Linearity & ADC resolution in simulation

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IJClab 01/09/2023

- **Study the energy resolution by varying:**
  - ADC resolution: 12, 14, 16 bits
  - non-linearity in electronics

- **Standalone simulation:** epic_brycecanyon.xml (latest geometry)

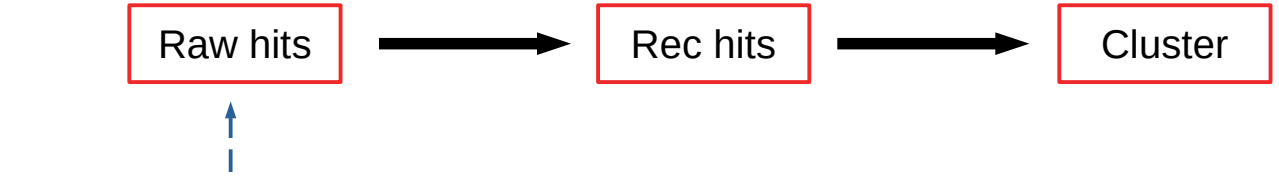
- **Single particle gun:**
  - particle: γ
  - Energy: 1, 2, 5, 10, 15, 20 GeV (10k events for each bin)
  - uniformly distributed, **η** from -1.87 to -3.14 (NEEMC acceptance: -1.79 to -3.55)

ADC resolution

- **Dynamic range is 20GeV:**
  - 12 bits → 4.9 MeV / bit
  - 14 bits → 1.2 MeV / bit (default in EICrecon)
  - 16 bits → 0.3 MeV / bit

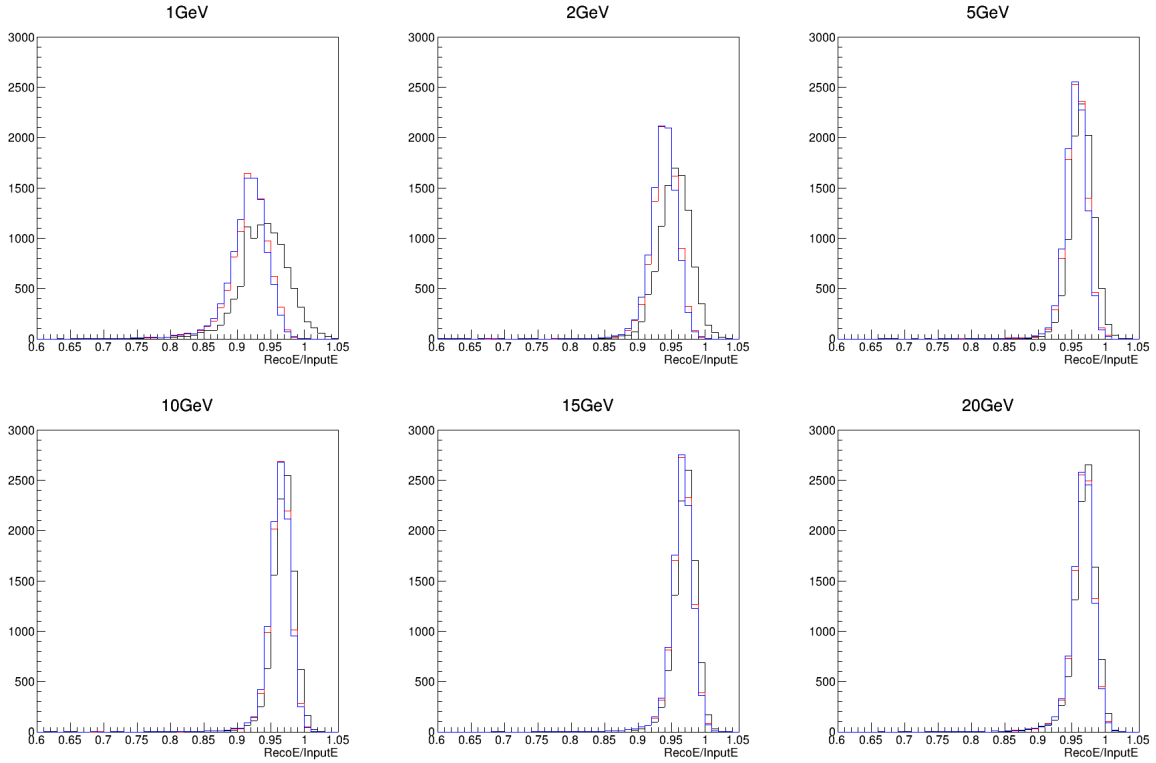
- Digital threshold value need to be scaled with the ADC resolution as analog noise didn't change with ADC resolution:

```
24          // threshold for firing
25          thresholdADC = m_cfg.thresholdFactor * m_cfg.pedSigmaADC + m_cfg.thresholdValue;
```

