CEDAR/KTAG status

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(University of Birmingham)

Ferrara Collaboration meeting - 5/9/2014

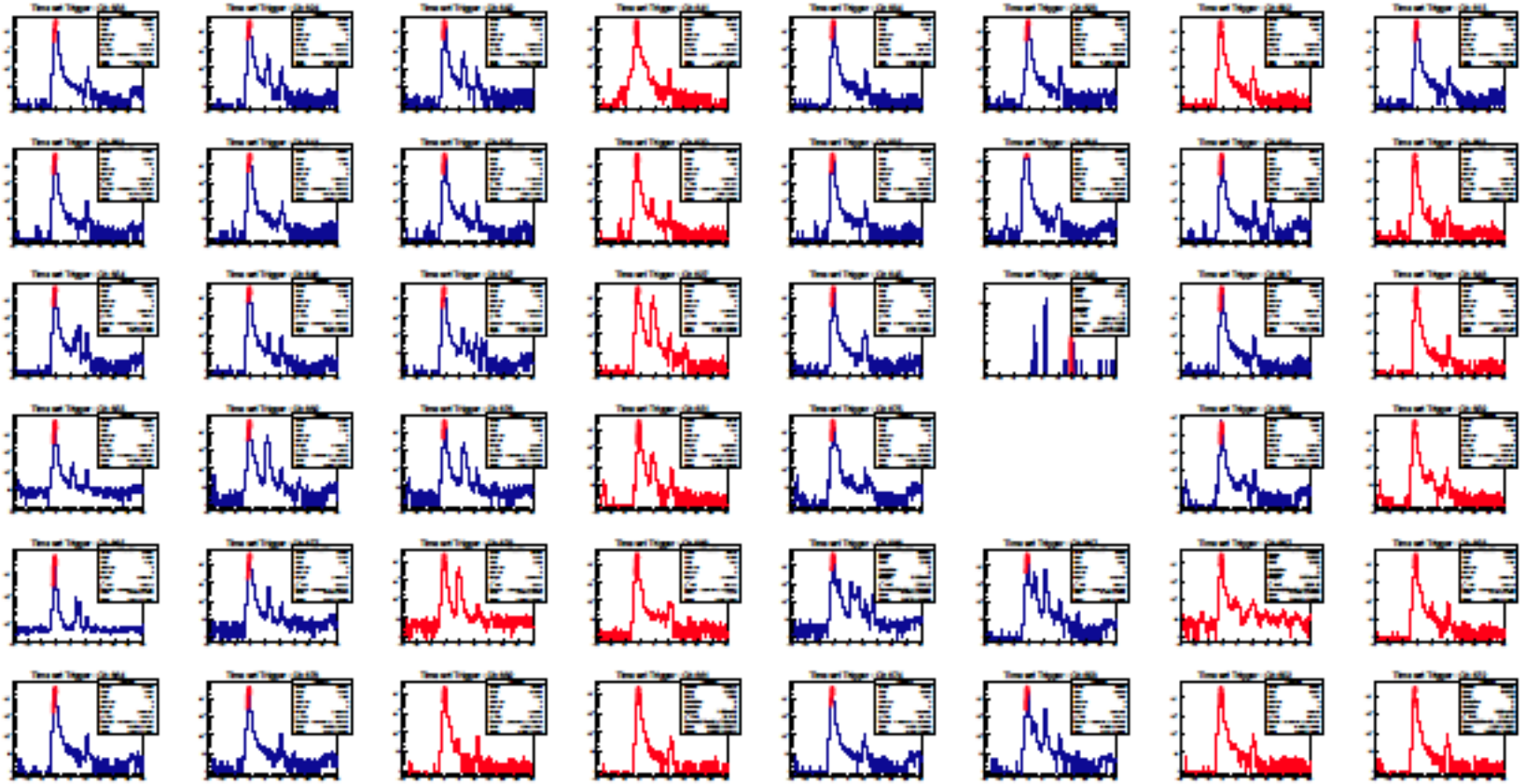
Light box
Assembly & Delivery at CERN

- 8 light boxes final design (run 2014):
  - new NINO board and mezzanines;
  - new High Voltage Patch Panel (HV PP) and frame;
  - new hybrid 48-PMT configuration (16 R7400U-03 + 32 R9880U-110 Hamamatsu series)
  - reinforced heat shrink on signal cables;
- 4 light boxes already installed inside KTAG crate (June 2014)
- Assembly of 2 light boxes performed in clean environment at University of Birmingham (July 2014);
- Delivery to CERN by S.Pyatt, A.Romano and A.Sergi on Sunday, 24th of August 2014
- Installation in ECN3 during the week 24th-28th/August 2014

"New" problems ...

- Last PMT delivery from Hamamatsu delayed by ~ 2 weeks -> only 2 light boxes assembled in time for the August trip to CERN
- One light box (no. 8) assembly smooth -> no unfamiliar problems
- One light box (no. 7) showed "suspicious" behaviour
- Several recovery procedures performed for this box – different NINO boards, mezzanines, signal cables – showed no improvements
- PMTs (only) re-used to assemble a different light box – some improvements noticed but light box still not behaving as expected

New lightboxes and secondary peaks



Lightbox 2 with NINO board 10

Current interpretation:

- Multiple peaks are triggered by cross-talk on the NINO board or mezzanine
- Peaks at time 0 can be hidden in the regular peak if all PMs are on
- Peaks at time > 0 are the result of cross-talk reflection on the HV divider
- Cross-talk signal seems to be around 1-2% of the primary one
- Visible on NINO board mainly at low threhsold (115mV)
- Apparently too small to be seen on oscilloscope
- Variation among LightBoxes due to a combination of different PM gain and different cross-talk on FE

Different mezzanine productions have different cross-talk

Possible to increase threshold on R9880 without loss in efficiency

Data collect of a channel-by-channel scan

August installation:

- all cabling finished/installed
- TDC cables : mostly tested
- all patch panels repaired/installed/tested
- splitter boards : installed and tested
- HV boards : replaced broken ones

Total of 6 boxes installed

HV accident

Prologue (June):

- LightBox 4 was tested and installed in June
- On the last day few HV boards were replaced for broken channels
- They were supposed to be tested at 100V to check for further broken channels

Event (August):

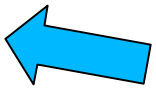
- Installed boxes 7 and 8
- After solving DAQ issues we started looking for bad readout channels:
  - No noisy (digital) channels
  - Moved to DCS and switched on HV for box 6 $\rightarrow$ all ok
  - Switched on HV for boxes 1, 3, 4, 7, 8 $\rightarrow$ box 4 ramped up to 2500V
  - It took about 1 minute to realize it and switch it off

