## Neutron-Rich Hypernuclei: state of the art



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# Event-by-event analysis π<sup>+</sup> inclusive spectra analysis Work in Progress & Prospects

## **Event-by-event Analysis:** already done...

- We went on to look at the topologies of single events in the inclusive  $\pi^+$  spectra (<sup>12</sup>C, <sup>6</sup>Li, <sup>7</sup>Li targets)
- 4 2 momentum regions selected:
  - $p_0 \Delta p < p_{REC} < p_0 + \Delta p \qquad (Region Of Interest)$

- $P_1 \Delta p < p_{REC} < p_1 + \Delta p \qquad (Region Of Comparison)$
- + p<sub>0</sub> = 261.8 (<sup>12</sup><sub>A</sub>Be), 254.1 (<sup>6</sup><sub>A</sub>H), 245.3 (<sup>7</sup><sub>A</sub>H) MeV/c (from theory)
- + p<sub>1</sub> = 220 MeV/c:
  - <u>Not too high ( >  $p_0$  )</u>, in order to avoid bad-reconstructed events...
  - *Not too low,* in order to avoid cuts due to the magnetic field...
  - <u>Not too near to  $p_0$ , in order to avoid  $\mu$ + contamination...</u>

 $+ Δp = 2σ_p = 2 FWHM / 2.355 ≈ 1.6 MeV/c (FWHM = 0.8% @ μ<sup>+</sup> peak)$ 

N.B. start value, to be enlarged in the following

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## Event-by-event Analysis: already done...

- At present ~ 250 events examined (out of ~ 550) in the Region Of Interest for all the targets
   For target 2 (<sup>6</sup>Li, search for <sup>6</sup><sub>A</sub>H):
  - All the events ( $\approx$  170) examined in the Region of Interest
  - $\approx$  300 events out of  $\approx$  1600 examined in the Region Of Compariso
- **For target 3 (**<sup>7</sup>Li, search for  ${}^{7}_{\Lambda}$ H):
  - $\approx$  80 events out of  $\approx$  150 examined in the Region of Interest
  - $\approx$  100 events out of  $\approx$  1000 examined in the Region Of Comparison
- We searched topological differences in the two regions (in order to fix some background rejection criteria)
- No significant differences found...

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## A comparison example (hits): detector view

#### **Region Of Interest**

![](_page_4_Figure_2.jpeg)

## A comparison example (P.R.): detector view Region Of Interest

![](_page_5_Figure_1.jpeg)

#### A comparison example (fit): detector view **FINUDA Experiment** Run n.1 2121

![](_page_6_Figure_1.jpeg)

![](_page_6_Figure_2.jpeg)

## A comparison example (hits): vertex view

![](_page_7_Figure_1.jpeg)

## A comparison example (P.R.): vertex view

![](_page_8_Figure_1.jpeg)

![](_page_9_Figure_0.jpeg)

## A comparison example (back-tr.): vertex view

#### Region Of Interest

![](_page_10_Figure_2.jpeg)

## Event-by-event analysis: work in progress...

- The same job has to be done for <sup>12</sup>C and finished for <sup>7</sup>Li
- A selection criterion for the background rejection does not clearly result from the visual analysis, but it has to be fixed and applied to the events (for example 3 or more hits not related to a track in the same μ-strip, or similar...)
- In the meanwhile, we are writing down detectors information for each examined event
  - Particular care is given to information *not stored in the "final" n-tuples* (i.e. # of fired TOFINO & μ-strips, # of hits per μ-strip, and so on) → Long and heavy job...
- A code to write the above information in a *stand-alone n-tuple* is ready; the idea is to use it in order to apply the selection criteria and re-construct  $\pi^+$  spectra (at least in the ROI and in the ROC)

## Inclusive π<sup>+</sup> spectra: Anticoincidence selections

- We tried to apply the following rejection criteria on the π<sup>-</sup> inclusive spectra from the existing production data:
- <sup>12</sup>C target (search for <sup>12</sup><sub>Λ</sub>Be, strong Pauli-blocking, πN decay suppressed):
  - Events with  $\pi^+$   $\pi^-$  coincidence rejected
- <sup>6</sup>Li, <sup>7</sup>Li targets (search for <sup>6</sup><sub>A</sub>H, <sup>7</sup><sub>A</sub>H, weak Pauli-blocking, NN decay suppressed):
  - Events with π<sup>+</sup> p coincidence rejected (p momentum > 200 MeV/c, in order not to reject π-p decays)
- <sup>12</sup>C, <sup>6</sup>Li, <sup>7</sup>Li targets:
  - Events with "bad" TOFONE times rejected (at least one TDC = 0 or prompt π<sup>+</sup> time too long)

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## Example: results for target 1 (<sup>12</sup>C)

![](_page_13_Figure_1.jpeg)

## Example: results for target 1 (<sup>12</sup>C)

![](_page_14_Figure_1.jpeg)

## Example: results for target 1 (12C)

![](_page_15_Figure_1.jpeg)

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## **General considerations**

- The spectra behaviour shown before is the same for all the examined targets (1,2,3,5,8)
- Well-known problems on the spectra produced in the July production
- Very few events with 2 or more reconstructed tracks → the π<sup>+</sup> - π<sup>-</sup> (<sup>12</sup>C target) or π<sup>+</sup> - high momentum p (<sup>6</sup>Li, <sup>7</sup>Li targets) coincidences to reject are very few too

→ no significant difference between blue and red spectra

- $\rightarrow$  very low background rejection power at present
- The condition of "good" TOFONE values is essentially
   equivalent to the condition on TOF used for the π<sup>+</sup> identification
   → no significant difference between blue and green spectra

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## An improved analysis:

![](_page_17_Figure_1.jpeg)

## Work in progress & Prospects

#### **1)** Event-by-event analysis:

- Detailed vertex information to be made "visible" to be handled
- Selection criterion to be fixed and applied
- **2)** Inclusive spectra analysis:
  - Better reconstruction efficiency needed (anyway, we already have good upper limits for the neutron-rich hypernuclei formation probability...)
- We are studying some possible improvements in the reconstruction code that can help us for the specified tasks
- Analysis will take advantage also from the foreseen reconstruction code developments (alignments...)
- ▲ Monte Carlo has been improved to allow background simulation for all the targets (thanks to Barbara Dalena & Stefano Piano)
  →  $\pi^+$  background subtraction in study

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