Automated verification of BLM threshold changes

A. Skaugen for the BLM team

November 25, 2011

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Time and energy dependence

- The quench level of the magnets depend on the time scale of the loss and the current beam energy.
- Losses are integrated in 12 different running integration windows (running sums).
- The losses are compared to a set of predefined thresholds for each of the 12 running sums and 32 energy levels, for a total of $12 \cdot 32 = 384$ thresholds.

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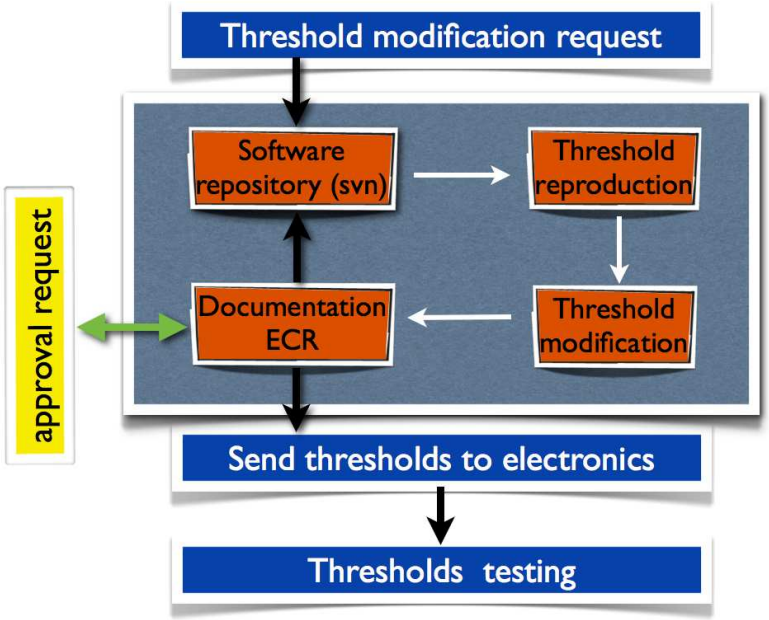
Total number of thresholds

4000 detectors x 384 thresholds = 1.5 million

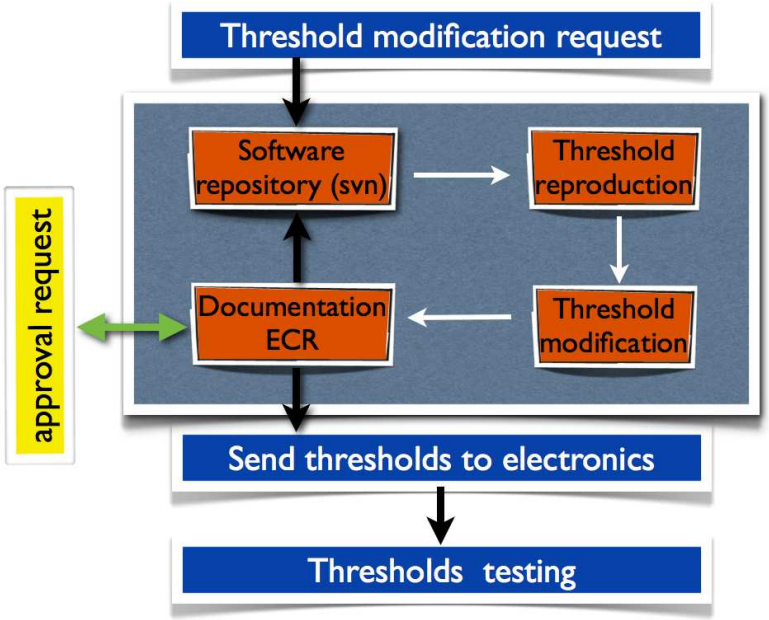
Motivation


Threshold modification request
Software repository (svn)
Threshold reproduction
Documentation ECR
Threshold modification
approval request
Send thresholds to electronics
Thresholds testing

Motivation

Existing tests

- A large number of tests are executed during the threshold deployment in order to minimize the probability of introducing wrong parameters into the system
- Most of the tests require visual verification and are susceptible to human error