HV accident: forensics

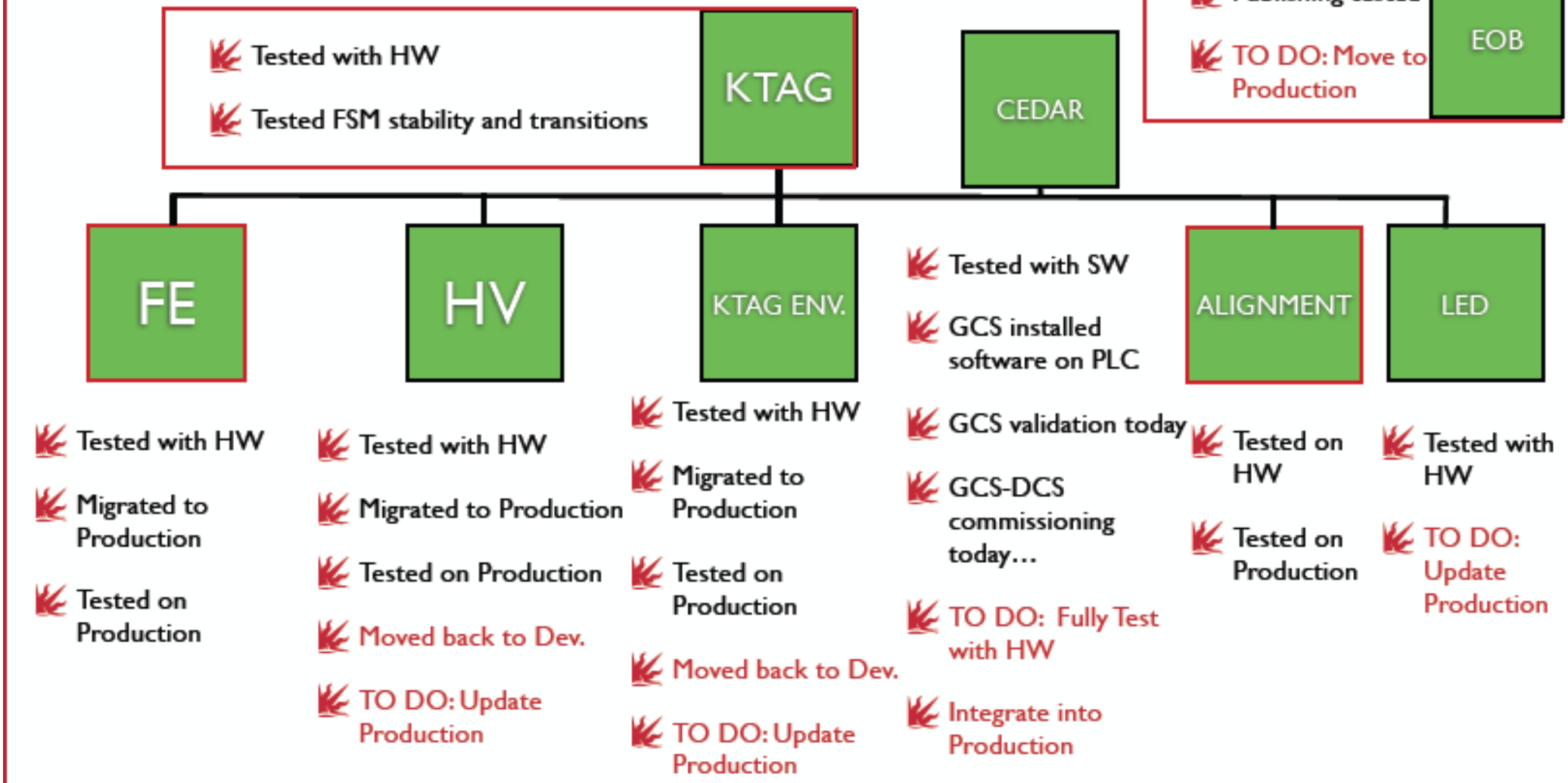
Causal sequence:

- On the last day few HV boards were replaced for broken channels
- They were supposed to be tested at 100V to check for further broken channels
- One was somehow missed
- DCS doesn't show the actual setting from HV hardware, but the last setting transmitted
- DCS doesn't transmit settings for switch on command
- The last setting is actually stored on the HV board, rather than on the crate
- The HV board came back from the pool with a random setting
- This random setting (including all limits) was used when switched on

DCS already changed !



Overall State



- Diagnosis - Mismatch between software settings and hardware
- Common component across NA62

HV

- Preventative Measures (DCS):
  - FSM logic modified to detect differences between settings on hardware and software
  - If a difference is found channel goes into error
  - Tested this by logging into the crate directly using the CAEN software and making some changes
  - FSM picked them up successfully
- Preventative Measures (User):
  - I am in the process of writing user docs in which -
  - I always suggest checking a single channel with the expert panel to look at all the settings - includes both software and hardware

