PHeSCAMI
Monte Carlo simulation updates

UNIVERSITÀ DI TRENTO

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GEANT4
A SIMULATION TOOLKIT

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30/05/2024

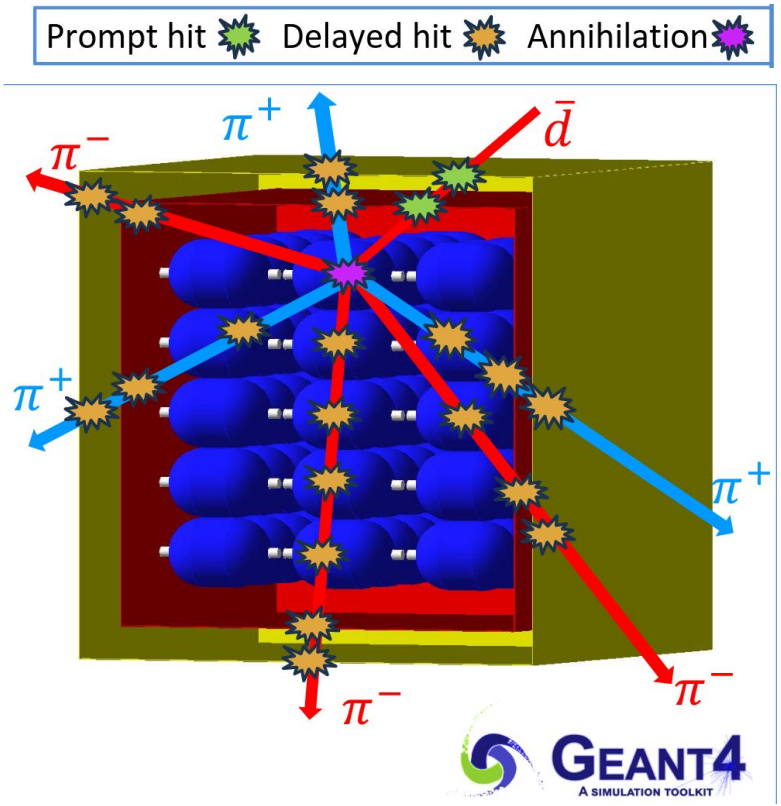
Monte Carlo geometry

Time of flight system (4 mm X 54 m^2) -> segmented plastic scintillators

Velocity resolution: σ_β **= 5 %**
Energy resolution: σ_E **= 5 %**

Helium Calorimeter (**HeCal**) -> 75 He tank (75 L and 310 bar)

