ECAL-P Background

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LUXE SAS Workforce

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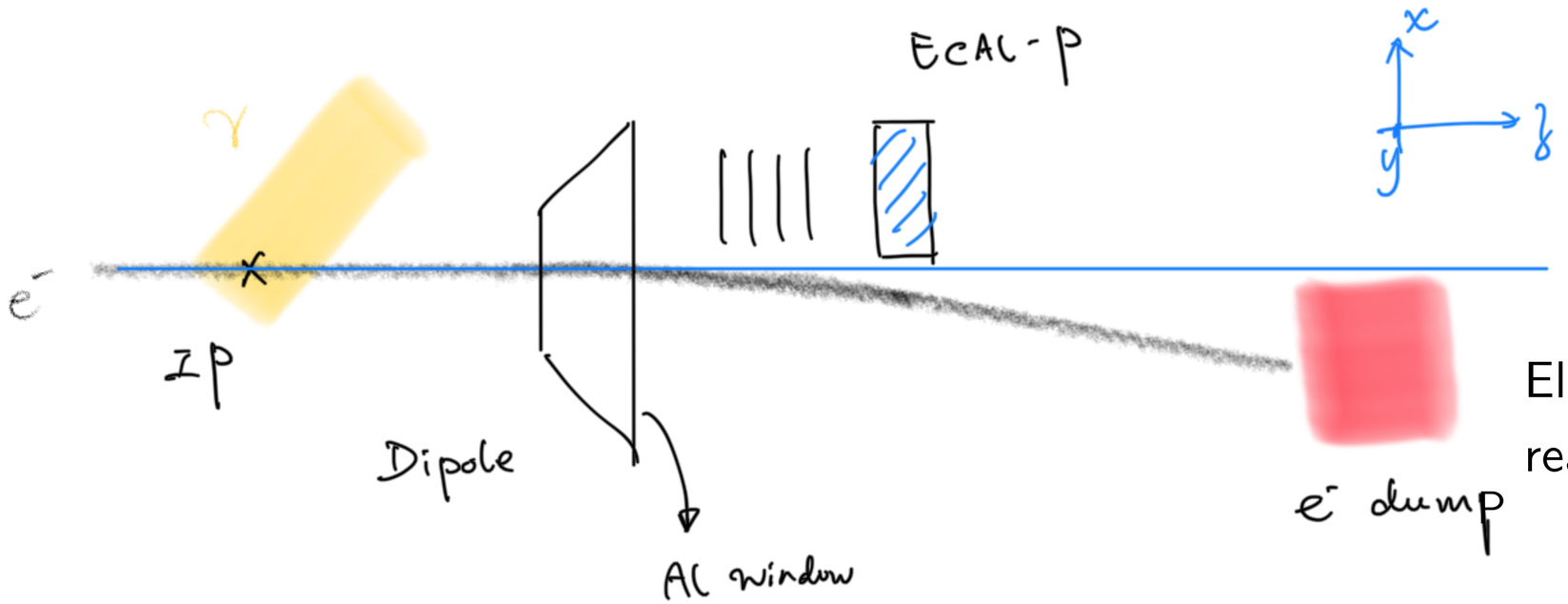
Previously in ECAL-P

