Bunch-compressor and Physics

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Introduction

- Two-stage bunch compressor gives the option to meet the RDR $\rightarrow$ NB requirements with

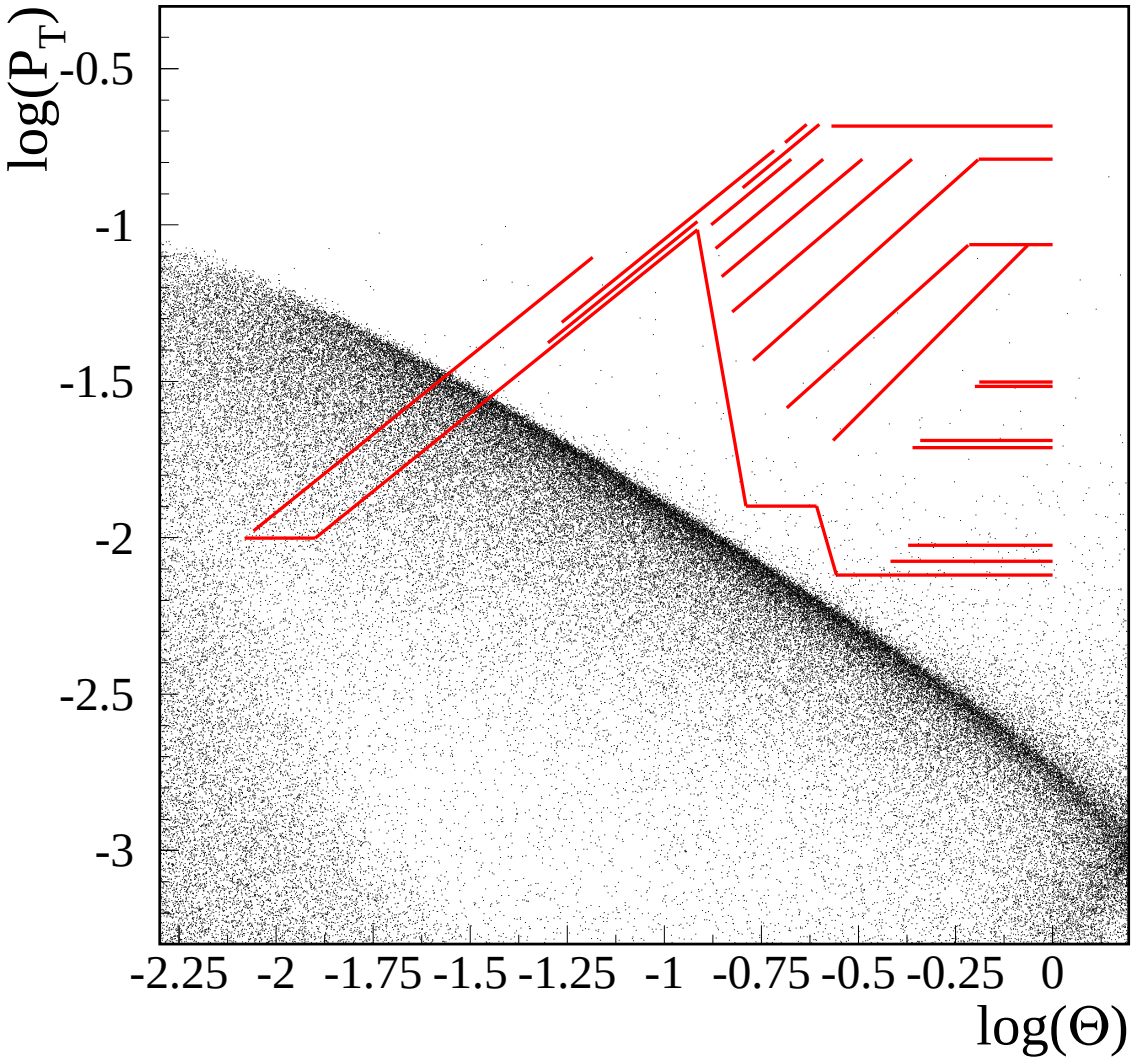
Low charge/more bunches

  while keeping the required luminosity by shortening the bunch.
- Kaoru just presented the scheme in the previous talk.
- I'll show some plots on the physics and detector implications
  - Pairs-background.
  - BeamCal
  - Tracking
  - Energy spectra

Pairs simulation

- Pairs generated by GuineaPig. Thanks Tony Hartin !
- Beam-parameters of Kauro's low charge option ("Modified Gao"). 78000/BX
- ... or the NB current working hypothesis (=SB2009).213000/BX.

Pairs in tracker: NB with TF



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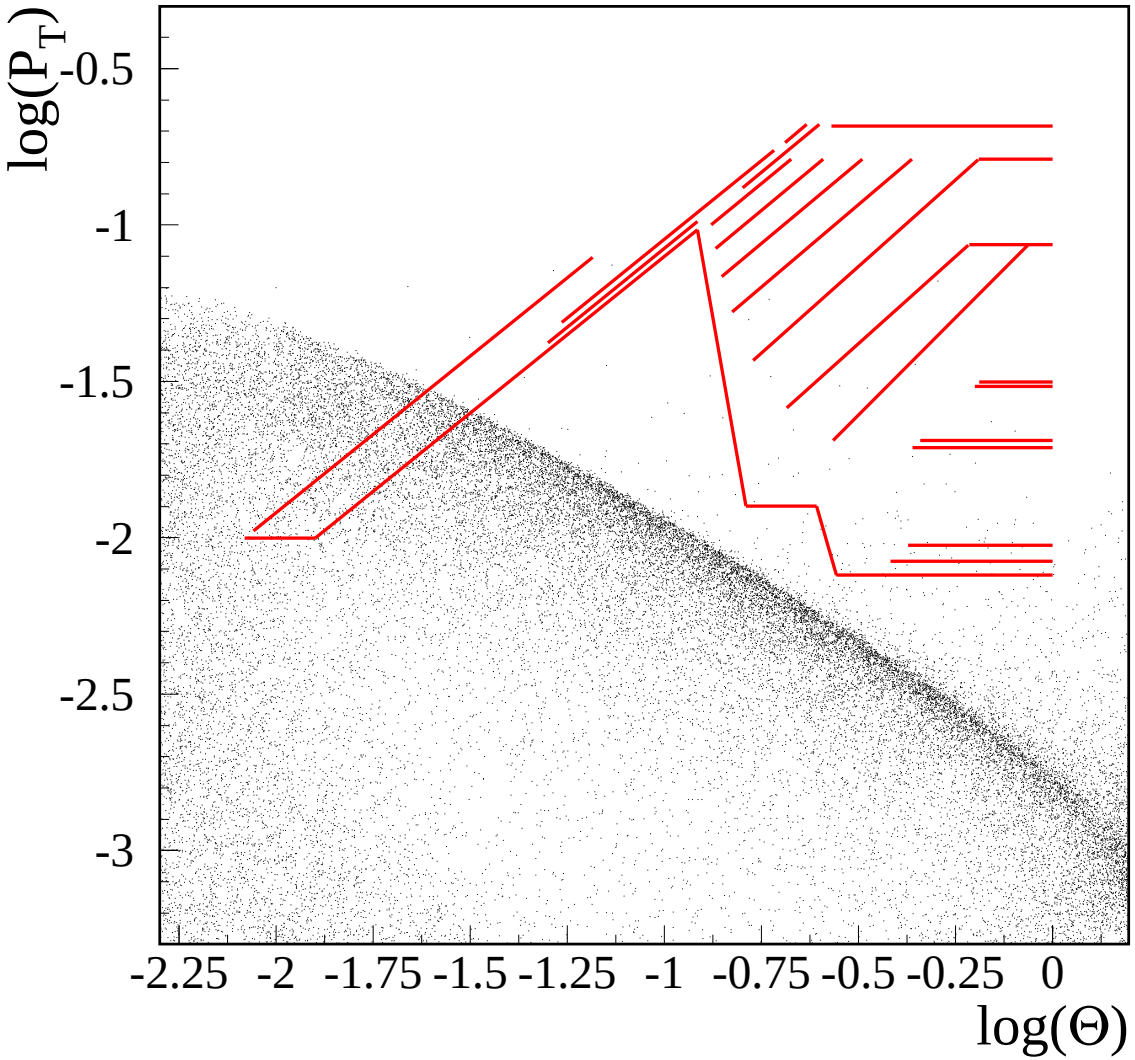