Time resolution: σ_t **~ ns**
Energy resolution: σ_E **= 10 %**

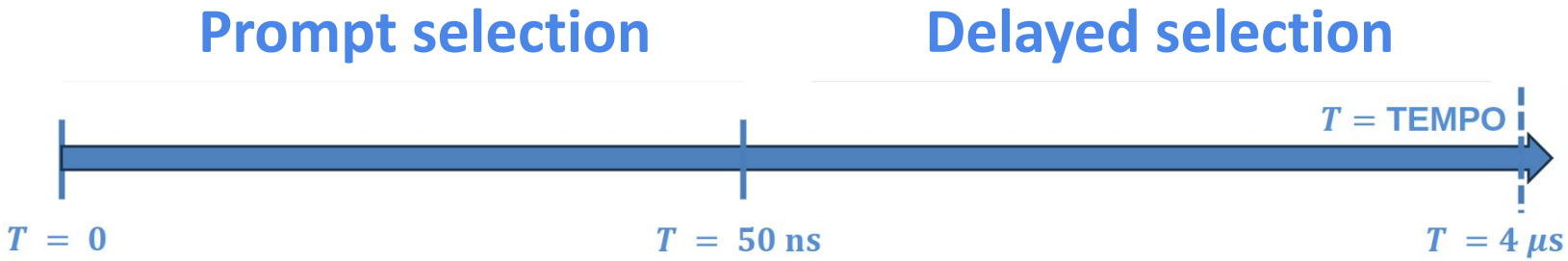


Trigger logic

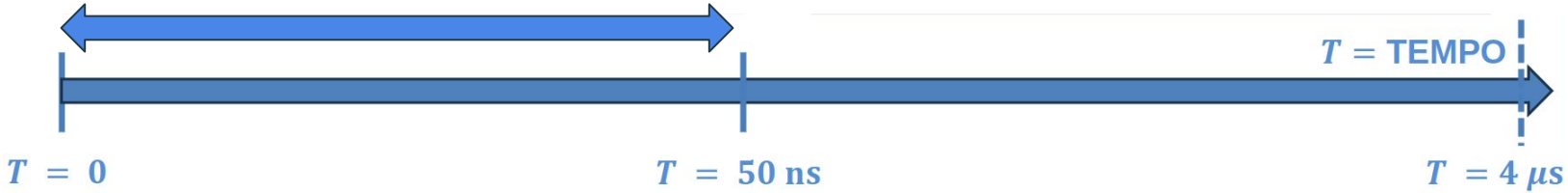
Two selections:

prompt -> against Minimum Ionizing Particles (MIPs)
delayed -> looks for evidences of an annihilation

Prompt -> **within 50 ns** and then a **gate** is opened (**3'950 ns**)
An event is acquired if the **delayed** selection is **satisfied between 50 ns and 4'000 ns**; otherwise is discarded.



Prompt selection



Max E_{dep} TOF > 2 **MIP_{TOF}**
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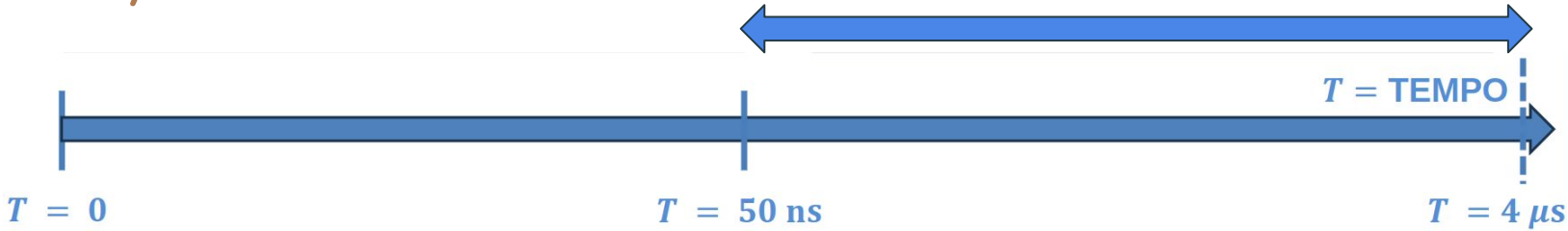
Max E_{dep} HeCal > 1.3 **MIP_{HeCal}**
Number of TOF prompt hit ≤ 3

MIP_{TOF} = 0.80 MeV

MIP_{HeCal} = 7.50 MeV

Number of TOF prompt hit: all hit with energy > 2 MIP_{TOF}

Delayed selection



Max E_{dep} TOF > 1 **MIP_{TOF}**
Max E_{dep} TOF > 1 **MIP_{TOF}**
Max E_{dep} HeCal > 1.3 **MIP_{HeCal}**
Number of TOF delayed hit > 4