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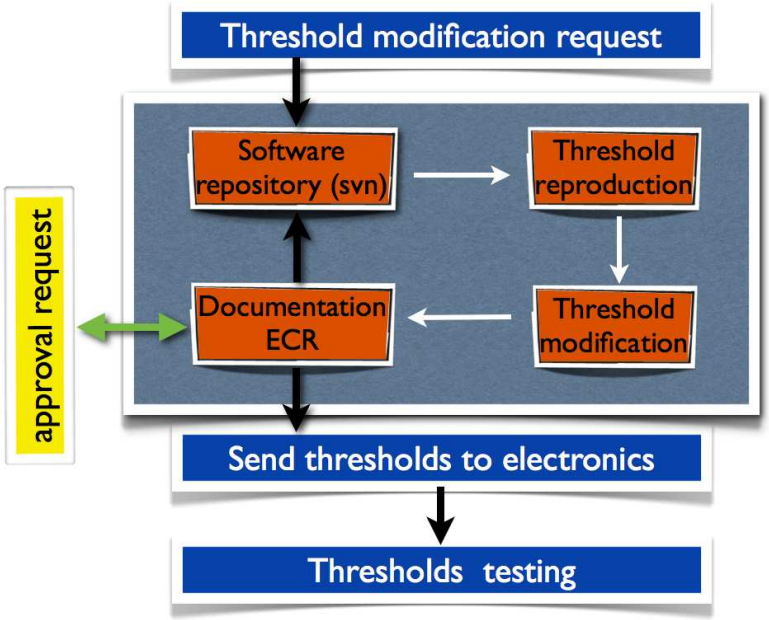
BLM audit

- “adequate protections against tempering or human errors are missing"
  “lack of software tools to detect erroneous values”
- The current efforts on threshold testing is being focused on automation



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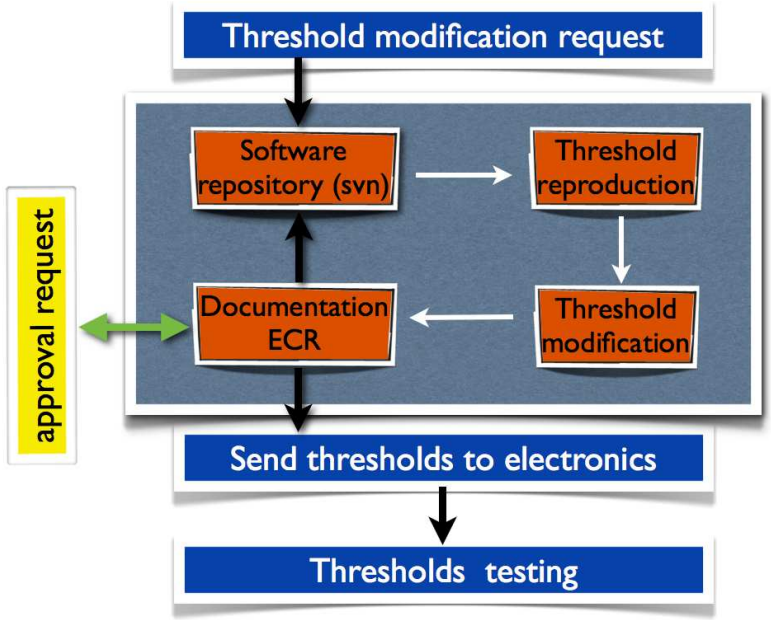

Requirements

- Recover the threshold table at any given time for all monitors around the ring
- Compare the recovered thresholds with each other
- Report any changes in a clear way

