PHeSCAMI
GEANT4 simulation

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Trento Institute for
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GEANT4
A SIMULATION TOOLKIT

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Detector concept

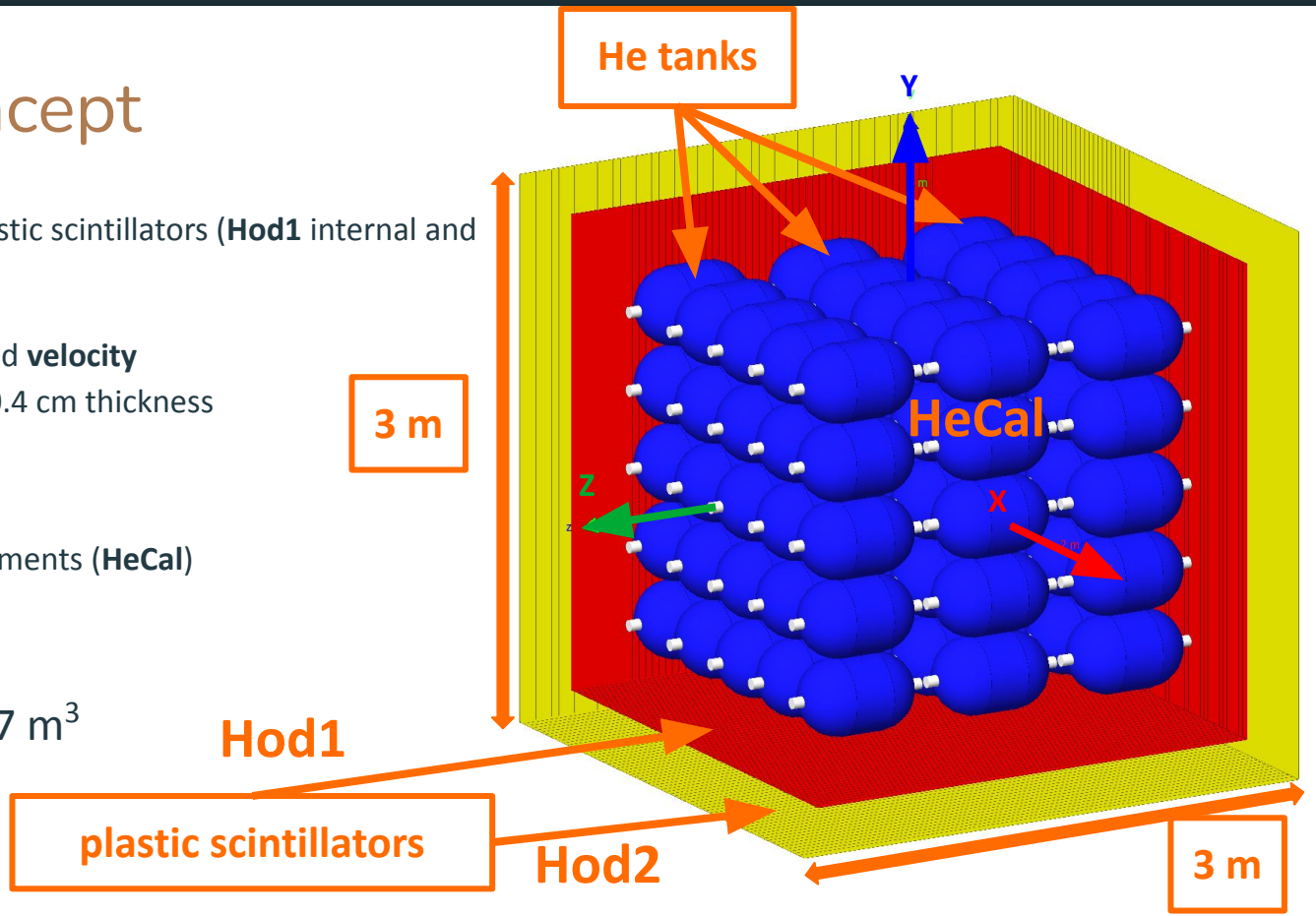
Two layers of **segmented** plastic scintillators (**Hod1** internal and **Hod2** external)

- **Time of flight** (ToF) and **velocity**
- 64 slab for each side 0.4 cm thickness

75 He vessels

- **Calorimetric** measurements (**HeCal**)

Total dimensions ~ 27 m^3



Simulated spectra and particles

Particles are **uniformly** generated **on a plane**.

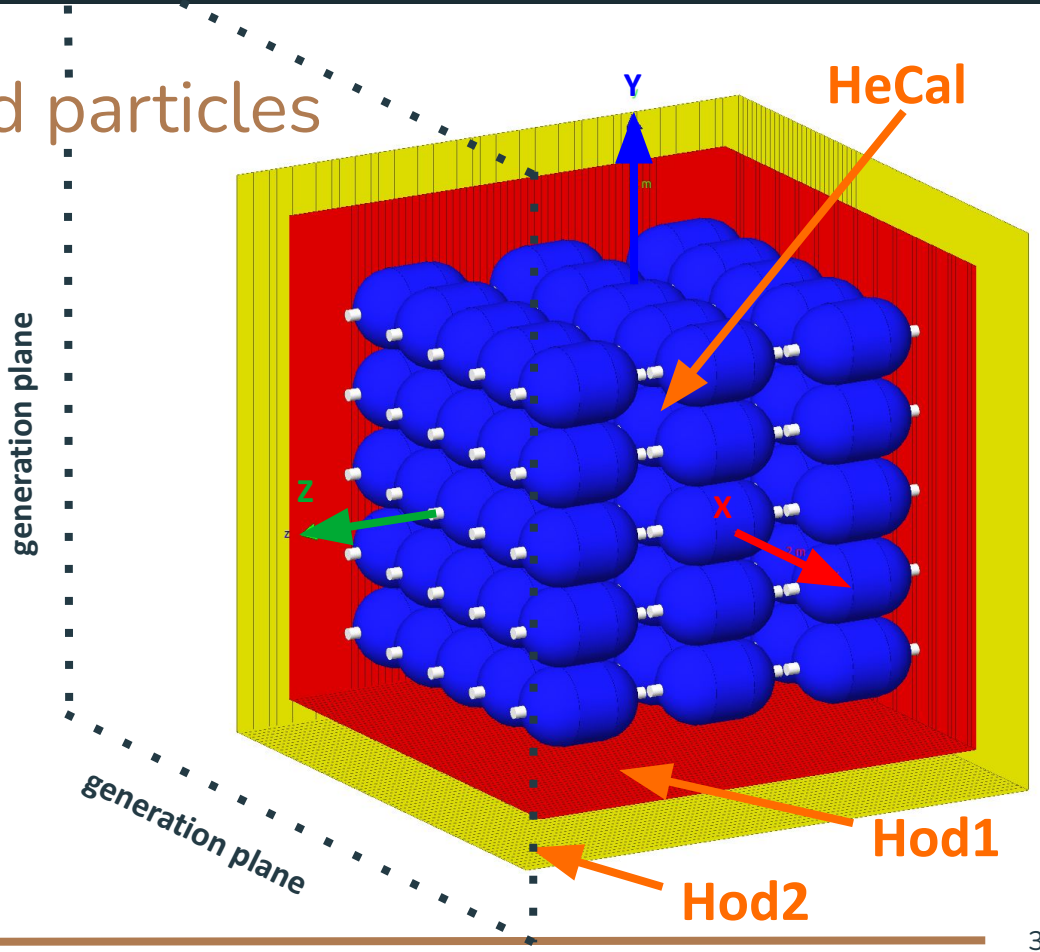
The **flux** is **isotropic**.

Shooting direction **opposite to z axis**.