16.5 GeV electrons hit on
Aluminium window

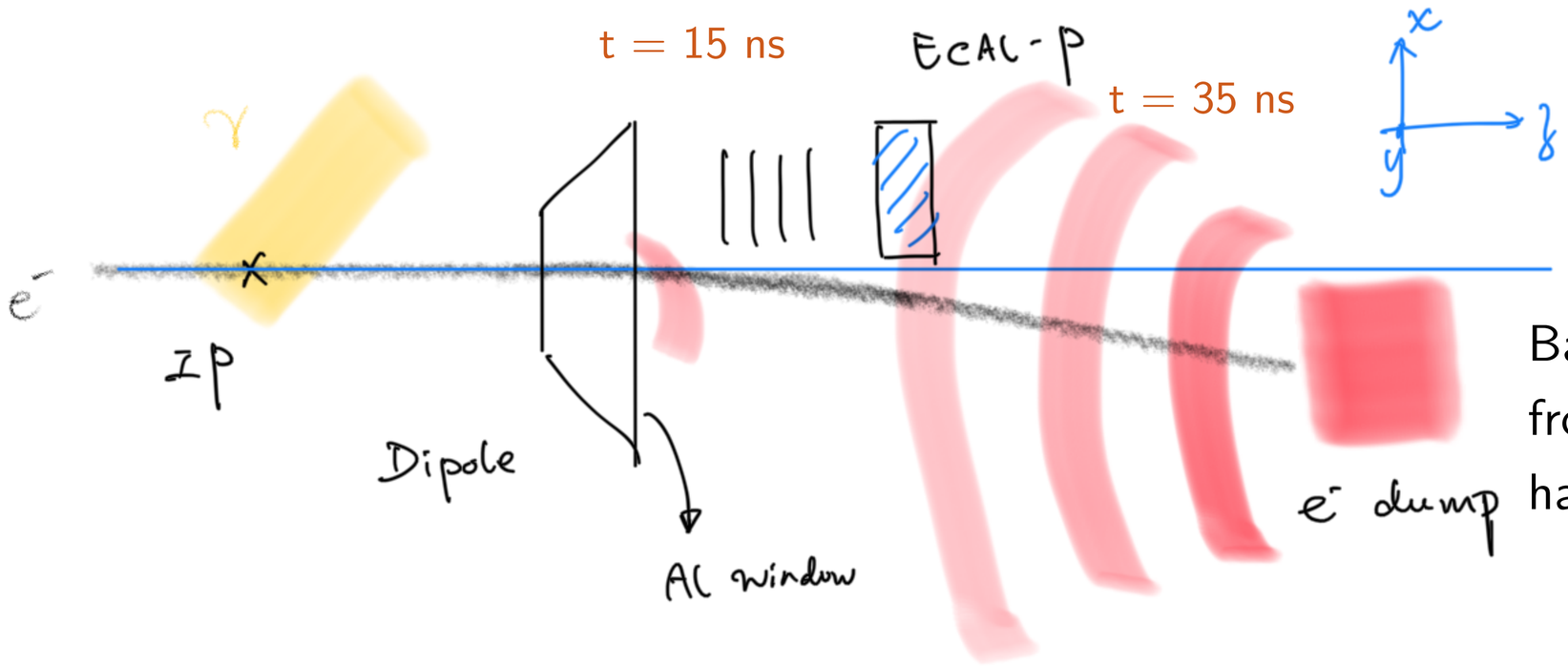


Electrons killed when reaching dump (in CDR)