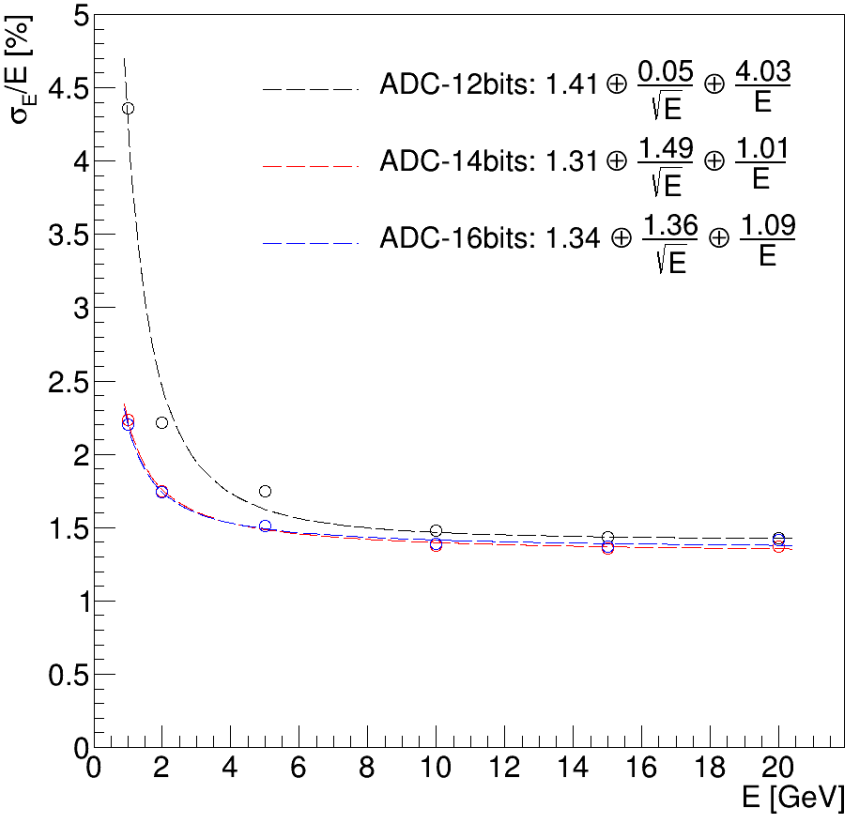


ADC resolution

Fit with the Gaussian

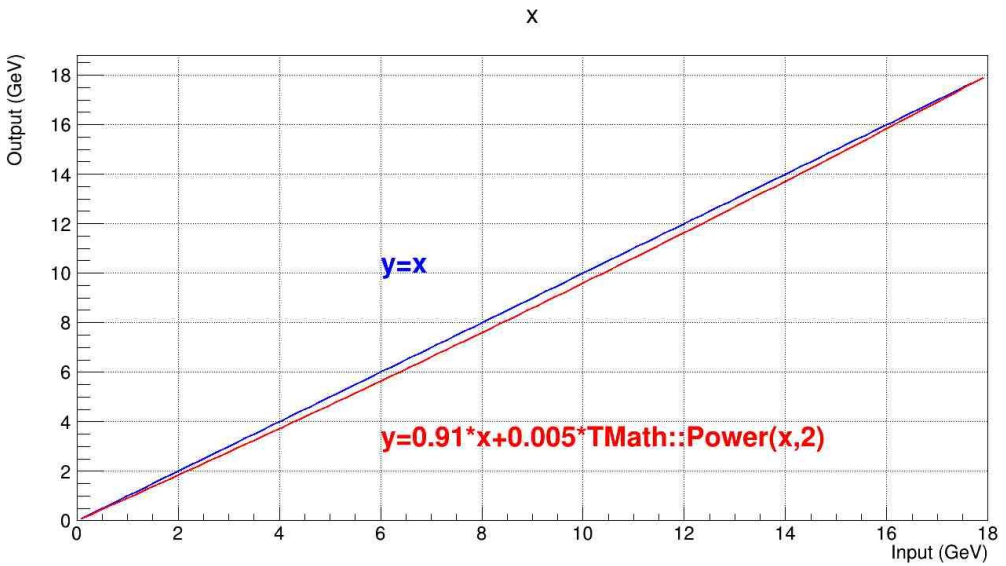


ADC-12 bits
ADC-14 bits
ADC-16 bits



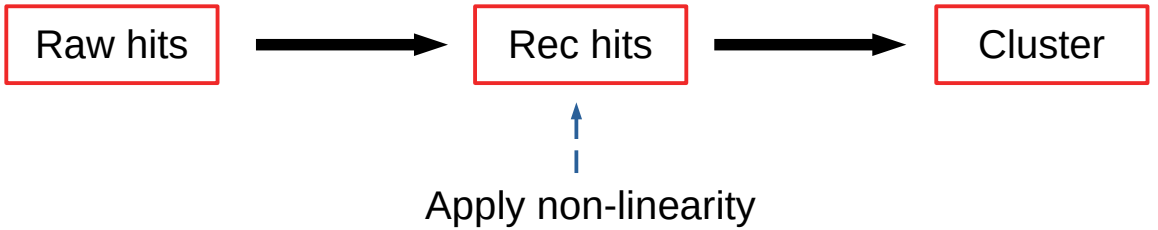