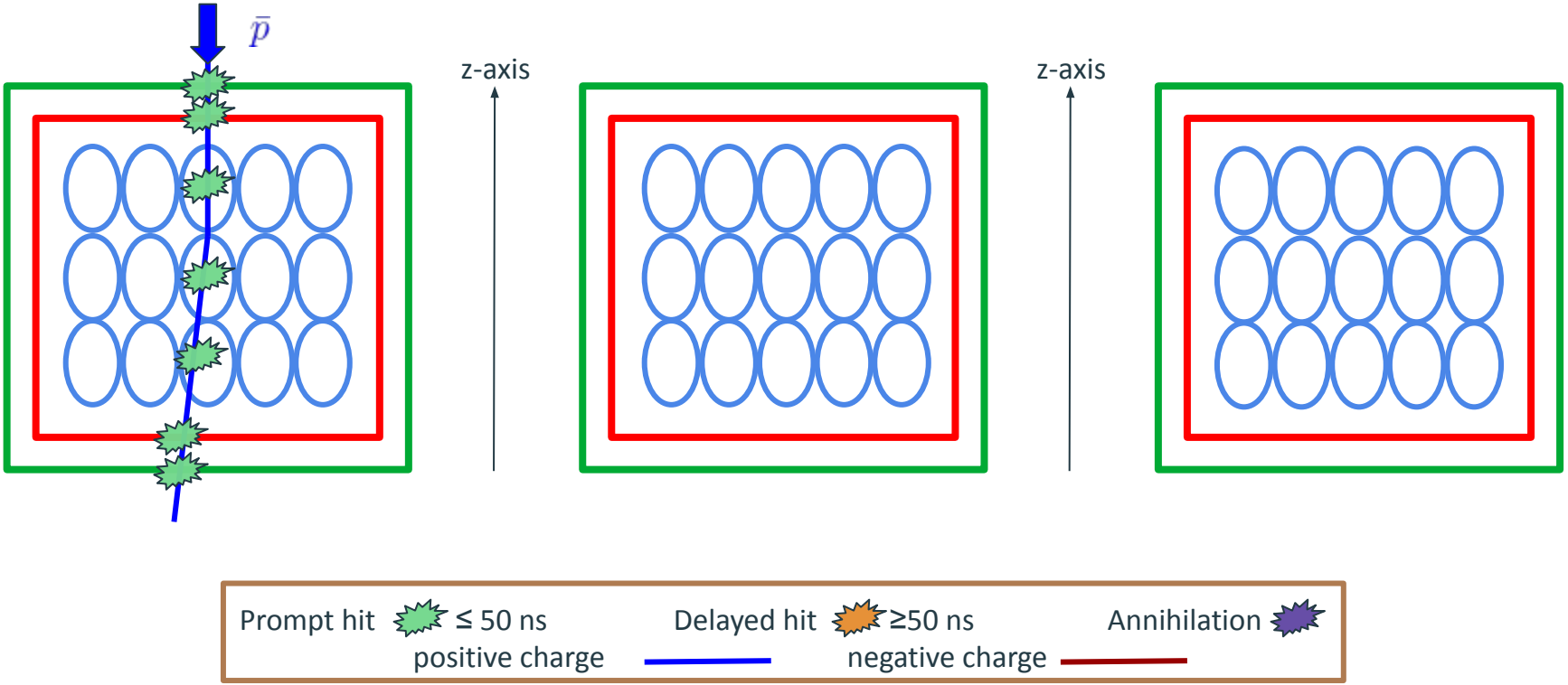
Spectral index -1: E_K^{-1}.

Kinetic energy range: **[10, 10'000] MeV/N**.

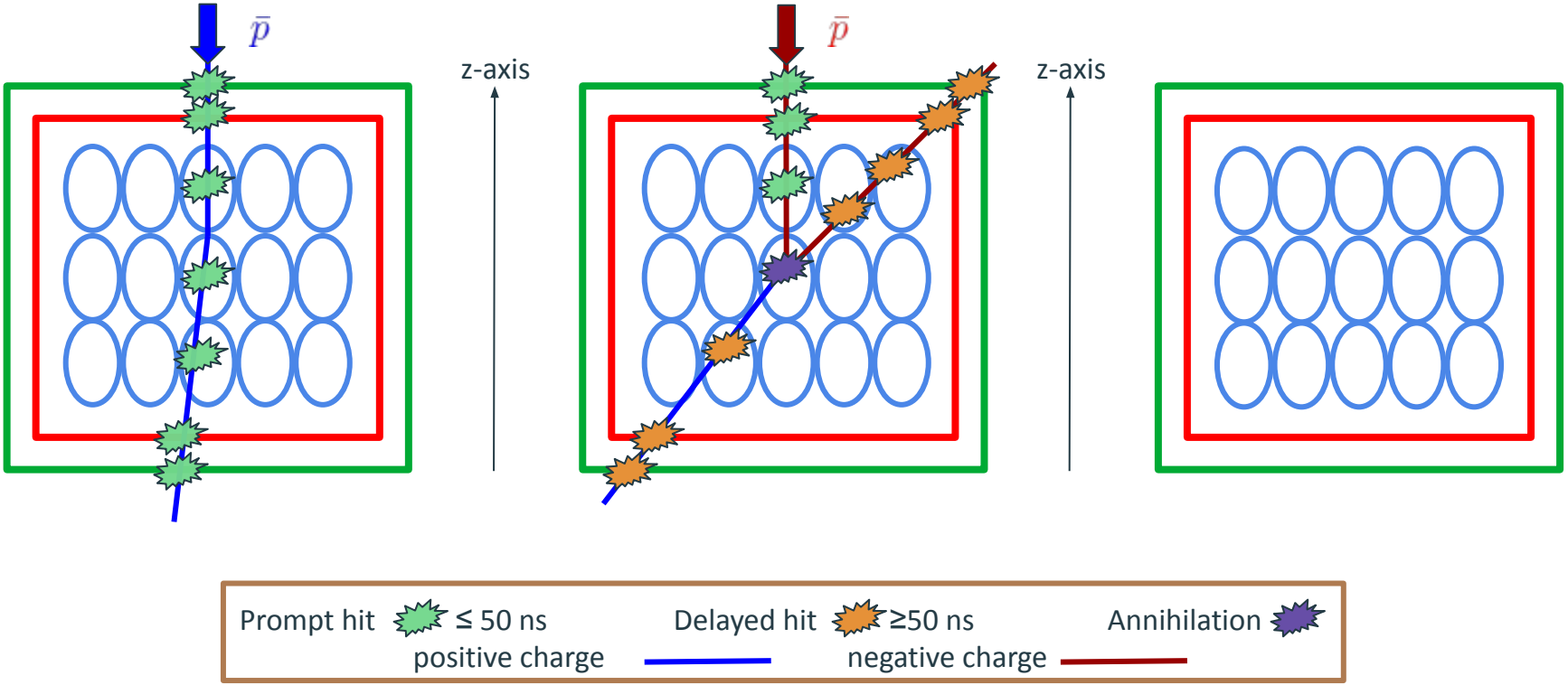
Particles simulated: $p,\ \bar{p},\ D,\ \bar{D}$ and ^4He .