HV

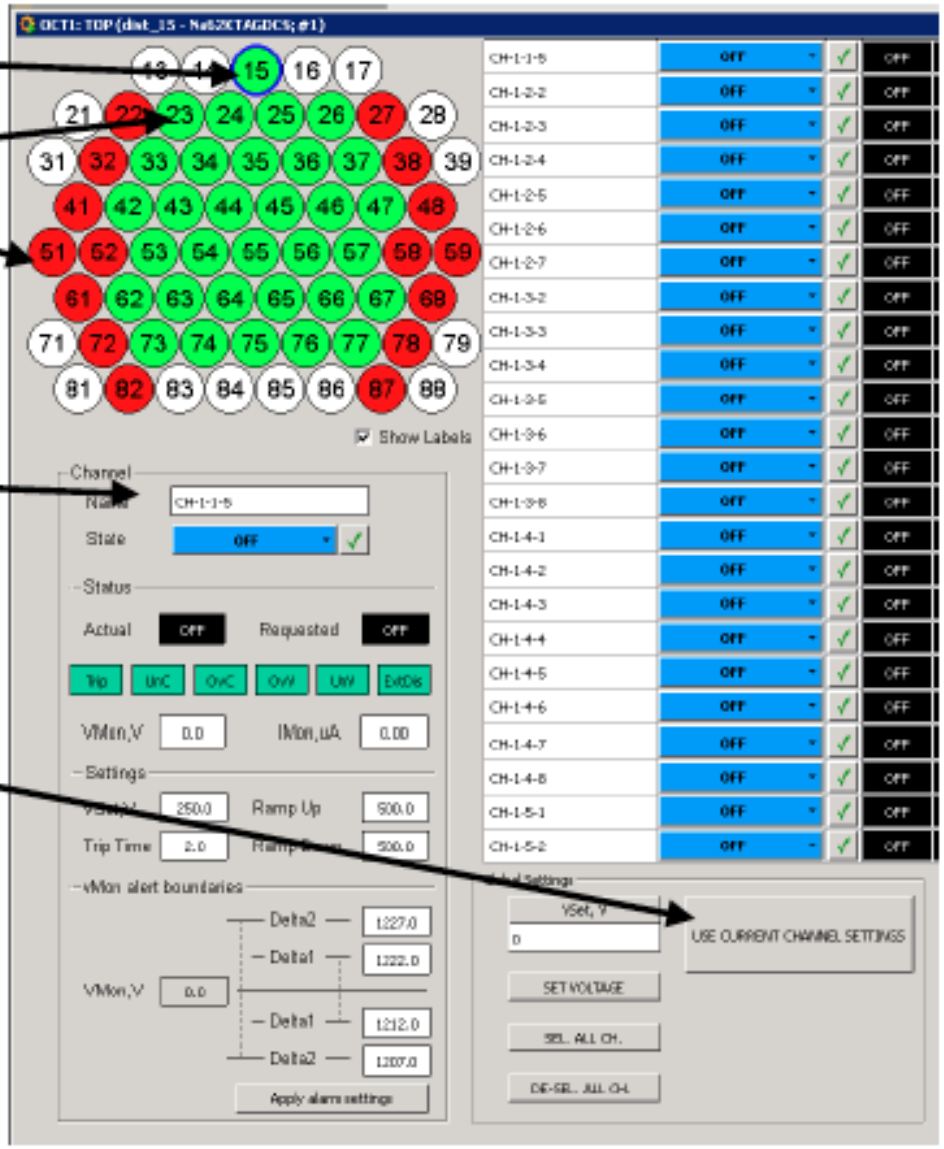
Selected channel highlighted

PMT type indicated by different colours

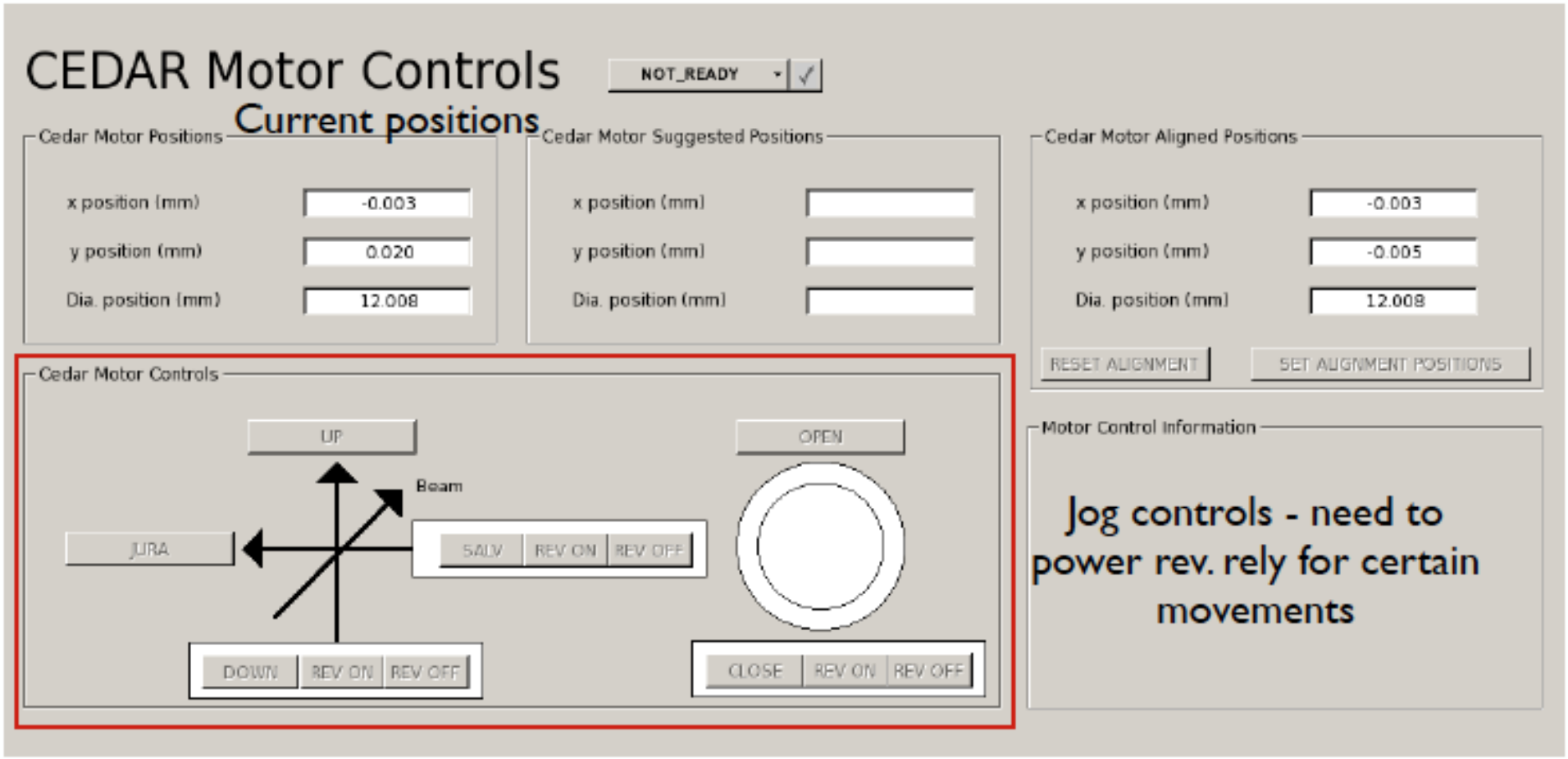
Selected channel highlighted - setting for that channel is now displayed

Global set will set all the channels of that type to those settings

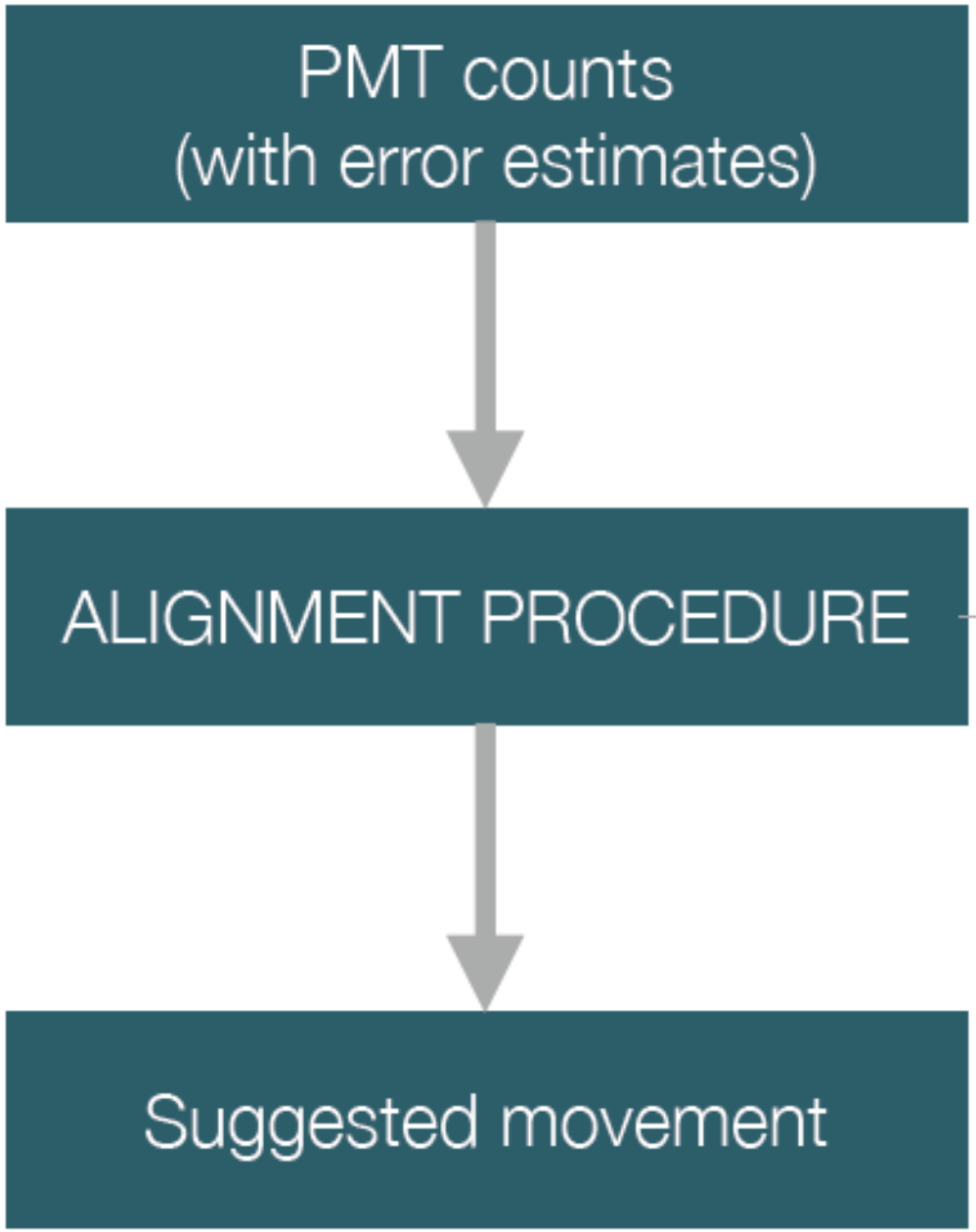
Only parameter not available from this panel is the trip current which must be set in the expert panel. **THIS IS STILL APPLIED TO ALL THE CHANNELS OF THAT TYPE**



Alignment


CEDAR Motor Controls
NOT_READY
Current positions
Cedar Motor Positions
x position (mm)
-0.003
y position (mm)
0.020
Dia. position (mm)
12.008
Cedar Motor Suggested Positions
x position (mm)
y position (mm)
Dia. position (mm)
Cedar Motor Aligned Positions
x position (mm)
-0.003
y position (mm)
-0.005
Dia. position (mm)
12.008
RESET ALIGNMENT
SET ALIGNMENT POSITIONS
Cedar Motor Controls
UP
OPEN
Beam
JURA
SALV
REV ON
REV OFF
DOWN
REV ON
REV OFF
CLOSE
REV ON
REV OFF
Motor Control Information
Jog controls - need to power rev. rely for certain movements

