Pad saturation test results

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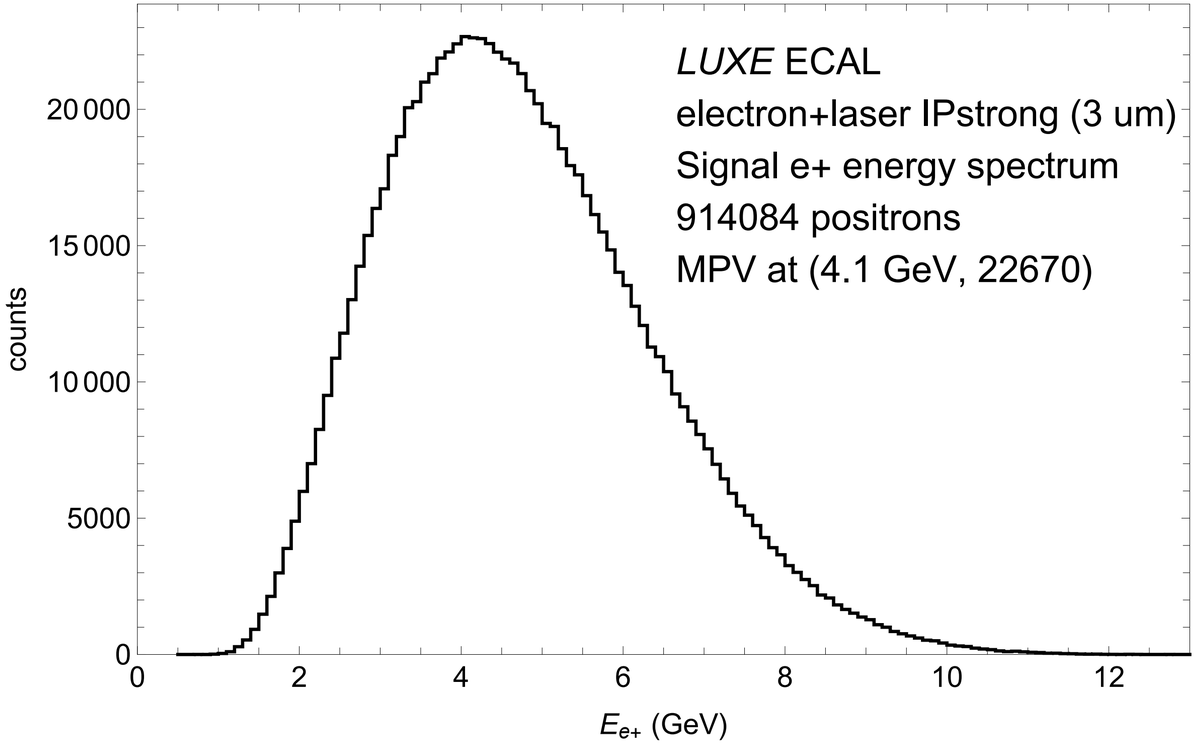
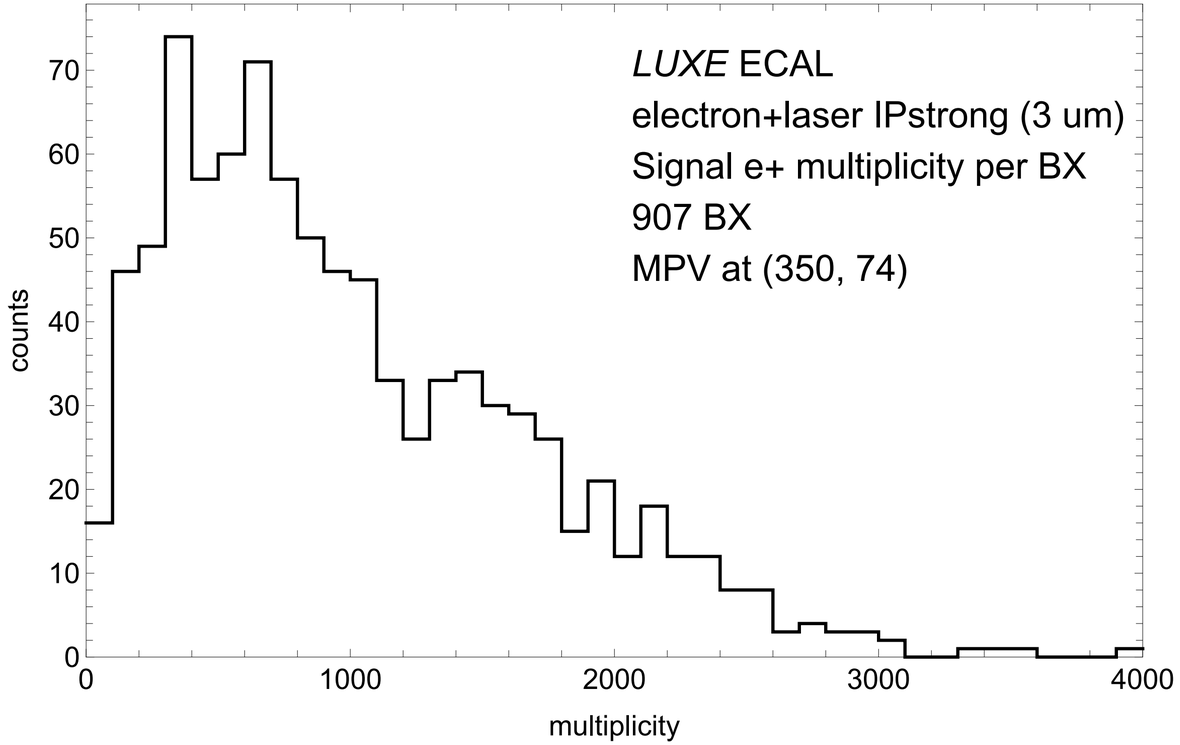
Signal infomation