Conclusion:
14-bits would be sufficiently good for energy resolution

Non-linearity of the readout

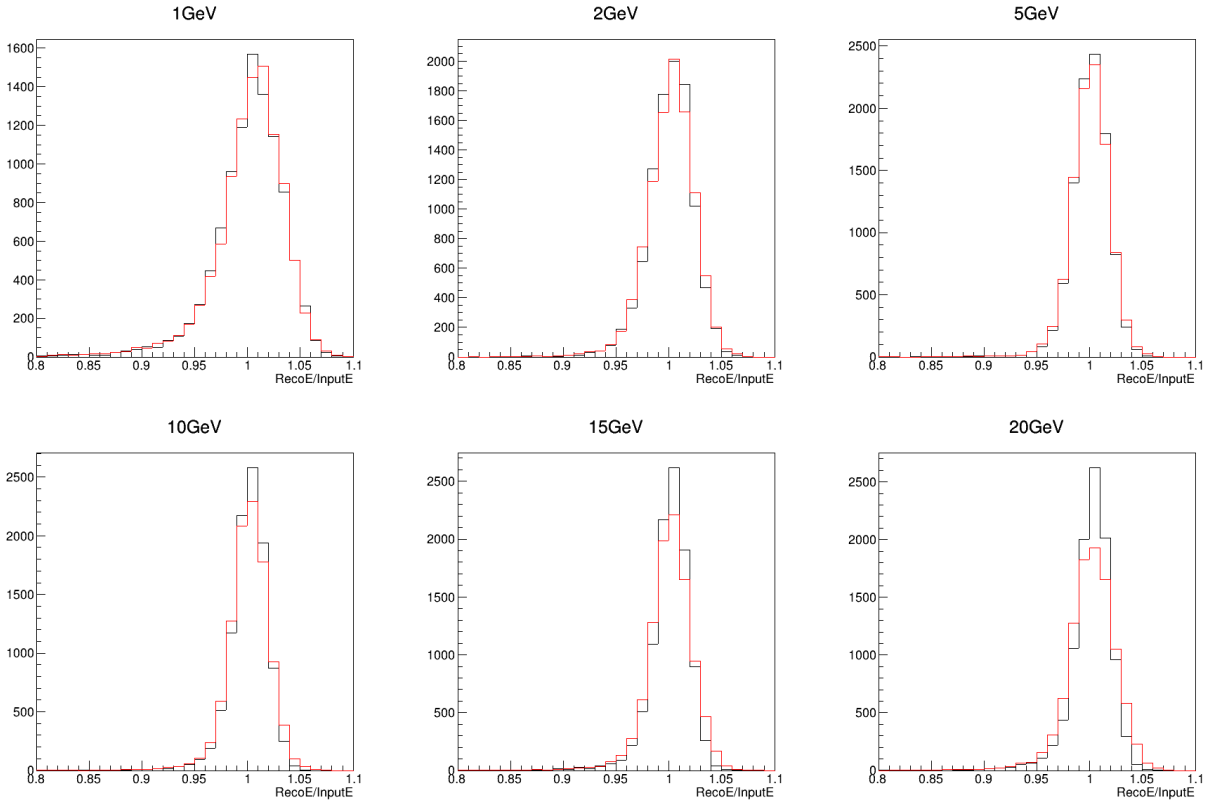


Non-linearity of electronics:
preamp, ADC...