MIP_{TOF} = 0.80 MeV

MIP_{HeCal} = 7.50 MeV

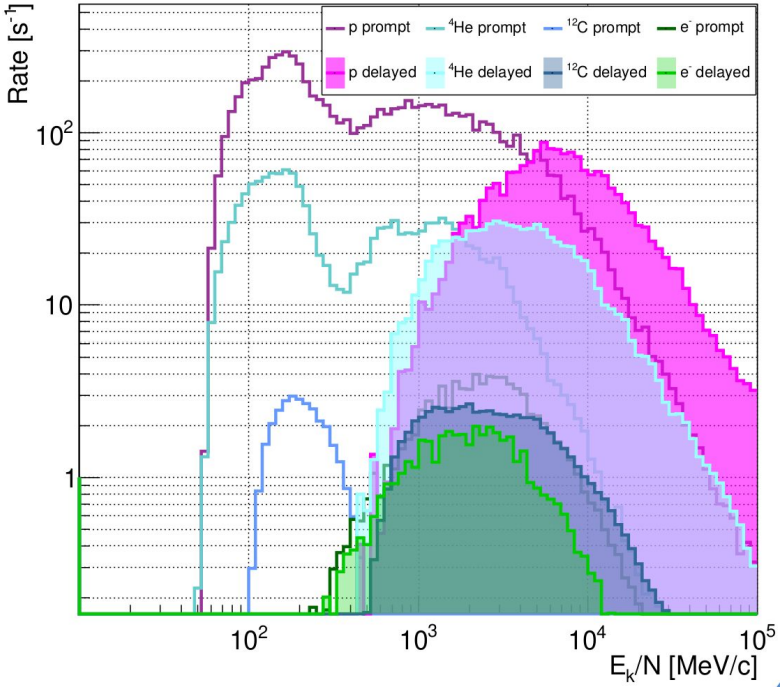
Number of TOF delayed hit: all hit with energy (1 MIP_{TOF}, 2 MIP_{TOF})

Expected rate

Expected rate for the most common particles and nuclei in Cosmic Rays (CRs):

- **p**
- **e^-**
- **^4He**
- **^{12}C**

Expected **acquisition rate for ordinary matter ~ 100 Hz**.



Geometric acceptances

Taking in account:

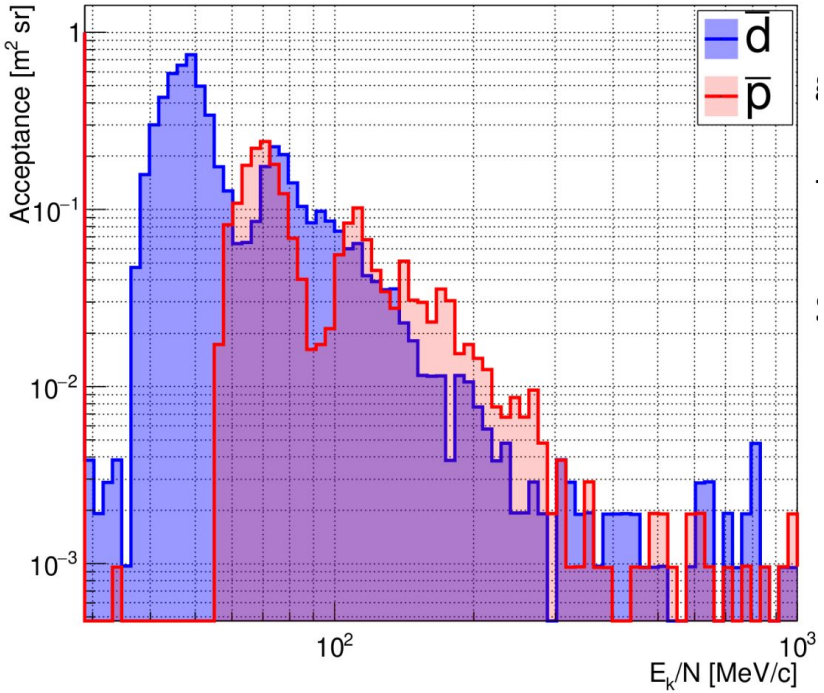
Probability to have an He metastable state ~ 3.3%

Annihilation between 50 ns and 4’000 ns.

Considering **3 balloon flight** (~100 days).