Signal positron energy spectrum



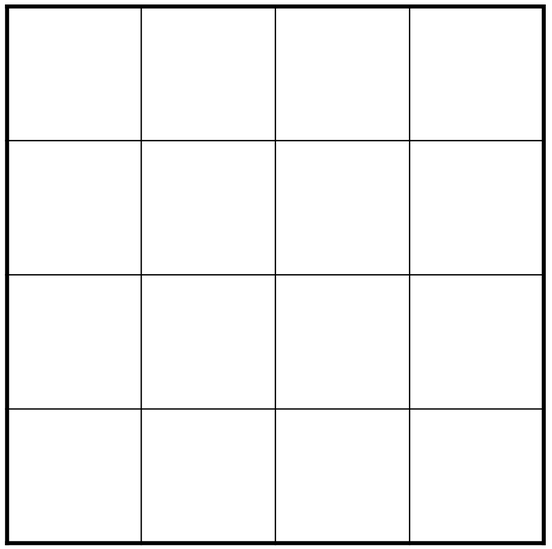
Singal positron number over BXs

The ECAL would be saturated once the multiplicity reached a threshold

Dynamic ranges

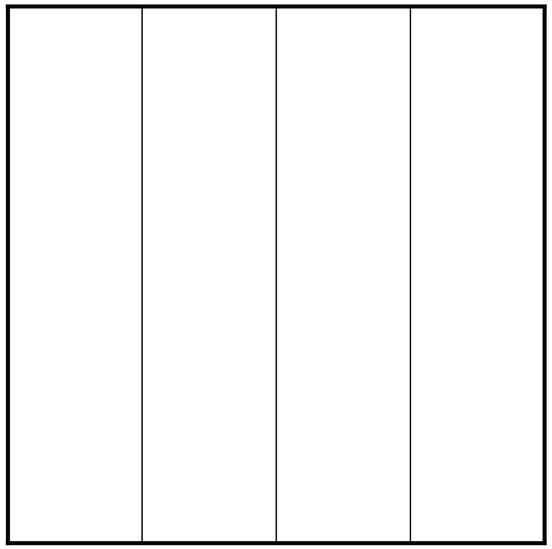
for 10-bit ADC

- 10-bit ADC has 1024 steps for data read-out
- Using each step for 1 MIP, the testing range will fall to (0, 1024) MIPs
- Two methods to go around this saturation
  a) switch to low-gain preamplifier, with each step for 2 MIPs: range (0, 2048) MIPs
  b) make the pad smaller to ease the burden of MIP per pad (namely, E_{dep} density)
- Without the details in GEANT4, we assume E_{dep} in a pad averagely distributed (at x-direction)



One pad averagely cut into 16 pads

Not suitable if the shower is constrained in y-direction



One pad cut into 4 pads along x-direction

TODO: study the E_{dep} distribution along y-direction

Dynamic ranges

for 10-bit ADC

- For a 5x5 mm^2 pad, the supportable energy deposition density free from saturation/cut with 1 MIP step will be 1024/25 MIP mm^{-2}
- BX that would be influenced by the cut-out has at least one pad with E_{dep} higher than the threshold
- Cut-out error = Higher E_{dep} - High Threshold (set to 1023.5 MIPs)
- To provide a higher detectable E_{dep} density, Yan suggested a non-symmetric ECAL
  - having finer pad in high E_{dep} density to get a better performance
  - using the normal-size pad in low E_{dep} density region to save budget
  - For the stronger showers, we have to turn to low-gain preamplifier with larger MIP step
- Questions & Difficulties to be solved
  - Where to put the finer pads?
  - How to adapt the change of geometry/setups?

