MKD ERRATIC TYPE 3

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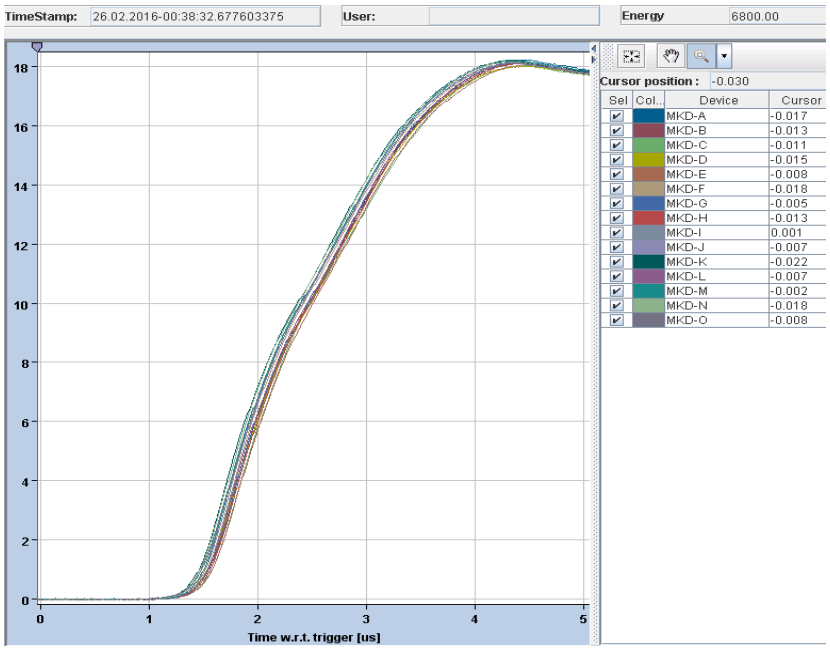
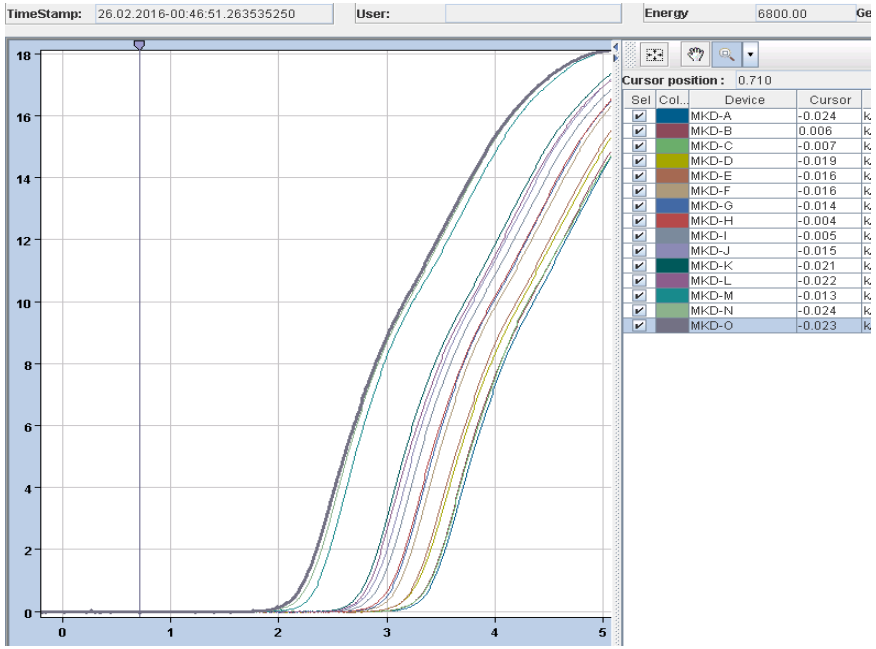
Outline

- Observations on the HW during energy scans
  - See presentation by **Viliam Senaj** in LIBD, 15th March 2016, https://indico.cern.ch/event/507471/
- Particle distributions
  - See presentation by **Matthew Fraser** in LIBD, 15th March 2016,

Observations

- Strange “triple erratic” on 26/02/2016 00:46:15 while conditioning LBDS2 at 6.8 TeV and pulsing every 10 min
- MKD/B2: generators O + N + M triggered by a signal in the retrigger system
- Then retrigger of the rest of generators



