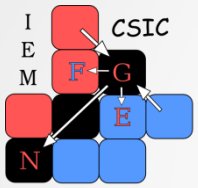

Unbound Beryllium: ^{13}Be

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28th April 2014

The s393 Experiment

- Study light neutro-rich nuclei (Be-Ne), using kinematically complete measurements, and inverse kinematics.

- **Objective**:
  - Studying unbound nuclei ^{13}Be using quasi-free scattering reactions

- $^{40}Ar^{11+}$ Primary beam at 490 MeV/u with an intensity of $6 \cdot 10^{10}$ ions/spill. The production target was Beryllium with 4011 mg/cm^2

$^{14}B(p,2p)^{13}Be$ Knockout reaction

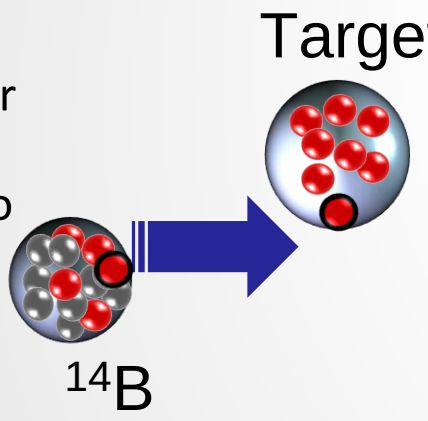
- Direct Reaction:

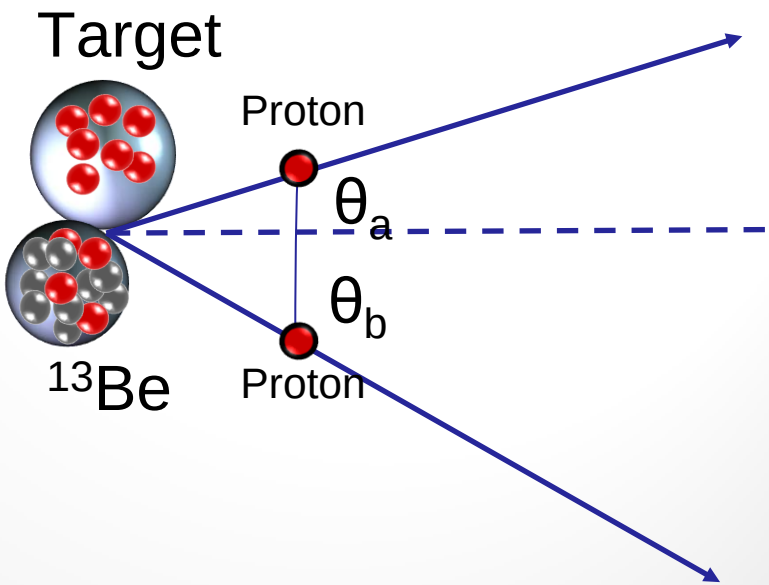
  These reactions occur quickly and proceed directly from initial to final states without producing an intermediate compound state.

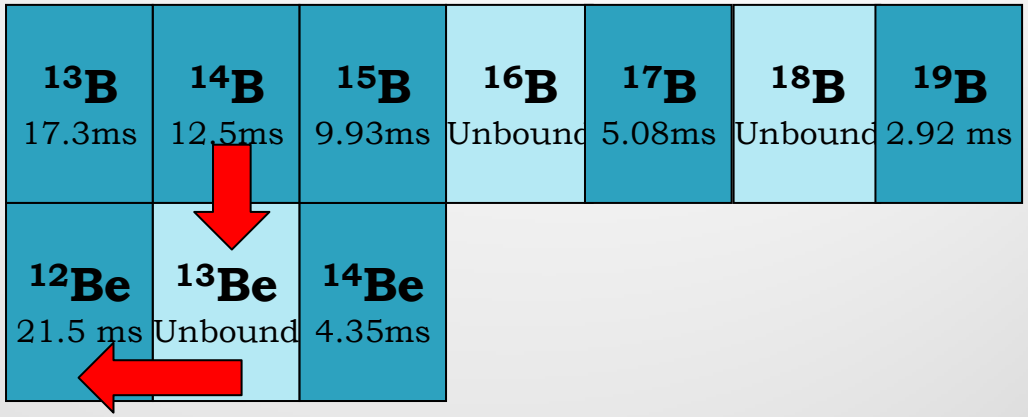
- If both outgoing particles have the same masses, in the lab system.:

$$\theta_A + \theta_B = \frac{\pi}{2}$$

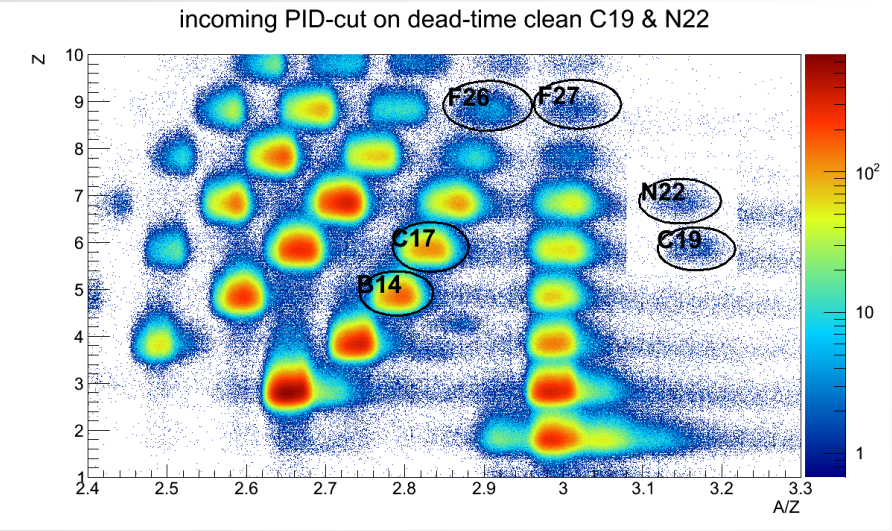
(p,2p), (p,np)