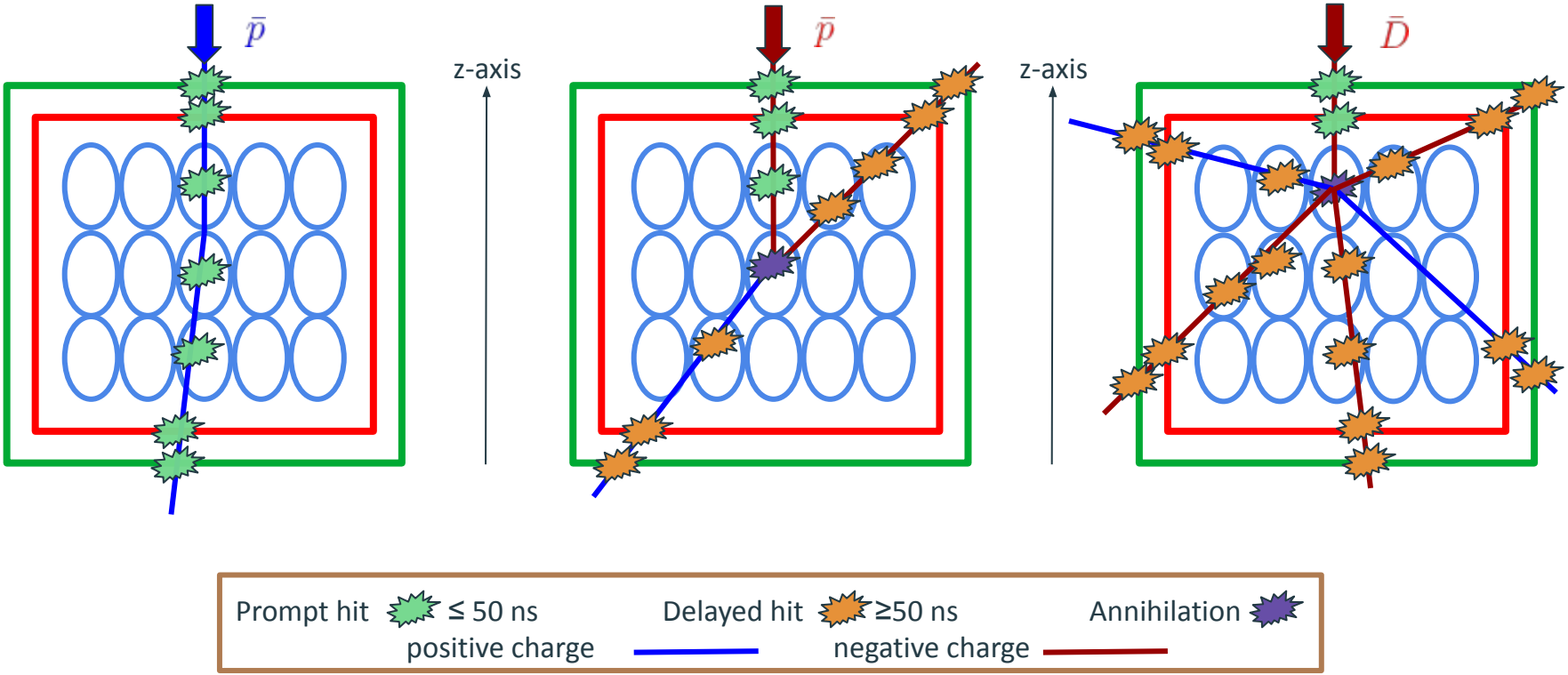
Particle identification



Particle identification



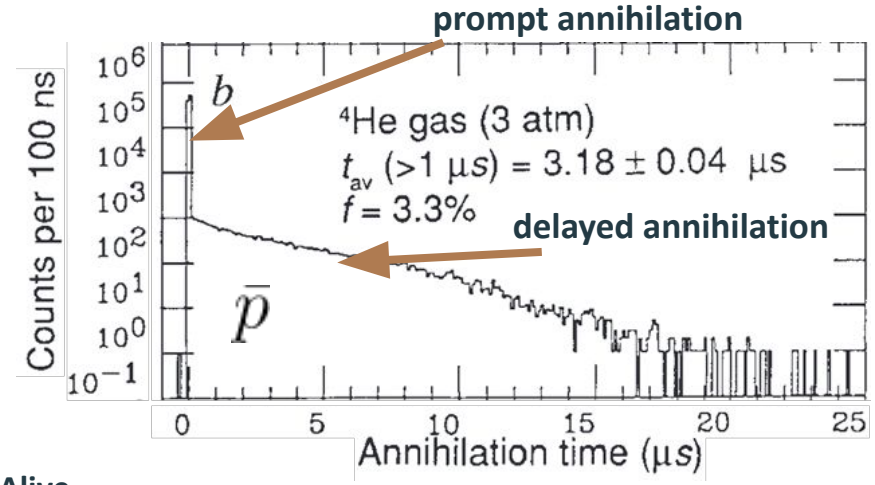
Particle identification



Implementation of the Helium metastable states

In the HeCal, we look for particles with:

- 0 kinetic energy
- mass > 900 MeV/c^2
- charge < 0



Code implementation:

- G4Track object, we look for **TrackStatus = fStopButAlive**.
  - Meaning, active rest physics processes are invoked, afterwords the current track is killed.
- **G4Step (postStep)** is used to retrieve the mass and charge of the particle corresponding to the given track.
- **The global time of the G4Track is increased by 0.9 ms (90'0000 ns).**

Hit merging

	Plastic scintillators	HeCal
Spatial resolution	0.5 [mm]	20 [mm]
Temporal resolution	100 [ps]	200 [ps]

Hit are merged taking into account **spatial** and **temporal resolution** of each detector. For example:

i-th hit: $E_i,\ \vec{r}_i,\ t_i$

j-th hit: $E_j,\ \vec{r}_j,\ t_j$

merged hit:

$$\frac{(E_i \cdot r_i) + (E_j \cdot r_j)}{E_i + E_j}$$

$$\frac{(E_i \cdot t_i) + (E_j \cdot t_j)}{E_i + E_j}$$

$$E_i + E_j$$

Event reconstruction

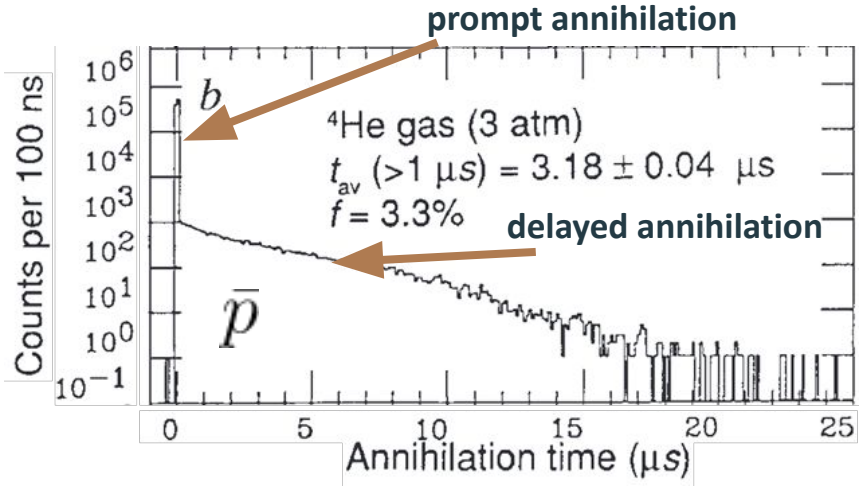
Each event with a **G4Hit in HeCal** is stored in the n-tuple.

ToF and **HeCal** are both **segmented**.

In each segment, the single **hits are summed** to get the total amount of energy deposited.

The **event** is **divided into two parts**: the first is named ***prompt***, the second is called ***delayed***.

- **50 ns** is the chosen **time threshold** (**customizable**).
- **~ 50% of the annihilation happens within this interval**



Trigger selections

Reference values for MIPs particles:
1. Energy deposited in **1 scintillator slab ~ 0.83 MeV**
2. Energy deposited in **1 He tank ~ 7.50 MeV**

If prompt requirements are met, a gate is opened (2 μs); within this time interval the event is stored, if satisfies the delayed requirements.