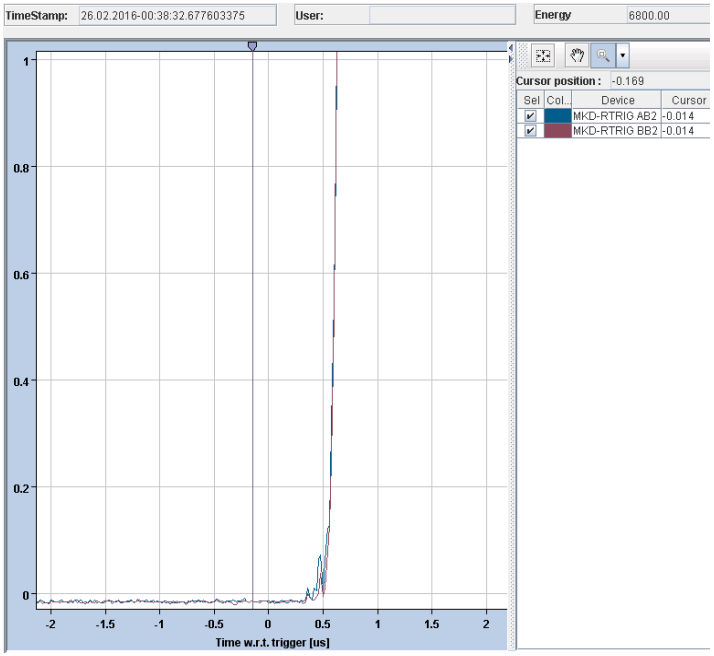


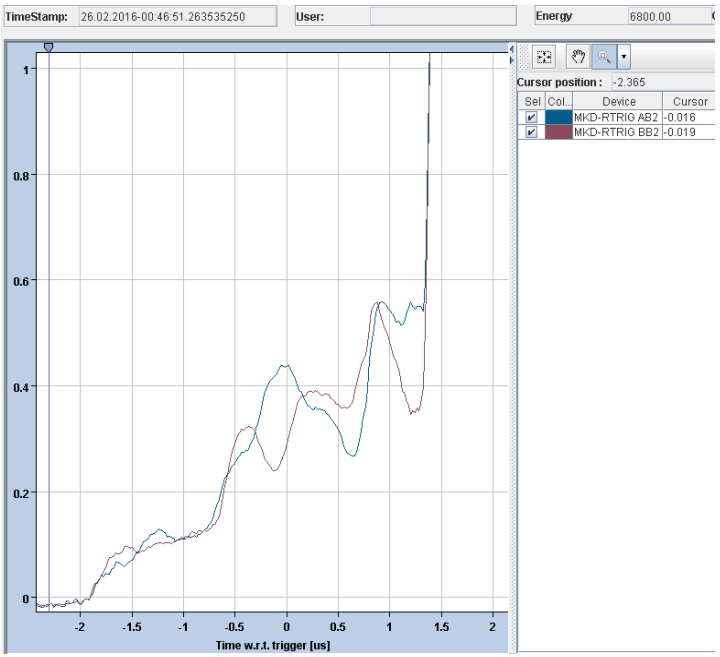
Post-erratic

- No damage, system continued pulsing
- Conditioning until 7 TeV (~11 a.m.) then 6h at 7TeV DC and 36h at 6.8 TeV
- Since 26/02 ~ 165 h at 7 TeV and 6 energy scans up to 7.1 TeV without problems
- MKD M, N, O (+ retrig line) under sparking surveillance - no further activity observed