FRS Settings



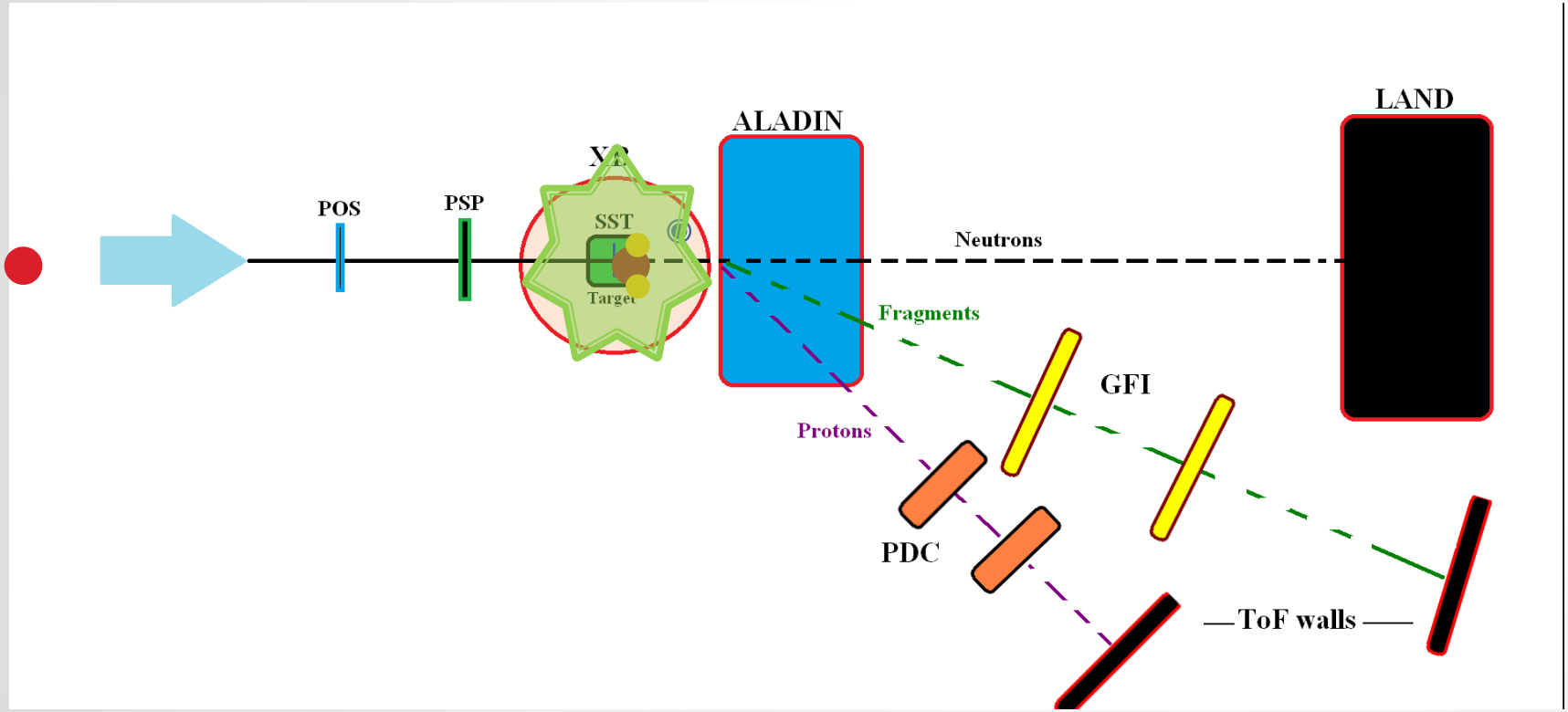
Incoming ion id-plot.

Setting	Run	Data(incoming ^{14}B)	Time	^{13}Be	Incoming/s	^{13}Be/s	production
4	413	$1.21\cdot10^{5}$	7h11m	46	4.68	$1.78\cdot10^{-3}$	$3.80\cdot10^{-4}$
4	414	$1.05\cdot10^{5}$	6h0m	41	4.86	$1.9\cdot10^{-3}$	$3.90\cdot10^{-4}$
4	427	$1.73\cdot10^{6}$	10h26m	542	46.06	$1.44\cdot10^{-2}$	$3.13\cdot10^{-4}$
5	385	$1.47\cdot10^{5}$	2h38m	84	15.51	$8.86\cdot10^{-3}$	$5.71\cdot10^{-4}$
5	386	$1.13\cdot10^{6}$	10h59m	294	30.67	$7.98\cdot10^{-3}$	$2.60\cdot10^{-4}$
5	388	$8.31\cdot10^{5}$	5h15m	235	43.97	$1.24\cdot10^{-2}$	$2.83\cdot10^{-4}$
6	473	$7.06\cdot10^{4}$	7h9m	24	2.74	$9.32\cdot10^{-4}$	$3.40\cdot10^{-4}$
6	480	$1.52\cdot10^{5}$	17h12m	54	2.45	$8.72\cdot10^{-4}$	$3.55\cdot10^{-4}$
6	515	$1.21\cdot10^{5}$	12h39m	47	2.66	$1.03\cdot10^{-3}$	$3.88\cdot10^{-4}$

	setting 4	setting 5	setting 6
A/Z	2.75	2.88	3.0
Example nuclei of interest	^{21,22}O ^{11}Be	^{23}O ^{11}Be ^{17}C, ^{14}B	^{18}C ^{24}O ^{12}Be ^{26,27}F
Target			
Pb	-	-	10
C	2	2	3
Empty	2	2	4
CH2	6	6	10
Setting FRS	1	1	1
	11	11	28