Minimum sensible flux for antideuterons:

$$\sim 2 \cdot 10^{-5}\ [\mathrm{GeV} \cdot \mathrm{m}^2 \cdot \mathrm{sr} \cdot \mathrm{s}]^{-1}$$



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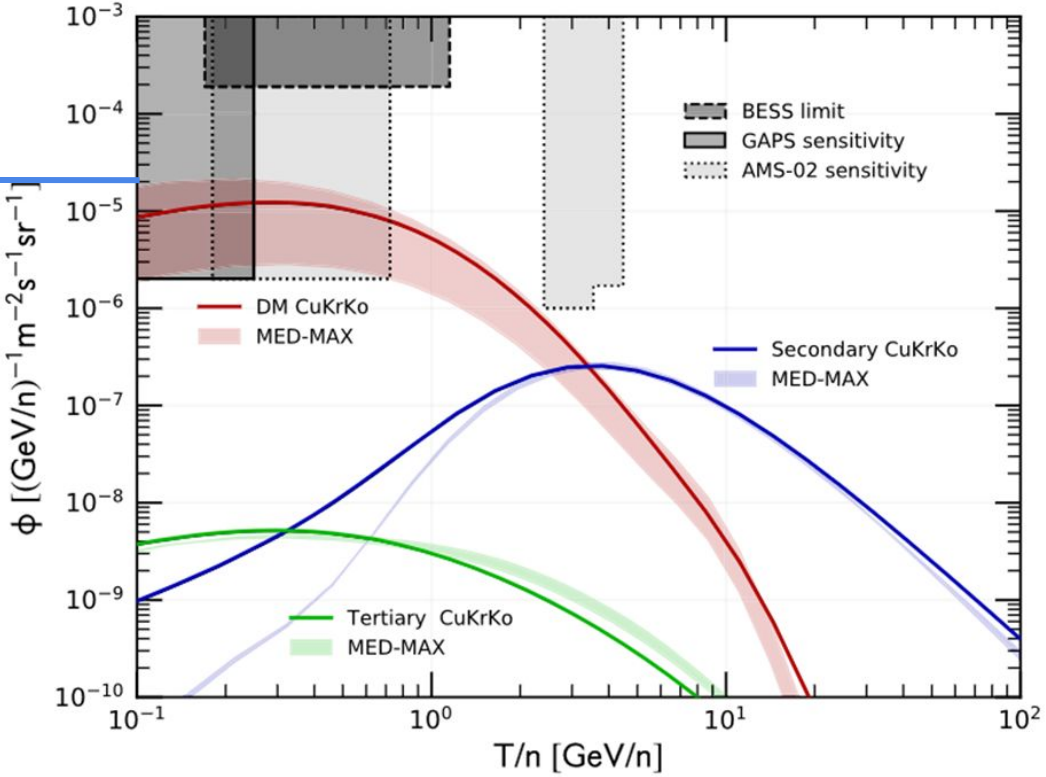
(36, 60) MeV/n