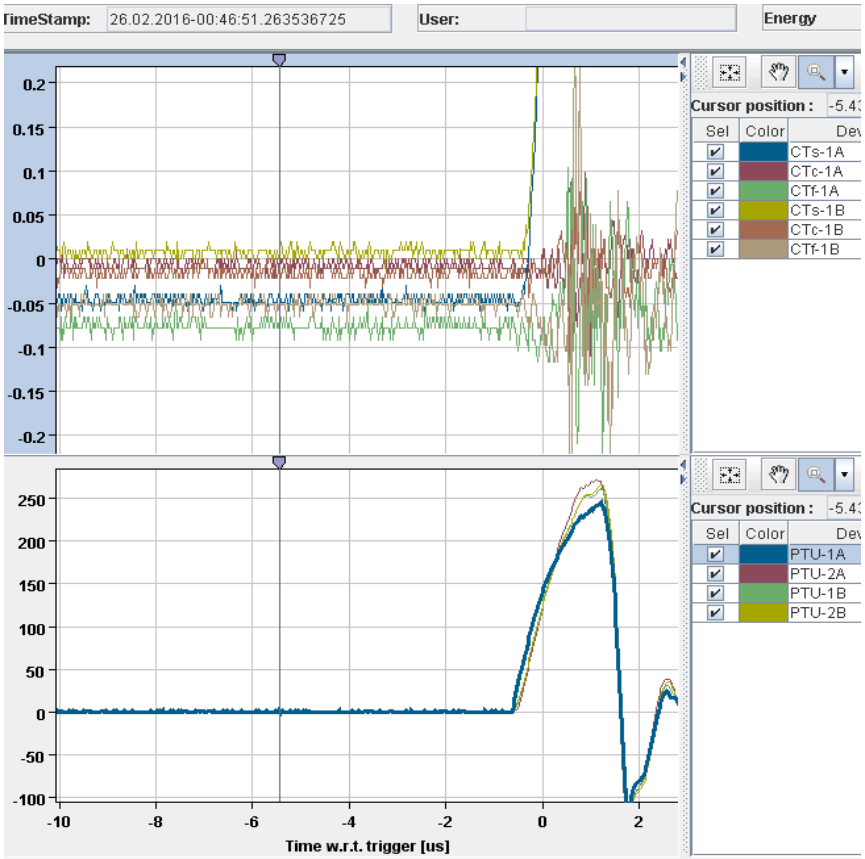
Difference to erratic type 1 and 2

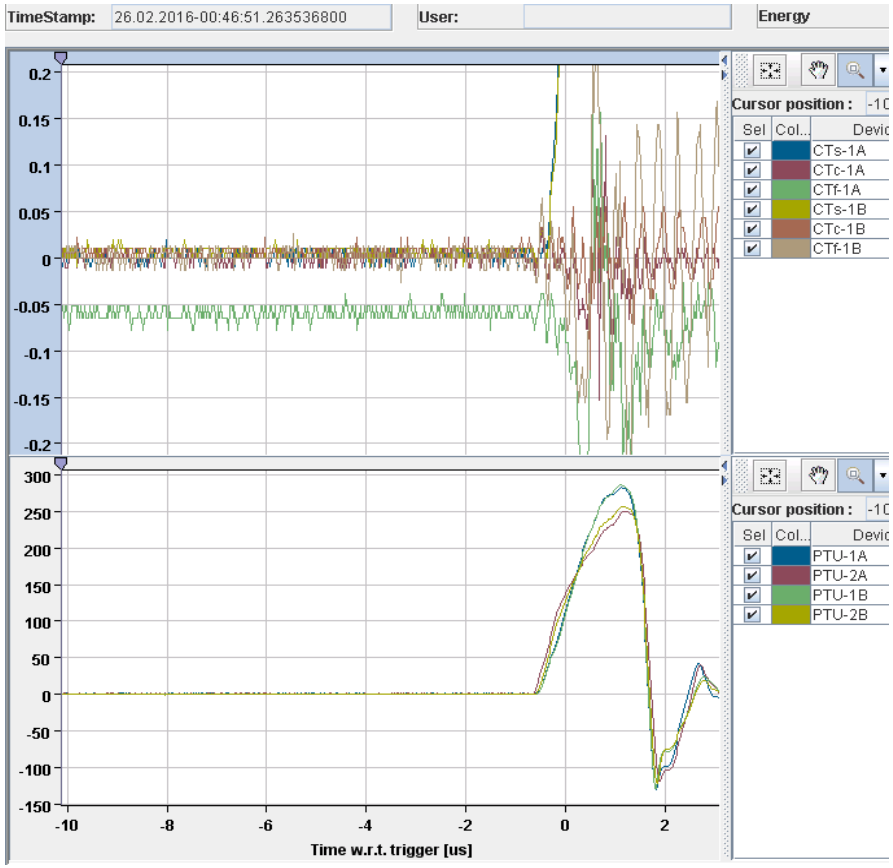
- Instead of fast rising signal on the retrigger line, measured a slowly creeping up voltage signal
- Normal magnet current rise time and waveform
- Before erratic – MKD L, M, N, O spent 64 h @ 6.5 TeV and 32 h @ 7 TeV (gen. A – K the same + more)
  - Probability of erratic increases with voltage and time of exposure