Setting 4≃38 h
Setting 5≃29 h
Setting 6≃113 h

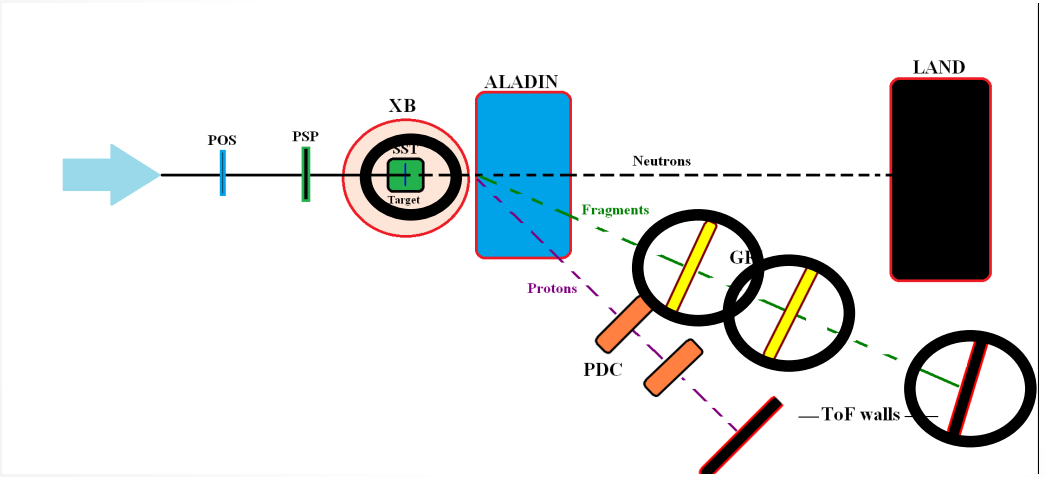
Experiment:Cave C



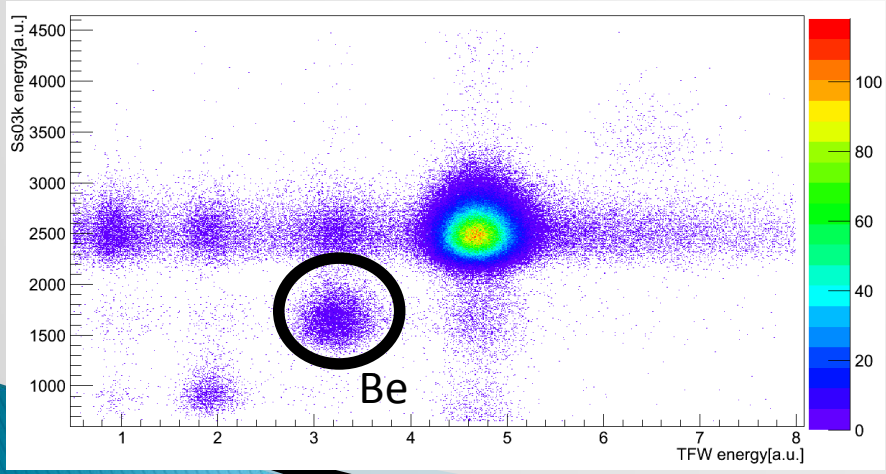
- Inverse & complete Kinematics
- Three targets
  - Protons(CH2)
  - Heavy(Pb)
  - Light (C)

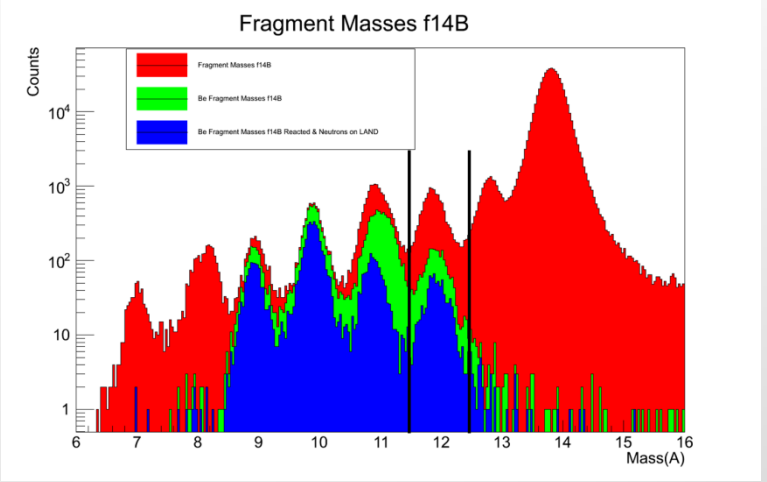
Analysis: Selecting the fragment mass

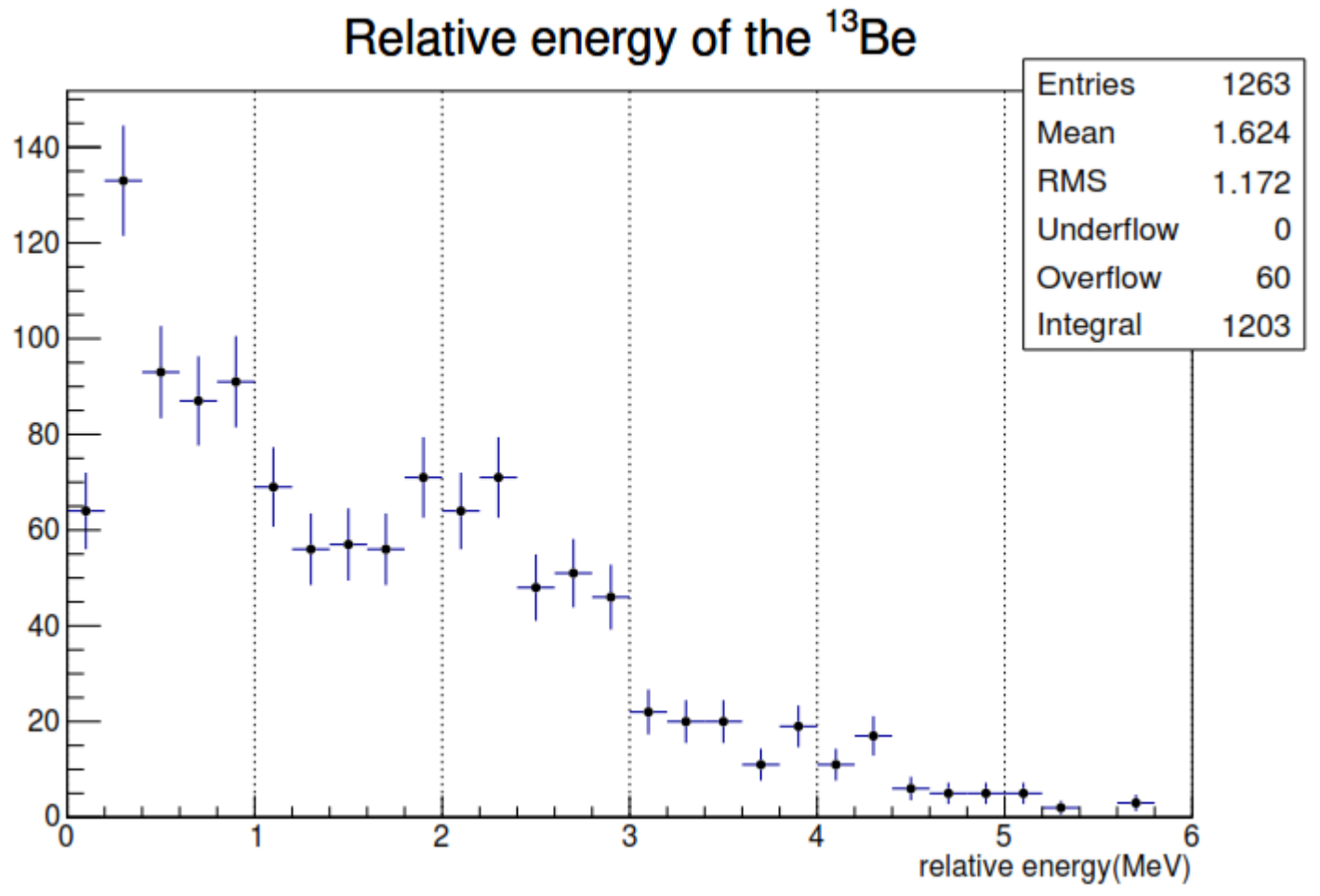
- Energy loss in the TFW & SST after the target: Identify the element after the reaction.
- Identify the isotope from the ALADIN position deviation and beta of the fragment.