Alignment procedures



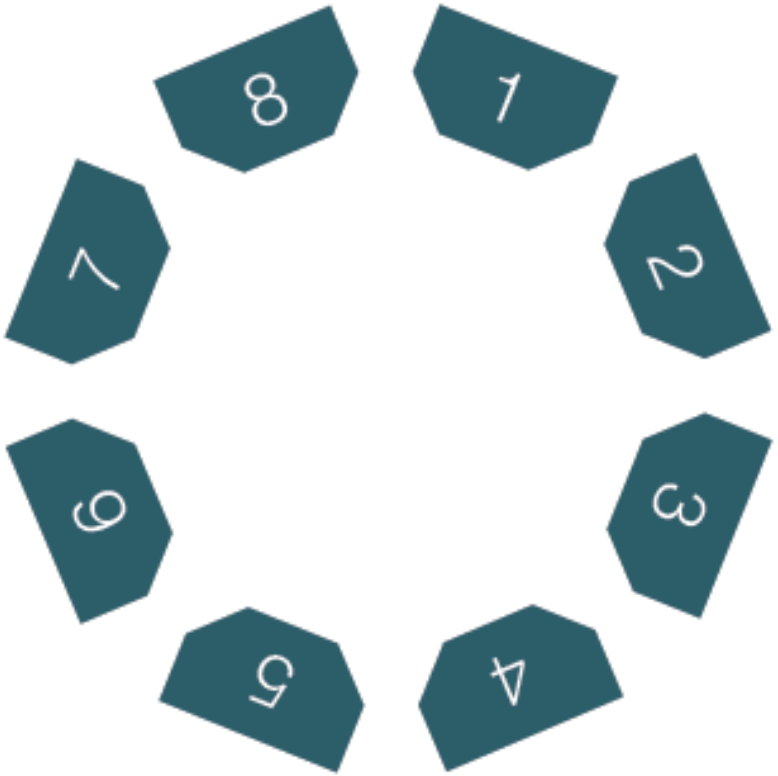
384 counts (+ errors)

reduce to N characteristic numbers
e.g.: asymmetries, geometric fit positions, grouped totals

convert to alignment:
e.g.: trial and error calibration curve, χ^2 fit,

Asymmetry procedure

- As defined in the CEDAR yellow report



U = 8 + 1

L = 6 + 7

R = 2 + 3

D = 4 + 5

- Monitor the asymmetries (U-D)/(U+D) and (L-R)/(L+R).
- Adjust alignment until all asymmetries are 0
- No calibration - just keep moving in the suggested direction until no improvement is possible

χ^2 procedure

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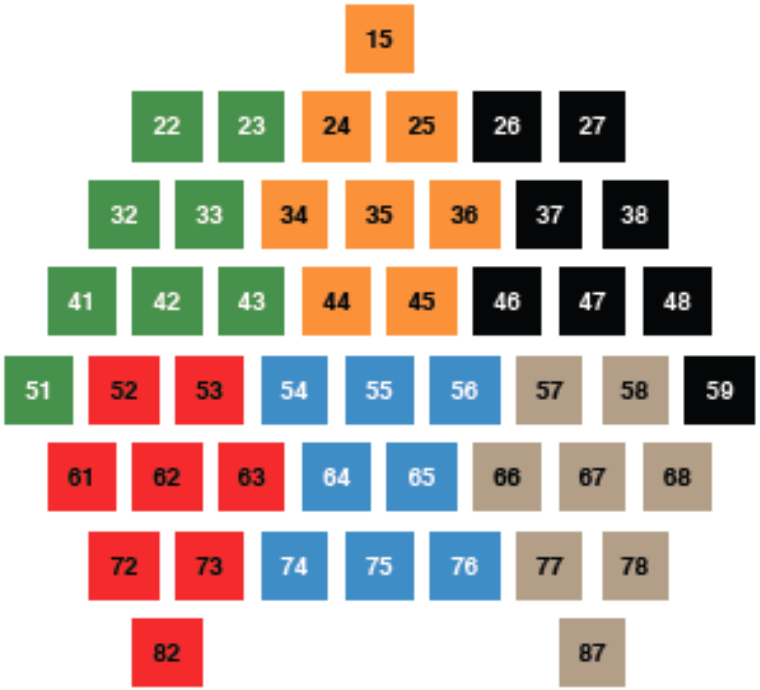
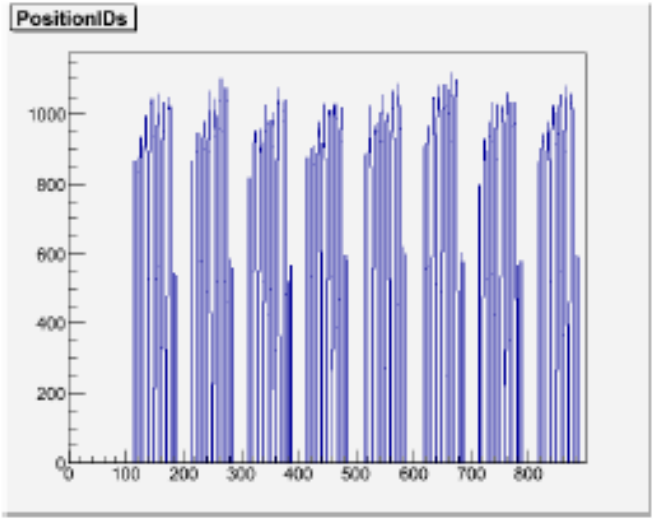
- Divide each octant into n blocks
  (e.g: rows or columns or halves or sixths etc.)
- Count the total number of PMT hits in each group → 8n totals
- Produce MC templates of these 8n totals fro each possible misalignment
- Determine misalignment in data by finding the template which minimises the χ^2 between these 8n numbers.

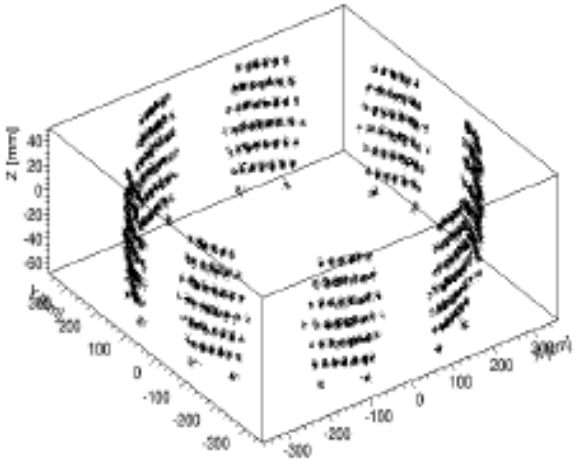


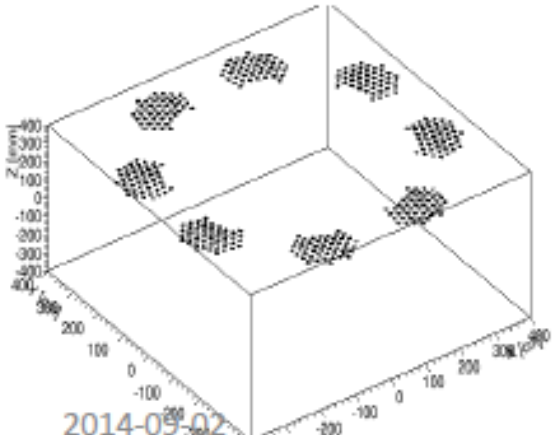
In practice, the best way to divide the octants is into sixths.



CEDAR vessel misalignment: geometrical fit approach

- Agreed input (with B'ham): reconstructed (photoelectons) per PMT (position ID),
- Conversion from ID to (XYZ) of the PMT centres (taken from MC)
- Rotation of the octants to XY plane to exploit circular symmetry of the detector
- Best circle fit performed, minimising (weighted) sum of squares of the distances between PMT centres and the corresponding nearest point on the fitted circle, to extract (X', Y') position of the circle centre
- Repeated in each of 1600 (simulated) misaligned bins i.e. for shifts of CEDAR vessel in range of (-4,4)mm in (XY), step 0.2mm
- done for 4 proposed diaphragm openings : 1mm, 1.5mm, 2mm, 2,5mm i.e 6400 fits





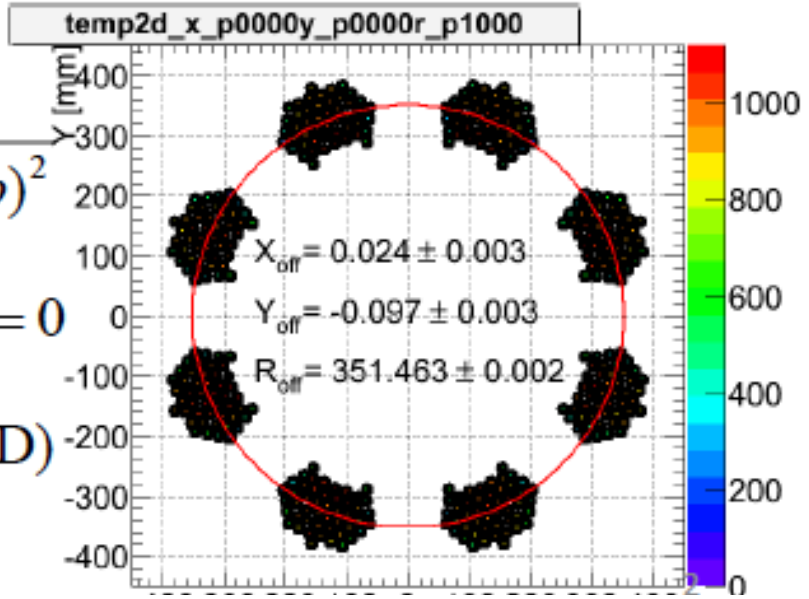
x,y- PMT centre coords

a,b-best circle centre coords

$$dR = R - \sqrt{(x-a)^2 + (y-b)^2}$$

$$f = \sum_{i=1}^{384} weight \cdot dR^2 \rightarrow \partial f = 0$$

done in TMinuit (MIGRAD)