Dynamic ranges

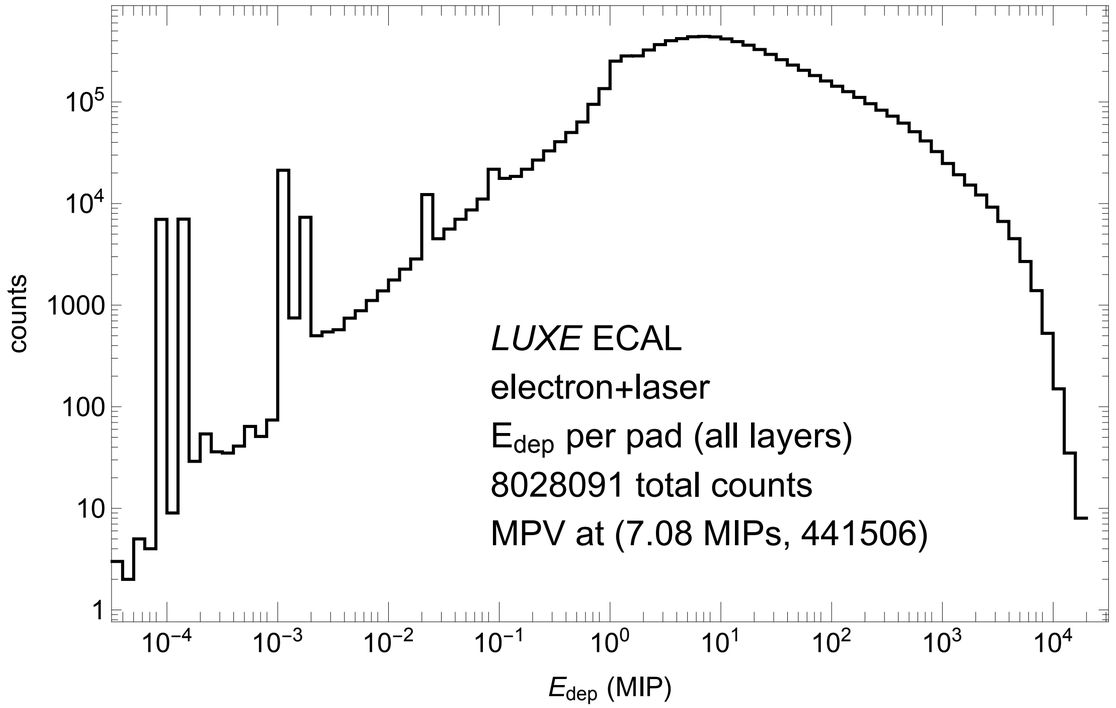
for 10-bit ADC

Pad size	5 x 5 mm^2	5 x 2.5 mm^2	5 x 1 mm^2	5 x 0.5 mm^2	5 x 0.25 mm^2
Manageable E_{dep} density (MIP mm^{-2})	40	80	200	400	800
BX been cut out of 907 BXs	79.2%	55.1%	17.8%	1.9%	0.0%

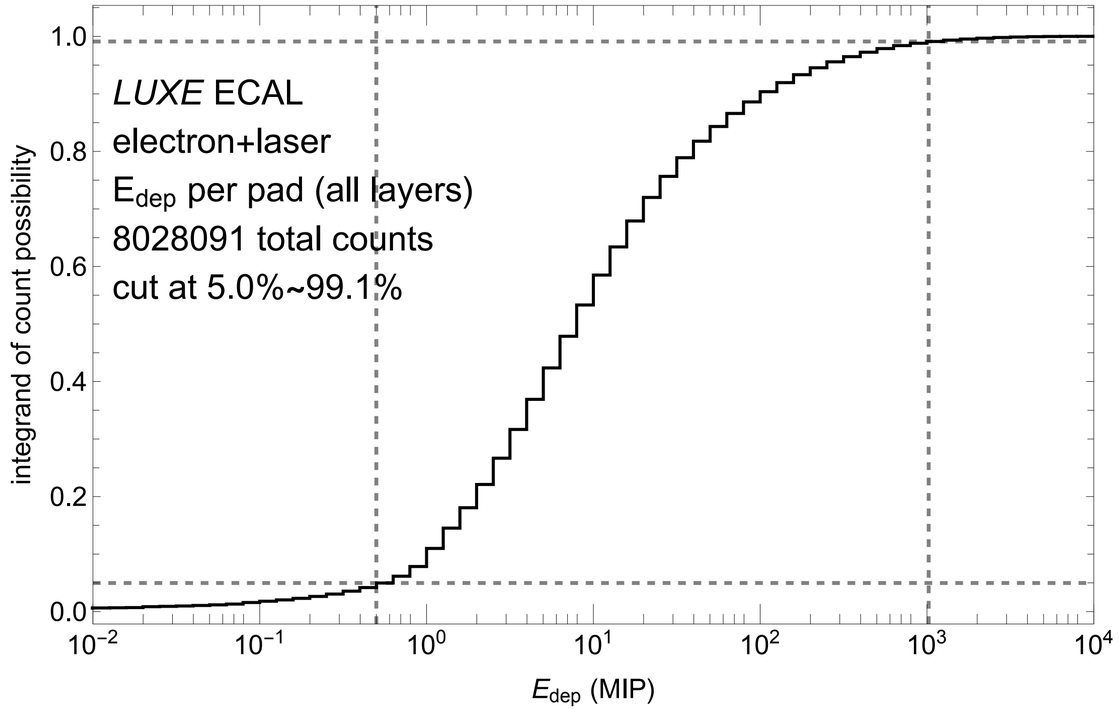
Pad size	5 x 5 mm^2	2.5 x 2.5 mm^2	1.7 x 1.7 mm^2	1.2 x 1.2 mm^2	1 x 1 mm^2
Manageable E_{dep} density (MIP mm^{-2})	40	160	360	640	1000
BX been cut out of 907 BXs	79.2%	26.0%	2.4%	0.1%	0.0%

Energy deposition per pad

all layers added up



Spectrum of energy deposition per pad



CDF (integrand) of the spectrum

Error out of dynamic range

(0, 1024) MIPs for 10-bit ADC

IPstrong MC 3 um e-laser (907 BX)

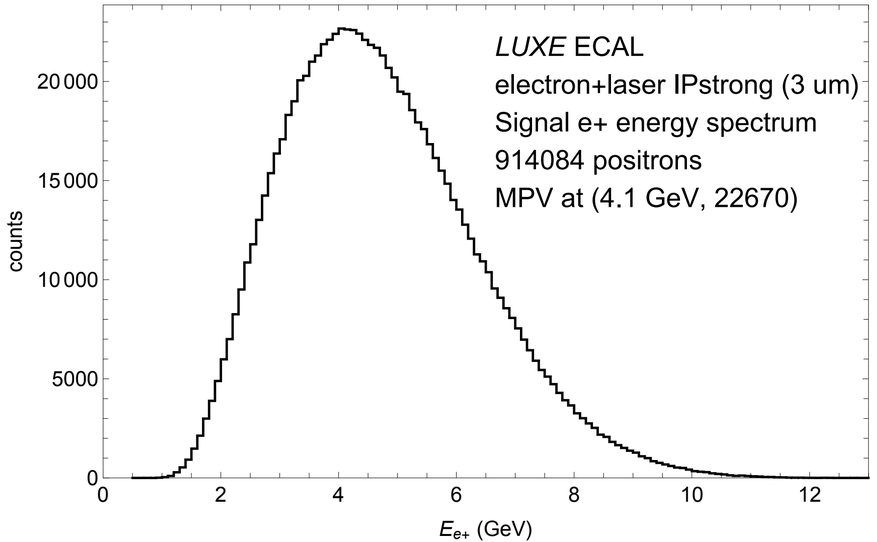
718 BX will be influenced by the cut at 1024 MIPs