t = 0 t = 14.5 ns t = 25 ns

Previously in ECAL-P

16.5 GeV electrons hit on
Aluminium window

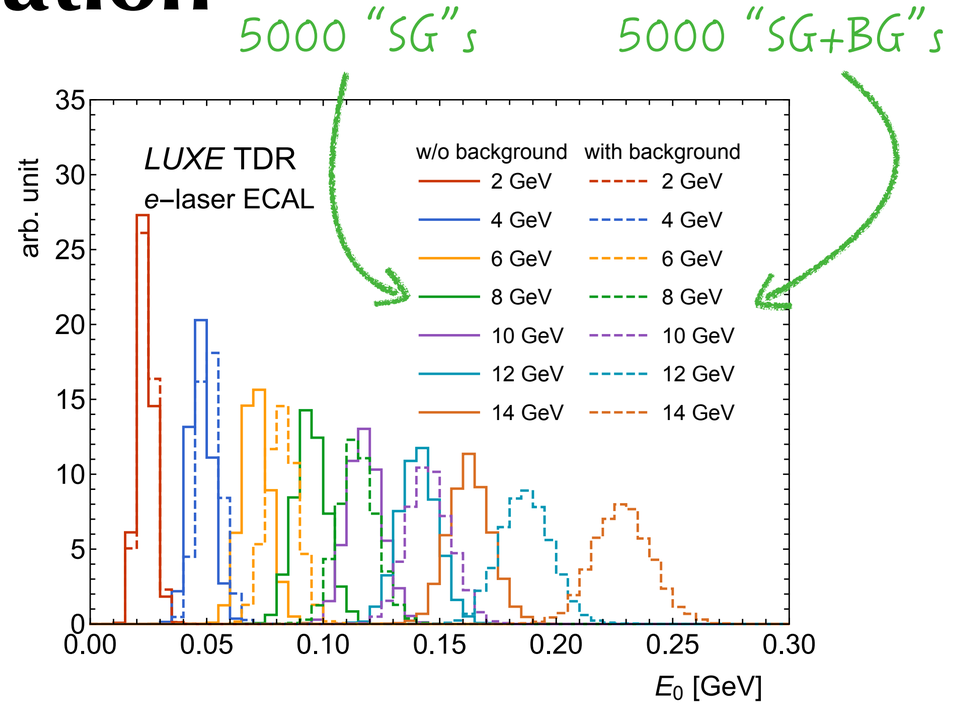


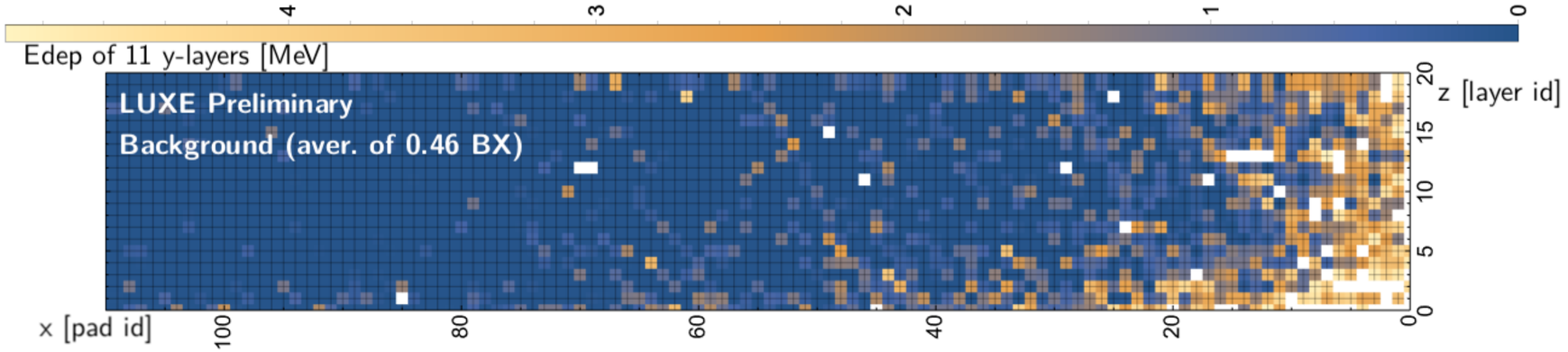
Backscattered neutrons from dump contribute to hadronic background

t = 0 t = 14.5 ns t = 25 ns

Background evaluation

- (Signal + Local background)/Signal
  - Signal: mono-energetic positron shower
  - Background: average BG from beam-only runs
  - Local BG: the part of BG in which pads SG has E_{dep}
- A smooth average BG is required
  - Low-probability high E_{dep} will be "enhanced" if it appears at the wrong place
- High statistics could possibly smooth them
- Or need to separate two kinds of background