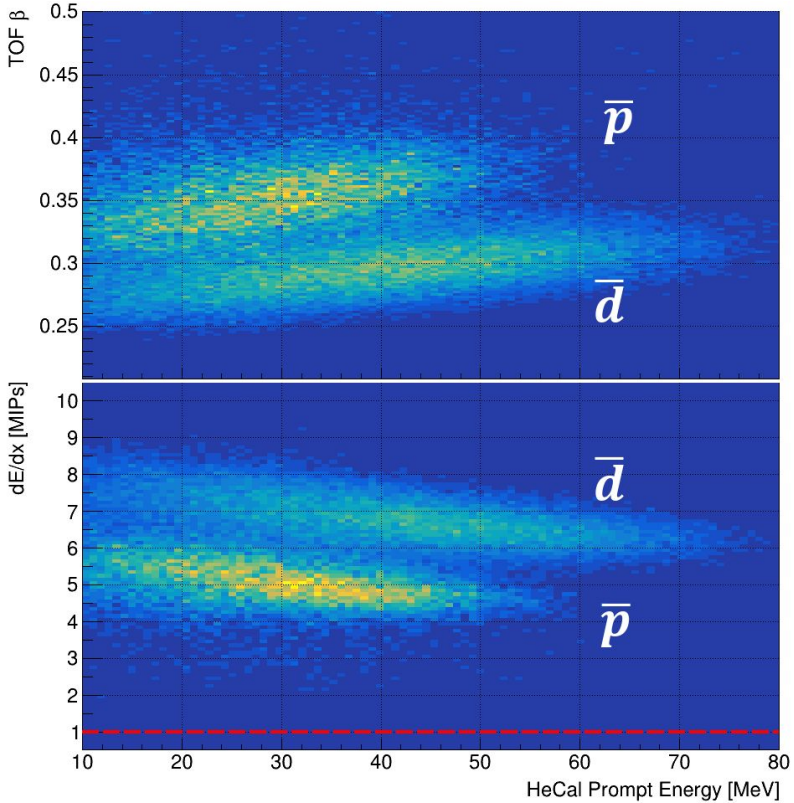
Antideuterons and antiprotons separation

Events after the trigger selections:

- **β_{TOF} vs HeCal prompt energy**

- **dE/dX in the outer TOF vs HeCal prompt energy**

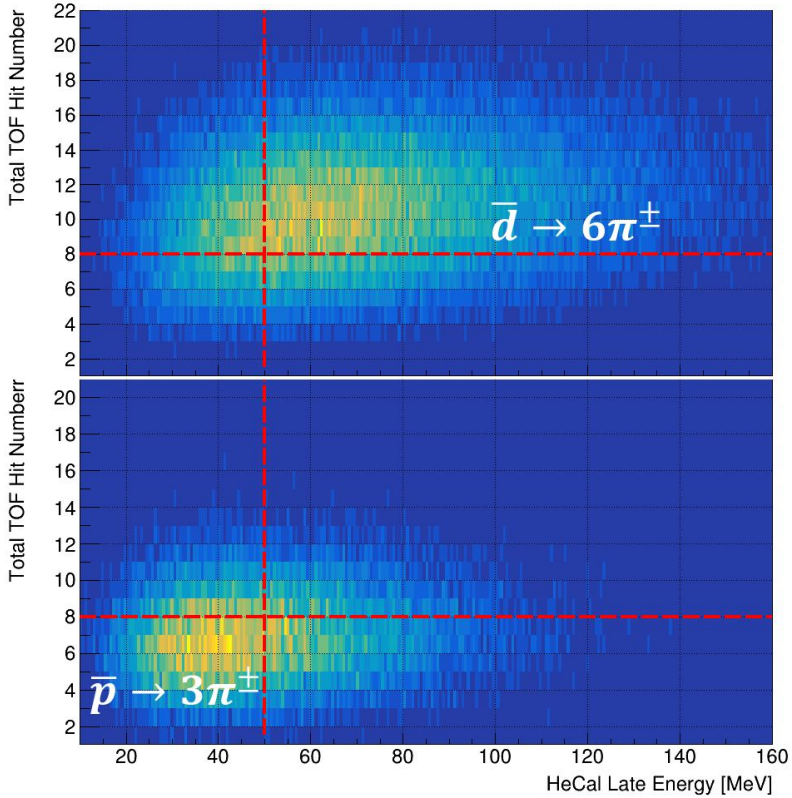
(dE/dX normalized to 1 MIP 2.0 MeV/cm)



Antideuterons and antiprotons separation

Events after the trigger selections:

- **Total number of TOF hit vs HeCal delayed energy**



Conclusions

- Ordinary matter is has an acquisition rate of ~ 100 Hz
- The minimum antideuteron flux is $2 \cdot 10^{-5}$ $[GeV \cdot m^2 \cdot sr \cdot s]^{-1}$

To do:

- Study the the antiprotons rejection power (track reconstruction and multivariate classifier)

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Thank you for your attention