GiBUU Simulation for Antiproton Nucleus Collision

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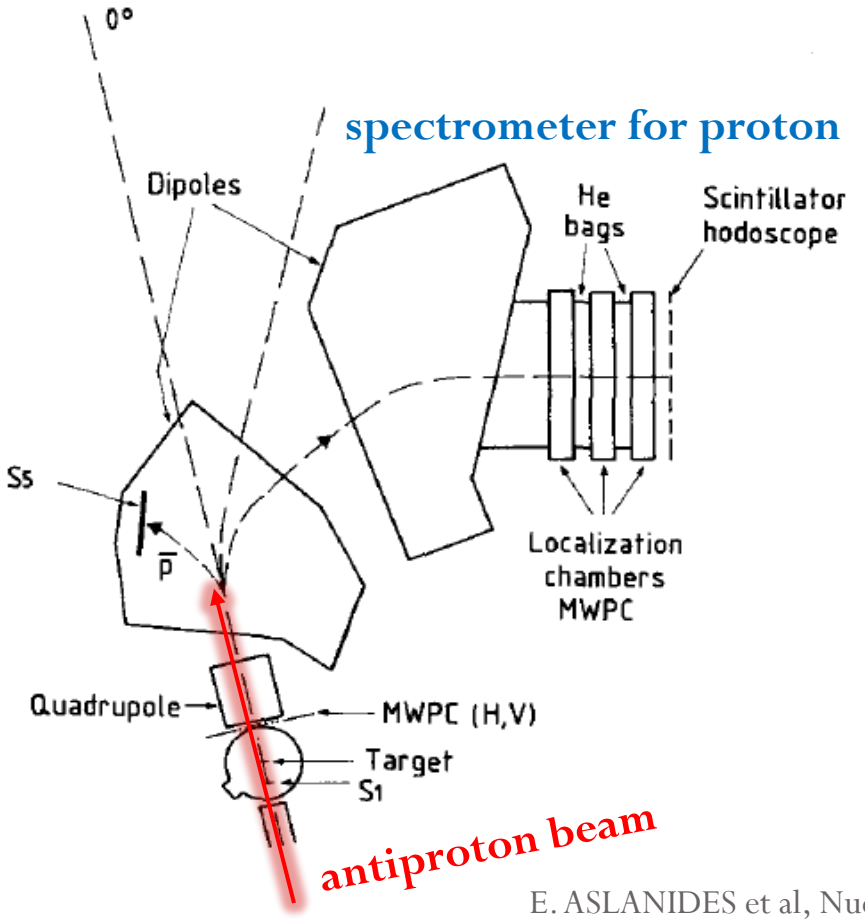
Outline