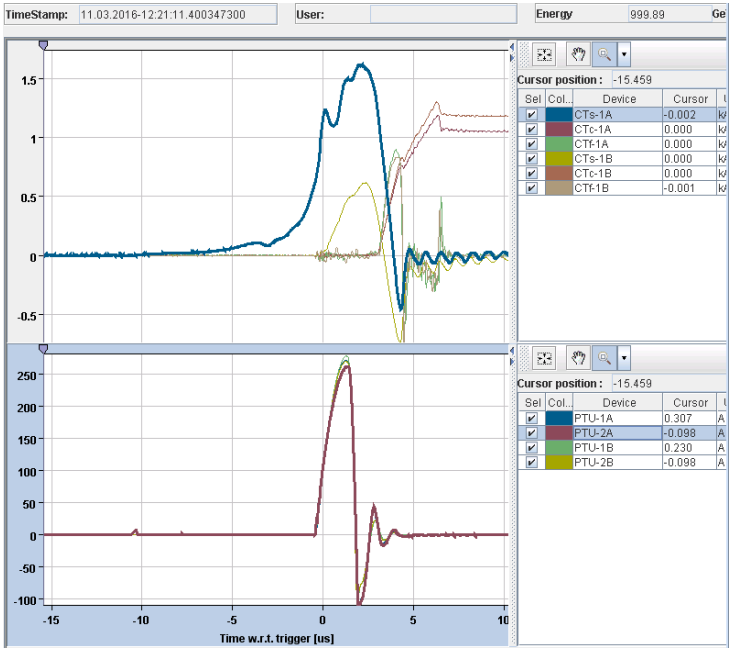
No sparking signal visible

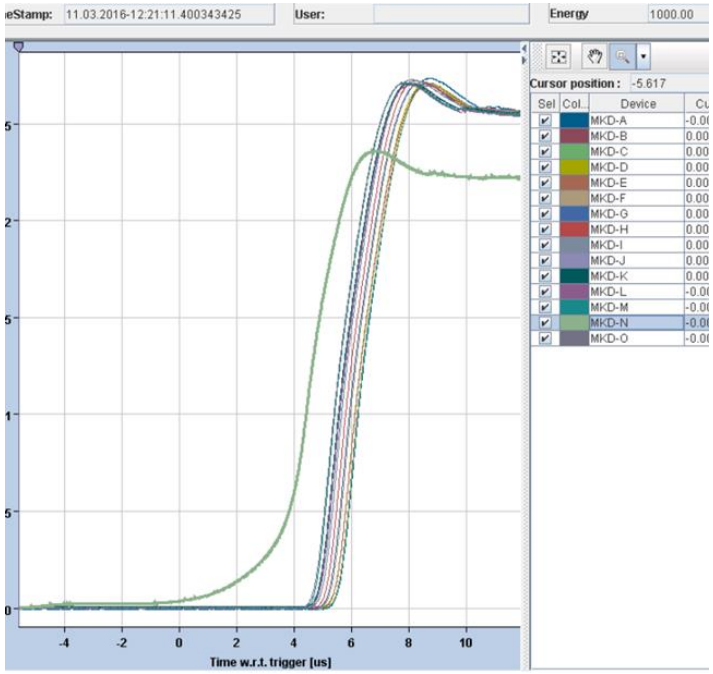




Tests after the erratic

- Try to mimic signal by injection of perturbation signal into the retrigger line
- Activated fast retrigger path of the most sensitive PTM which has a ~factor 2 lower sensitivity than the logical path depending on the MOSFET threshold voltages (5-6 Volts vs 11 Volts)
- As a result, the stack supplied by activated PTM starts slow commutation process with high commutation losses
- Less current in a magnet and risk for GTO stack