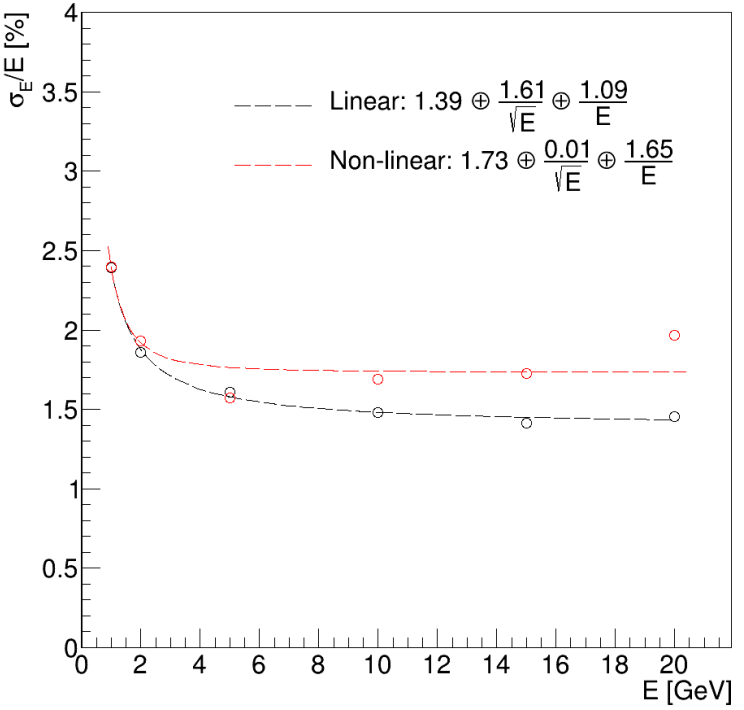
Default digitization:14bits



Non-linearity of the readout



linear
non-linear



Conclusion:
loss ~0.2% energy resolution for 0.5% non-linearity

Calibration

Decoding the cell ID (decimal to binary) from dd4hep

Cell ID (decimal)	Cell ID (binary)	Column 8-bit (binary)	Column (decimal)	Row 8-bit (binary)	Row (decimal)	sector 4-bit	Detector 8-bit	position X	MinX	Column (pos)	position Y	MaxY	Row (pos)
23249255	00010110001011000001101100111	00010110	22	00101100	44	0001	01100111	-174.25	-625.25	22	-276.75	625.25	44
44159335	00101010000111010001101100111	00101010	42	00011101	29	0001	01100111	235.75	-625.25	42	30.75	625.25	29

Generate the cell ID in decimal automatically and place them in an array

```
unsigned int CellID[] = {36823399, 37871975, 38920551, 39969127, 41017703, 42066279, 43114855, 44163431, 45212007, 46260583, 47309159, 48357735, 49406311, 50454887, 51503463, 52552039, 53600615, 54649191, 55697767, 56746343, 57794919, 58843495, 59892071, 60940647, 61989223,
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```

Generate the fluctuation of each module, 1% [Gaus(1.00, 0.01)] for this case, and place them in an array

