Second look at the results of the 2012 analysis of triplet thresholds

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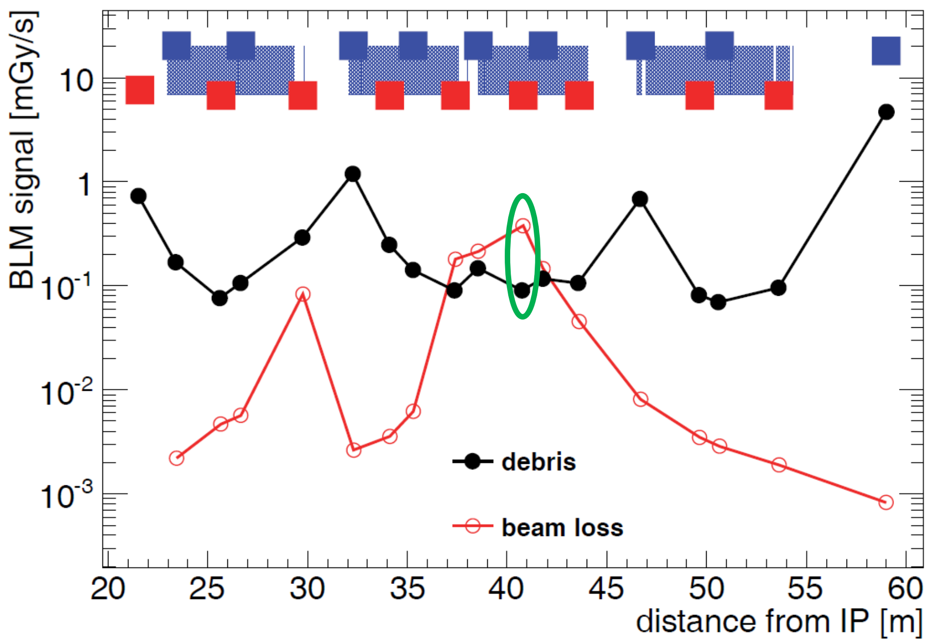
Key facts

- Triplet magnets work at ~30% of steady state quench limit and much higher margin for short losses.
- There is time to perform sophisticated analysis of BLM signals for instance in Software Interlock System (SIS).
- The signals from the debris are well understood.
- Simulations of beam losses have precision not expected a few years ago.

2012 results

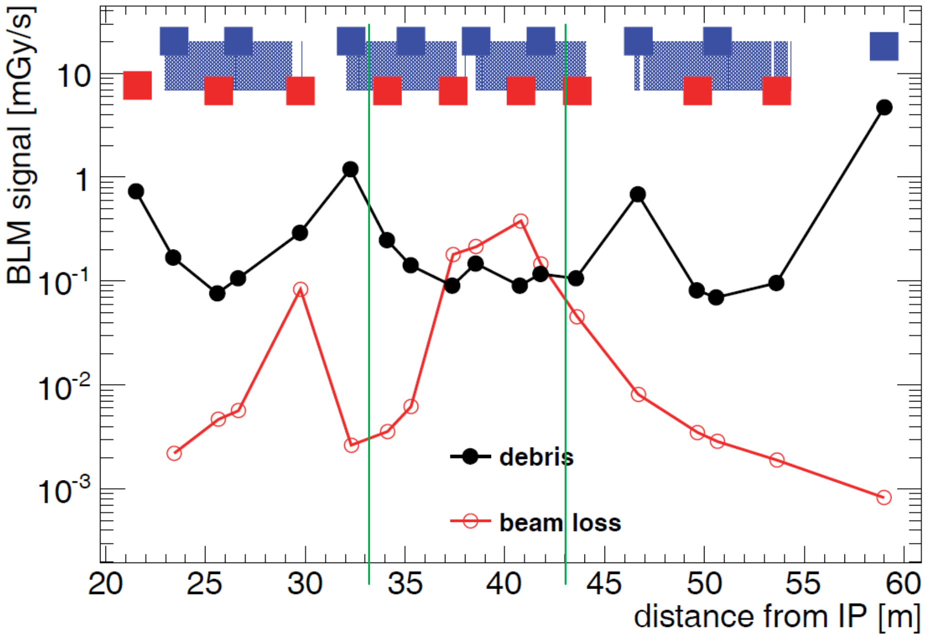


[Estimation of thresholds for the signals of the BLMs around the LHC final focusing triplet magnets](), IPAC12, CERN-ATS-2012-093

Most likely the dangerous is sum of the signals, ie when loss appears during luminosity production.

- at first situation looks not comfortable: several BLMs see higher signal from debris than from quench-provoking loss
- however for the ***best*** BLM margin is > 4
- this is not much, but maybe adding another BLM around can help to distinguish loss from debris?