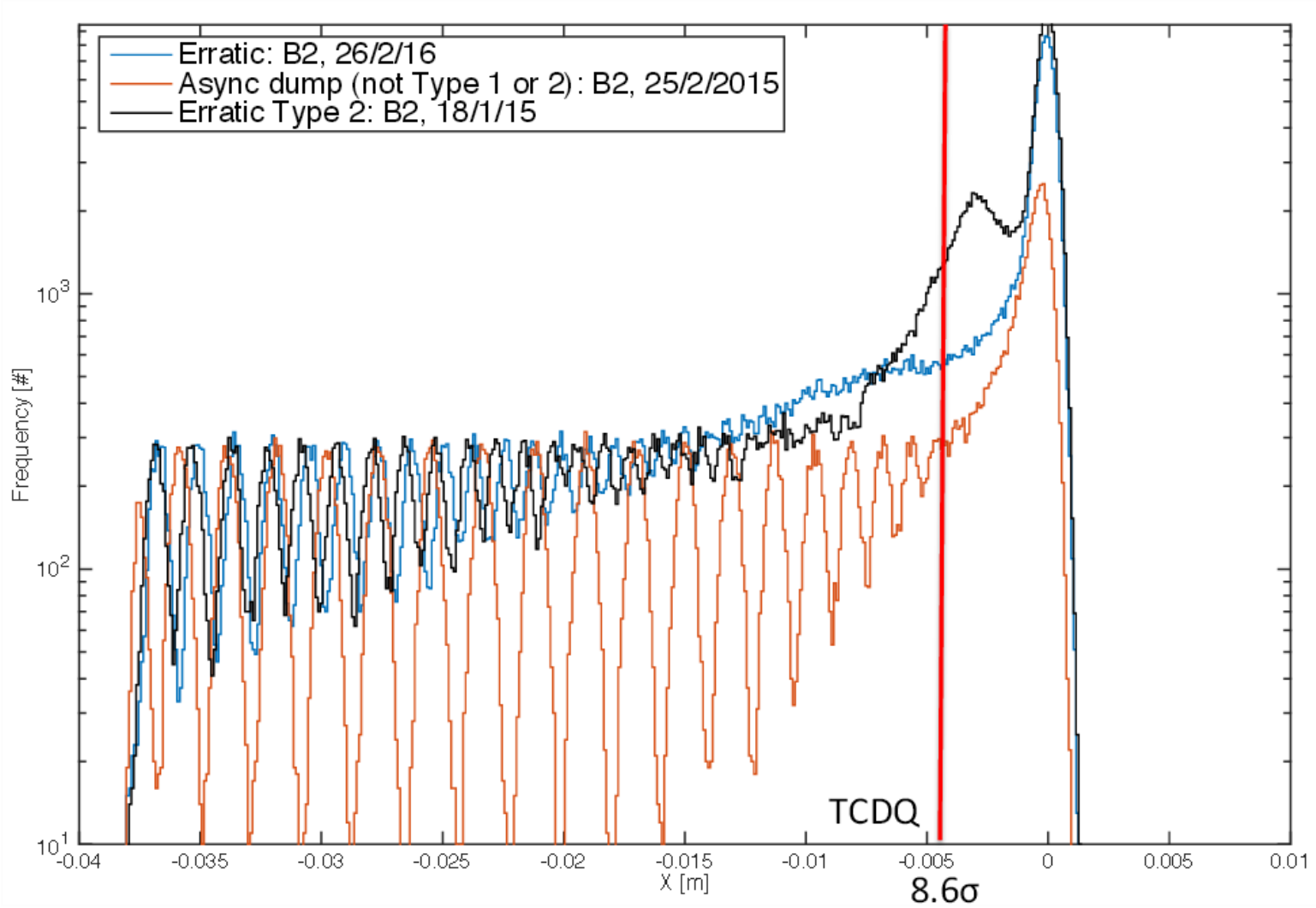




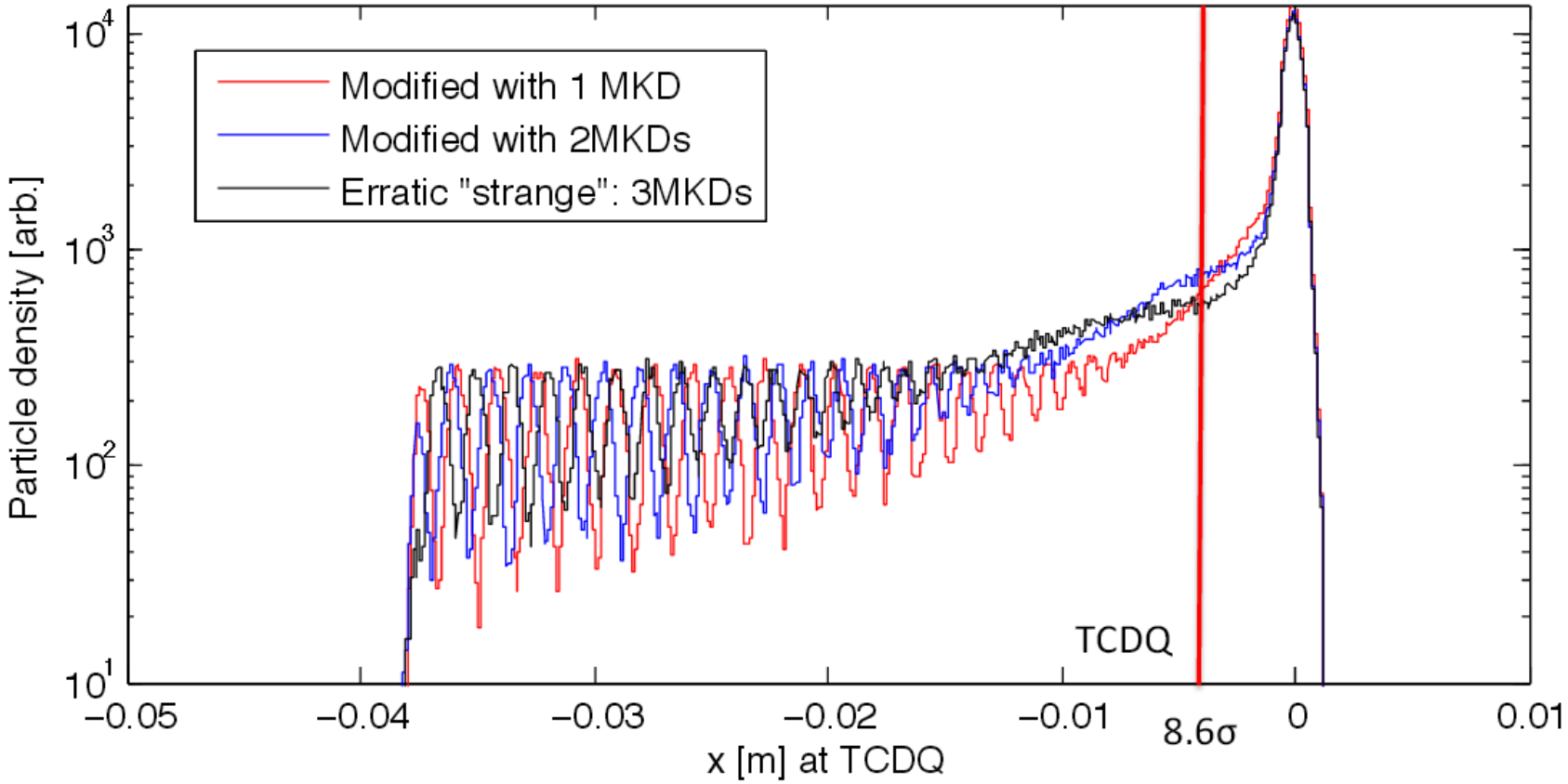
Possible mitigation

- Short term
  - Additional instrumentation in the tunnel (during the energy scans and reliability run)
  - Further tests in the lab
- Longer term – all to be studied in detail
  - Modifications of fast retrigger path - individual adjustment of threshold to higher value than today
    - increased immunity to perturbations
    - Would increase retrigger delay, thus cannot be done now
  - Modifications of the logical path – faster logic with eventually lower threshold; gain of ~ 150 ns possible
  - Modification of the analogic power part of PTM; gain of ~ 50 ns expected
  - Timescale EYETS at the earliest - or part of upgrades foreseen on GTO stacks and controls during LS2
- Before any HW modifications should review the retrigger time specification