From ^{14}B







$$(M_{inv})^2 = \left(\sum E_i\right)^2 - \left(\sum P_i\right)^2 = (M_0 + E_{rel})^2$$

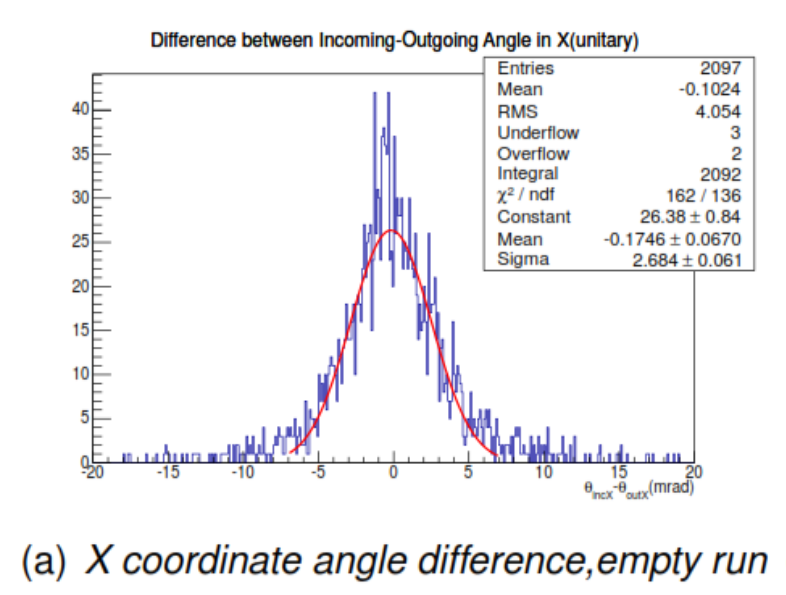
$$E = \gamma m c^2$$

$$p = \gamma m \beta c$$

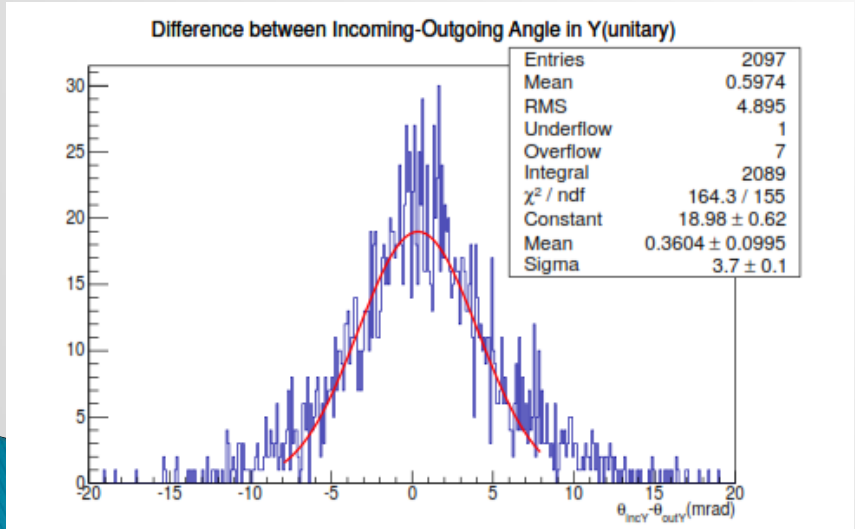
$$E_{rel} = \sqrt{m_n^2 + M_{12Be}^2 + m_n \cdot M_{12Be}\gamma_n\gamma_{12Be}\left[1 - \beta_n \cdot \beta_{12Be} \cdot Cos(\theta_{fra-n})\right]} - m_n - M_{12Be}$$

Outgoing-incoming angle

Empty run

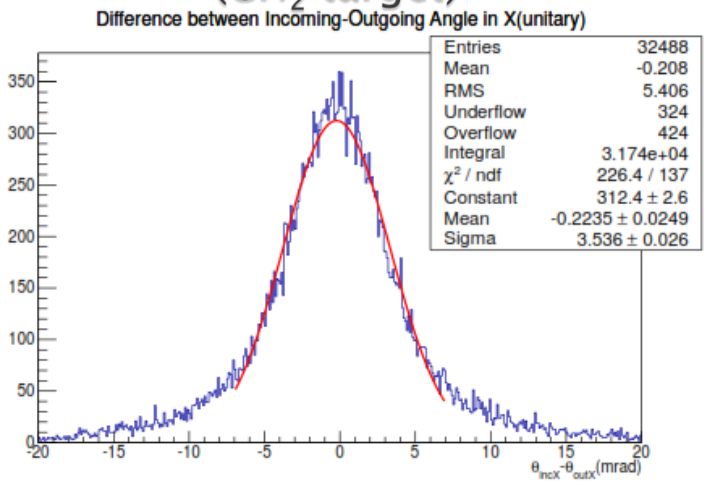


(a) *X coordinate angle difference,empty run*

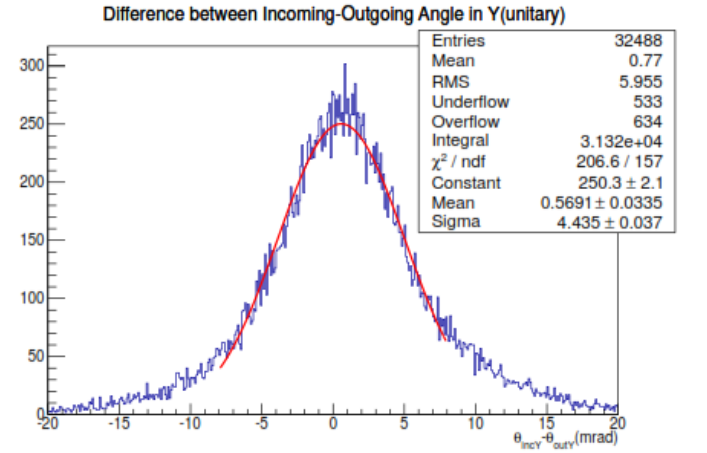


(b) *Y coordinate angle difference,empty run*

Unreacted Beam (CH_2 target)



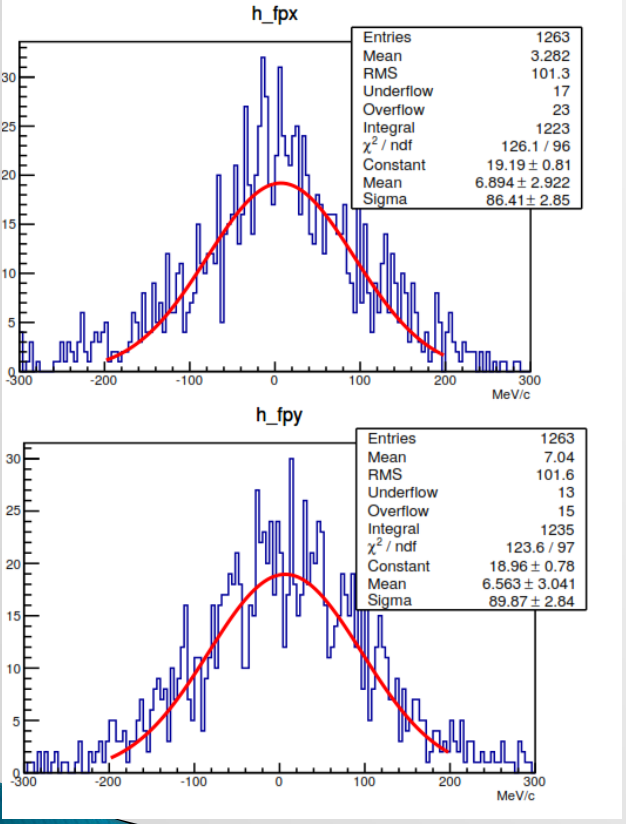
(a) *X coordinate angle difference.Run 427, unreacted beam with CH_2*