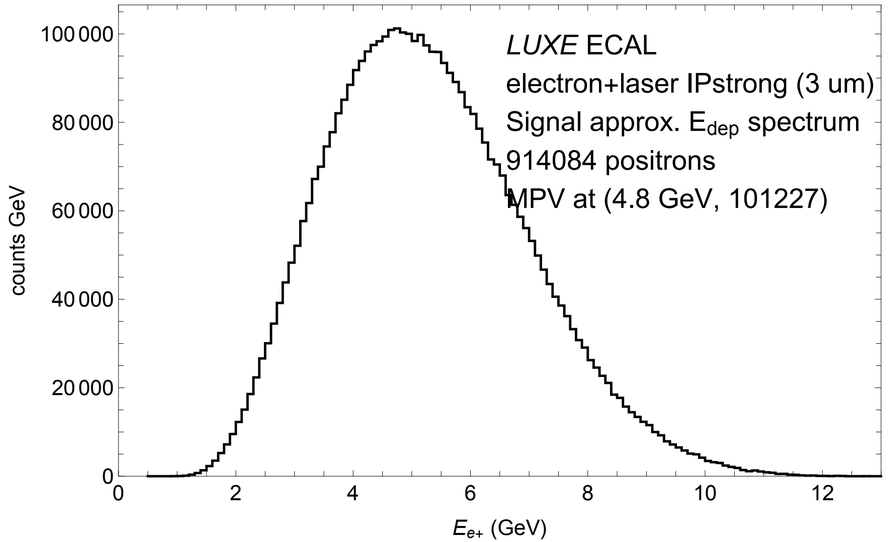
1 MIP = 4 fC = 90 keV

Layer	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
cut-out pads (%)	5.8	6.8	7.4	**7.5**	7.2	6.9	6.5	5.9	5.4	4.8	4.4	4.0	3.8	3.7	3.7	3.9	4.0	4.3	4.6	4.9	7.0
Error E_{dep} (kMIP)	16.58	2008	8179	14661	18398	**18707**	16381	12754	8923	5609	3136	1532	628.9	204.6	49.25	11.16	4.39	4.11	4.12	3.93	5.30
Error E_{dep} (MeV/BX)	1.64	199	812	1455	1826	**1856**	1625	1266	885	556	311	152	62.4	20.3	4.89	1.11	0.44	0.04	0.41	0.39	0.53
Error/ Total E_{dep} (%)	0.23	10.2	23.0	29.6	**31.7**	31.0	28.4	24.5	19.8	14.9	10.2	6.20	3.21	1.33	0.41	0.12	0.06	0.08	0.10	0.13	0.30
Total E_{dep} (MeV/BX)	701	1946	3522	4910	5755	**5985**	5725	5168	4466	3739	3056	2454	1943	1521	1178	907	695	528	401	302	178

Edep heatmap

- Find the best position for finer pad (to detect higher E_{dep} density)
- High MIP pads located on the y's central pad (-2.5 mm, 2.5 mm) of each layer
- E_{dep} spectrum is proportional to the positron spectrum and the energy of positron
- Two ways to identify the E_{dep} in a pad over BXs:
  - the highest E_{dep} over BXs
  - the averaged E_{dep} over BXs
  - The position with the highest MIP density differs in this two methods