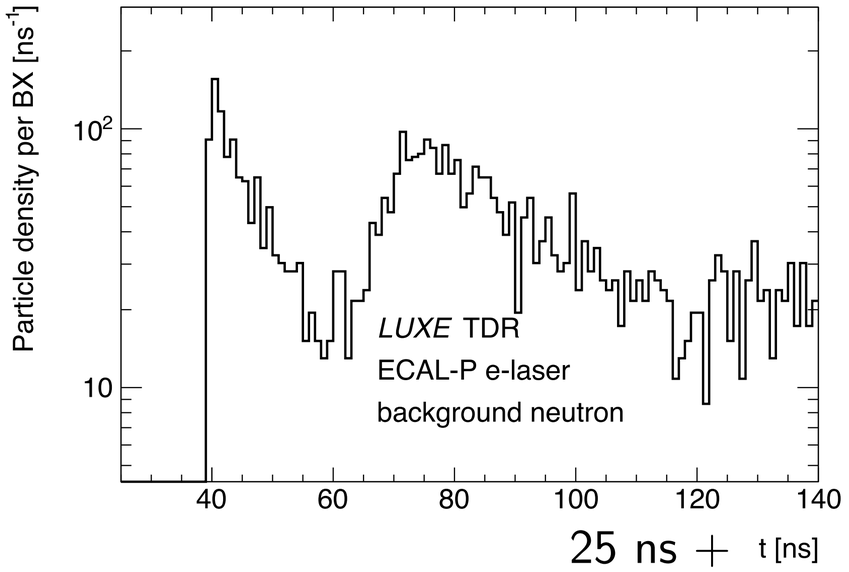


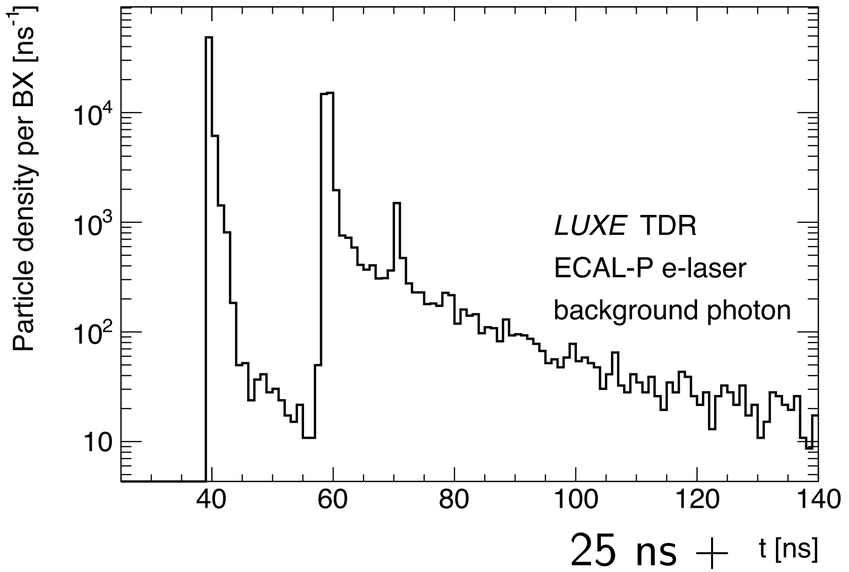


Challenges

- Hadronic background
  - not considered in the CDR
  - forms island-like irregularly high E_{dep} in ECAL
- Neutron shields applied (since Feb 2022)
- To improve statistics,
  - extra 2 BX simulated (thanks to Sasha)
  - 0.46 BX in last report (Nov 2022)
  - Still have irregular E_{dep} ...
- Idea:
  1. Keep the averagely smooth background
  2. Randomise the irregular background

Technical problem: How to distinguish hadronic background from the averagely smooth one?
(The information is stored in different “trees”)