Recovering thresholds from the logging database

Logging database

- The BLM system sends the abort thresholds to the logging database
- Thresholds are logged only when they change
- A change can happen due to one of the following two reasons:
  - A change introduced by a user
  - In response to a change in the beam energy
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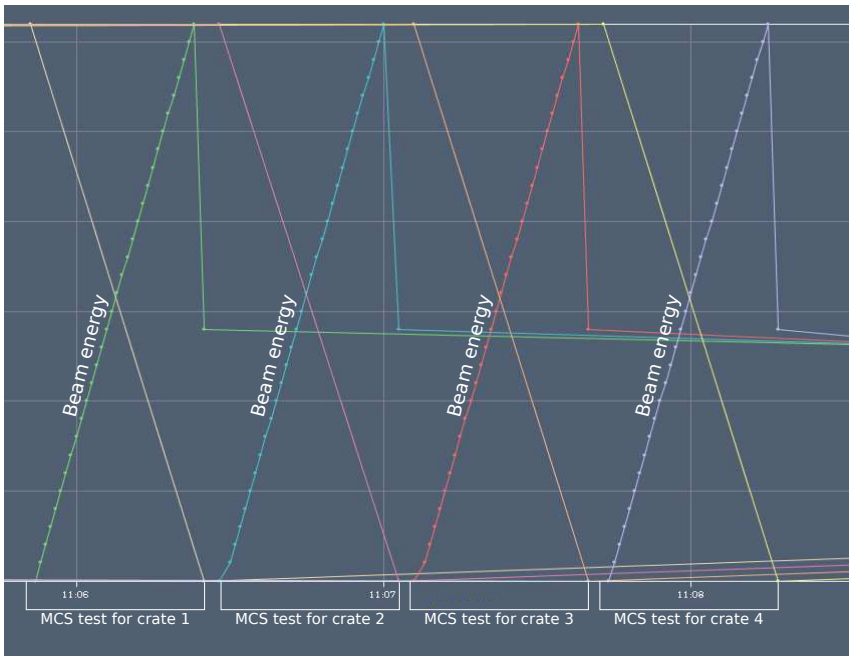
Time difference

- The MCS tests happen at different times for different crates
- Beam energy is stored in a separate variable for each crate



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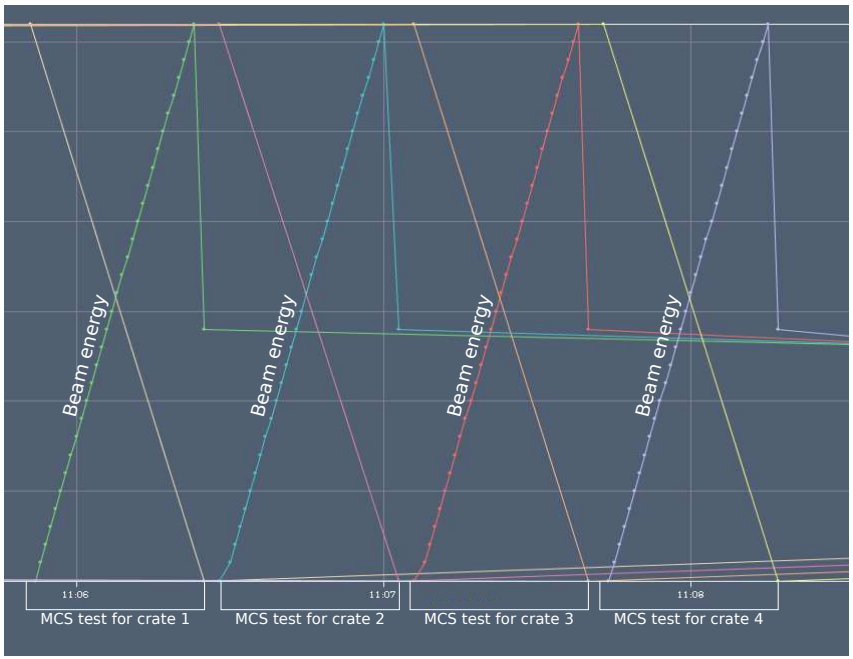
LSA db

The LSA db contains all the information needed to determine the mapping between monitors and crates.