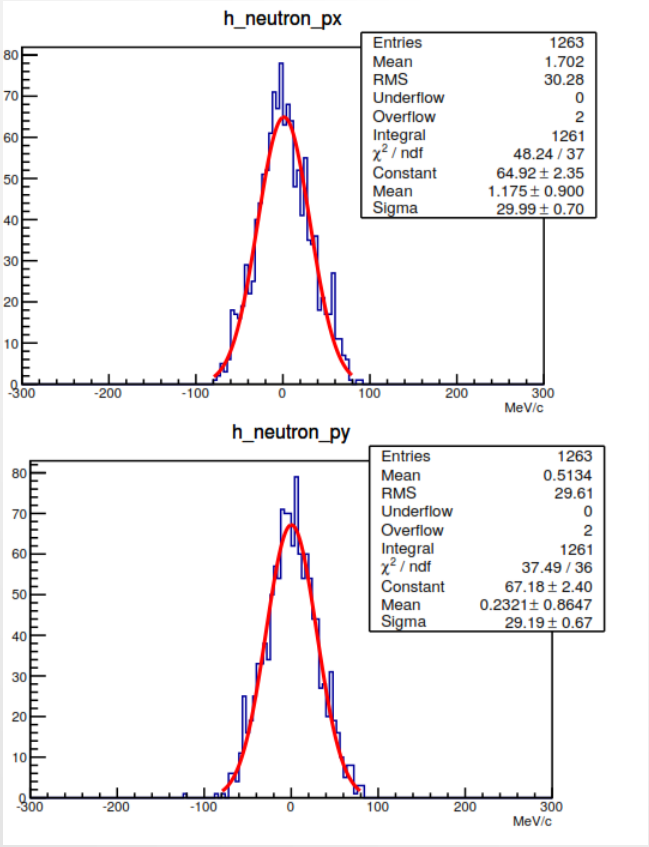
(b) *Y coordinate angle difference.Run 427, unreacted beam with CH_2*

Momentum distribution

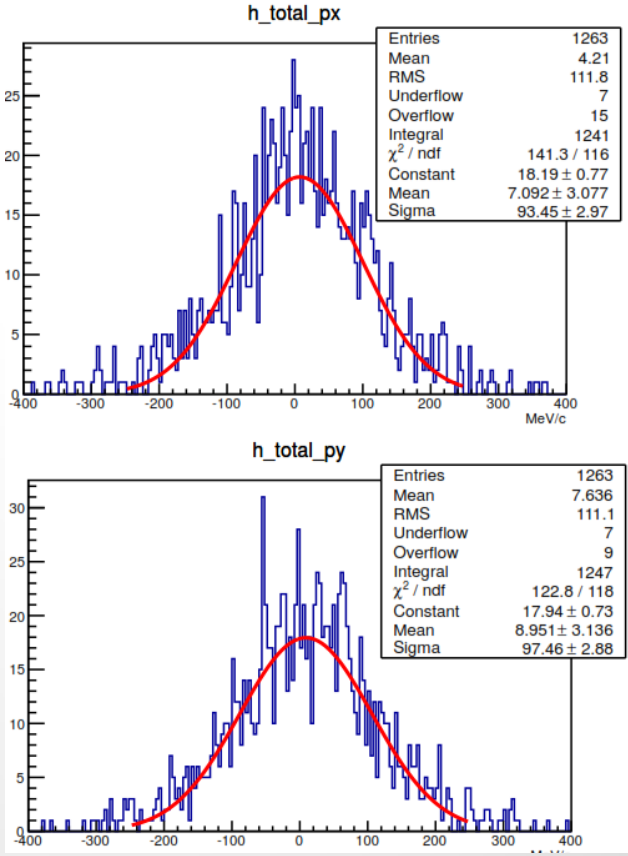
Fragment(^{12}Be)