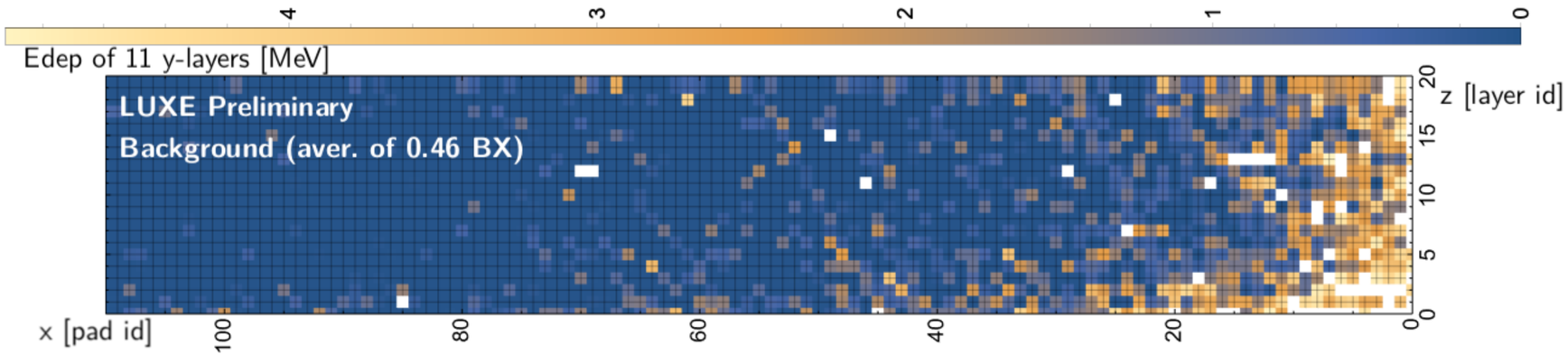
Separation

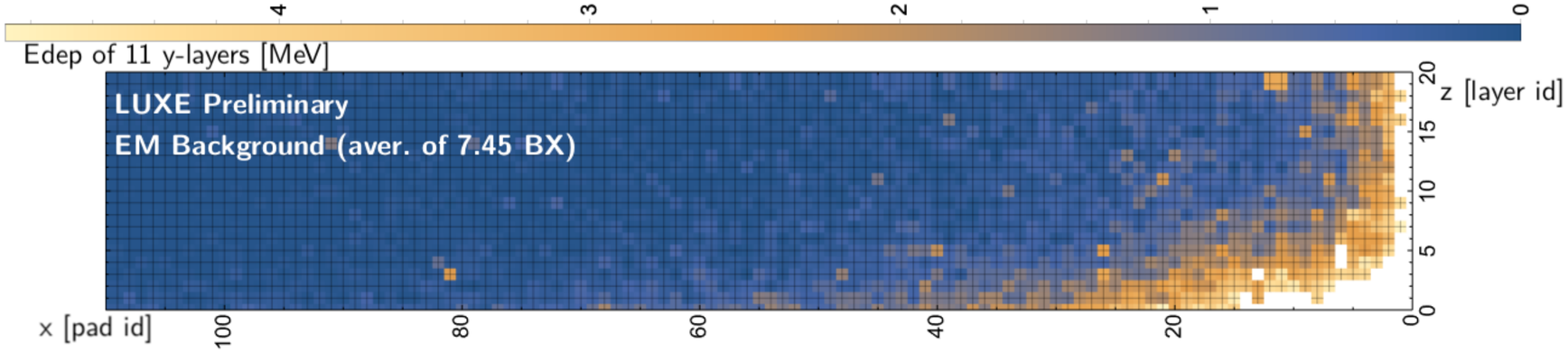
- Separation in time, space, and/or Edep
  - Cut at 20 ns / 1 MeV