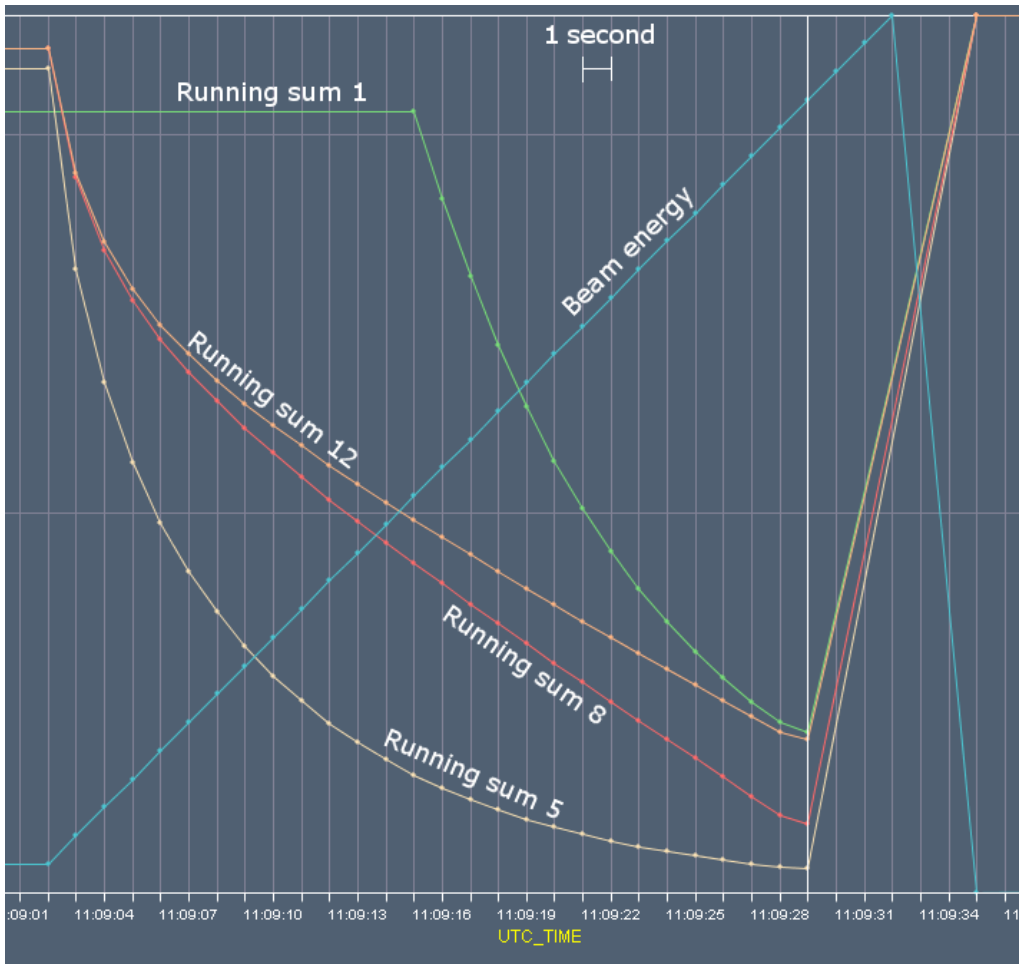


Threshold evolution during an MCS check

Logging of thresholds

- Thresholds are stored for each blm in one variable per running sum
- Thresholds are logged when they change. This happens when the beam energy changes.
  - Unless the thresholds are equal.

Example: `BLMQI.07L1.B2I10_MQ` (nov 13 2011)



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4. For each running sum:
   - For each logged change in energy level, recover the threshold logged simultaneously *or before*

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Comparing thresholds

- The threshold tables for all monitors are recovered at two given times, using the above procedure
- For each monitor, energy level and running sum, the ratio between the new and old thresholds is computed

Command-line interface

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Look between two specific times