Alignment scenarios

- **On the proton peak**
  - Uncomplicated by neighbouring peaks
- **On the kaon peak**
  - Useful for continuous monitoring
- **A possible plan:**
  - Pressure scan to find peaks
  - Initial alignment on proton peak - large aperture, possible large misalignment
  - Fine alignment on proton peak - small aperture, possibly after another pressure scan
  - Fine alignment and continuous monitoring on kaon peak

Conclusions Alignment

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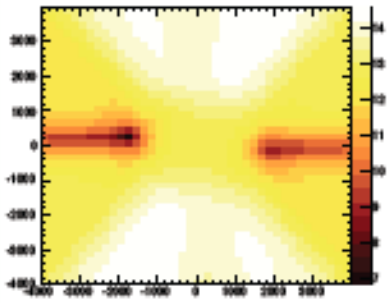
- In some situations both χ2 fit and asymmetry methods work and geometry
- We can use these situations to cross check
- All alignment information should be visible during data taking

Alignment Online Monitor

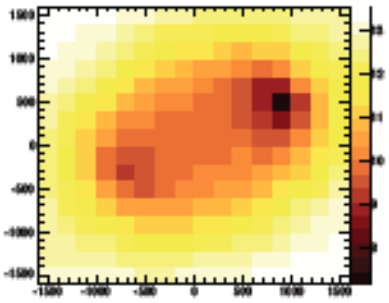
X^2



Position: (+1.3, −2.7)

Go: (−1.3, +2.7)

Geometric fit



Position: (+1.2, −2.6)

Go: (−1.2, +2.6)

Asymmetry

U/D: +0.2

L/R: −0.4

Box 4 back to Birmingham for inspection and repair
Impossible to buy/deliver more PMTs at short notice

Borrowed PMTs from RICH for now -- THANKS !

September Plan

- 3 light boxes (2 of them already assembled) will be shipped to CERN for installation during the last week of September
- No delay is foreseen for work on the DAQ and the DCS commissioning:
  - TDAQ work can proceed with Tel62 boards installed inside the KTAG crate;
  - DCS work can run independently on the number of light boxes installed;
  - Plans for performing pressure scan and alignment are ongoing.

DCS work progressing well

We have a plan for the alignment procedure

Spares

Latest MC productions

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- Full details here: http://epweb2.ph.bham.ac.uk/user/newson/alignment.html
- NA62MC v.350, NA62Reconstruction v.351
- QE applied in NA62 and not in NA62Reconstruction
- Currently QE code is just duplicated - should we put it in Cedar/Persistency so the same code can be reused?

NB: Pure kaon sample, looks ~ the same as pure proton sample at the same aperture

Pions and Kaons

Pressure:1.71 bar

Misalignment: -4mm to 4mm

Diaphragm: 1mm and 1.5mm

Step size: 0.2mm

Seeds: 42 and 52

Protons

Pressure: 1.91 bar

Misalignment: -4cm to 4cm

Diaphragm: 2mm and 5mm

Step size: 2mm

Seeds: 42 and 52

- Selection in Reconstruction is 2 PMTs in 2 octants

Proton peak: 5mm aperture

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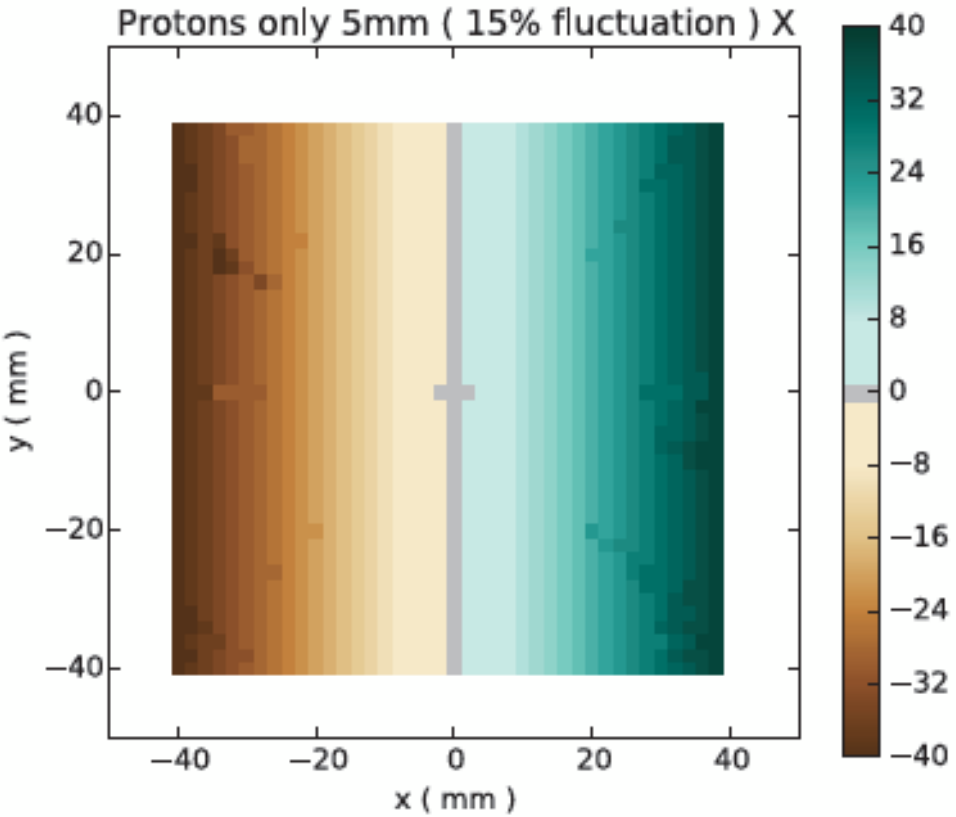
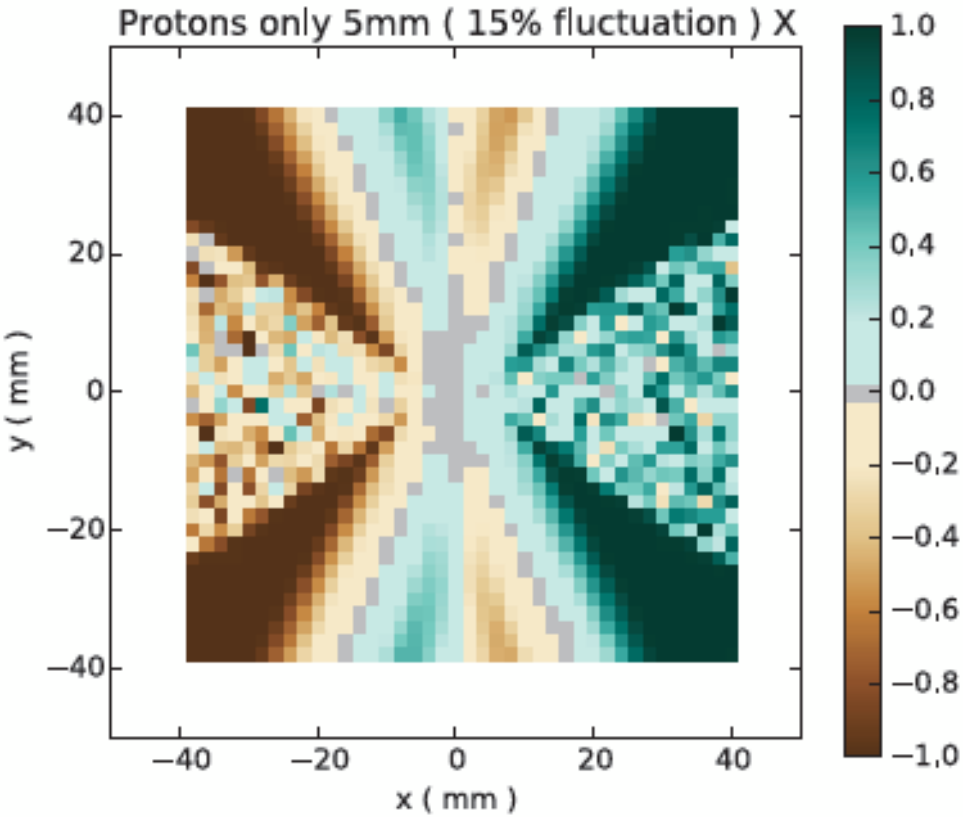
χ^2