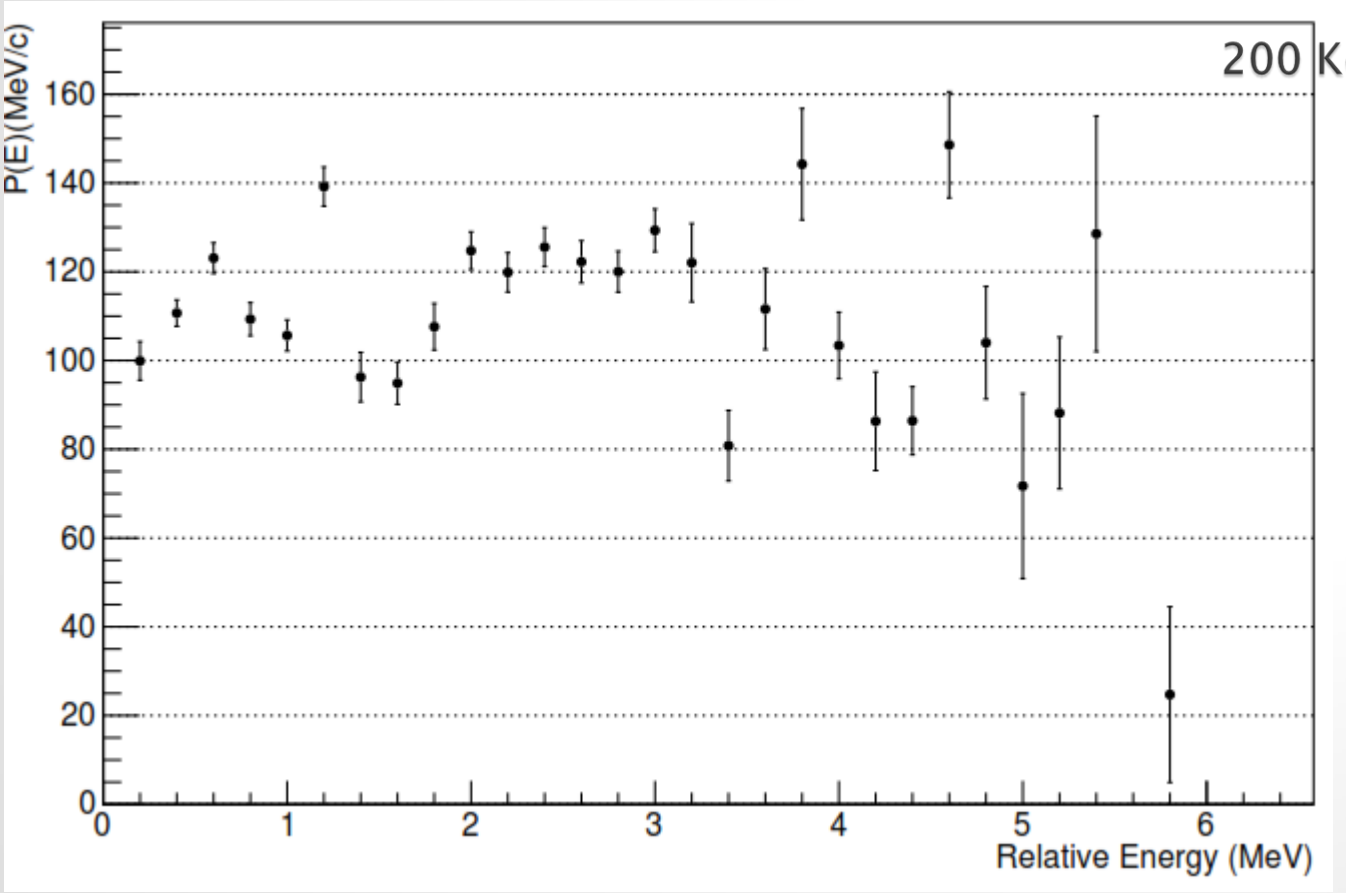
Neutron



Total momentum

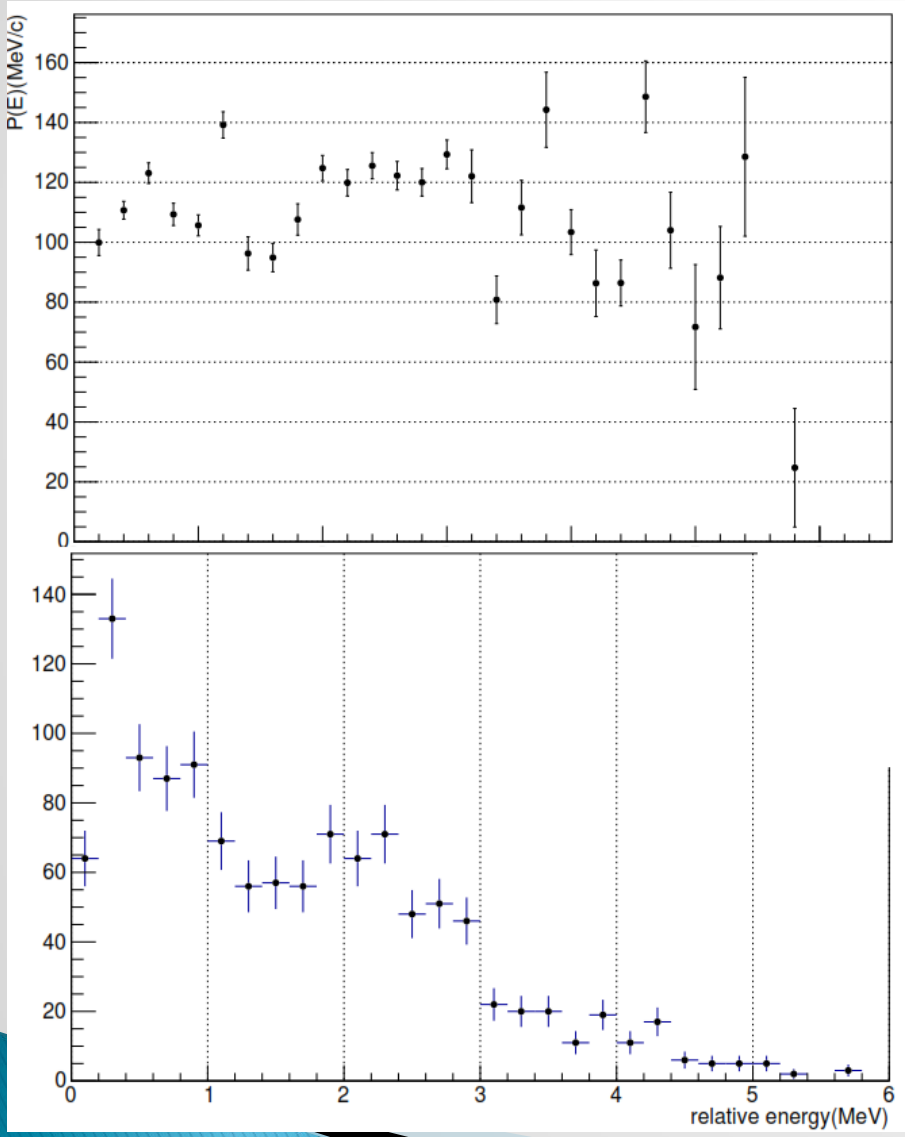


Momentum profile: X coordinate

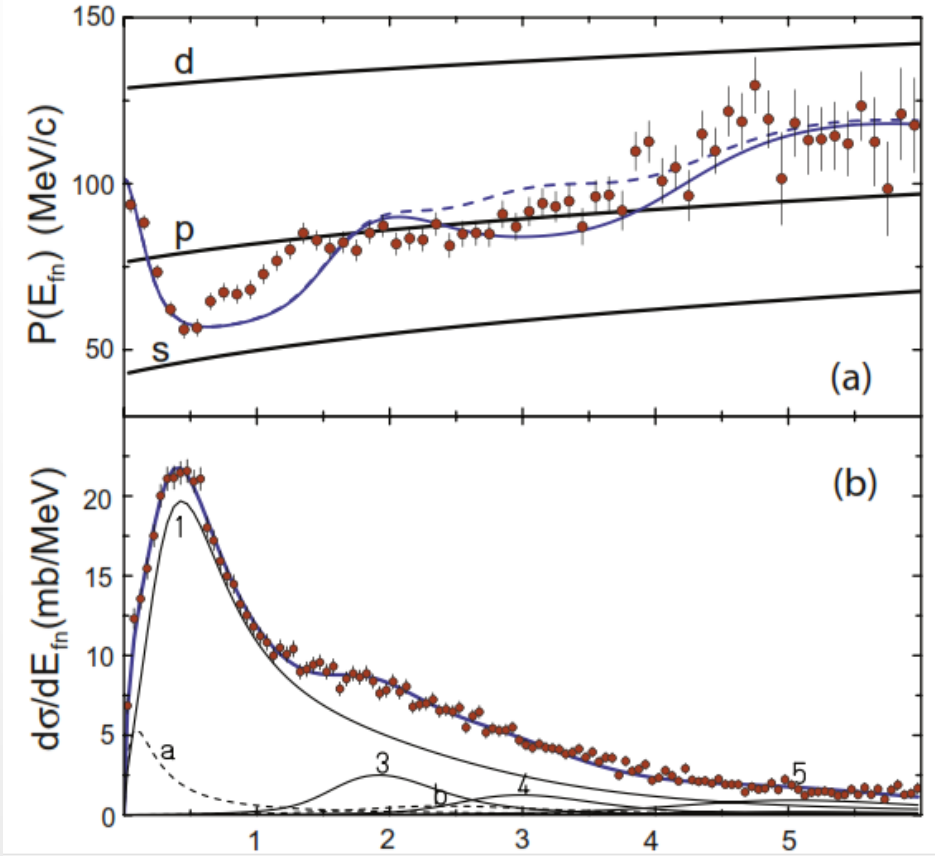