Observations

The Low-Charge option yields:

- Less pairs, by a factor 3
- Larger detector stay-clear

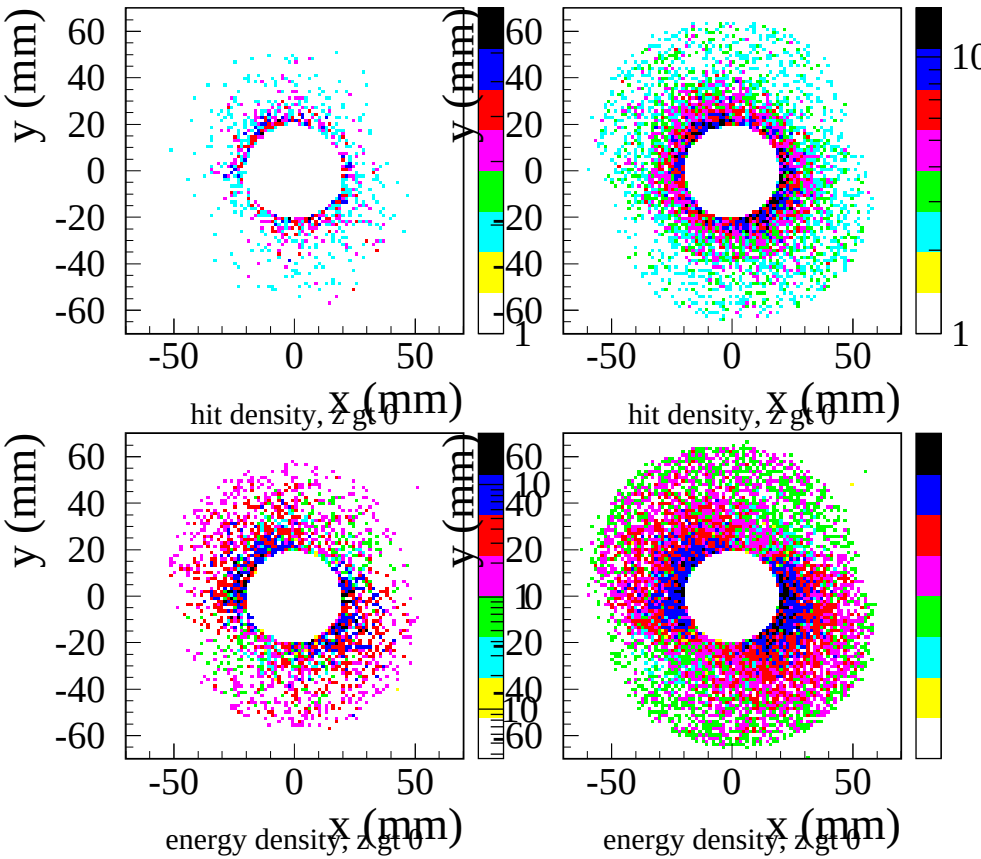
Tracking: Hits in Vertex detector, TPC ...

Full simulation (Mokka), with crossing-angle and anti-DID field needed, so not available.t
However, we did this study in the other direction:

- SB2009 no TF = 2 $\times$ RDR nom; SB2009 with TF = 2.6 $\times$ RDR nom.
- This was the same ratio as the ratio of number of pairs.
- So we expect a reduction by a factor 3.
- The ILD VTX integrates of a certain time-window $\rightarrow$ twice as many BX:es with low-charge net effect: reduction by 1.5!
- Ion feed-back in the ILD TPC is not an issue: so slow that nb of trains is what matters, not nb bunches.
- In Sid, all detectors are read out BX-by-BX: should get the full factor 3.

BeamCal

- Only GP, but with crossing-angle and anti-DID.
- Both hit-densities (top) and energy-density (bottom) matters.
- The issue: can one better see a $\approx$ 250 GeV electron from a $\gamma\gamma$ process over the pairs-background in Low-charge (left, NB w/ TF left)?
- Radius vs. Energy.
- Low-charge cone end 10 mm closer, and has less pairs and less energetic ones.



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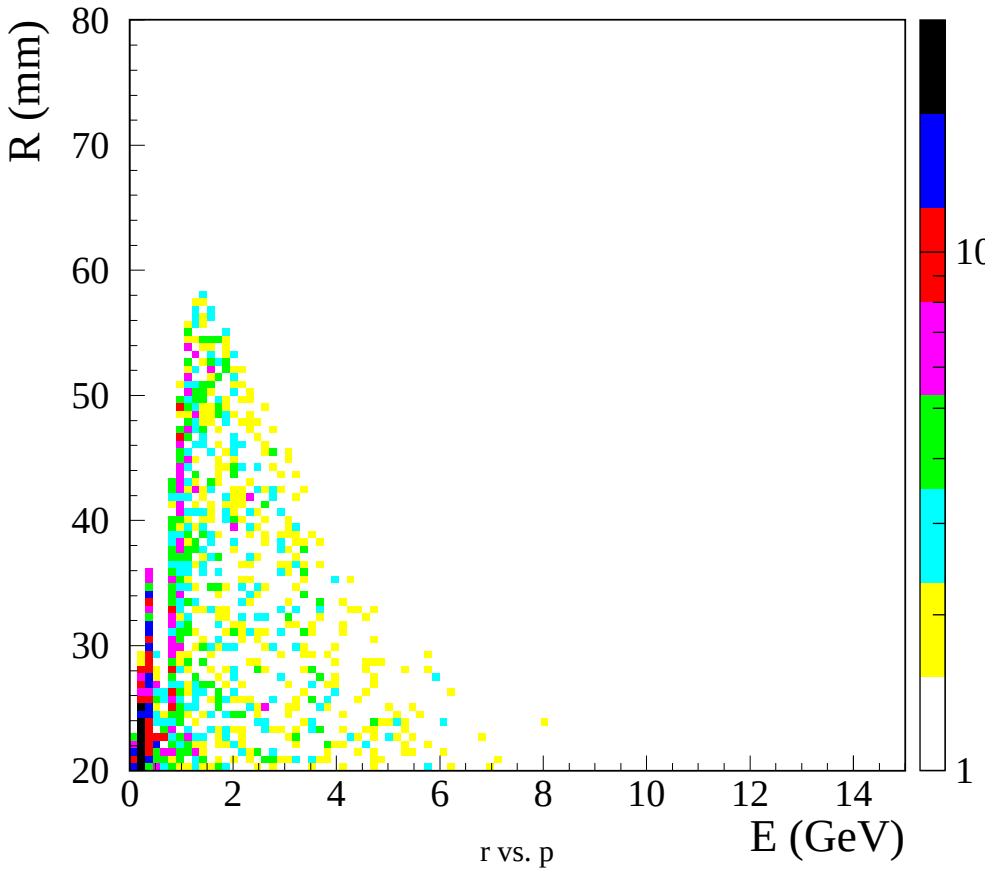