1. Introduction
2. GiBUU simulation
3. Outlook

1. Introduction

- Antiproton nucleus collision – LEAR experiment in 1980s @CERN



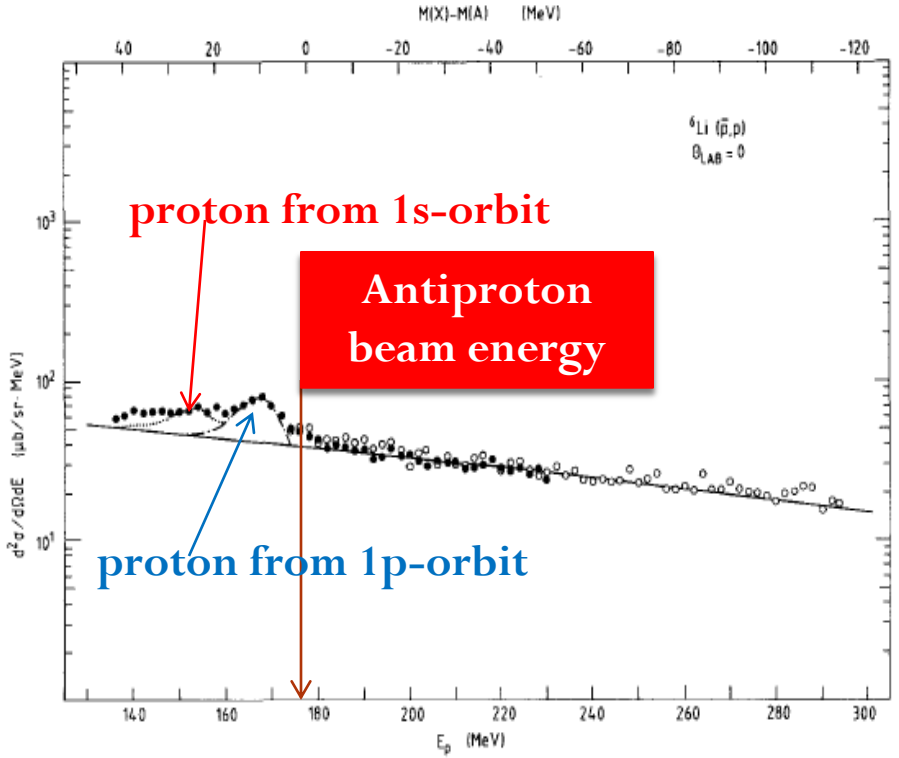


Fig. 2. Double differential cross sections for the ^{6}Li(p̄, p)X reaction at $E_p = 177.9$ MeV. The full line corresponds to an average temperature $T = 101$ MeV. The dash-dotted line is the result of a quasi-free scattering calculation corresponding to an effective proton number $N_{eff} = 0.15$. The dotted line represents the contribution of the quasi-free scattering on 1s-shell protons with an effective proton number 0.09.

E. ASLANIDES et al, Nucl. Phys. A470(1987)445-460

1. Introduction

- **GiBUU** – **Gi**eßen **B**oltzmann-**U**ehling-**U**hlenbeck

The GiBUU project

The **GiBUU project** is aiming to provide an unified transport framework in the MeV and GeV energy regimes for

- **elementary reactions on nuclei**, as e.g.
  - **electron** + A,
  - **photon** + A,
  - **neutrino** + A,
  - **hadron** + A (especially **pion** + A and **proton** + A)

p-bar + A

- and for **heavy-ion collisions**.

For those reactions, the flow of particles is modelled within a Boltzmann-Uehling-Uhlenbeck (BUU) framework. The relevant degrees of freedom are **mesons** and **baryons**, which propagate in mean fields and scatter according to cross sections which are tuned to the energy range of 10 MeV to more than 10 GeV. In the higher energy regimes the concept of **pre-hadronic** interactions is implemented in order to realize *color transparancy* and *formation time* effects. For a general overview of the model, please refer to our recent review paper:

Transport-theoretical Description of Nuclear Reactions
O. Buss, T. Gaitanos, K. Gallmeister, H. van Hees, M. Kaskulov, O. Lalakulich, A. B. Larionov, T. Leitner, J. Weil, U. Mosel
Phys. Rept. 512 (2012) 1-124 Inspire arXiv:1106.1344

- Boltzmann-Uehling-Uhlenbeck Equation:

$$\left(\partial_t + \nabla_p H \cdot \nabla_r - \nabla_r H \cdot \nabla_p\right) f_i(r,p,t) = I_{coll}[f_i, f_N, f_\pi, f_\Delta, \cdots]$$

$$H = \sqrt{[M + U(\boldsymbol{r}, p)]^2 + \boldsymbol{p}^2}$$

1.http://gibuu.physik.uni-giessen.de/GiBUU/ 2.T. Leitner et al, ACTA PHYS.POL.B 40(2009)2585-2592

2. GiBUU simulation

- The productions of pbarA collision

  mesons: $pi^{\pm}$, pi^{0}; $K^{\pm}$, K^{0}; ω; ……

  baryons: N, Δ, Ω, Σ, ……

- Interested event:

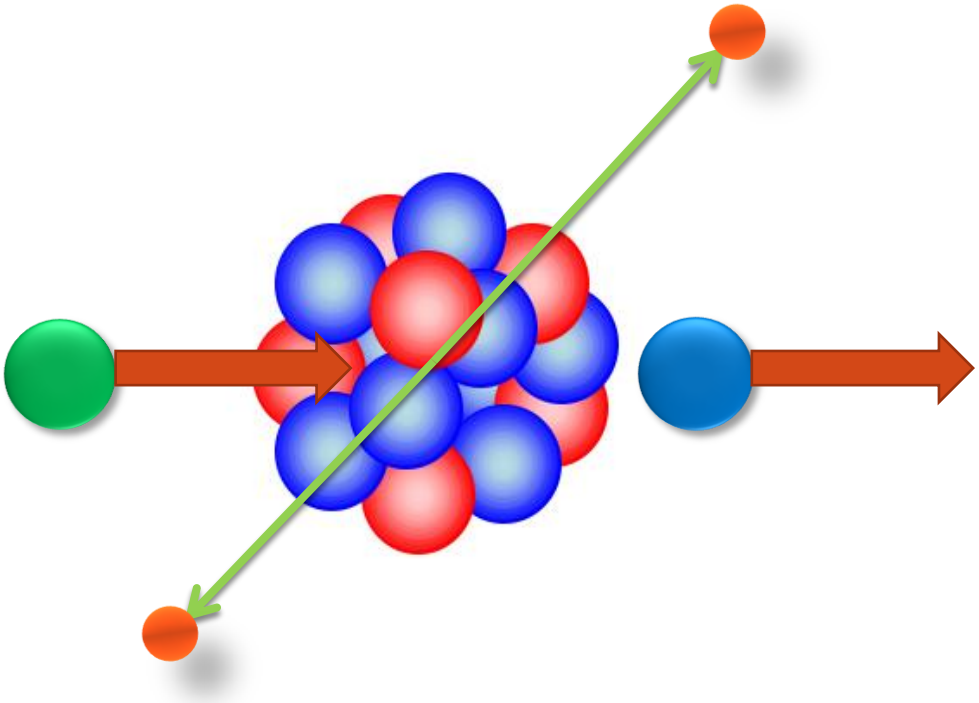
1.cutting condition one:

one knocked-out proton

2.cutting condition two:

two mesons emitted

back to back



2. GiBUU simulation

- the event from GiBUU

antiproton beam energy: 1.5GeV; target: ^{16}O

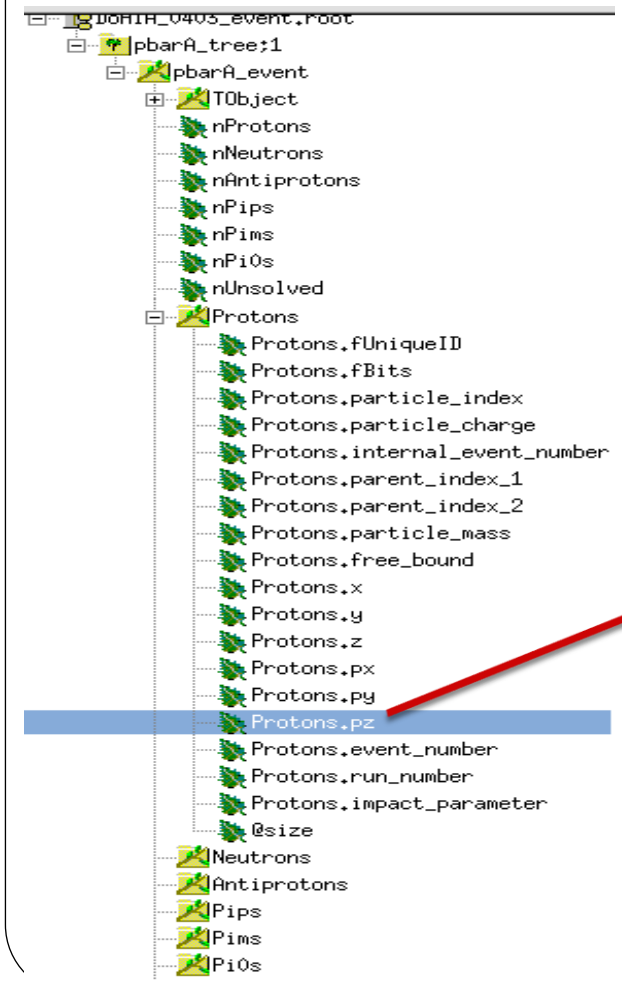
Both in laboratory frame

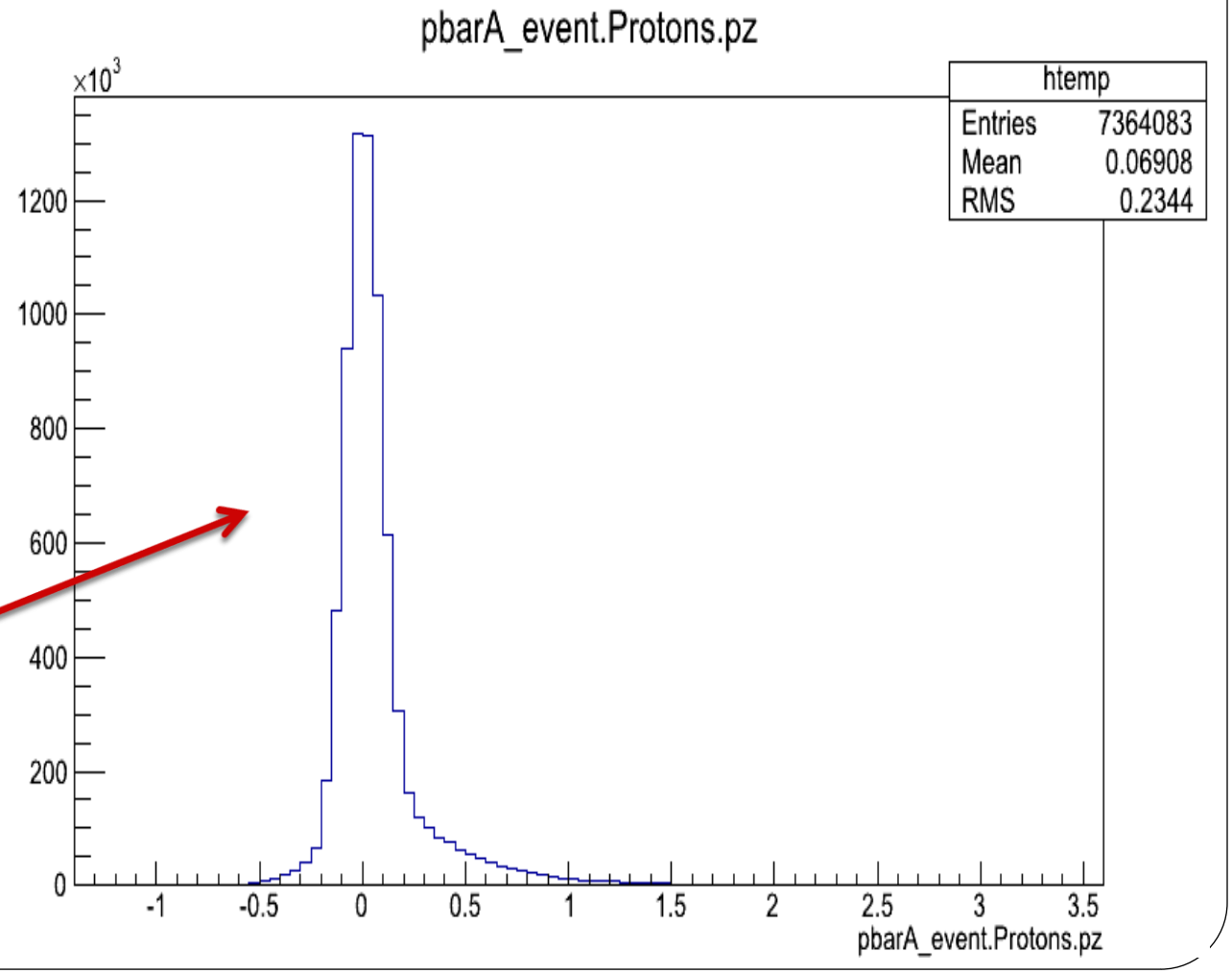
particle ID & charge | parent ID 1 &2 | position (x, y, z) | momentum (p_x, p_y, p_z)