$$P(E) = \sqrt{Var(p)} = \sqrt{< (p_f + p_n)^2 > - < (p_f + p_n) >^2}$$

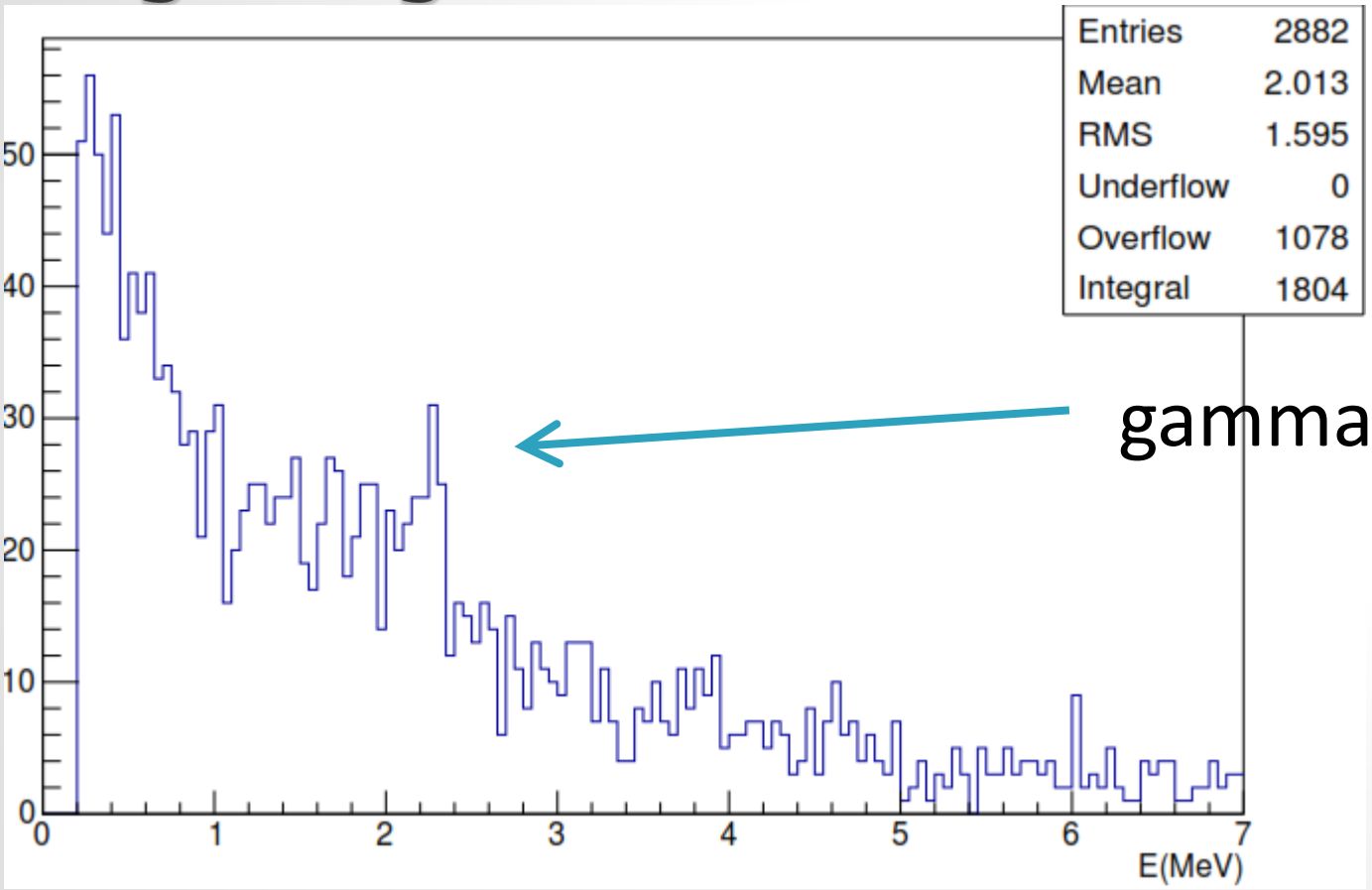
Comparing with previous results



From PRC87 064316(2013)