Prompt selection (< 50 ns)

Max E_{dep} Hod1	> 1.6 MeV
Max E_{dep} Hod2	> 1.6 MeV
Number of slab Hod1	≤ 2
Number of slab Hod2	≤ 2
Max E_{dep} HeCal	> 7.5 MeV

Delayed selection (> 50 ns)

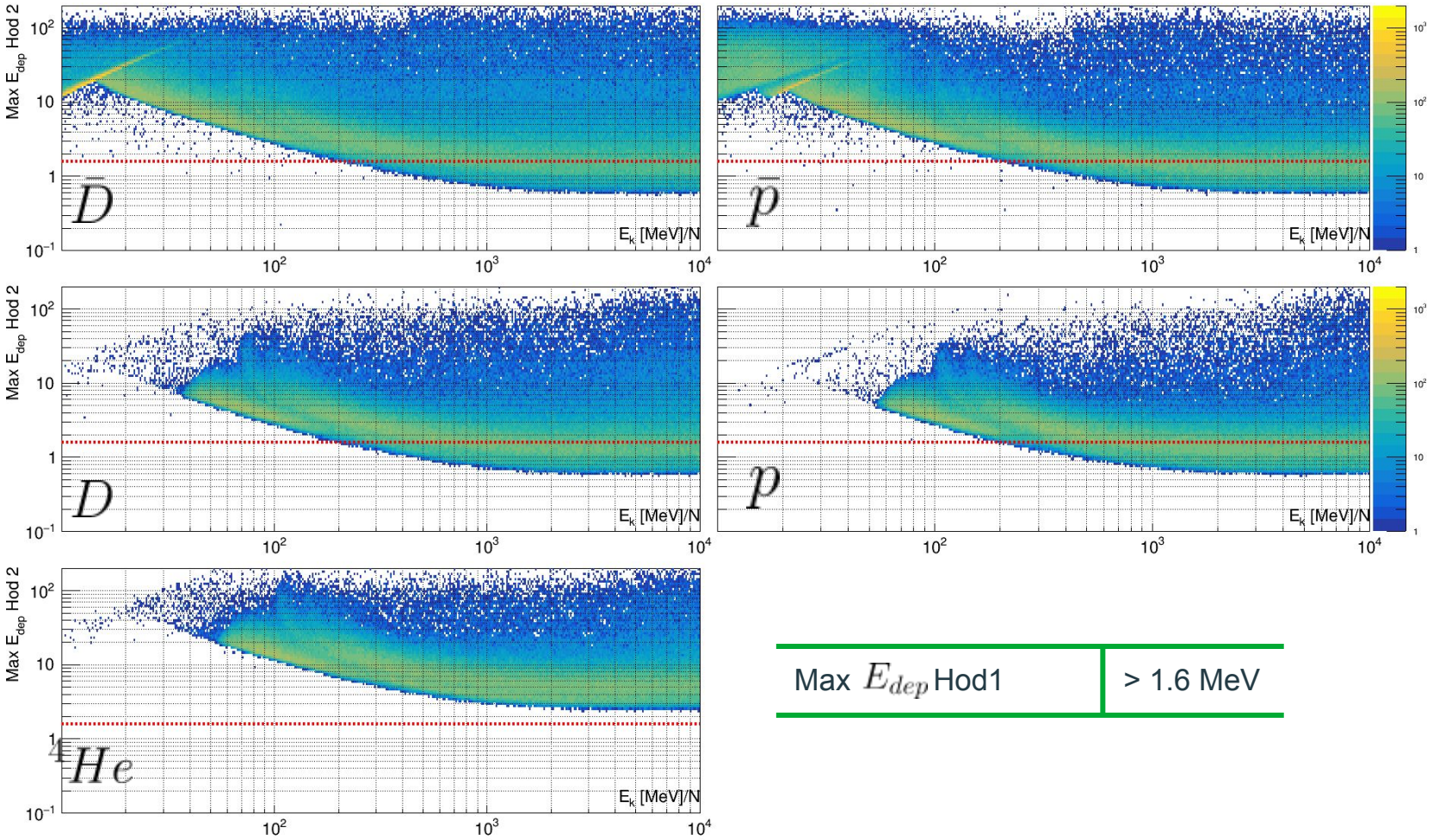
Max E_{dep} Hod1	> 0.8 MeV
Max E_{dep} Hod2	> 0.8 MeV
Number of slab Hod1	> 2
Number of slab Hod2	> 2
Max E_{dep} HeCal	> 7.5 MeV

- Max E_{dep} Hod1/Hod2: maximum energy released in one slab, within 50 ns (prompt) or after 50 ns (delayed)
- Number of slab Hod1/Hod2: slabs number with E_{dep} higher than threshold (1.6 MeV for prompt or 0.8 MeV for delayed).
- Max E_{dep} HeCal: : maximum energy released in one tank, within 50 ns (prompt) or after 50 ns (delayed).

Single particle contributions (50 ns)

Single contributions (50 ns)

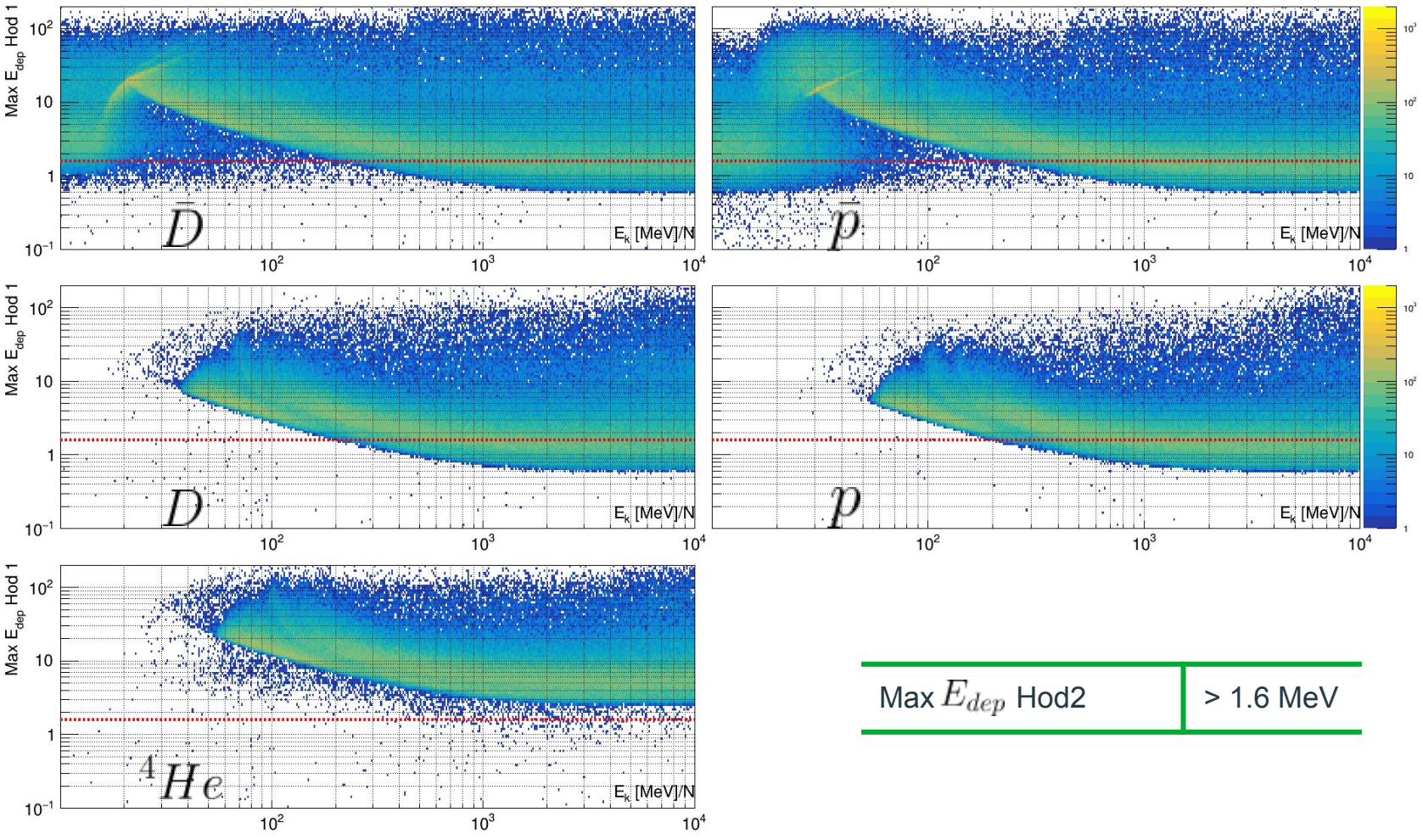
Prompt max E Hod2



Max E_{dep} Hod1	> 1.6 MeV

Single contributions (50 ns)