Total records: 6.1k/BX

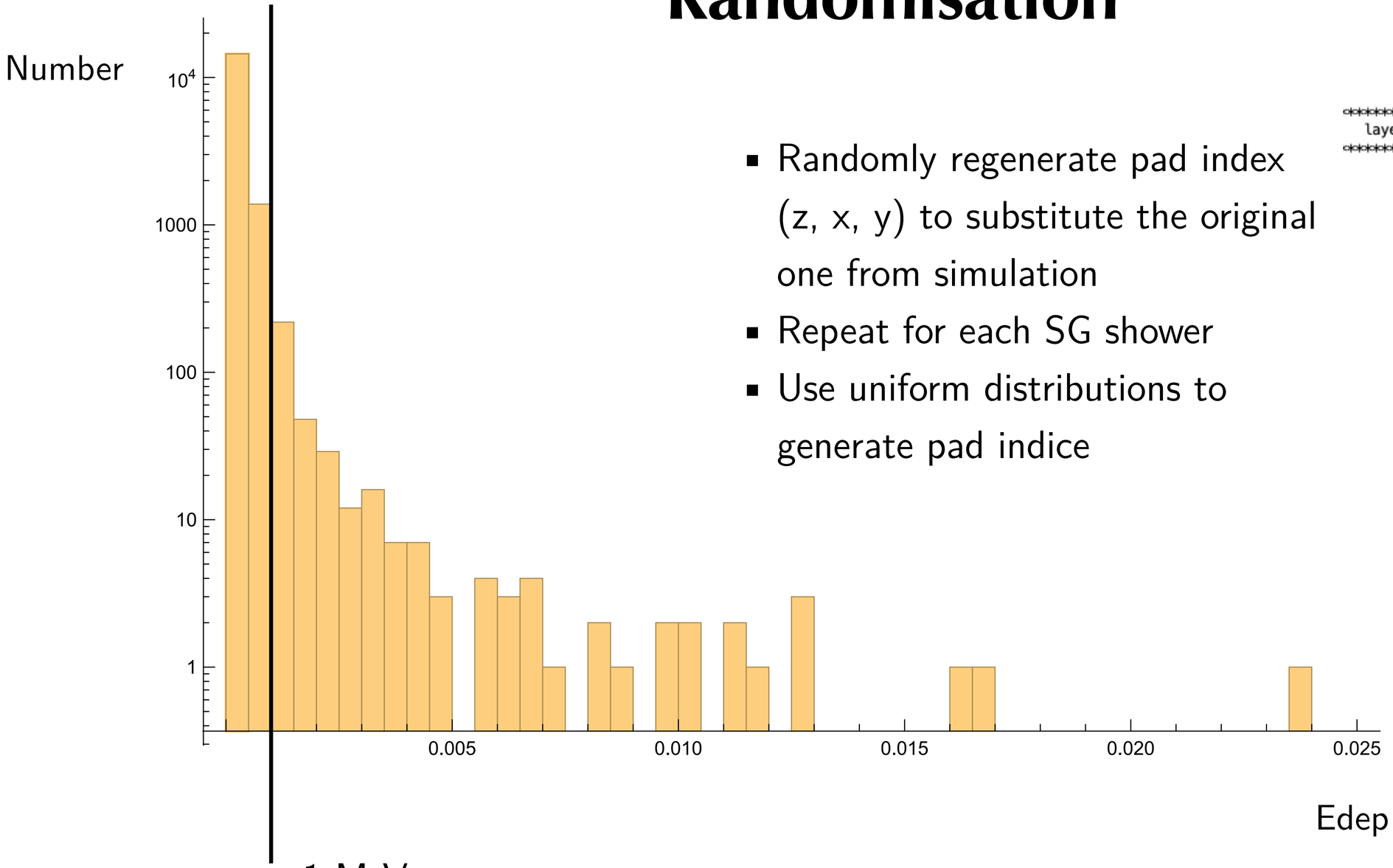
Cut-out records: 650/BX

layerid	cellx	celly	edep
18	52	6	0.0010809
17	2	1	0.0013039
11	26	10	0.0010762
16	98	10	0.0021620
18	61	10	0.0019286
17	74	7	0.0010823
17	106	10	0.0018788
10	35	0	0.0022622
19	42	5	0.0017155
18	25	5	0.0010698
2	24	6	0.0012217
4	45	0	0.0011449
14	1	8	0.0014564
5	17	0	0.0011747
11	35	6	0.0010070
13	99	7	0.0014256
13	63	9	0.0011155
1	53	6	0.0025060
14	84	6	0.0016487
9	6	1	0.0011490
8	17	10	0.0011974
12	12	5	0.0011332
10	34	0	0.0012514
10	11	3	0.0044093
17	103	4	0.0010814





Randomisation



- Randomly regenerate pad index (z, x, y) to substitute the original one from simulation
- Repeat for each SG shower
- Use uniform distributions to generate pad indice