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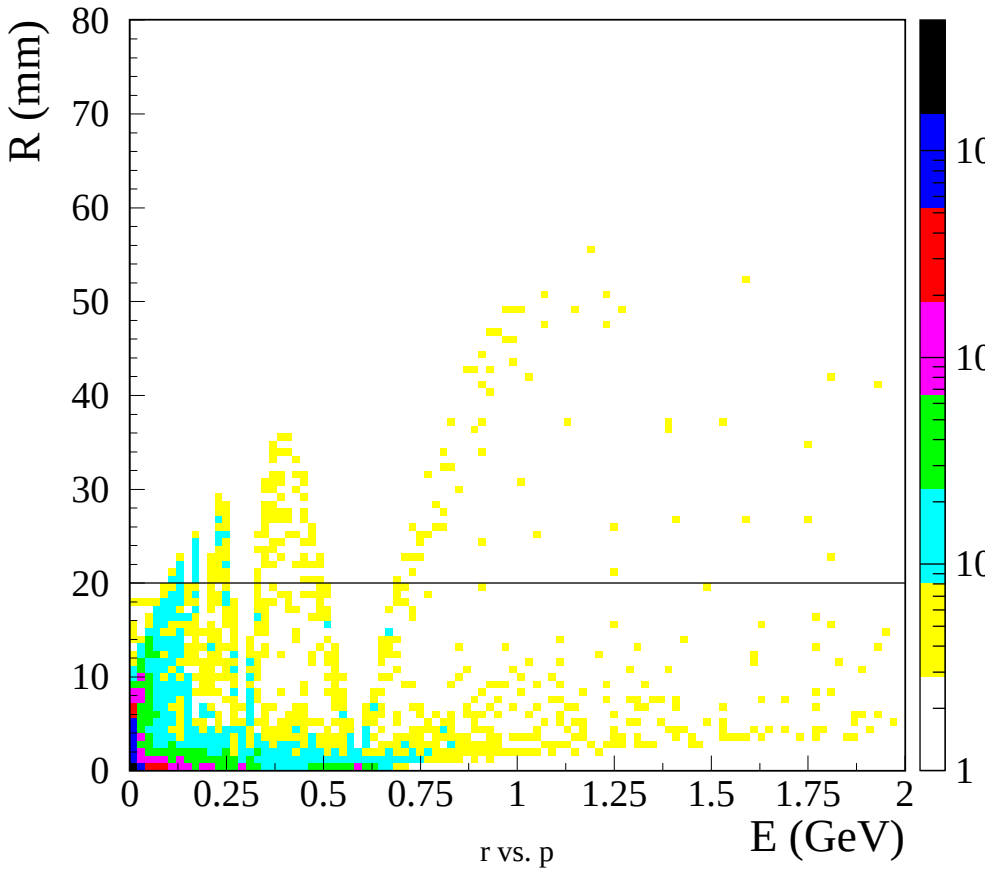

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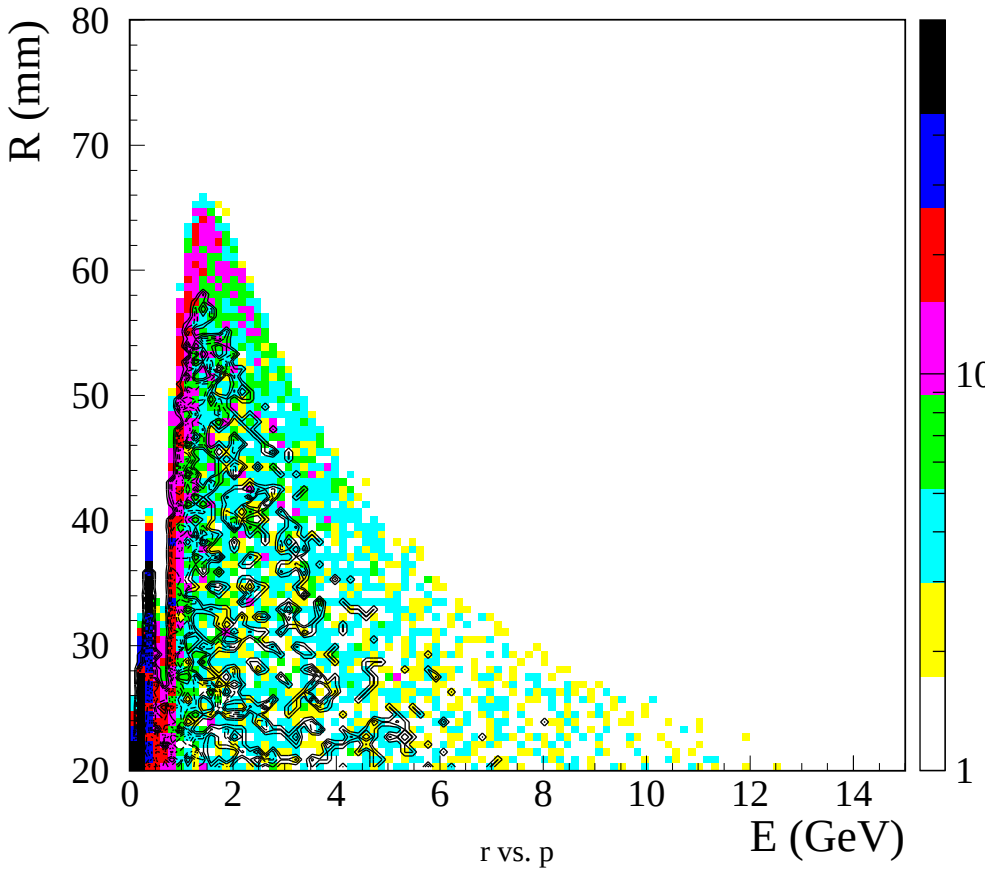
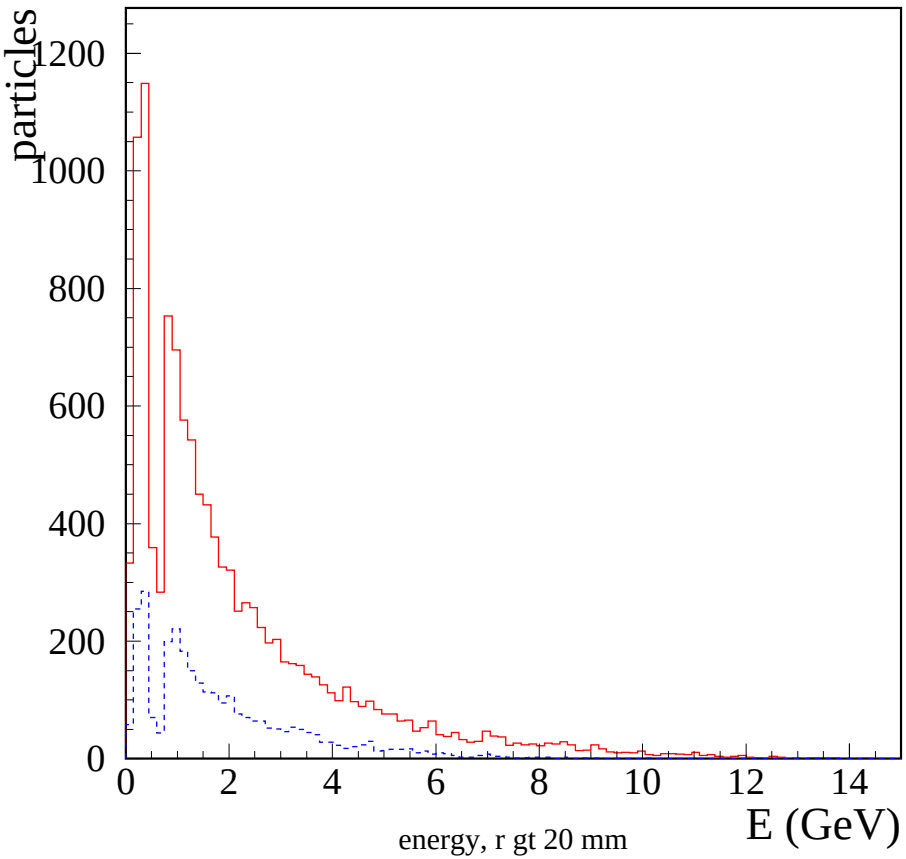