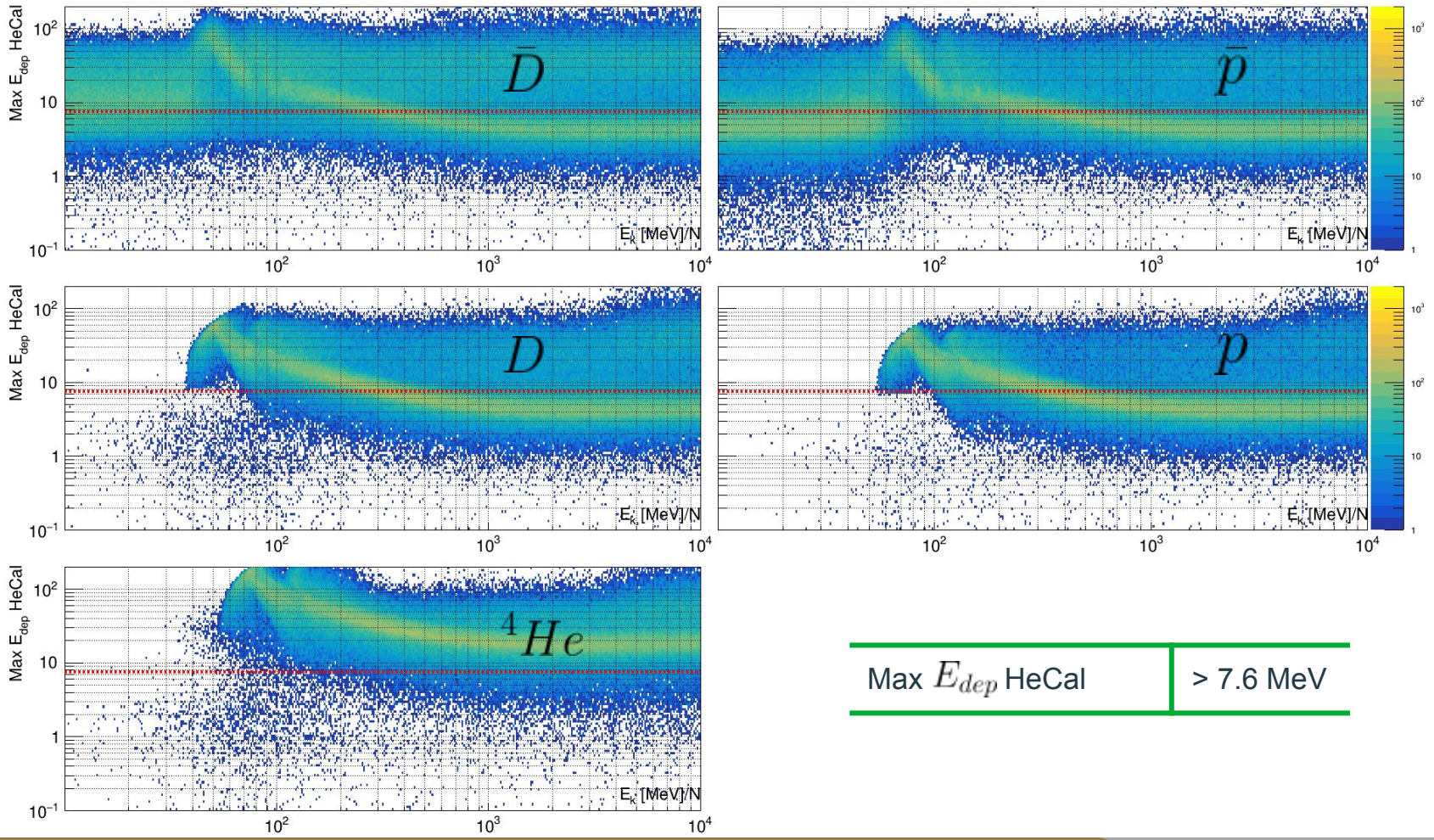
Prompt max E Hod1



Max E_{dep} Hod2	> 1.6 MeV

Single contributions (50 ns)

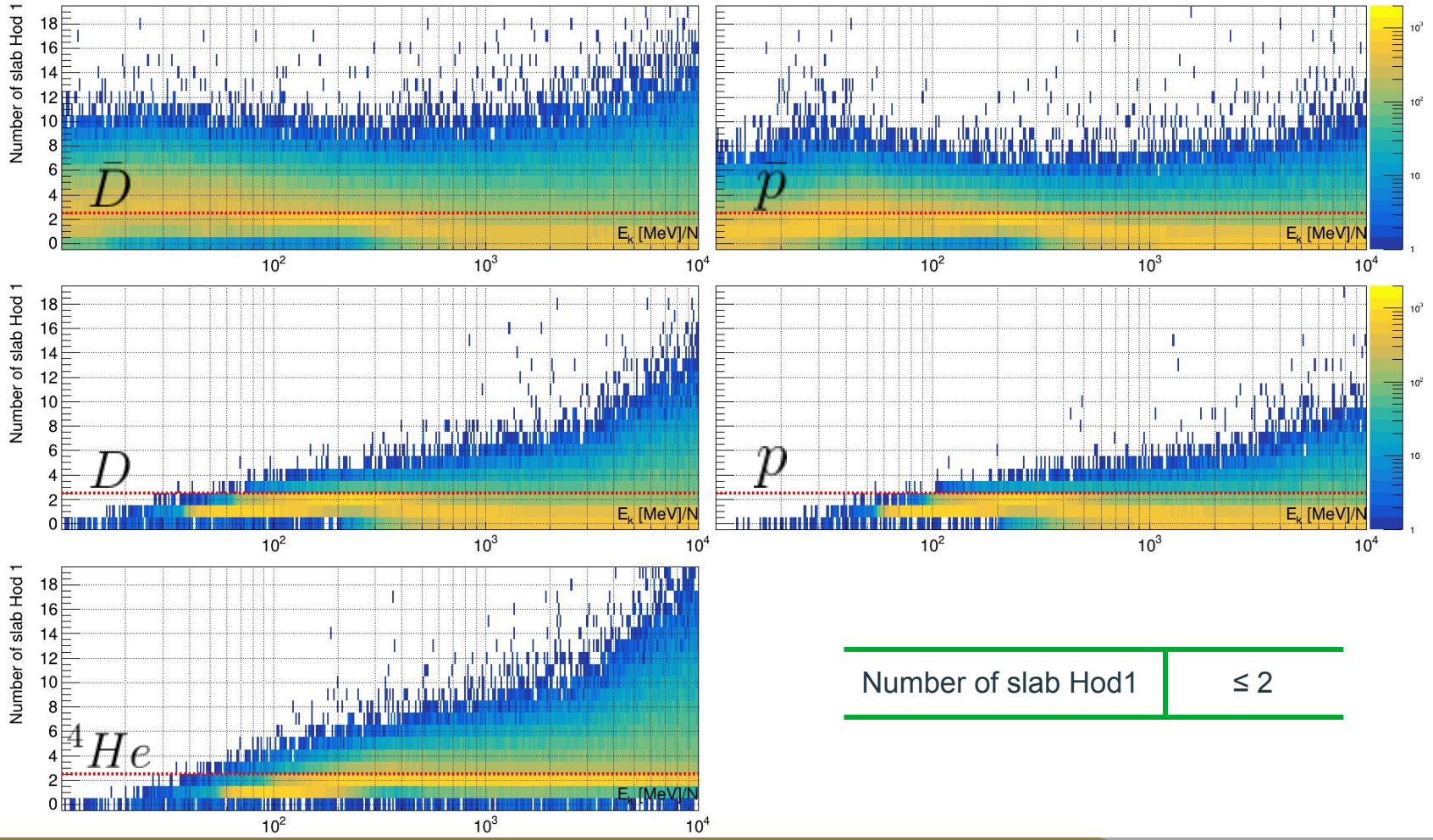
Prompt max E HeCal



Max E_{dep} HeCal	> 7.6 MeV

Single contributions (50 ns)