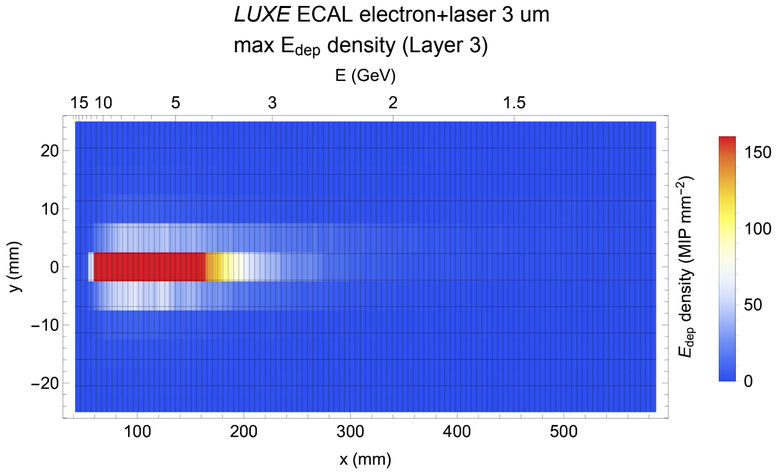


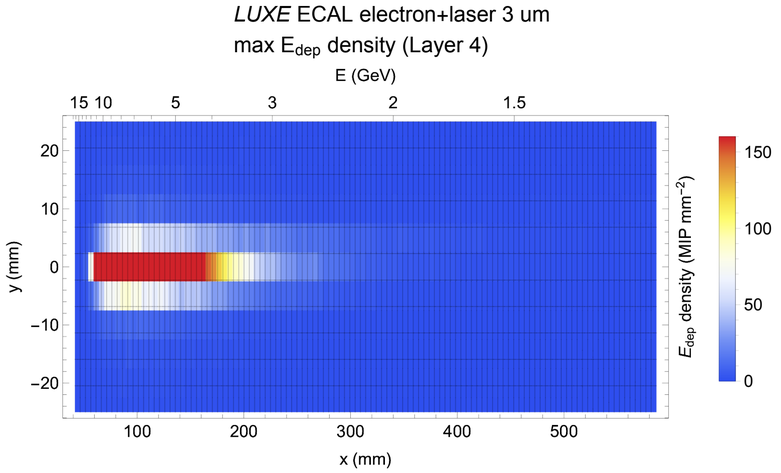


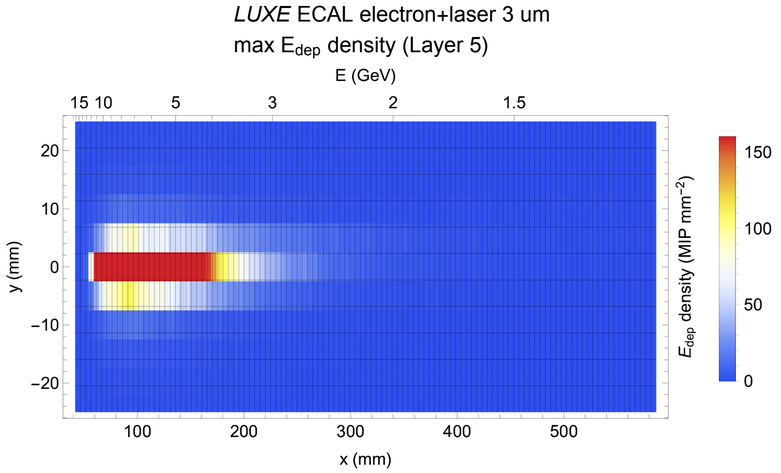
Peak Edep heatmap per layer

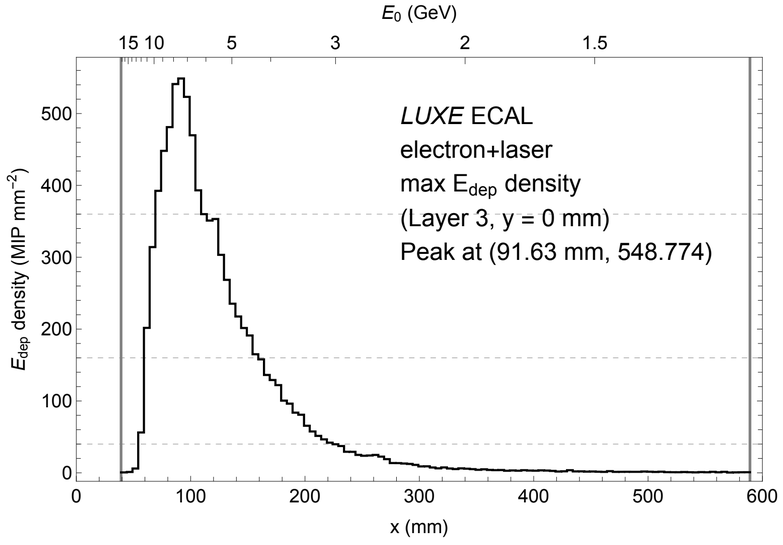
Saturated set at 160 MIP mm^{-2}

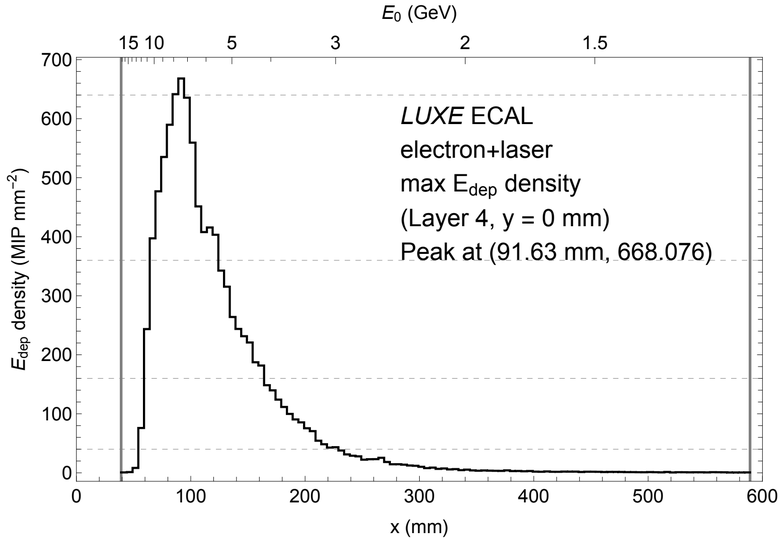