Looking for gammas of the ^{12}Be: XB

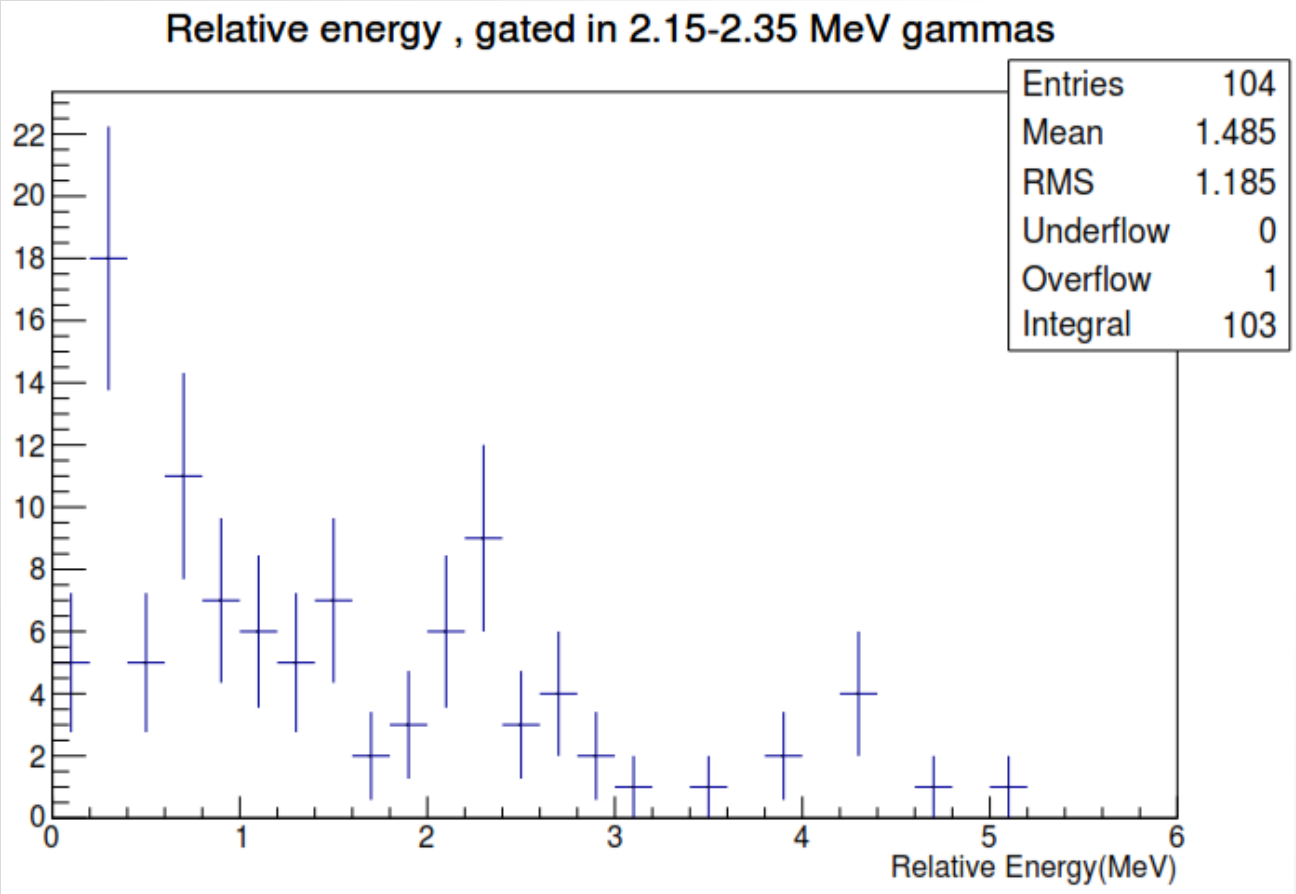


The two main gamma sources are:

- 2^+ state at 2.11 MeV
- 1^- state at 2.71 MeV

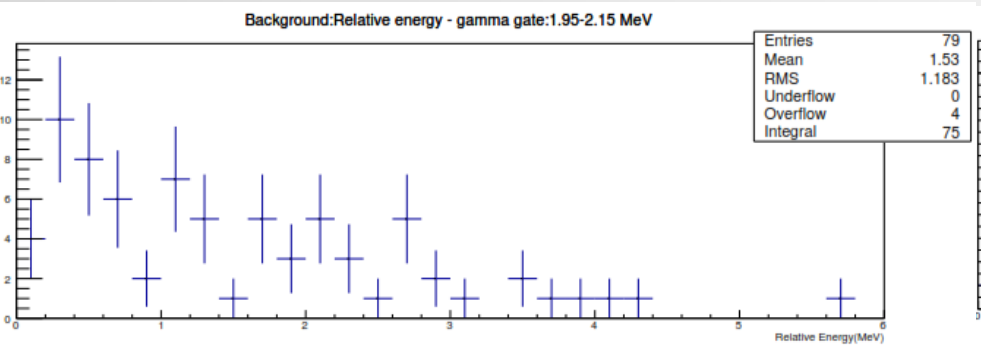
None of them seems like the possible peak showed.

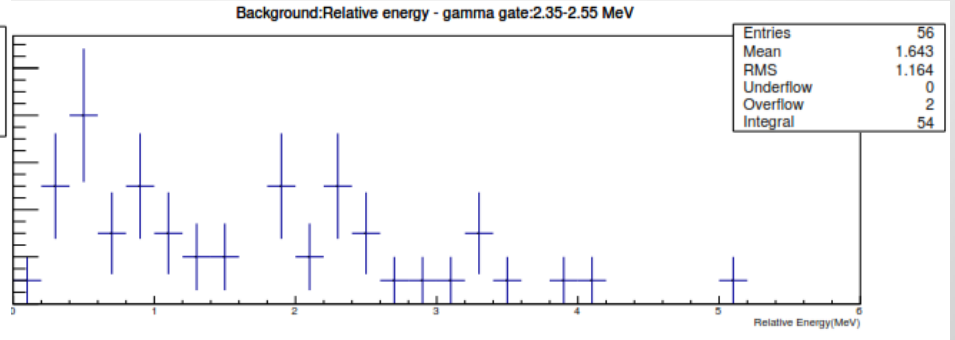
Gamma checking: Energy after gating



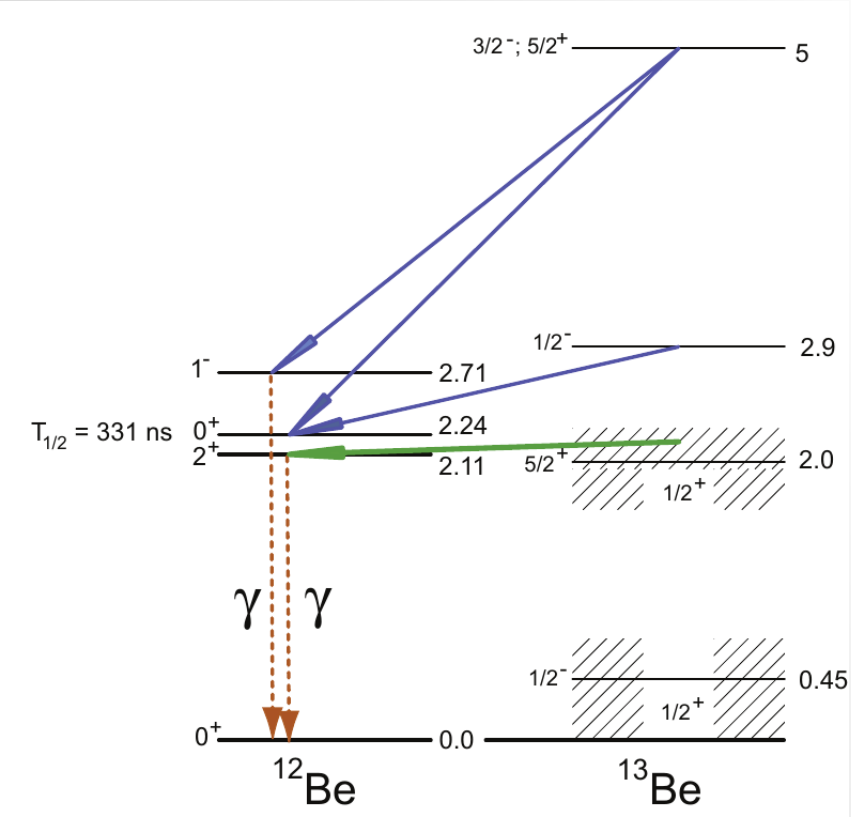
No feature

No gamma





Interpretation



- No gammas → fed the 0^+ of the ^{12}Be
- M. Profile analysis-> Only fed p-d states-> 5MeV or 2.9 MeV state

Next steps

- LAND efficency
- Check the p2p
- Improve interpretation -> Momentum profile analysis theoretical fit
- Fit the possible states to Breitt-Wigner curves on the relative energy plot.
- Suggestions?

Gracias! Tack!