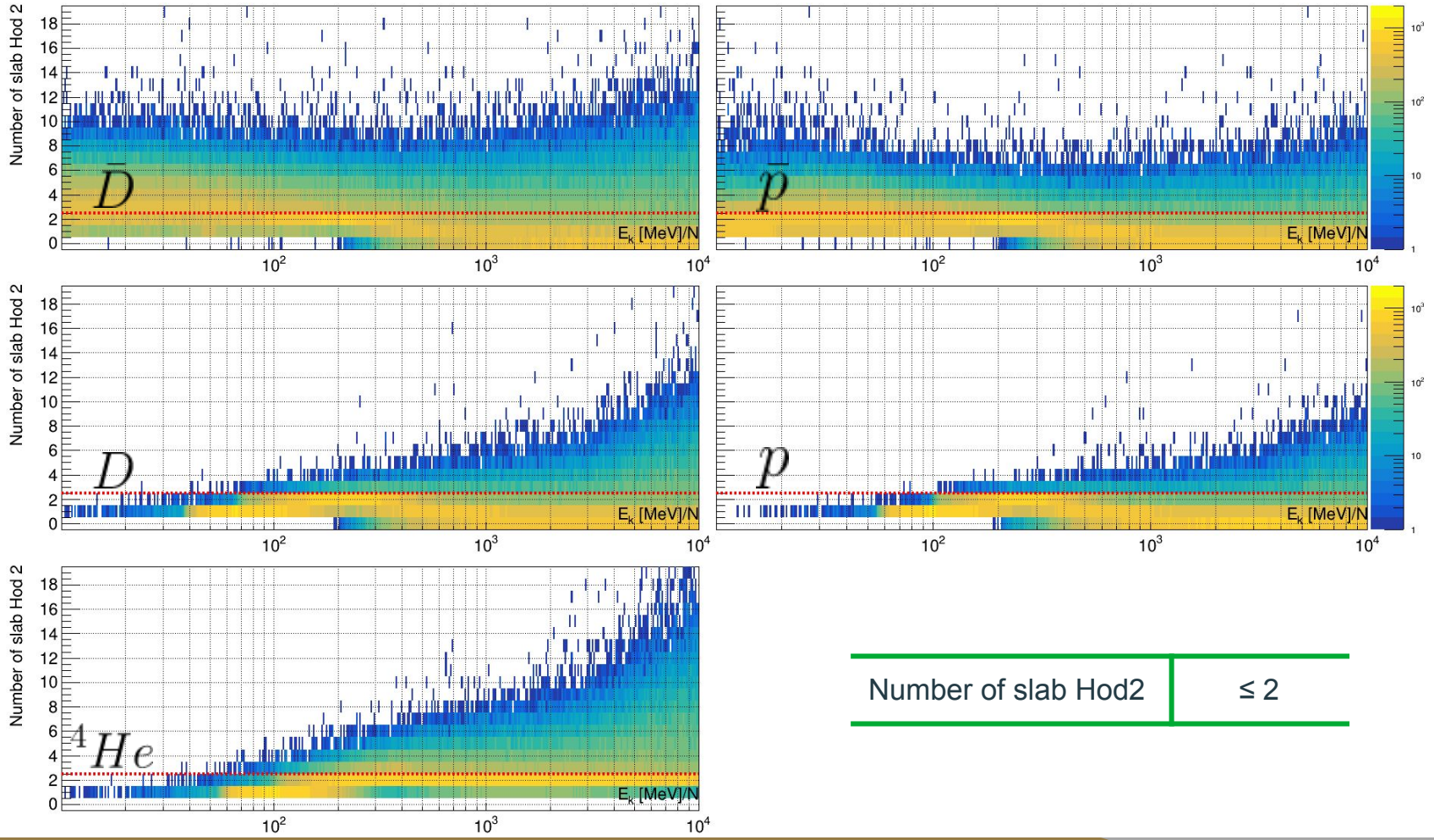
Prompt number of slab Hod1



Number of slab Hod1	≤ 2

Single contributions (50 ns)

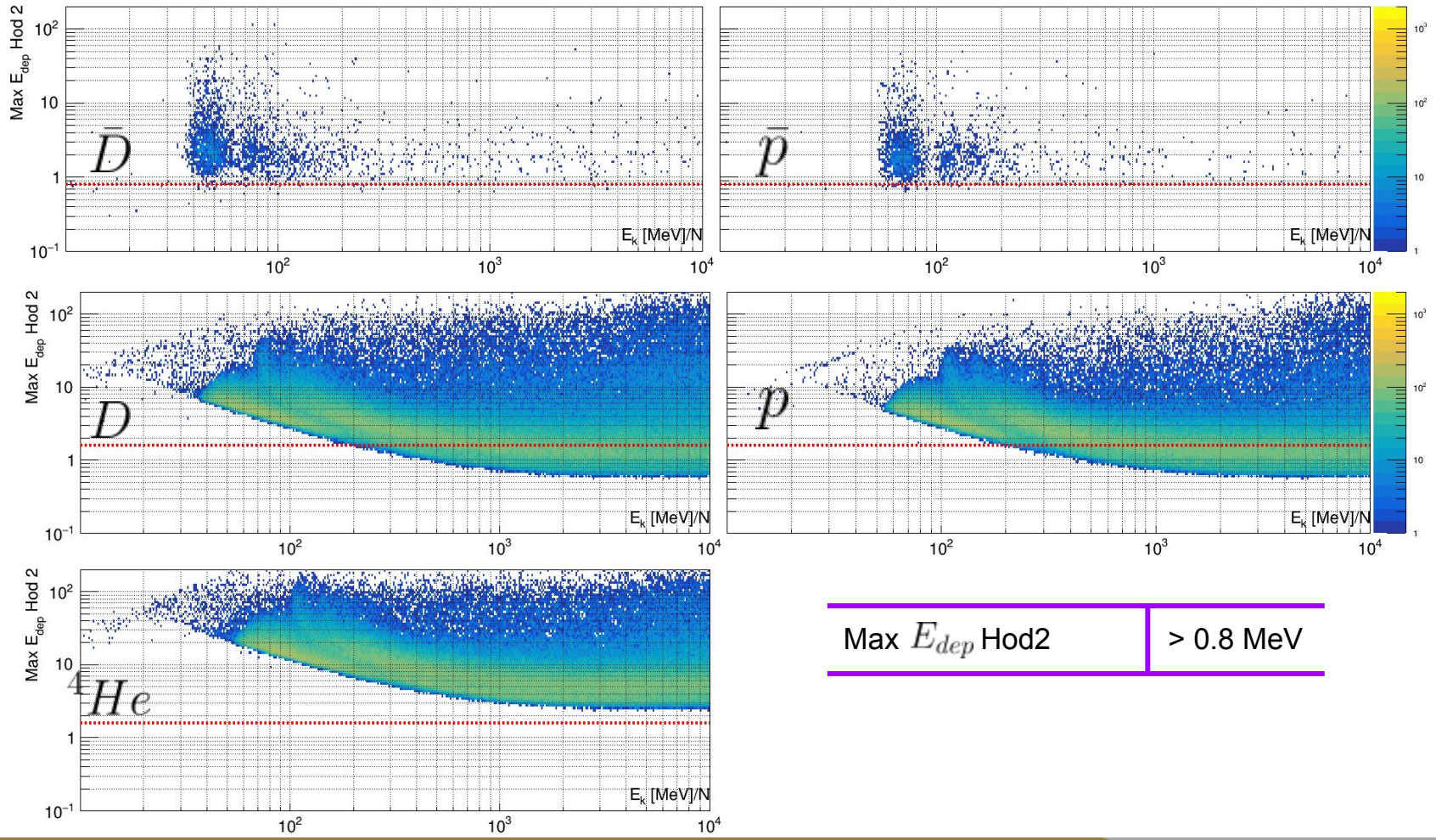
Prompt number of slab Hod2



Number of slab Hod2	≤ 2

Single contributions (50 ns)

