of cross-talk
- no new data till review

□ Thanks to all the people who made this result possible!!!

2003/09/14 06.25