Erratic type 3 effect on the beam

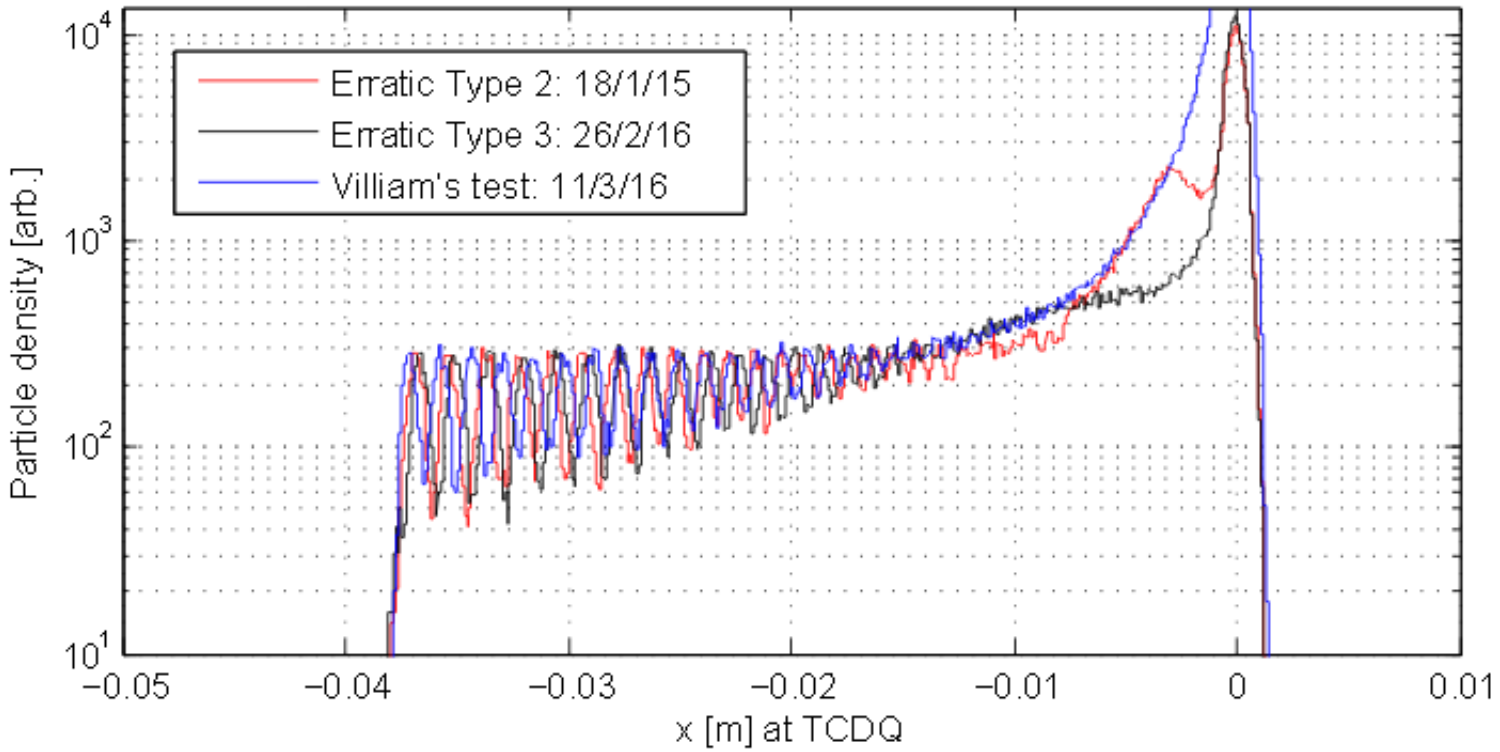


Erratic type 3 with one or two MKDs prefire



Particle distribution for test-erratic

- Test-erratic happened at 1-2 TeV
- To be tested if this erratic is possible at higher energies



Conclusions

- The reason for the erratic type 3 observed on 26th Feb. 2016 is a slowly rising signal on the retrigger line; its origin is not yet identified
  - A similar signal as observed can be injected into the retrigger line and by careful (devil) adjustment (~mV) one can generate an even worse case of erratic with reduced current in the magnet – this case will be shown by Roderik
  - But the source of the signal cannot presently be explained
  - The expected failure rate can consequently also not be estimated

- Effect on the beam
  - Particle density induced by type 3 on the TCDQ and in the circulating beam aperture (4 - 8.6 sig) is not worse than type 2 erratic; even for one or two MKD prefiring
  - Type 2 erratic remains our worst case after this event (type 2 is considered and validated for run 2)

- Next
  - Investigations in the lab to understand source of type 3 and its energy dependence
  - Presently working on MKD generators upgrade for run 3 – up to now the focus lies on reducing the probability of sparking
  - Aim to mitigate this new error source in the upgraded design – retrigger path modifications
  - Add retrigger signal surveillance system – under preparation
  - Need to re-define specification of retriggering – are the 800 ns still appropriate?

PTM retrigger schematic