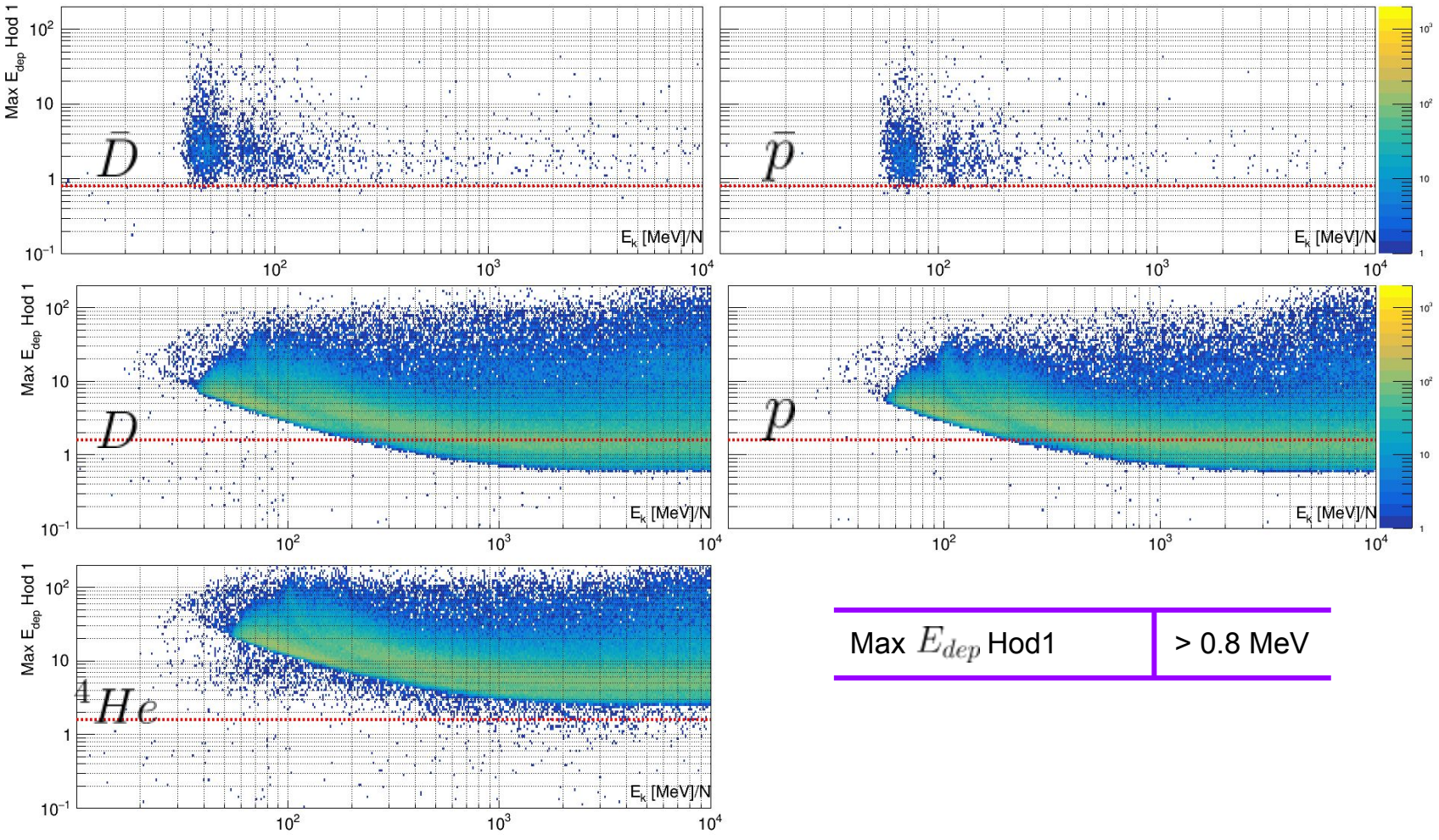
Delayed max E Hod2



Max E_{dep} Hod2	> 0.8 MeV

Single contributions (50 ns)

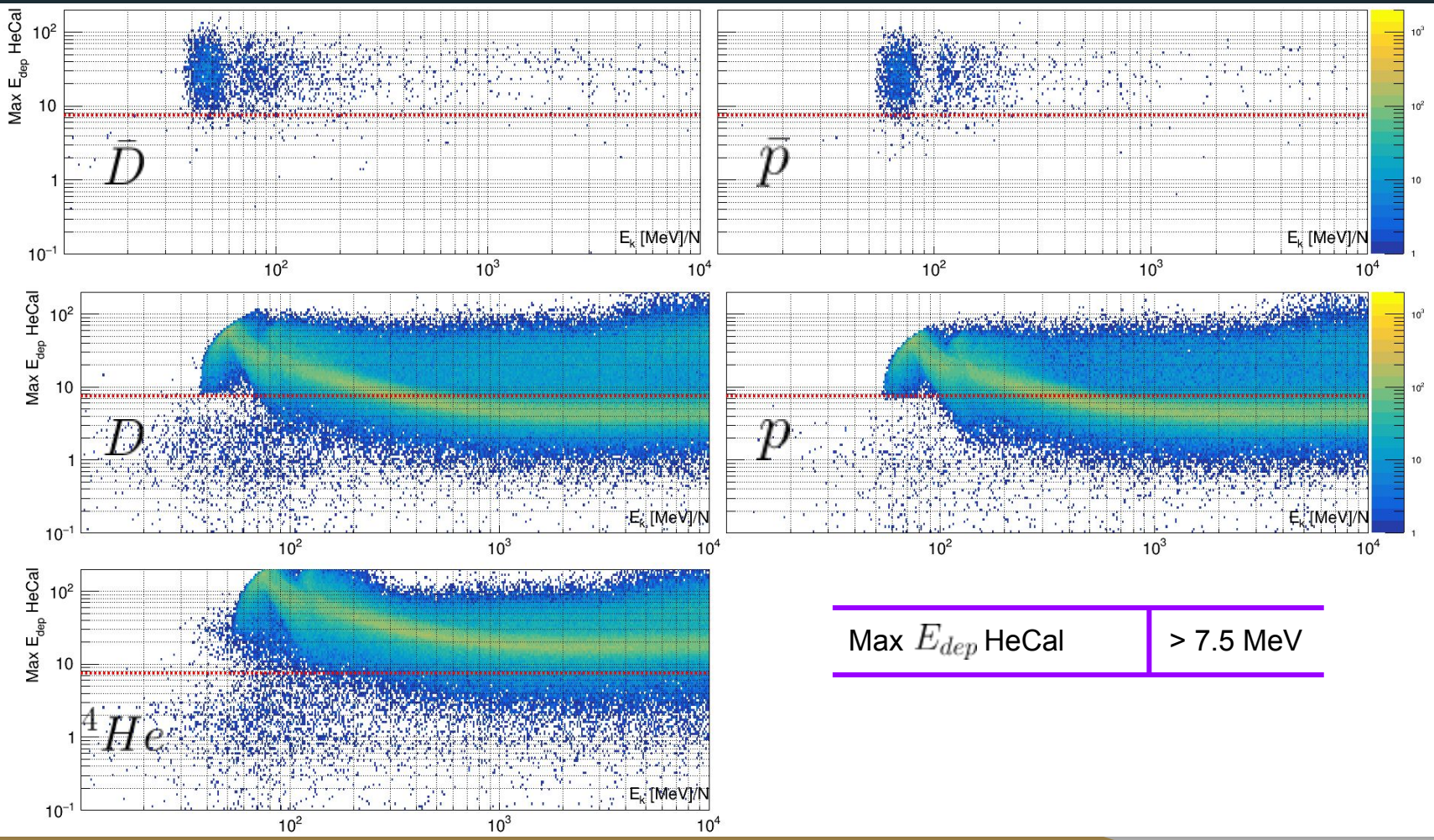
Delayed max E Hod1



Max E_{dep} Hod1	> 0.8 MeV

Single contributions (50 ns)