BeamCal

- Distribution of particle energy for r $>$ 20 mm.
- Total energy in BeamCal per BX: 24 TeV for NB w/ TF, 5.5 TeV for Low-charge.
- Number of particles per BX: 11500 for NB w/ TF,3000 for Low-charge.
- Energy density vs Radius: NB w/ TF has about three time more at any given radius, and extends 10 mm further.
- All the relevant numbers decreases by a factor 3



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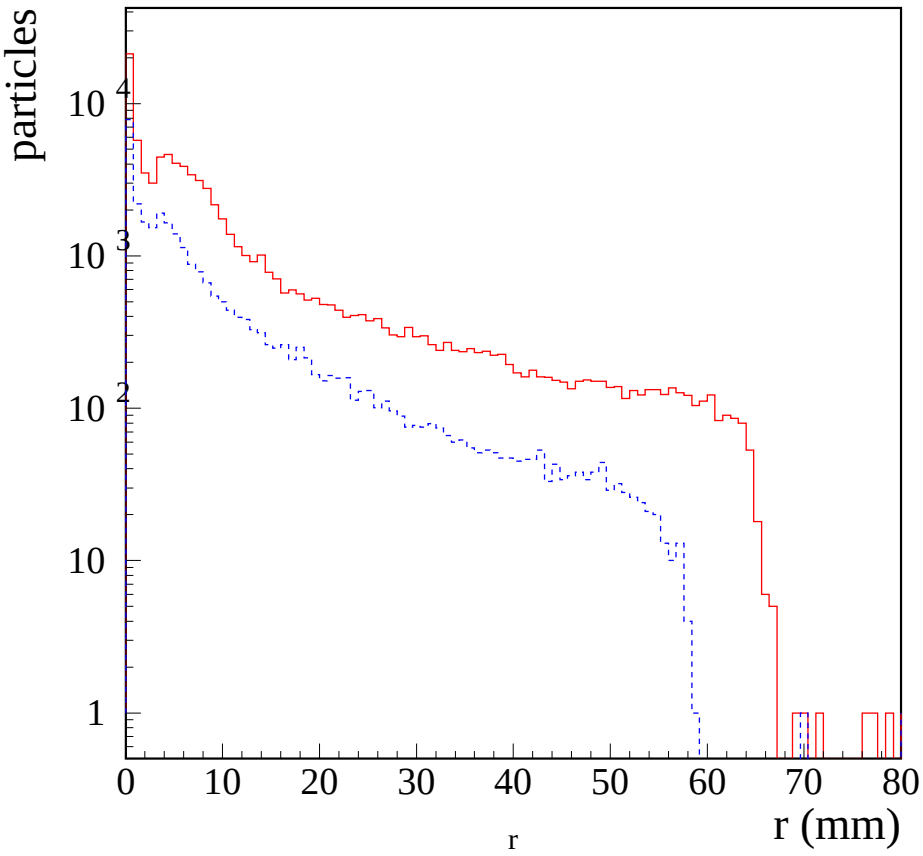

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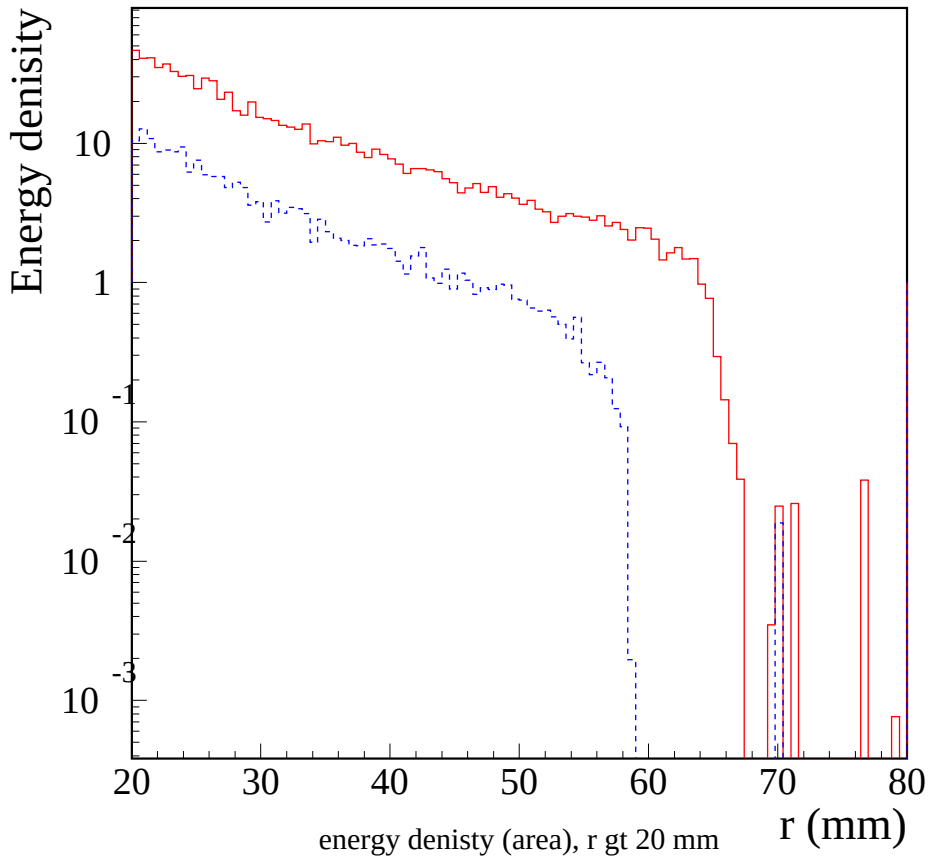

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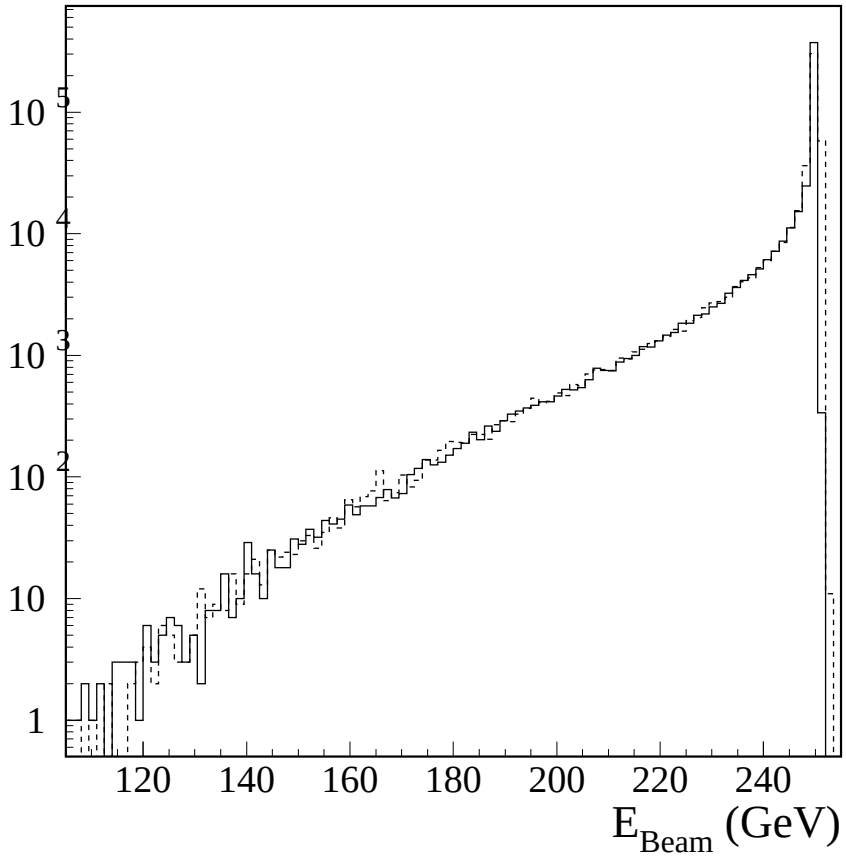
Beam-spectra

- Full beam-spectra for electrons (dash) and positrons (solid), for Low-Charge
- ... and the peak.
- Full E_{CMS} distribution for Low-Charge (solid) and NB w/ TF (dash)
- ... and the peak.
- CAVEAT: same *total* lumi. Nevertheless, increase within 2 σ is clear.