101	0	1151690	2	0	0.138	1	-55.381	-33.112	63.148	-0.509	-0.309	0.571	504	9	0.00
101	-1	1157087	2	0	0.138	1	48.545	28.394	50.765	0.152	0.098	0.170	504	9	0.00
1	0	17	0	0	0.938	0	1.304	-2.098	1.028	-0.034	0.047	0.098	505	9	0.00
1	1	17	0	0	0.938	0	2.329	-0.709	0.298	0.151	0.068	0.050	505	9	0.00
101	1	1156215	103	0	0.138	1	12.107	78.949	-9.835	0.069	0.495	-0.084	505	9	0.00
1	1	17	0	0	0.938	0	2.498	1.295	0.135	0.006	-0.145	-0.000	505	9	0.00
1	1	1153060	1	-1	0.938	1	5.089	-2.184	83.318	0.088	-0.048	2.029	505	9	0.00
1	0	17	0	0	0.938	0	-1.106	1.791	-0.162	-0.093	0.059	-0.001	505	9	0.00
1	0	17	0	0	0.938	0	1.021	1.860	0.590	0.042	-0.197	0.094	505	9	0.00
1	0	17	0	0	0.938	0	-1.212	-0.114	-2.286	-0.089	-0.100	0.080	505	9	0.00
1	1	17	0	0	0.938	0	0.634	-0.482	-1.005	-0.054	0.118	-0.049	505	9	0.00
1	1	17	0	0	0.938	0	-2.897	1.982	0.501	-0.077	-0.104	-0.069	505	9	0.00
1	0	17	0	0	0.938	0	2.670	1.231	3.023	-0.010	0.064	-0.108	505	9	0.00
1	1	17	0	0	0.938	0	-2.689	2.897	1.649	0.060	-0.044	-0.009	505	9	0.00
1	0	17	0	0	0.938	0	-2.051	-0.558	3.066	0.057	-0.036	-0.084	505	9	0.00
1	1	1156531	3	0	0.938	1	-18.428	-24.959	-34.298	-0.229	-0.313	-0.446	505	9	0.00
1	1	17	0	0	0.938	0	-0.237	1.651	-0.772	-0.021	0.087	-0.139	505	9	0.00
1	1	17	0	0	0.938	0	0.335	2.983	1.200	0.135	-0.071	0.035	505	9	0.00
101	-1	1156215	1	-1	0.138	1	-19.209	41.903	-16.795	-0.036	0.078	-0.035	505	9	0.00
101	-1	1154339	2	0	0.138	1	9.839	-19.688	50.262	0.019	-0.038	0.095	505	9	0.00
101	1	1156215	1	-1	0.138	1	-24.062	-14.542	75.502	-0.086	-0.054	0.267	505	9	0.00
101	-1	1156531	3	0	0.138	1	34.533	57.804	38.713	0.117	0.195	0.126	505	9	0.00
101	-1	1156215	103	0	0.138	1	35.382	-32.466	59.548	0.155	-0.163	0.259	505	9	0.00
1	1	1166575	1	1	0.938	0	0.035	-1.361	0.423	-0.098	0.067	-0.117	506	9	0.00
1	0	1165479	1	1	0.938	0	0.784	1.579	0.166	-0.109	0.010	-0.227	506	9	0.00

2. GiBUU simulation

- data analysis with ROOT – select the event





2. GiBUU simulation

- cutting conditions for event selection:

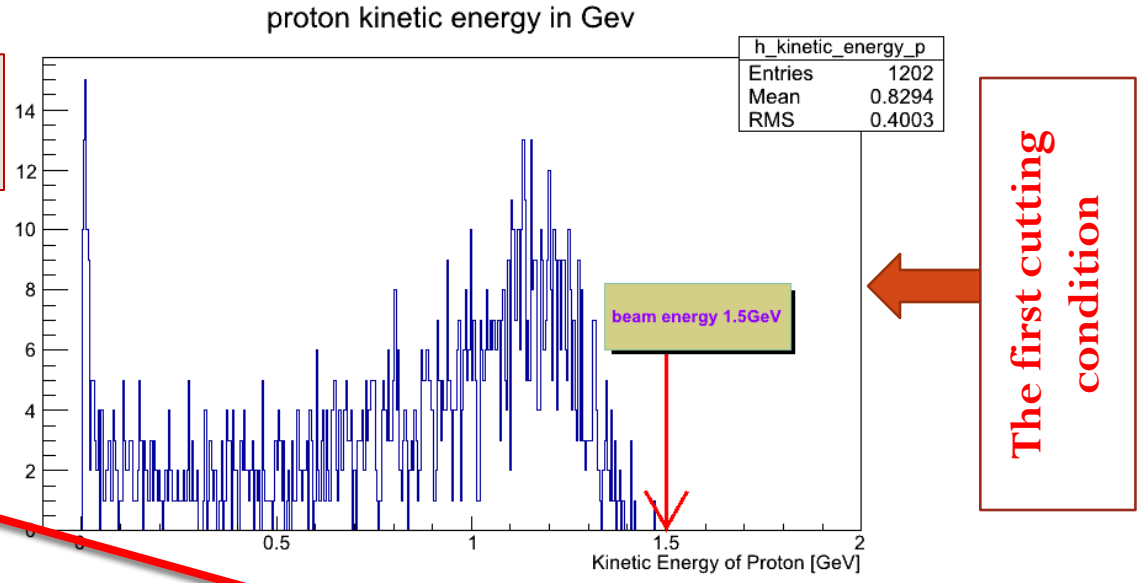
  ① knocked out proton by anti-proton in the forward direction;