Asym



- Here the pure kaon MC samples are used to represent protons
- χ2 outperforms asymmetry method
- Care needed: very few hits at these large misalignments

Proton peak: 1.5mm

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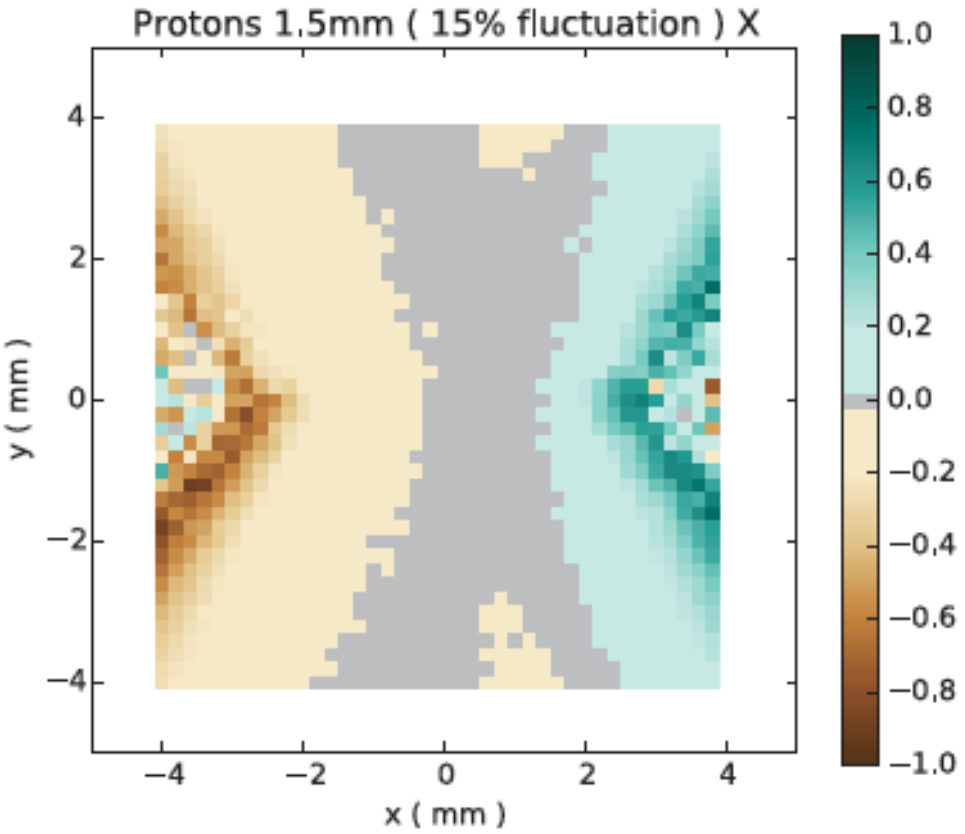
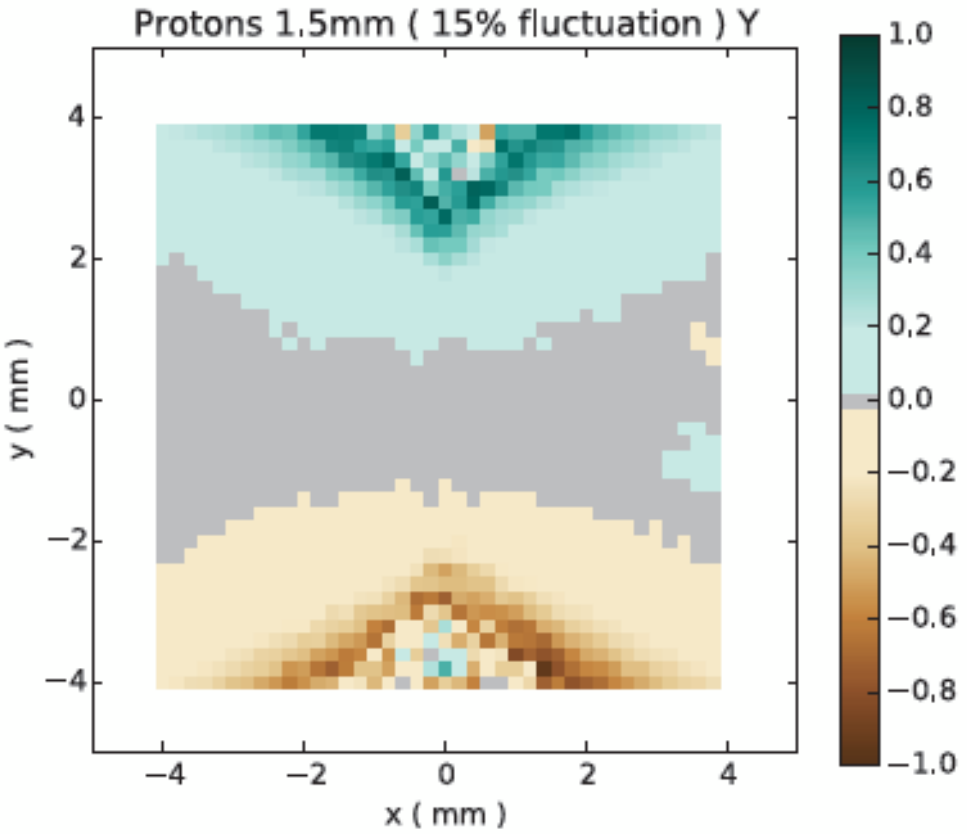
Asym





- With a 1.5mm diaphragm and smaller misalignment on the proton peak, asymmetry is a useful tool