Layers 3-5

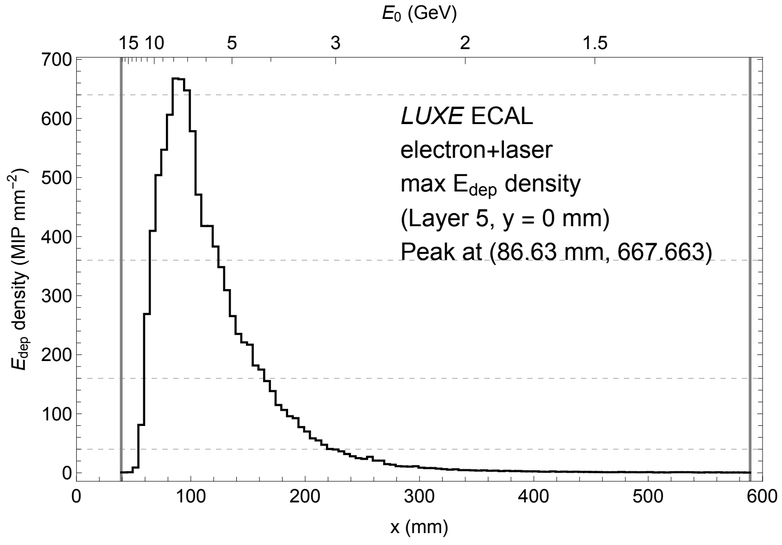








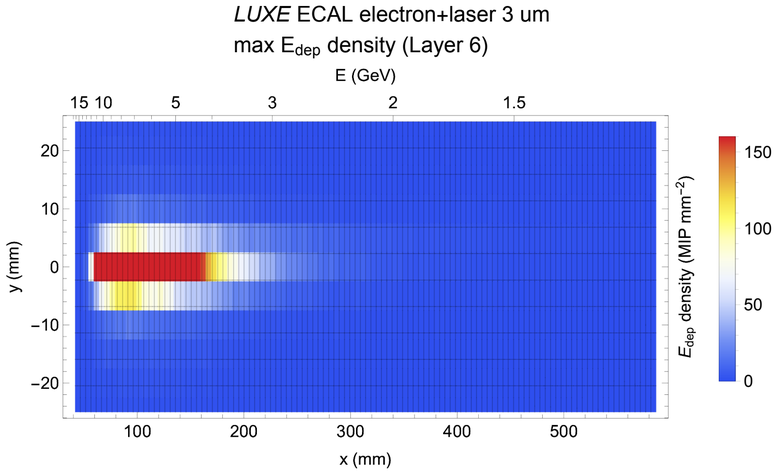


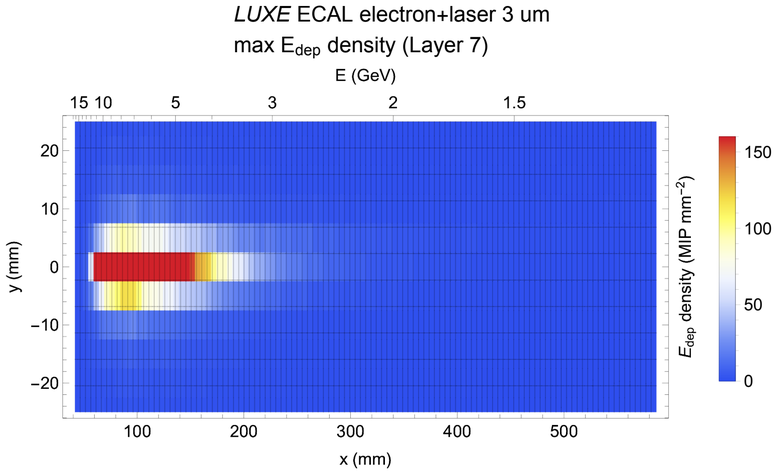


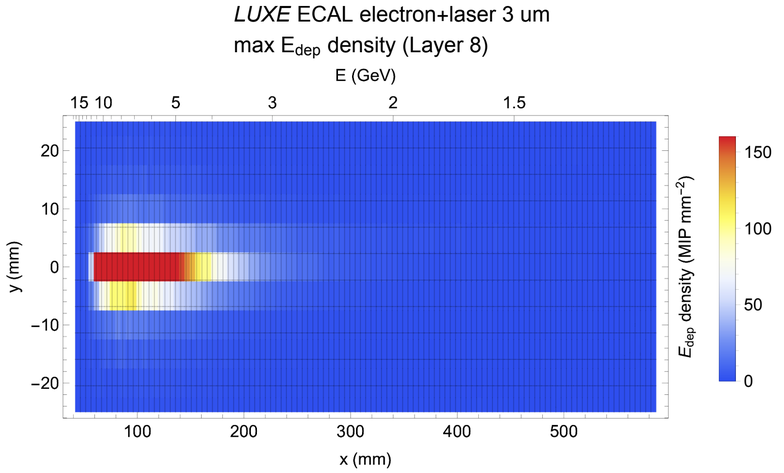
Peak Edep heatmap per layer

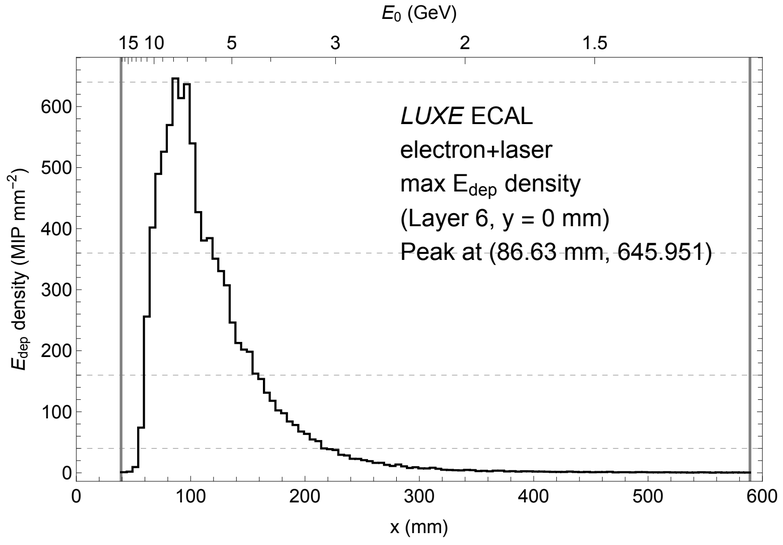