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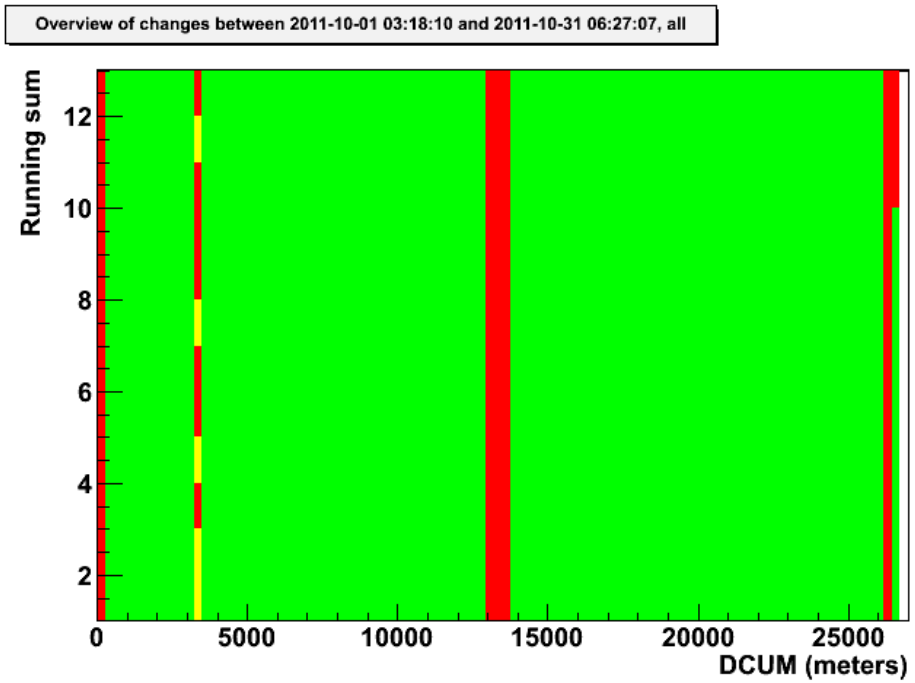
Approximately 15 minutes running time. This makes it feasible to run the tool after every threshold modification and react quickly in case of undesired changes.

Overview histogram



Green → No change

Yellow → Small change

Red → Large change

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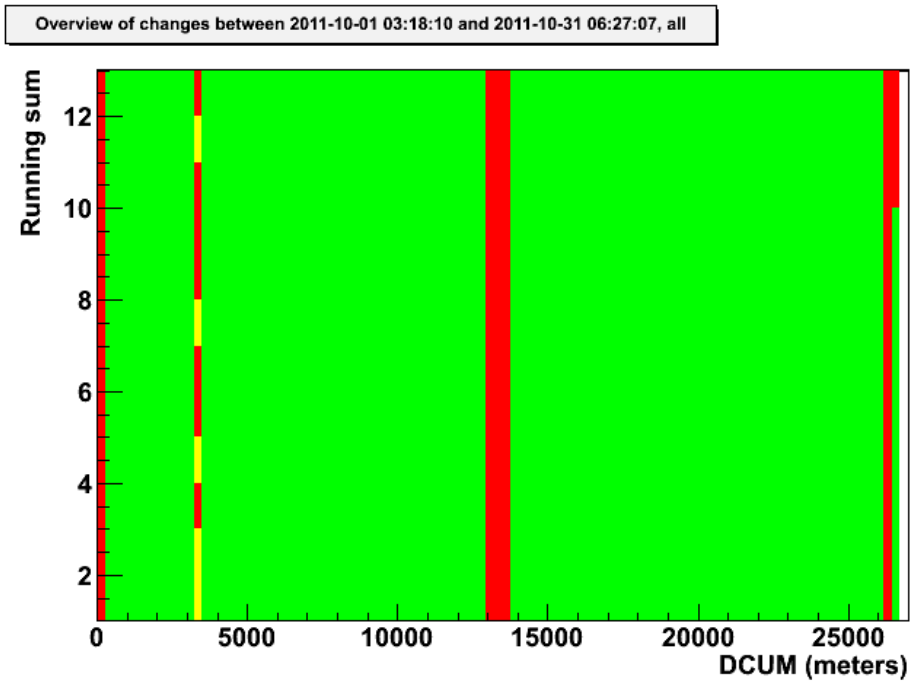

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Definition of size

$$x = \sqrt[32]{\prod_{\text{Energy levels}} \frac{\text{new threshold}}{\text{old threshold}}}$$