Kaon peak: 1mm

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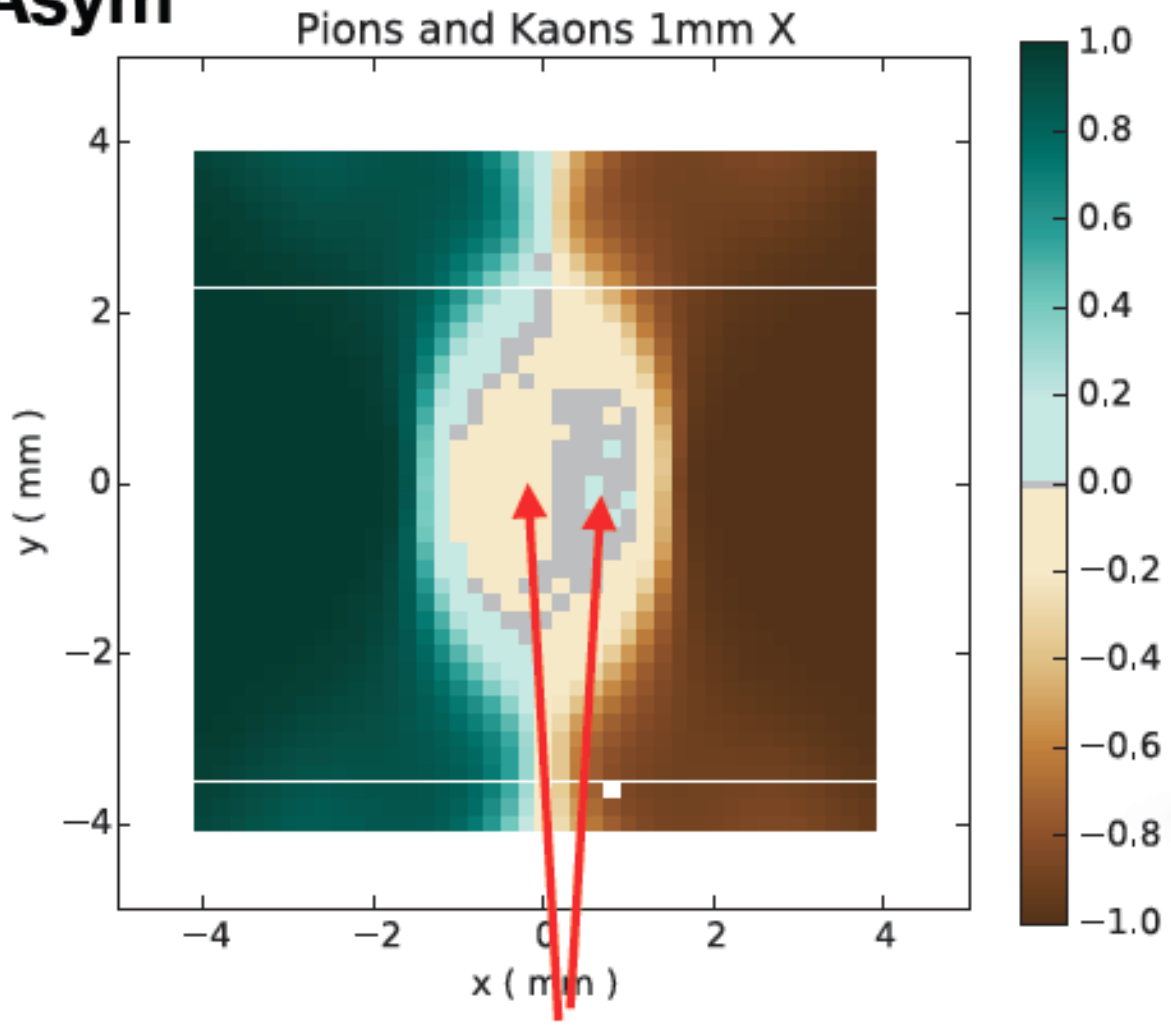
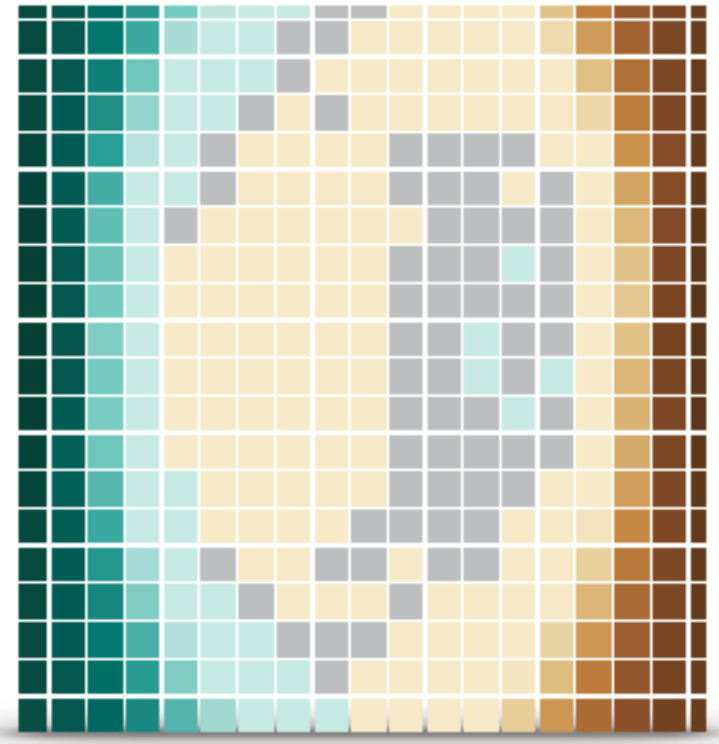
- Including kaons and pions, on the kaon pressure peak

Asym



Zoom



The colours should be this way round

(most of the plot is wrong)

Kaon peak: 1mm

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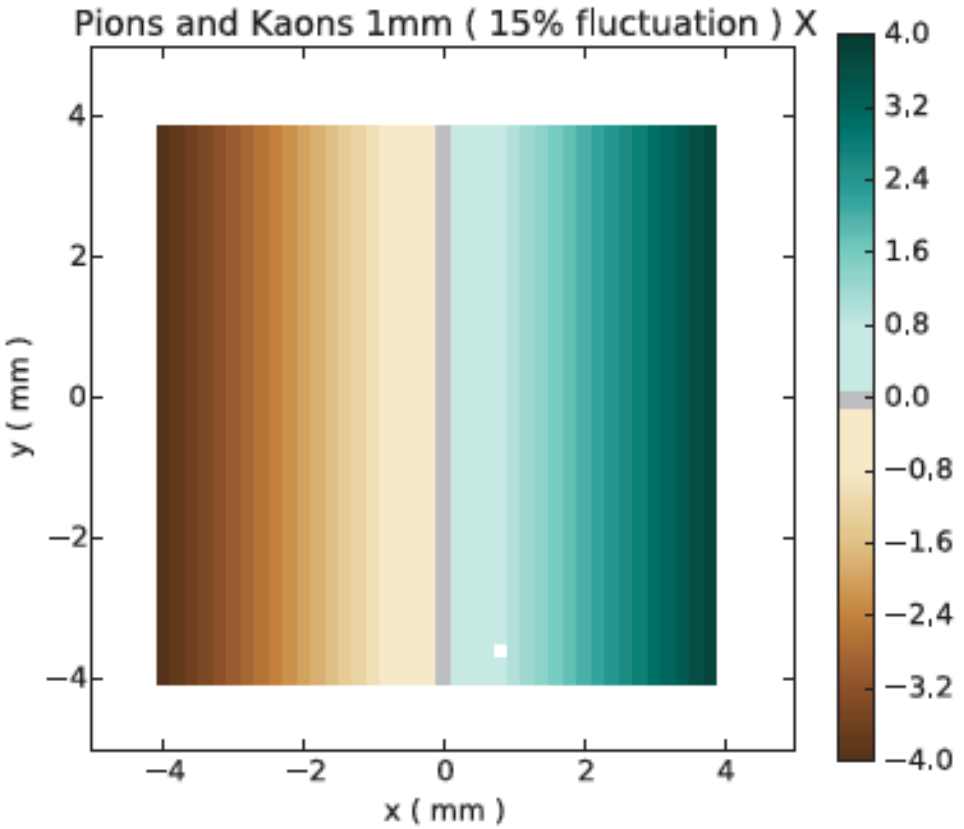
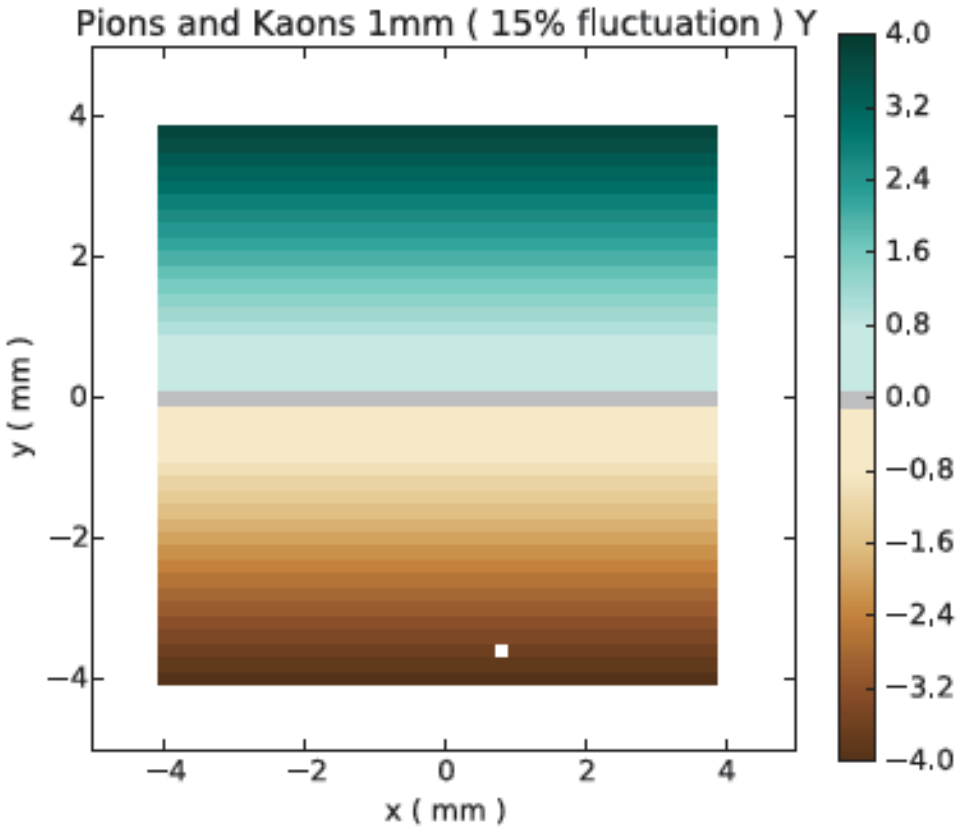
χ^2