  ② two pions { $pi^+ + pi^-$; $pi^0 + pi^0$

- **NO INTERESTED EVENT** was found from around 4million events

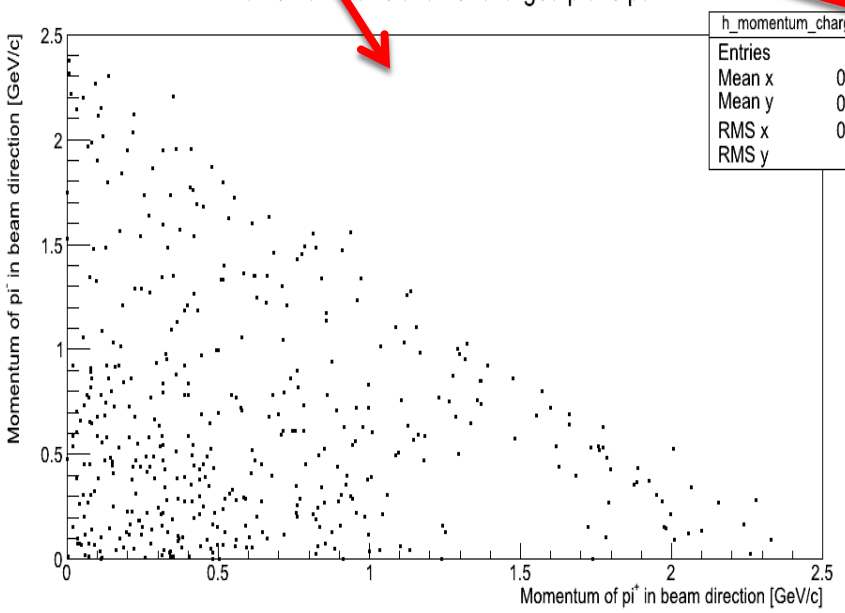
2. GiBUU simulation

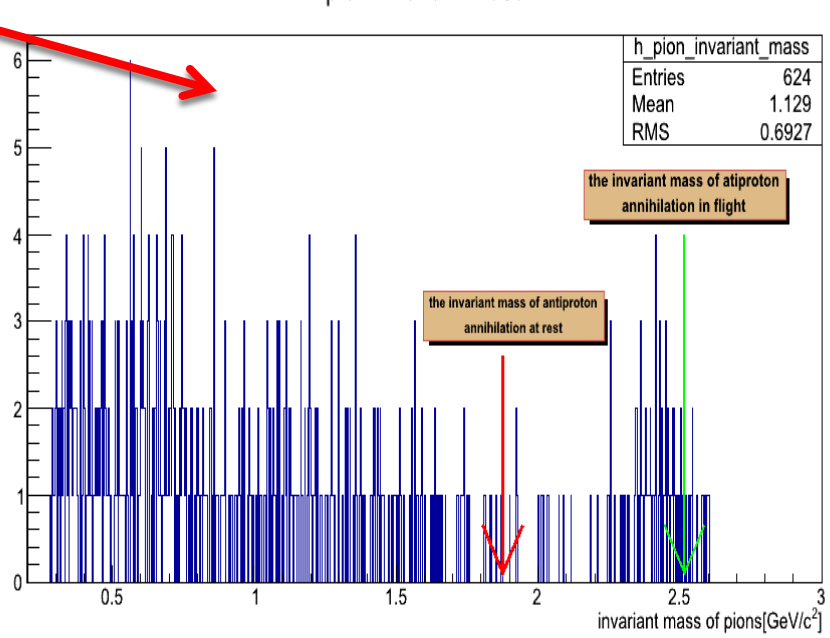
Beam Energy: 1.5 GeV
Target: ^{16}O



The first cutting condition

The second cutting condition





Outlook

- More data from GiBUU simulation

1. simulation using HIMster;
2. kaons pair could be the second cutting condition;

- What is the event?

  one knocked out proton + two mesons emitted back to back & having the invariant mass around 1.876GeV/C^2

- Once getting the event, input the event into PandaRoot by event generator

Thank You !