$x < 1.0001$: No change

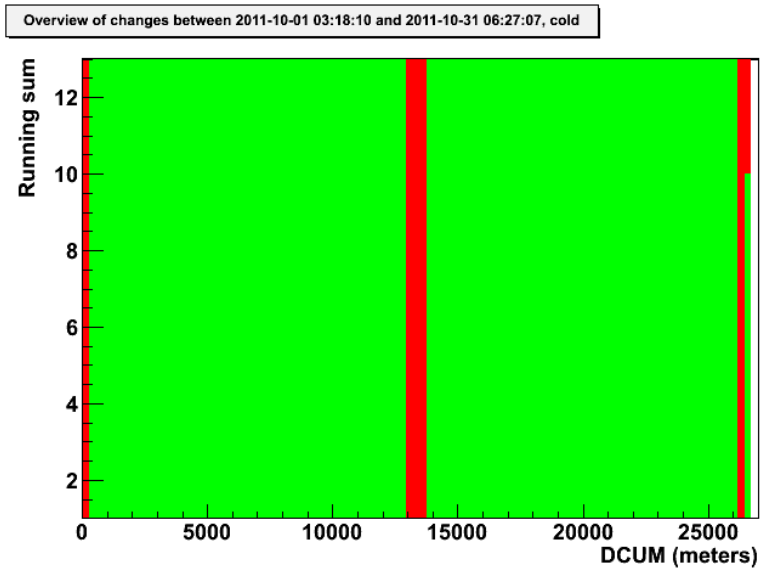
$1.0001 \leq x < 2$: Small change

$x \geq 2$: Big change

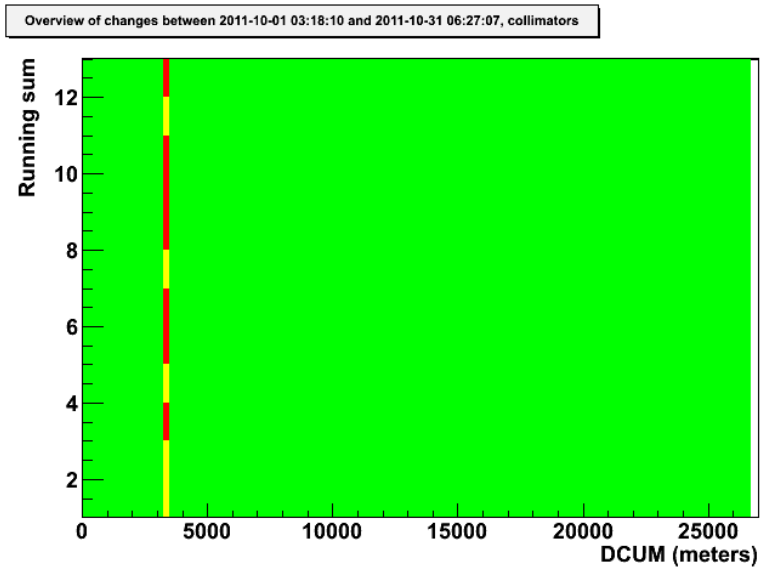
Categories

Plots are also split depending on what kind of element the monitor protects

Cold magnets:

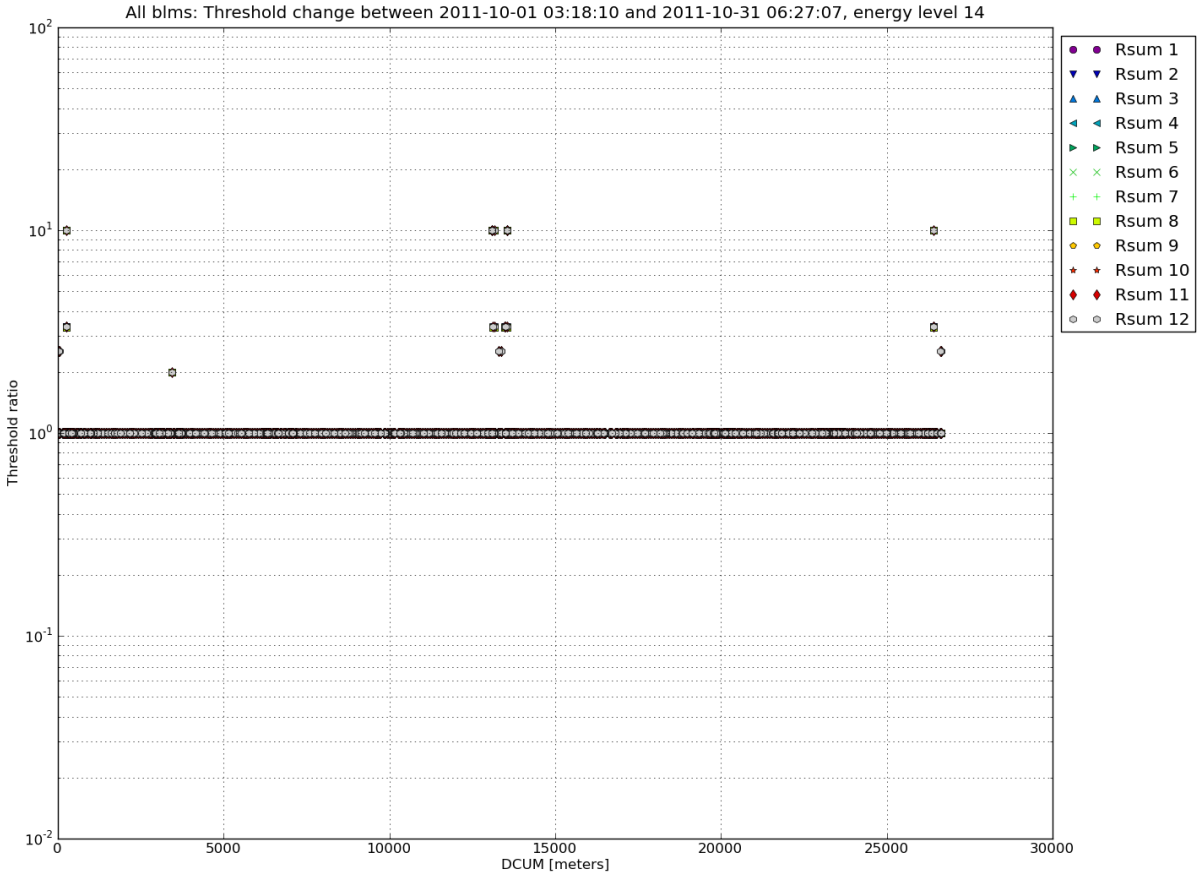


Collimators:



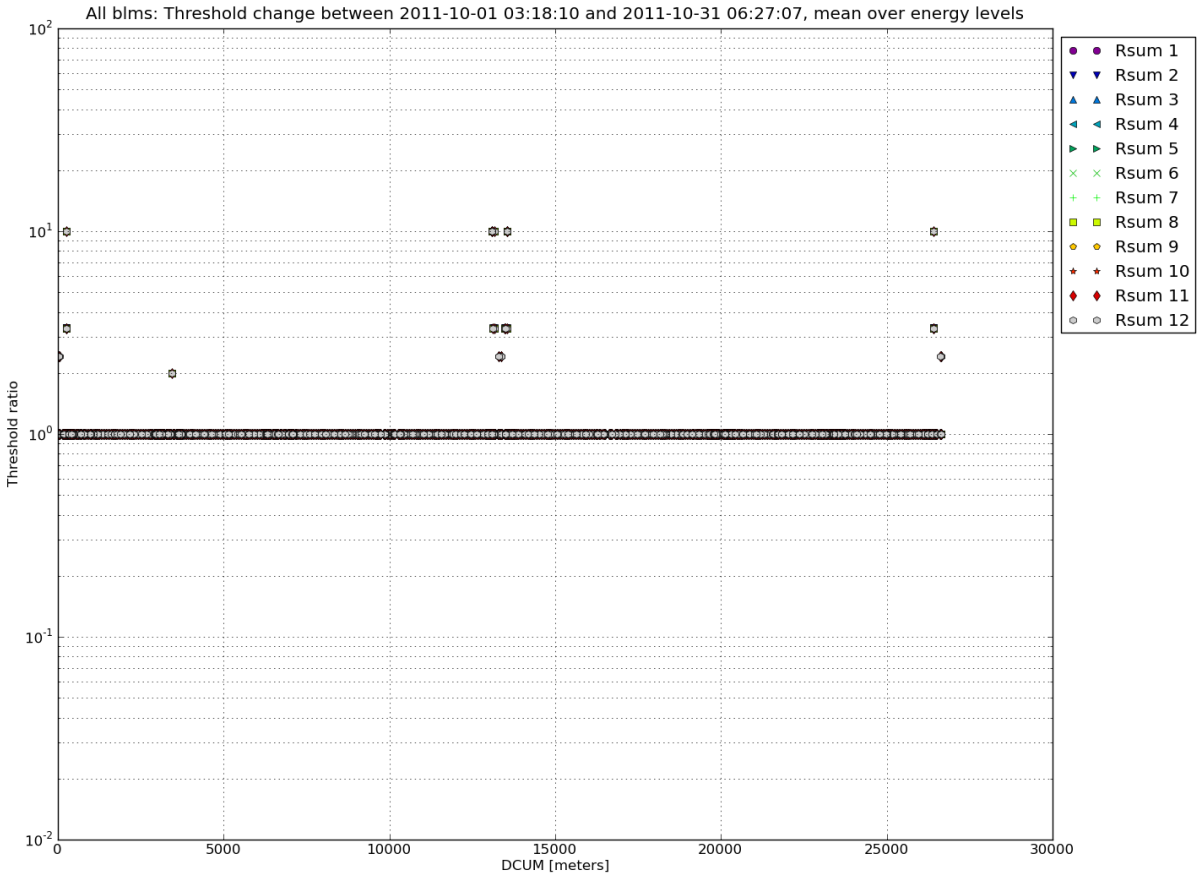
Energy levels

Plot the ratio of change vs. dcum for one particular energy level



Mean of all

Same as above, but take the geometric mean over energy levels



Textual output

```
Family THRI.SS.B1.1_MQM:
    BLMQI.06R5.B1E10_MQML_XRP, crate CFV-SR5-BLMR, dcum 13556:
        Change between 2011-10-01 03:17:32 and 2011-10-31 06:25:15:
            All energy levels:
                All running sums changed with ratio 10

Family THRI_2_MQXB_LumLoss:
    BLMQI.02R1.B2I23_MQXB, crate CFV-SR1-BLMC, dcum 34:
        Change between 2011-10-01 03:16:55 and 2011-10-31 06:26:30:
            Energy levels [0, 1]:
                Running sums [10, 11, 12] changed with ratio 2.63757
            Energy level 2:
                Running sums [10, 11, 12] changed with ratio 2.63229
            Energy level 3:
                Running sums [10, 11, 12] changed with ratio 2.62806
            Energy level 4:
                Running sums [10, 11, 12] changed with ratio 2.62301
            (...)

Family THRI_XRP:
    BLMEI.07L1.B2E20_XRP, crate CFV-SR1-BLML, dcum 26402:
        Change between 2011-10-01 03:18:10 and 2011-10-31 06:27:07:
            All energy levels:
                All running sums changed with ratio 3.33381
```

Cronjob

- The tool was designed to be run after every threshold deployment to prodect against erronous values
- We also get the ability to run the tool automatically at regular intervals, in order to keep a history of expected and unexpected changes
- It currently runs on a linux machine once per week, with reference dates the execution time and one week before
- When done, a report is sent via email to a list of BLM experts

Conclusion

- A tool has been developed for threshold verification.
  - Allows to recover threshold tables from the logging database at a given time for all monitors around the ring
  - Performs comparisons between two sets of threshold tables monitor by monitor
- Step forward on the automation of thresholds test and verification
- Tool executed after thresholds modification
- Executed automatically on a weekly basis (since October 31st)

Vectornumeric

The variables

- New logging format starting from September
- 12 new variables:
  - `LHC.BLMI:THRESH_RS01`
  - `LHC.BLMI:THRESH_RS02`
  - ...
  - `LHC.BLMI:THRESH_RS12`
- Logs thresholds for *all* BLMs

The advantage

Tens of times faster database lookup when interested in all BLMs