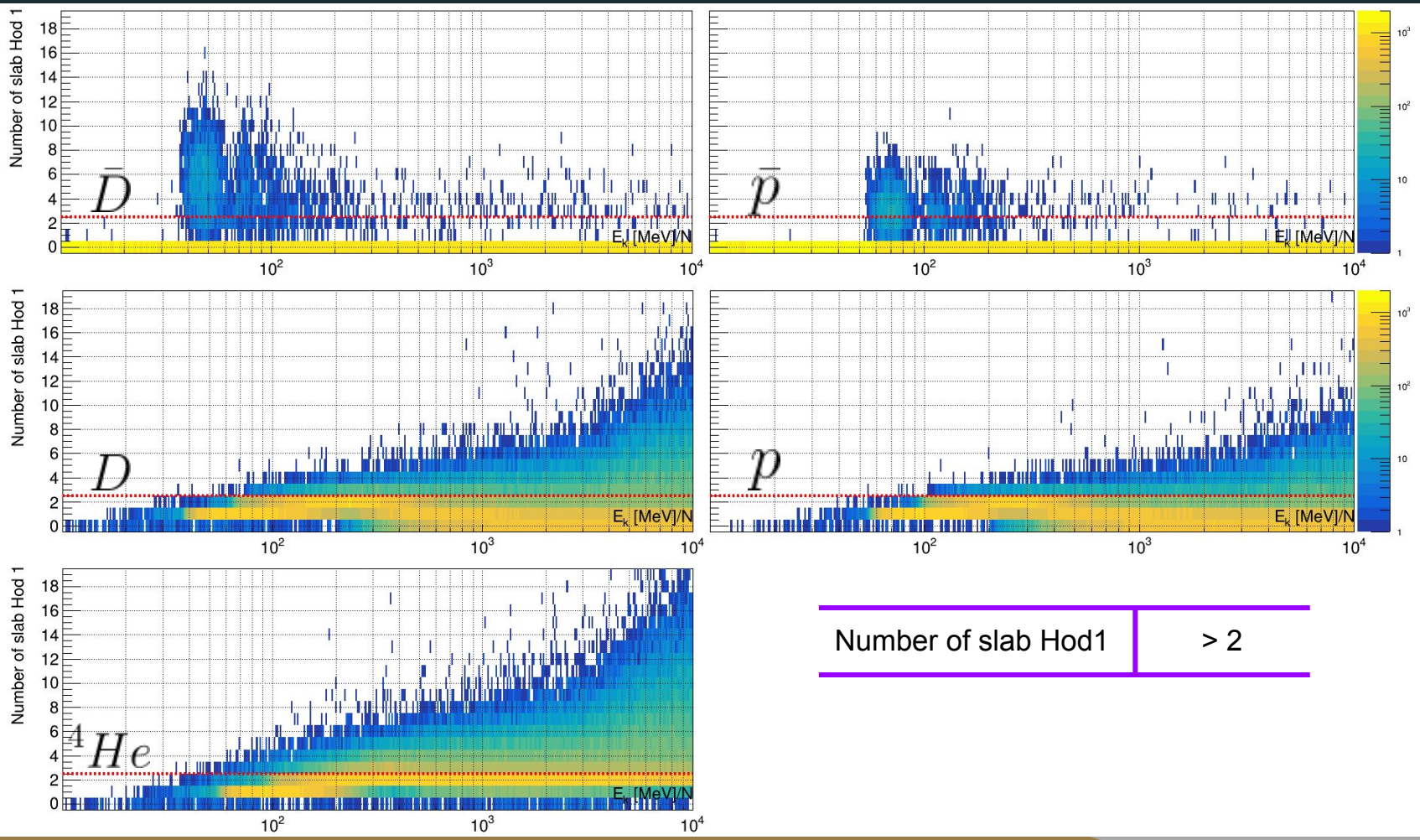
Delayed max E HeCal



Max E_{dep} HeCal	> 7.5 MeV

Single contributions (50 ns)

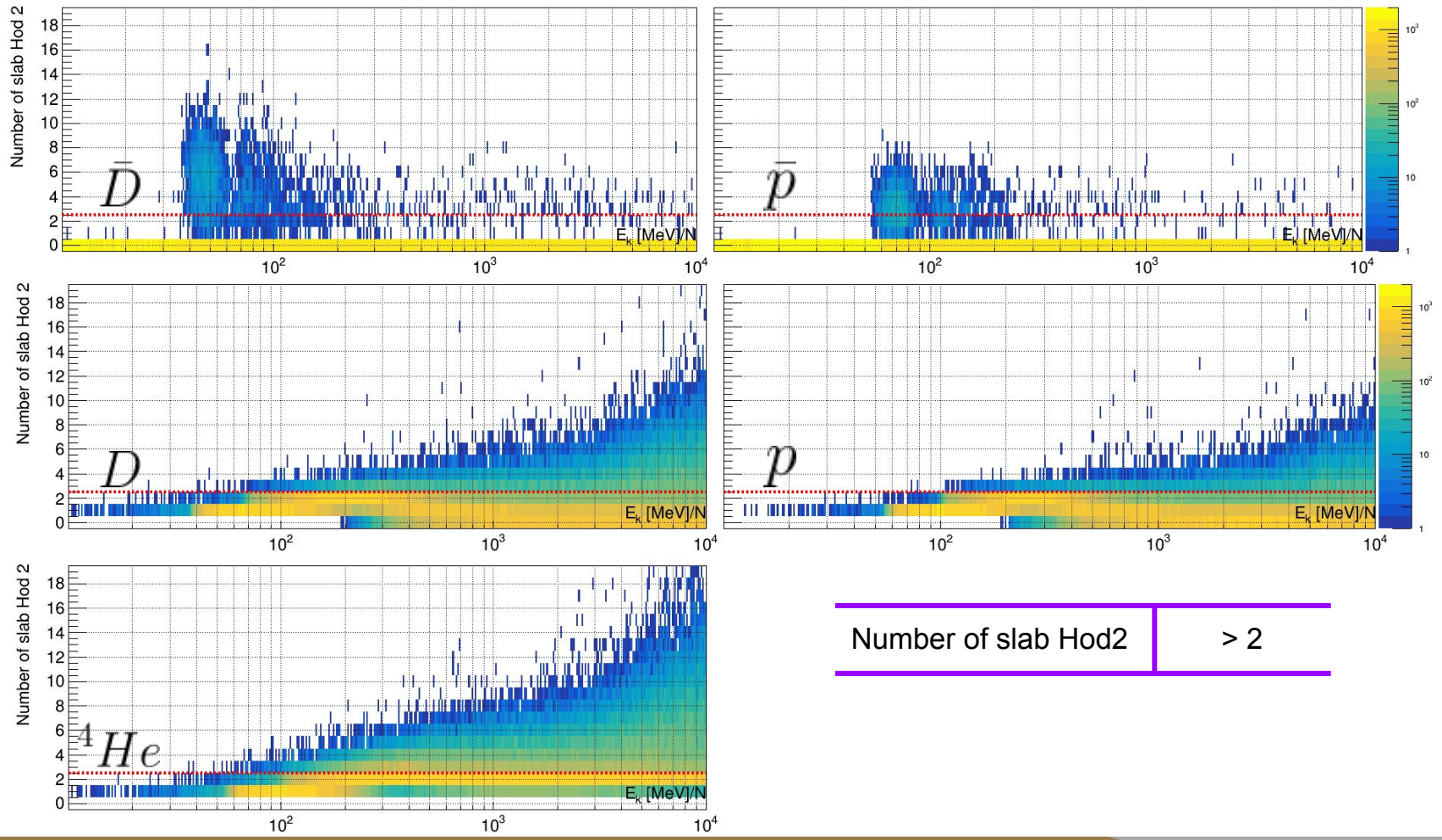
Delayed number of slab Hod1



Number of slab Hod1	> 2

Single contributions (50 ns)

Delayed number of slab Hod2



Number of slab Hod2	> 2

Conclusions

A preliminary version of a trigger selection has been presented.

Next steps:

The efficiencies of the prompt and delayed selection must be evaluated.

The number of scintillators slab, can be evaluated between two thresholds.