Layers 6-8

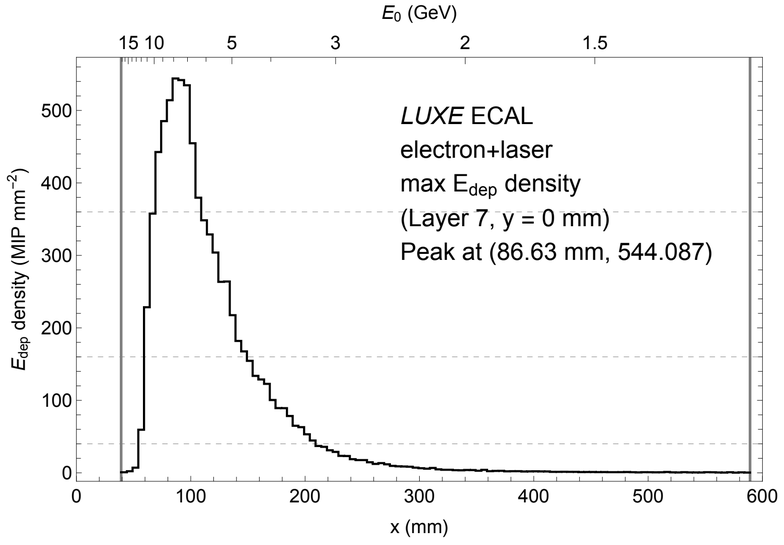
Saturated at
160 MIP mm^{-2}

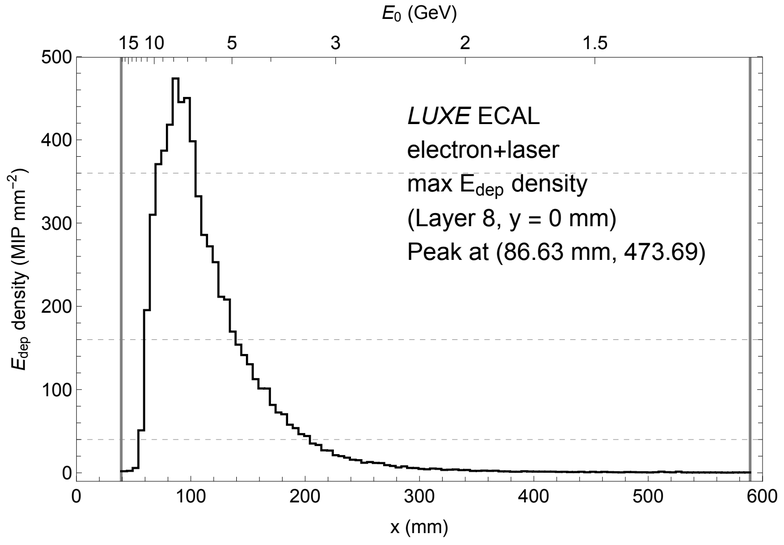








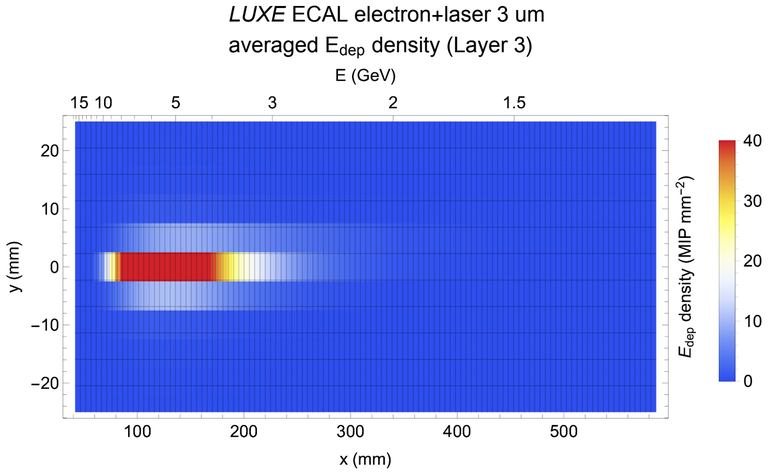


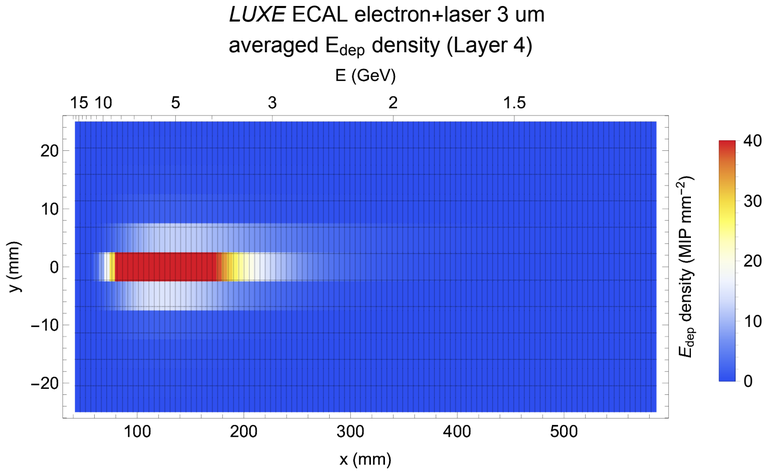


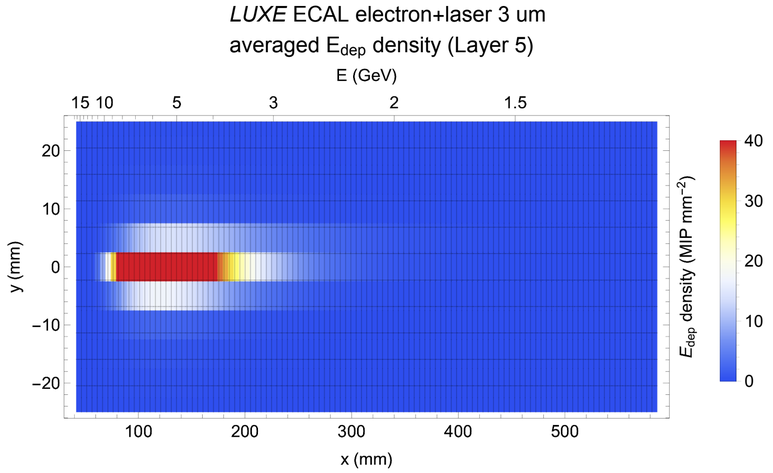