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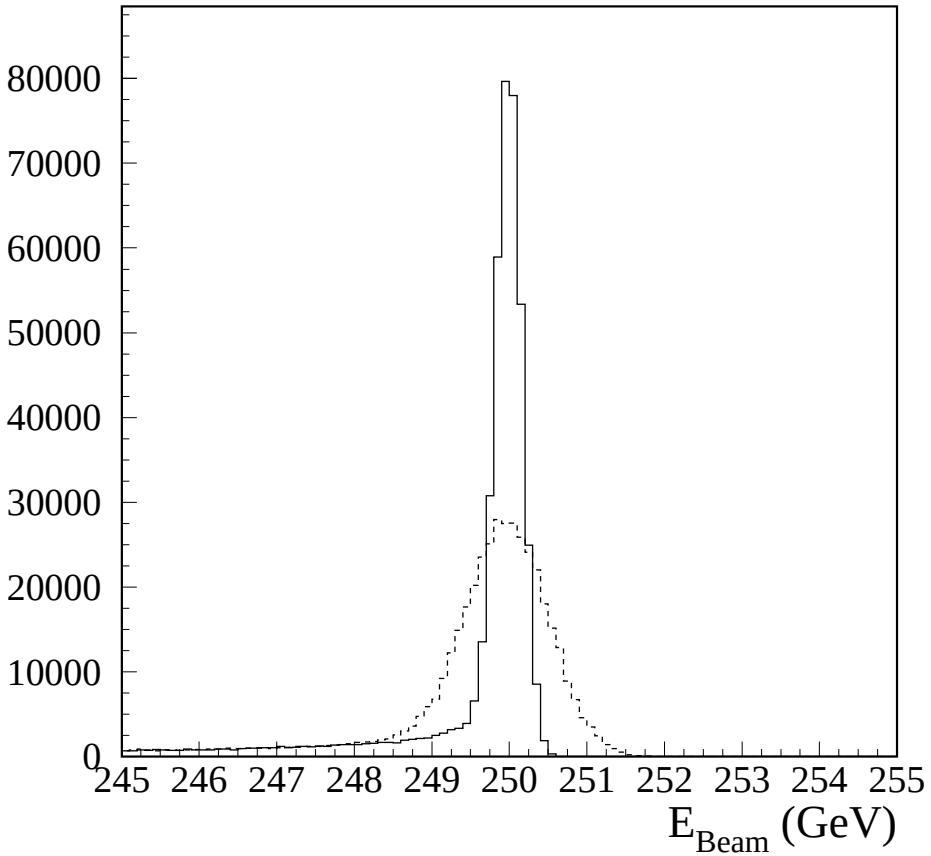

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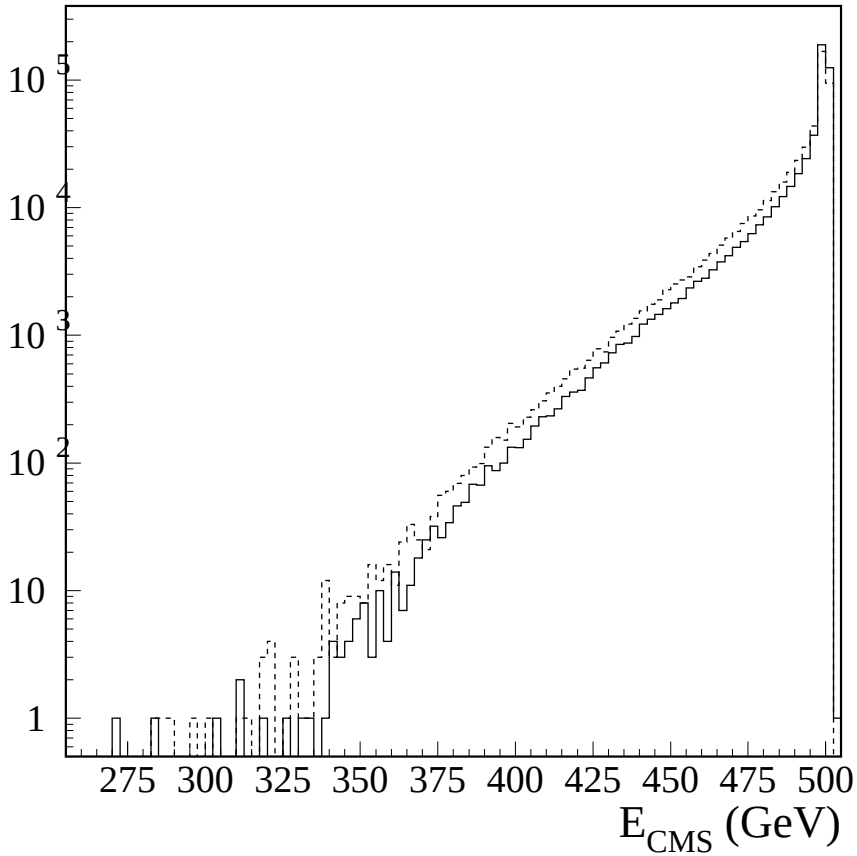

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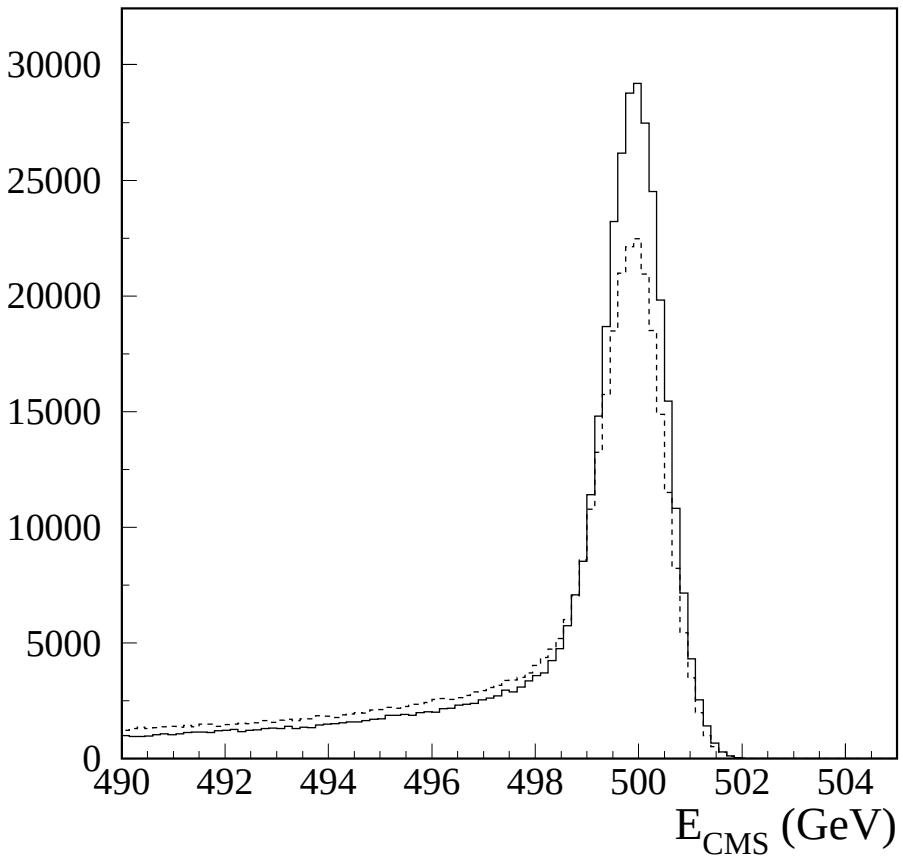