layerid	cellx	celly	edep
18	52	6	0.0010809
17	2	1	0.0013039
11	26	10	0.0010762
16	98	10	0.0021620
18	61	10	0.0019286
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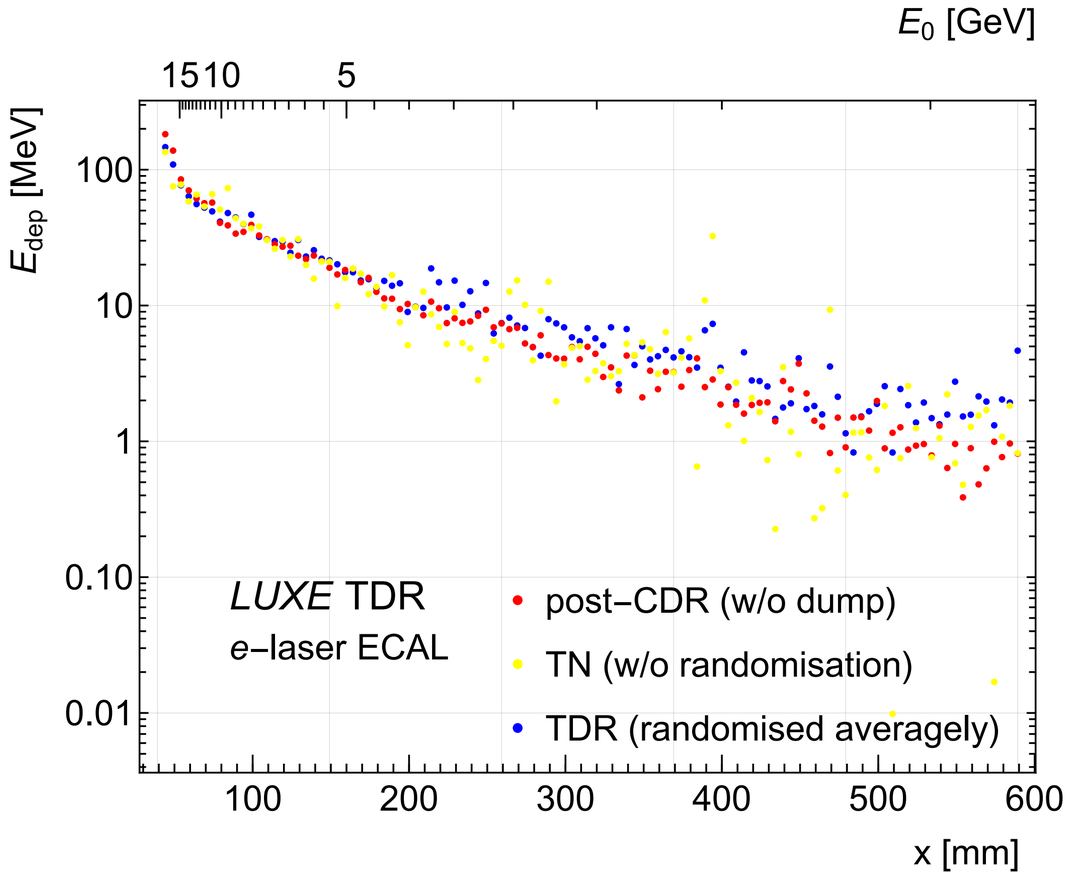
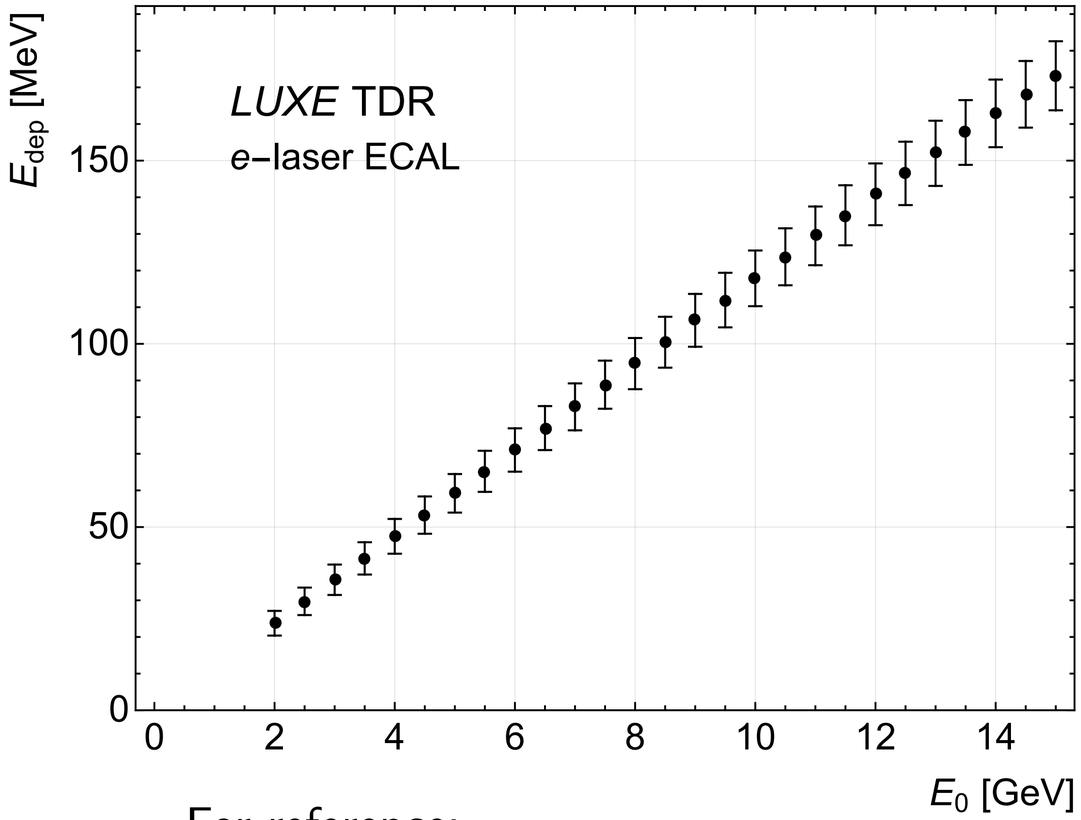
Randomisation