```
const float misalignmentArray[] = {0.99878, 0.989132, 1.00684, 0.989248, 1.00033, 1.00745, 1.00034, 0.994734, 1.00463, 1.00201, 1.02125, 1.00372, 1.01021, 1.00783, 0.998722, 0.996632, 0.993128, 1.01308, 0.990642, 0.973276, 0.992273, 0.994784, 0.979847, 1.0005, 0.991054, 0
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```
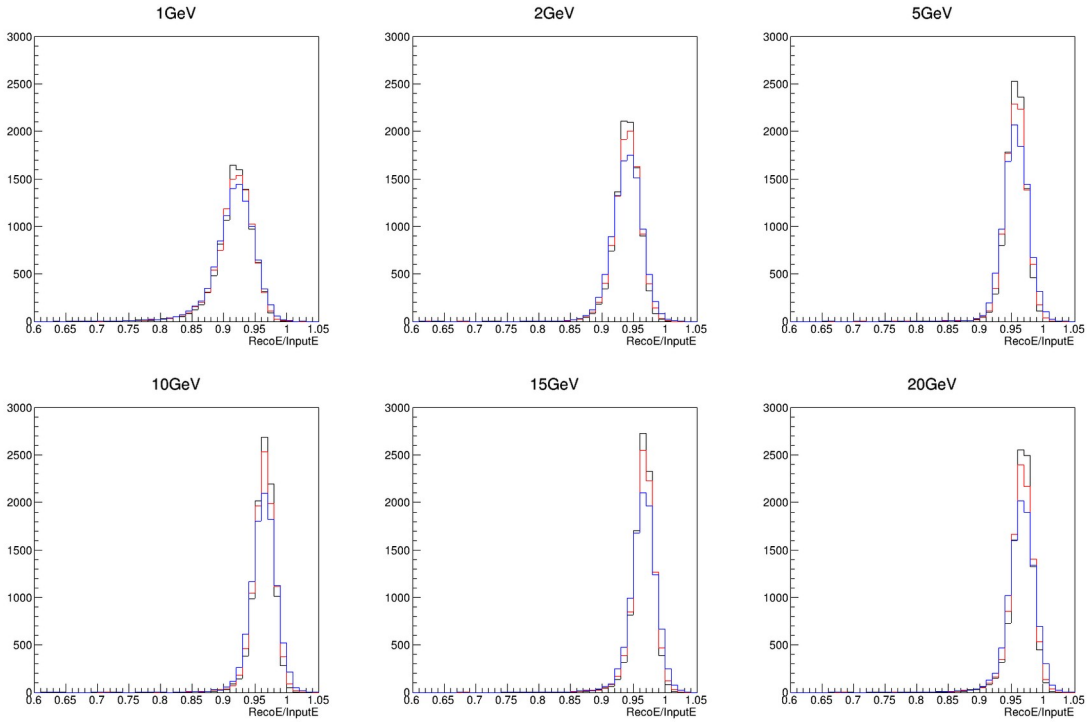
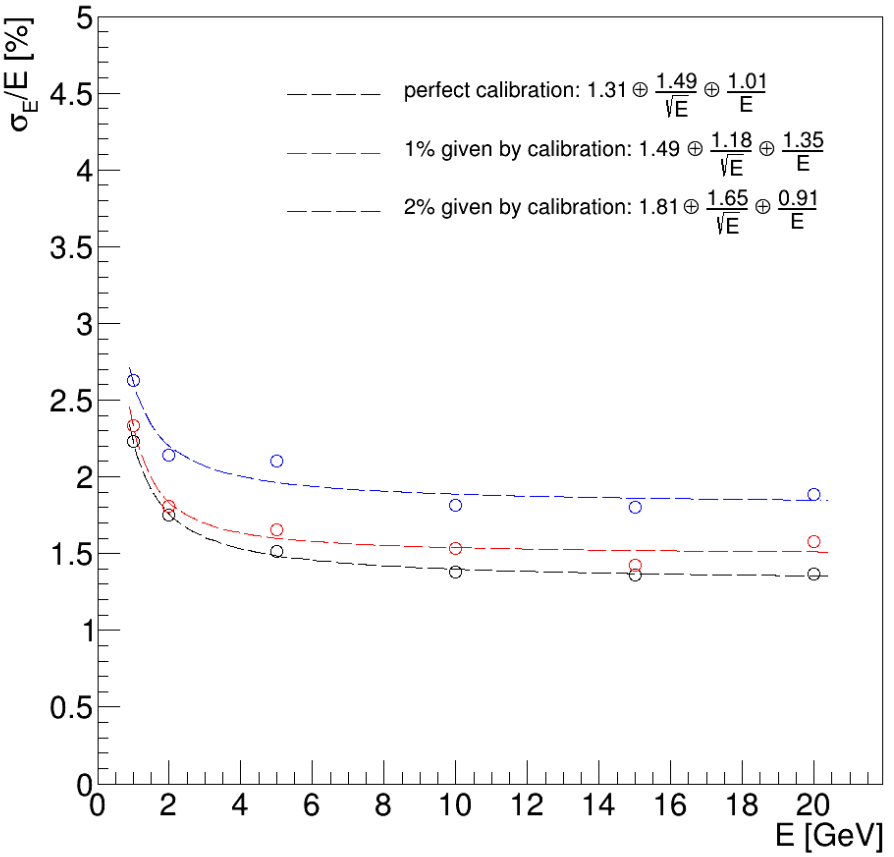

Calibration



Perfect calibration
1% fluctuation given by calibration
2% fluctuation given by calibration



Conclusion:
0.5% worse for 2% fluctuation given by the calibration