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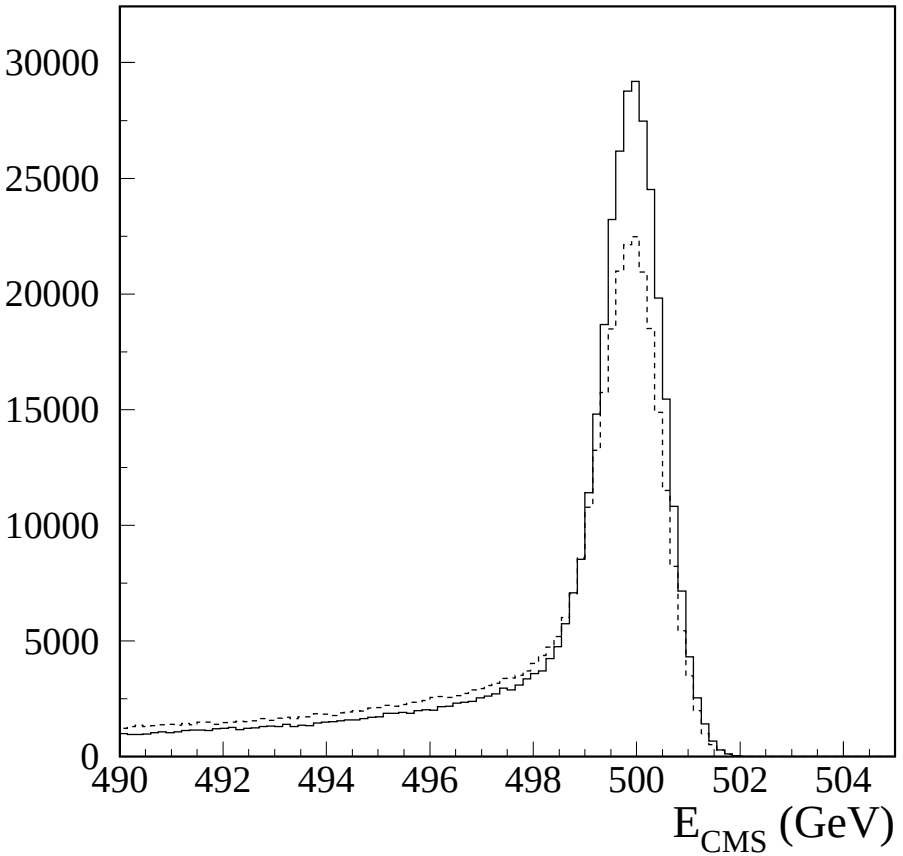

NB, Low-charge and Physics

Potential effects:

- Luminosity within 2 σ of nominal increases: higher signal.
- Half as much beam-strahlung:
  - less overlayed tracks (real or fake): Saves fragile event topologies.
  - Less than half as much energy in BeamCal: Less $\gamma\gamma$.
- Lower probability for a $\gamma\gamma$ event *in the same BX* as the physics event.

Also here:

We have done similar studies in the SB2009 - RDR evaluation.

See eg. reports on stau-production in LCWS 2009 (Beijing).

Compare with "RDR , SB2009 and $\tilde{\tau}$:s" from BAW II

Potential effects on the $\tilde{\tau}$-channels:

- Decrease of $P(e^+)$: Less signal, more background for $\tilde{\tau}_1$, and more signal, but still more background for $\tilde{\tau}_2$
- Incoming energy-spread grows: end-point blurred.
- Luminosity within 1 % of nominal reduced: lower signal.
- Twice as much beam-strahlung:
  - more overlayed tracks (real or fake): Destroys τ topology.
  - Twice as much energy in BeamCal: More $\gamma\gamma$.
- Higher probability for a $\gamma\gamma$ event *in the same BX* as the physics event (this effect has not yet been studied).
- Also: Total luminosity decrease for SB2009 w/o TF.

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Evaluating physics effects

Impossible to re-do fully simulated samples - months of Grid-time - , so a transformation from between parameters is needed !

- Luminosity: Utterly Straight-forward. Just re-weight final results (or state that they take shorter/longer time to get...) one Day
- Polarisation: Straight-forward relative weighting of generated samples with P=(-1,1) and P=(1,-1). (NB.: For ILD. SiD uses pre-mixed samples.) one Week
- Beam-spectrum Re-run GP, extract and treat energy-spectra.Re-weight events to modify the fully simulated samples to an other parameter-set. few Weeks
- BeamCal: Change the energy density wrt. numbers from RDR simulation. A Month
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- With the help of Tony, I looked at the pairs-distribution for bunches displaced 0.5, 1 or 2 σ in y.
- Question was: the number of pairs goes down for sure, but where do the end up?
- Conclusion: No problem, the distribution in space does not change.

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- Two parameter sets A1 (5 % BS) and B1 (10 % BS).
- B1 gives higher Lumi, but ...
- ... it hits the beam-pipe (even at 4T ILD field)
- Options:
  - Go with A1. We are asked to do 1 ab^{-1}, not x years ...
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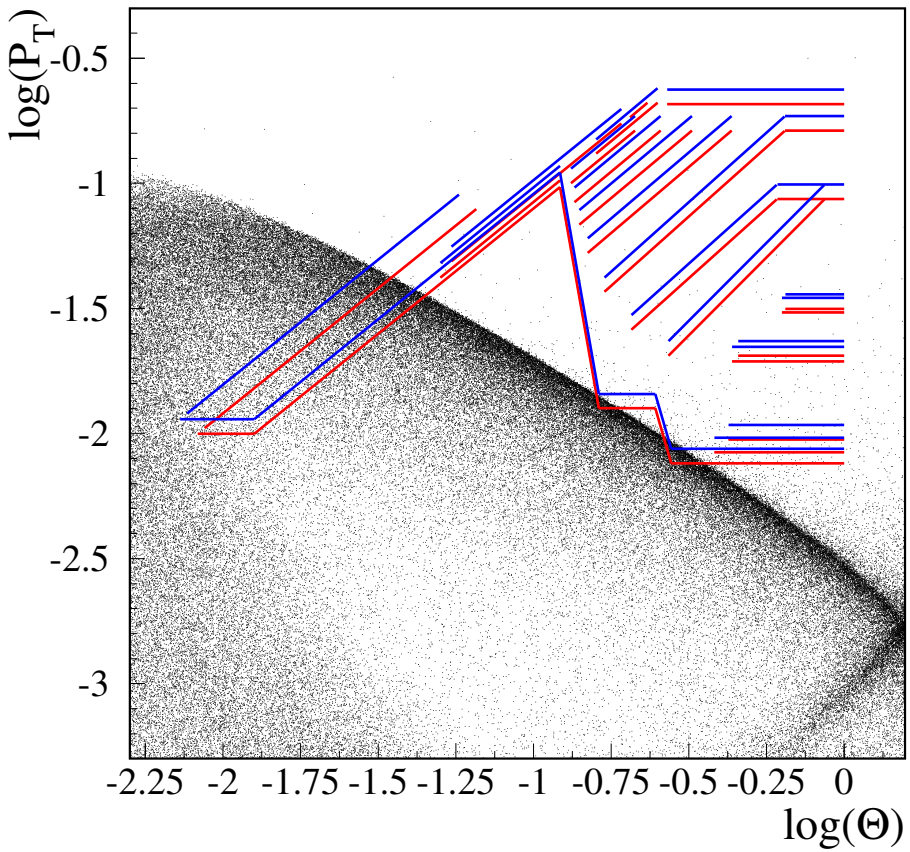