Signal variation analysis



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- for simplicity consider only region with maximum beta, where the losses are most likely to occur
- debris do not follow above rule (they don't care about beta)
- assume we know perfectly the expected shape of debris signal in this region ($D_{exp,i}$) – the black curve

Signal variation analysis

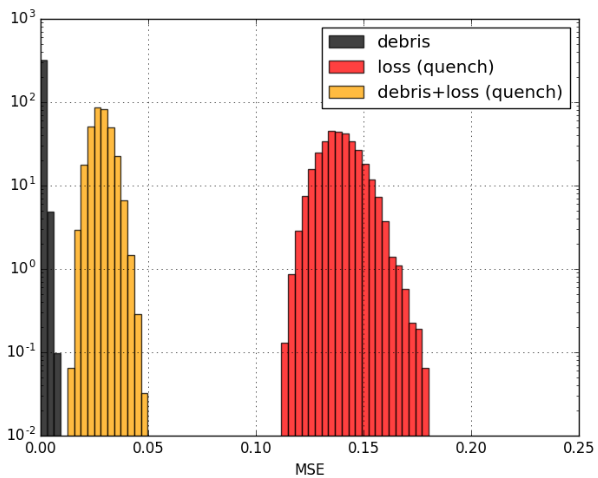
- Deviation of the actual BLM pattern (S_i) from expected (Mean Squared Error):

$$\Sigma(D_{exp,i} - S_i)^2$$

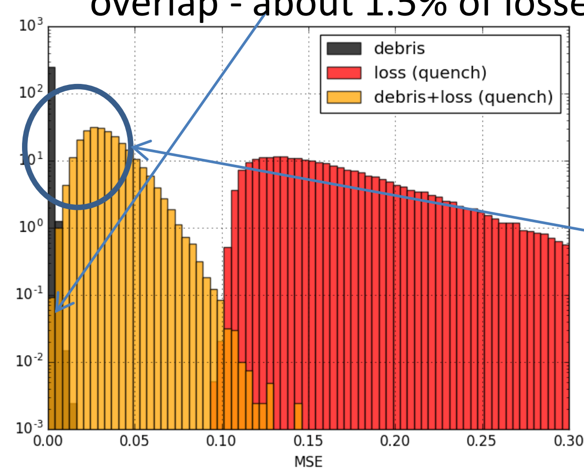
- lets variate signal of each BLM independently by 10%

optimistic?
pessimistic?

- after running this toy Monte-Carlo on 10^5 variations– no overlap between debris and quench events, but overlap and bad separation at 50% of loss variation.



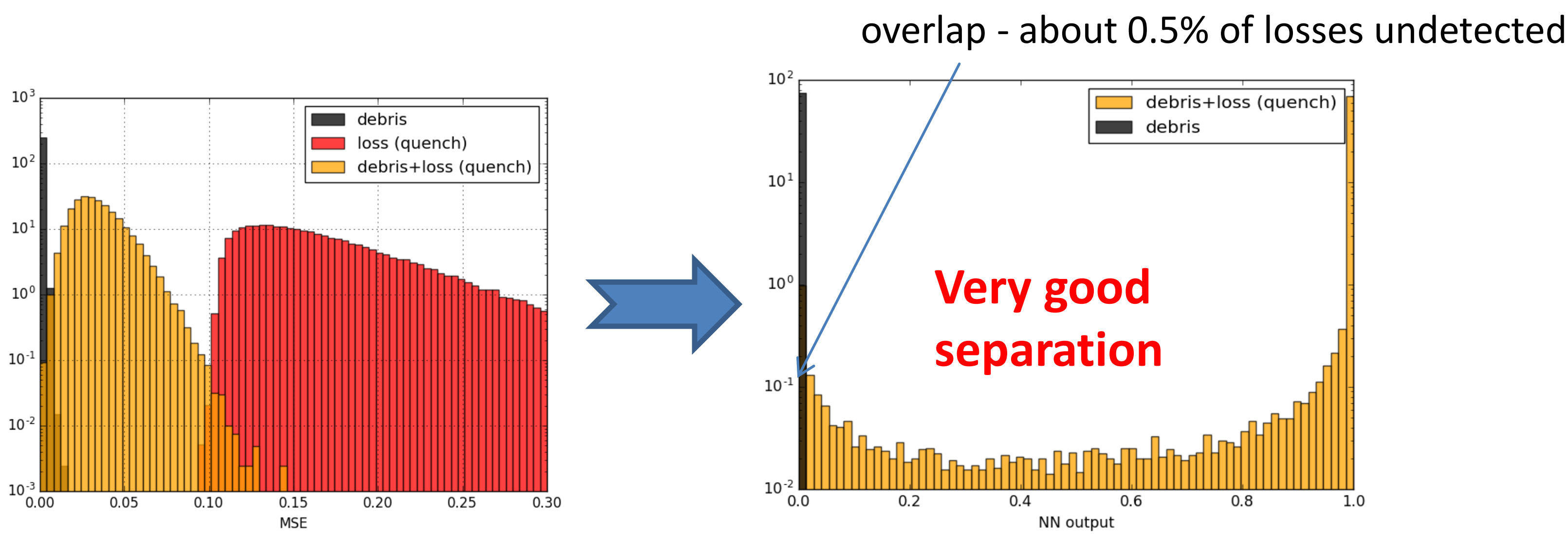
10% debris variation,
10% loss variation



10% debris variation,
50% loss variation

Pattern recognition

- Pattern recognition methods proven to be very efficient.
- They are indication how well the two patterns can be distinguished.
- Pattern recognition is good task for a neural network.
- TensorFlow library, 3-layer network, learning sample 2000 events



Conclusions

- Current BLM system has unexplored potential which could solve, at least partially, triplet steady-state quench issue.
- Results of toy Monte Carlo model presented here are based on gut feeling, investigation of debris pattern (eg. VdM scans) and loss scenarios is necessary.
- Radial sampling (CryoBLMs) of would give additional, valuable information but maybe no crucial for quench protection of triplet magnets.