Averaged Edep heatmap per layer

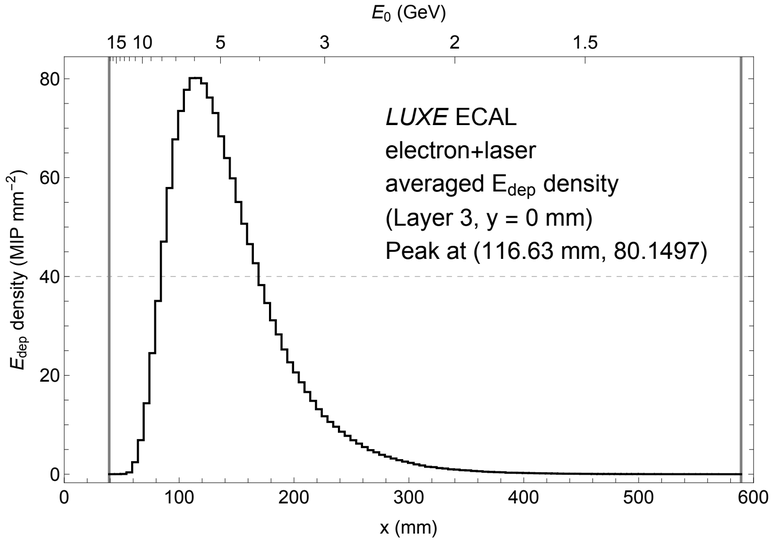
Layers 3-5

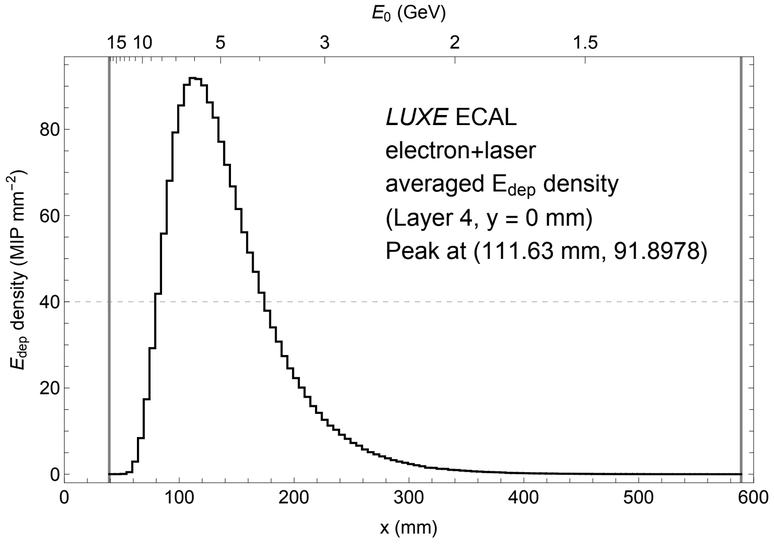
Saturated at 40 MIP mm^{-2}

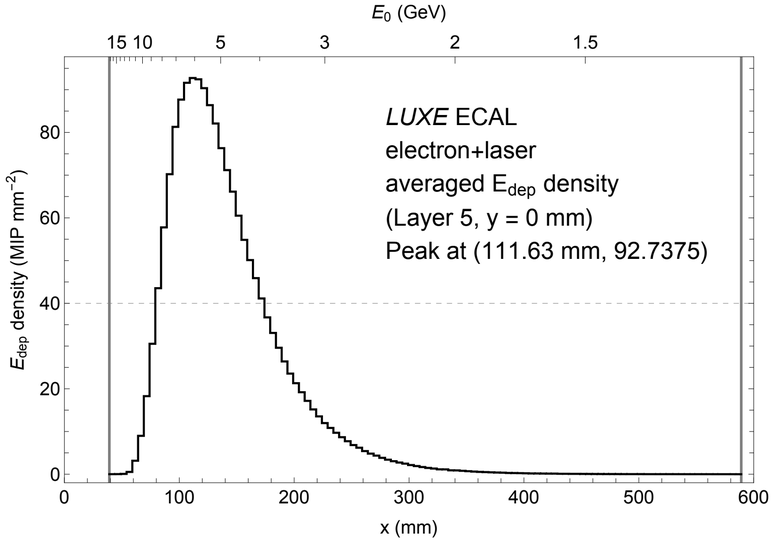












Averaged Edep heatmap per layer

Layers 6-8

Saturated at 40 MIP mm^{-2}