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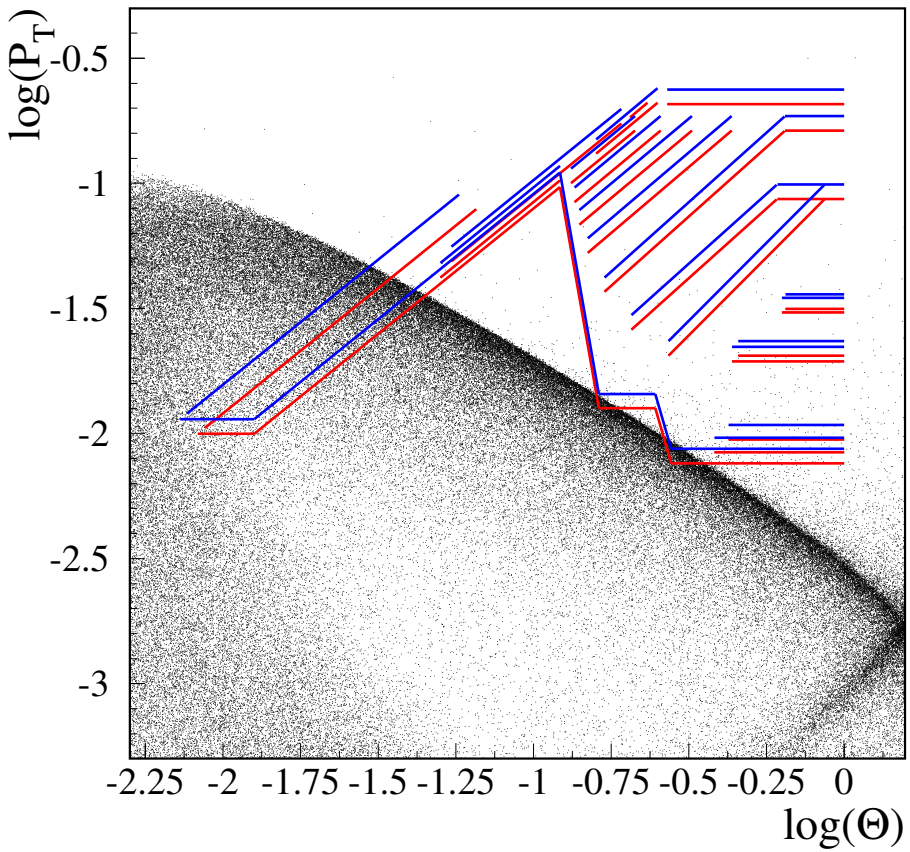

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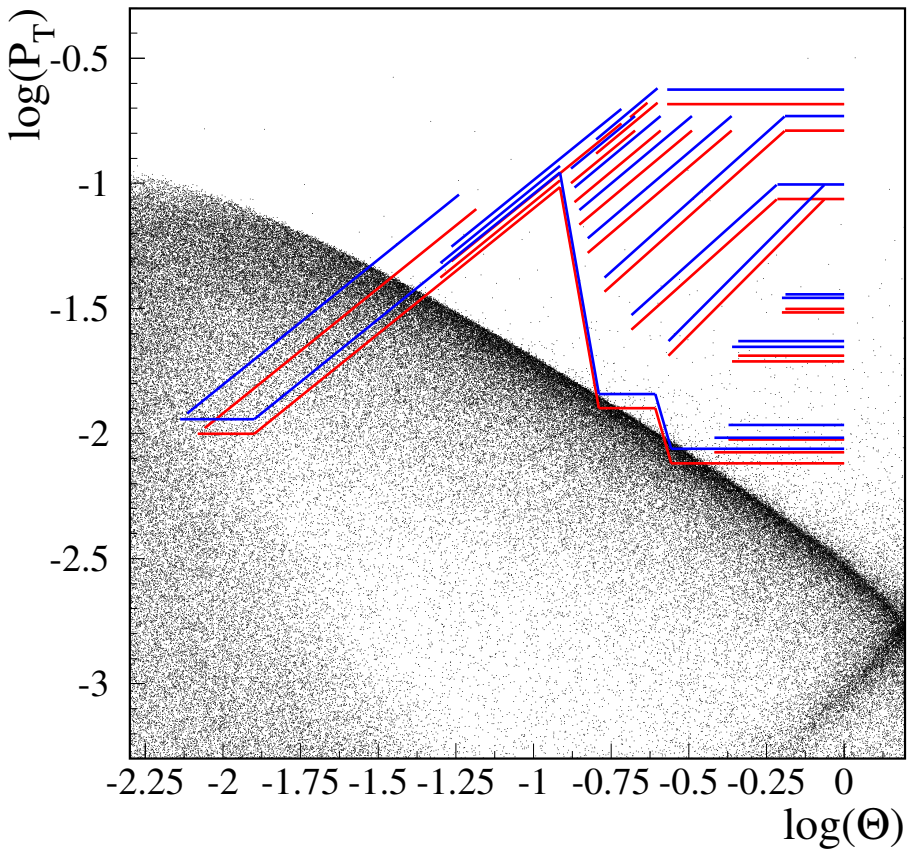

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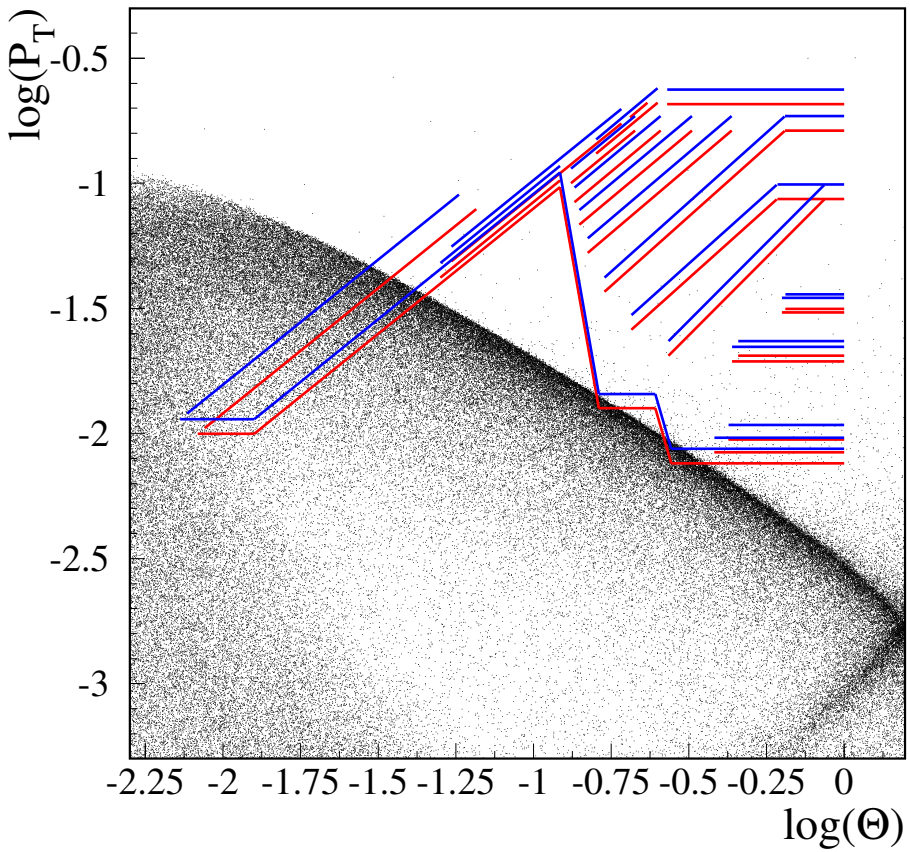