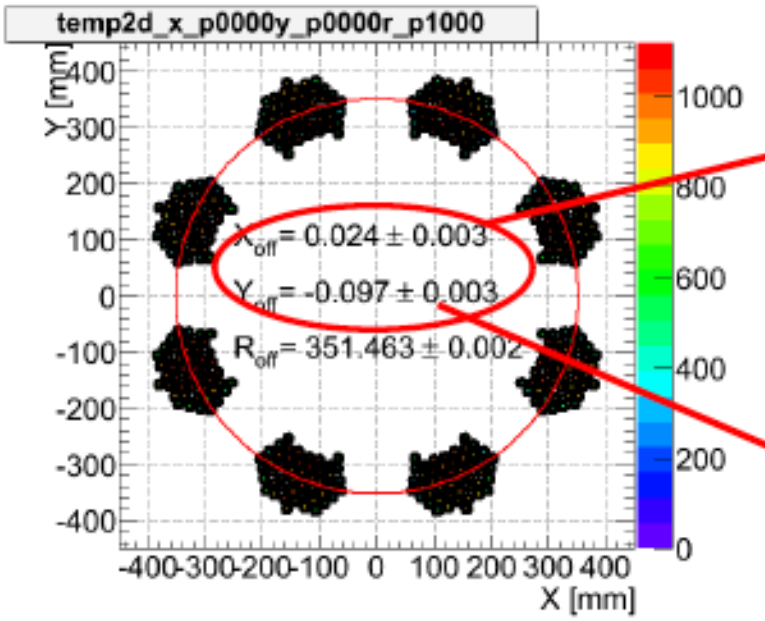


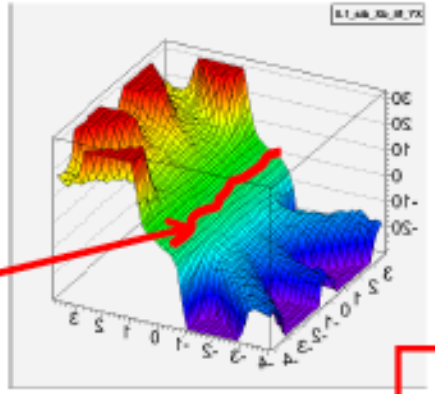
- χ2 method continues to work in MC

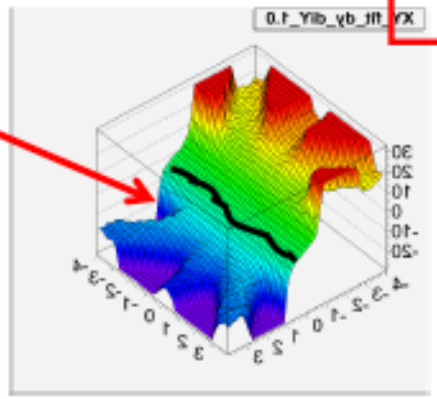
CEDAR Alignment Procedure

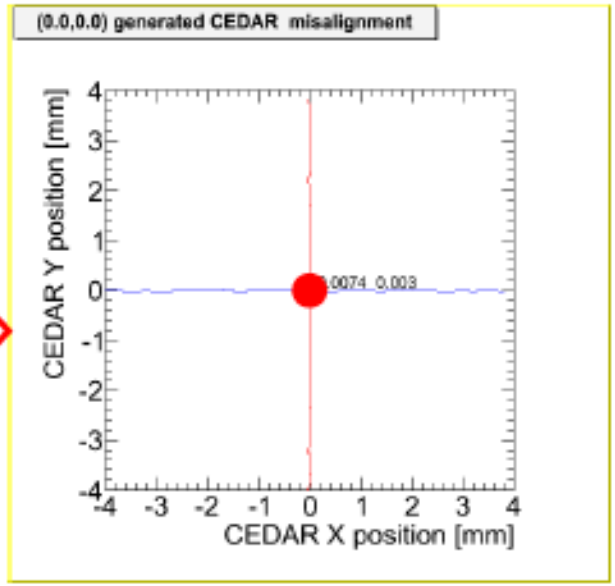
- Best Circle Fit performed on the block of data (e.g. burst) to obtain (X',Y') with errors
- $X' \pm \Delta X'$
- $Y' \pm \Delta Y'$

  defines (up/down) boundaries for the contours on the MC templates
- Intersection between contours mark the CEDAR vessel actual position
- Straight forward e.g.









- Contour's intersection plot visible to shifter

Geometrical method:

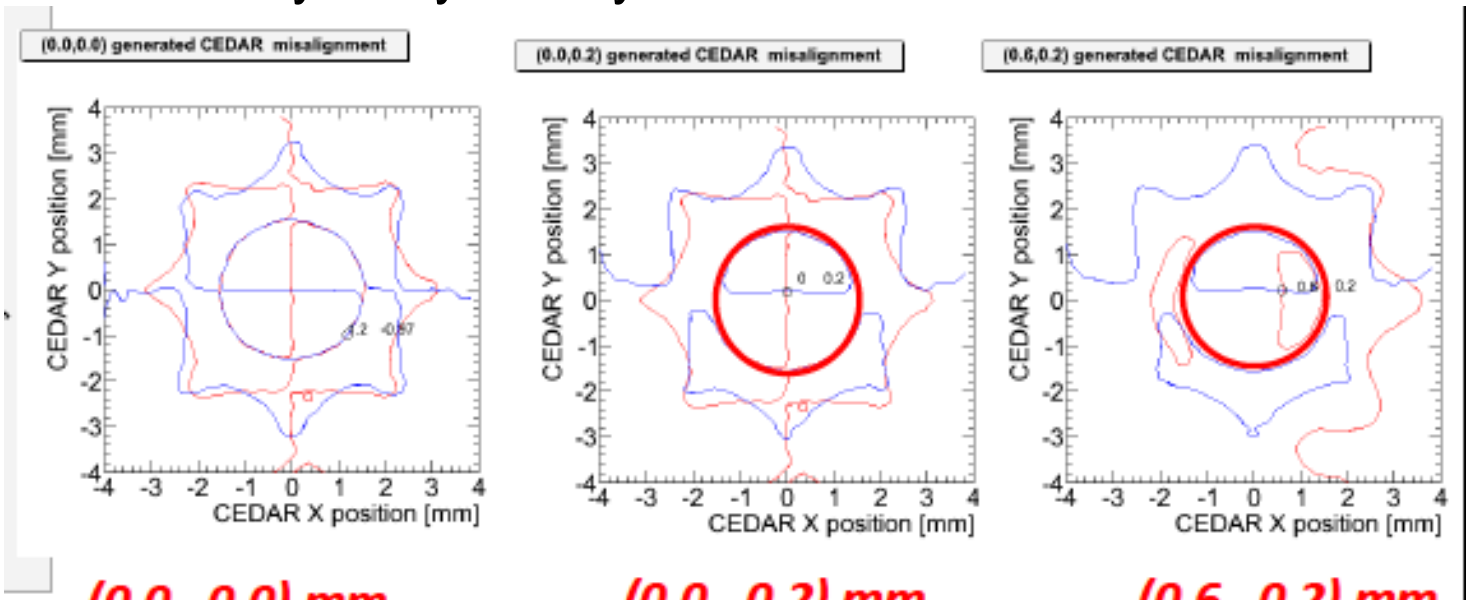
For pure kaons, fit performs well up to large values of misalignment
i.e. no degenerate solutions

Kaons plus pions beam mixture forces complex topology,
i.e. degeneracy

Usable within 1 mm radius from the CEDAR central position

Still usable after considering PMT fluctuations

Need geometrical balancing of the PMT array in case of a channel failure - rely on symmetry



EOB

- All publications checked to ensure DIM server is working
- Final publication is likely to be:
  - NA62/DCS/KTAG/EOB - struct containing all info discussed
- Also info is published singularly so can be monitored by anyone who needs to - offline database for example
- Status flags are now set so that they are true if in the READY state false otherwise
- Talks being held this week about mechanism for adding the data into the EOB