After randomisation (blue), BG

E_{dep} per tower turns smoother

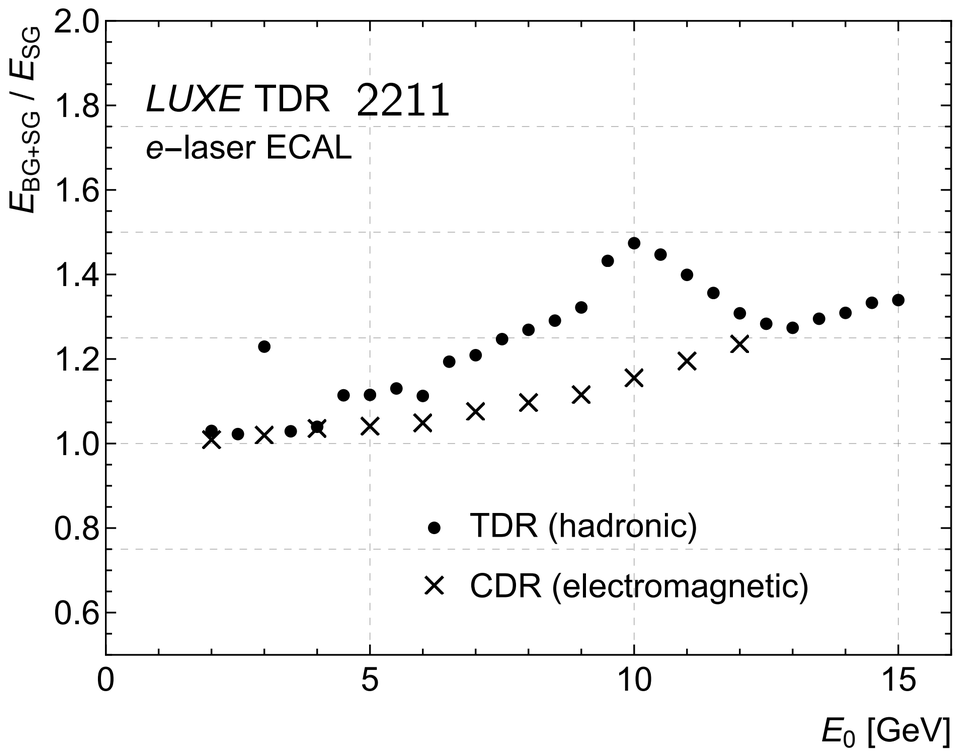


For reference:

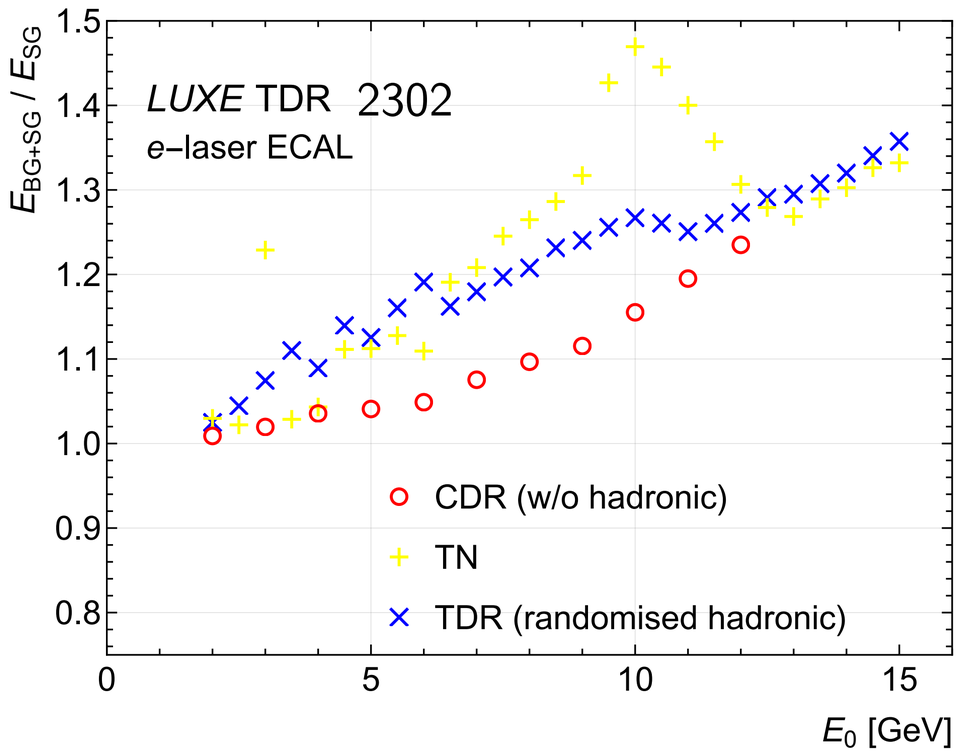
Energy deposition of a positron shower

Results

Before randomisation



After randomisation



Higher statistics and randomisation successfully remove the peaks at around 3 GeV and 10 GeV

Summary

- Fluctuation in the structures in background-over-signal ratio is smoothed by higher statistics simulation and randomisation
- Method of randomisation:
  - Separate hadronic background from averagely smoothy background by making cuts at time and energy deposition
  - Keep the smooth background while add the randomly re-distributed irregular background
- Next steps (if needed):
  - Separate hadronic and EM background “from root”
  - More statistics through simulation

Bonus for Python user in LUXE: LUXEStyle for matplotlib