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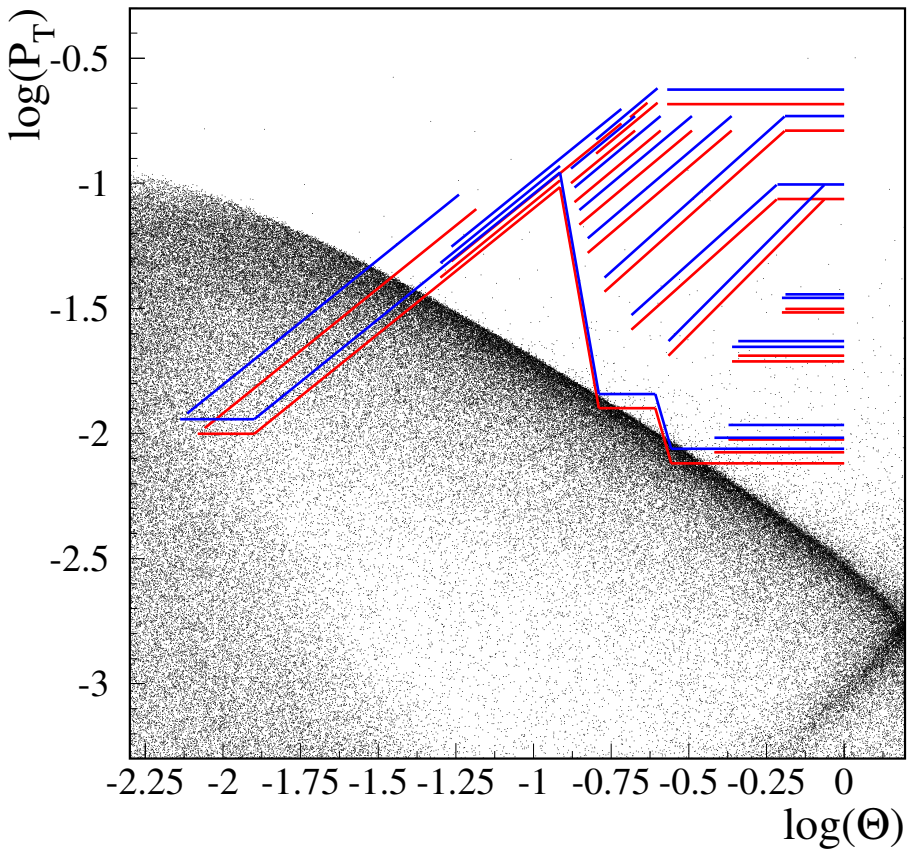

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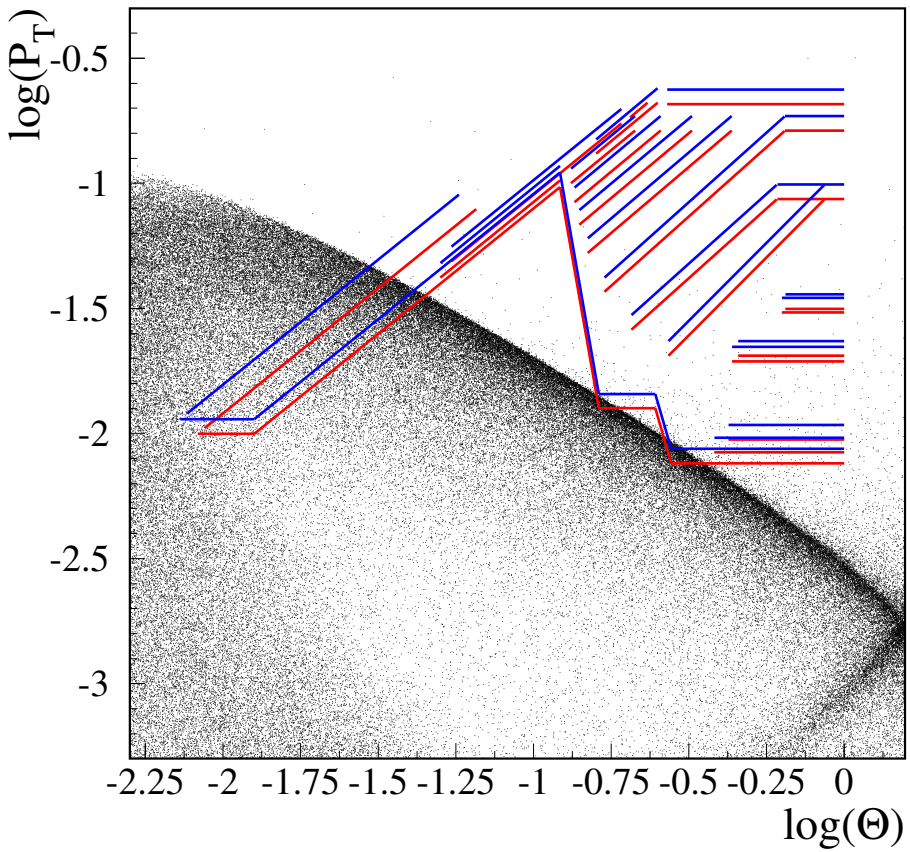

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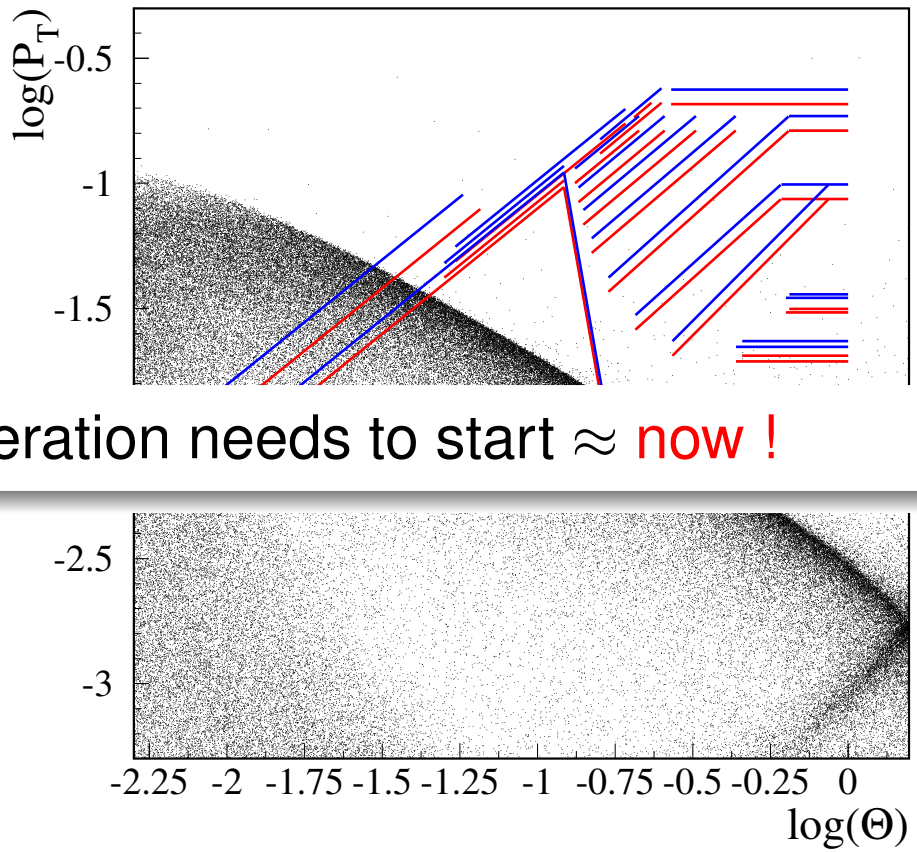

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