Study of ^{6}He - d reactions at the ACCULINNA-2 separator

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Heavy Ion Laboratory, University of Warsaw

JINR 114 Flerovium FLNR 60 лет! Dubna

NICA days 2019

HIL Heavy Ion Laboratory

OUTLINE

- Flerov Laboratory of Nuclear Reactions

OUTLINE

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- Research motivation

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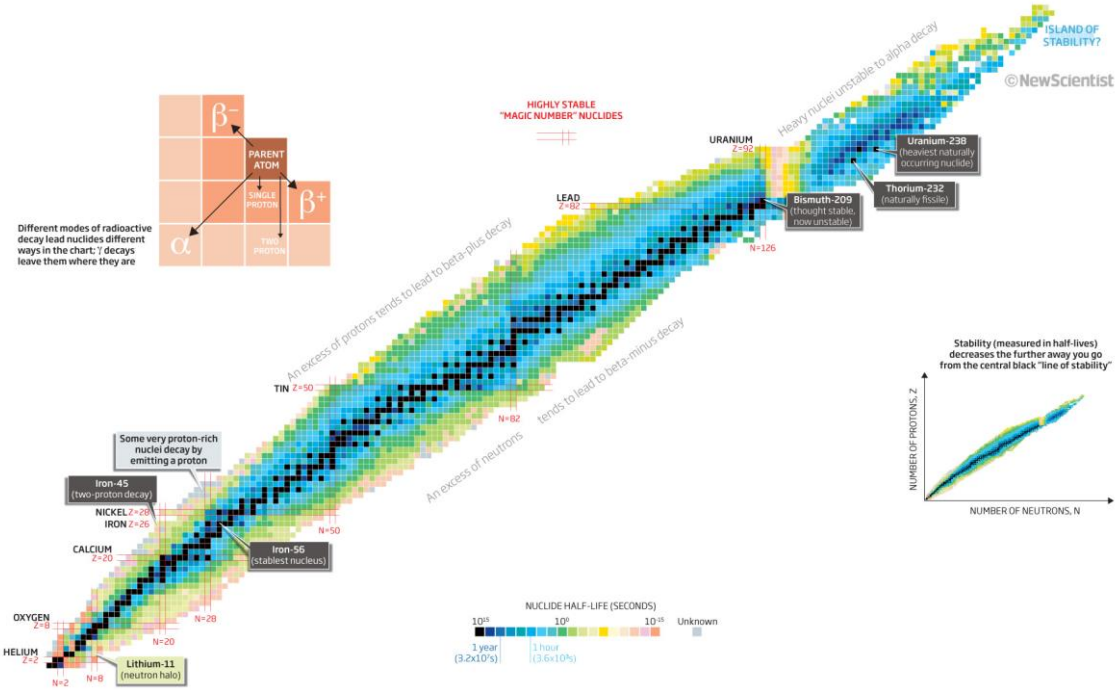
- Conclusions

FLEROV LABORATORY OF NUCLEAR REACTIONS


ISLAND OF STABILITY?
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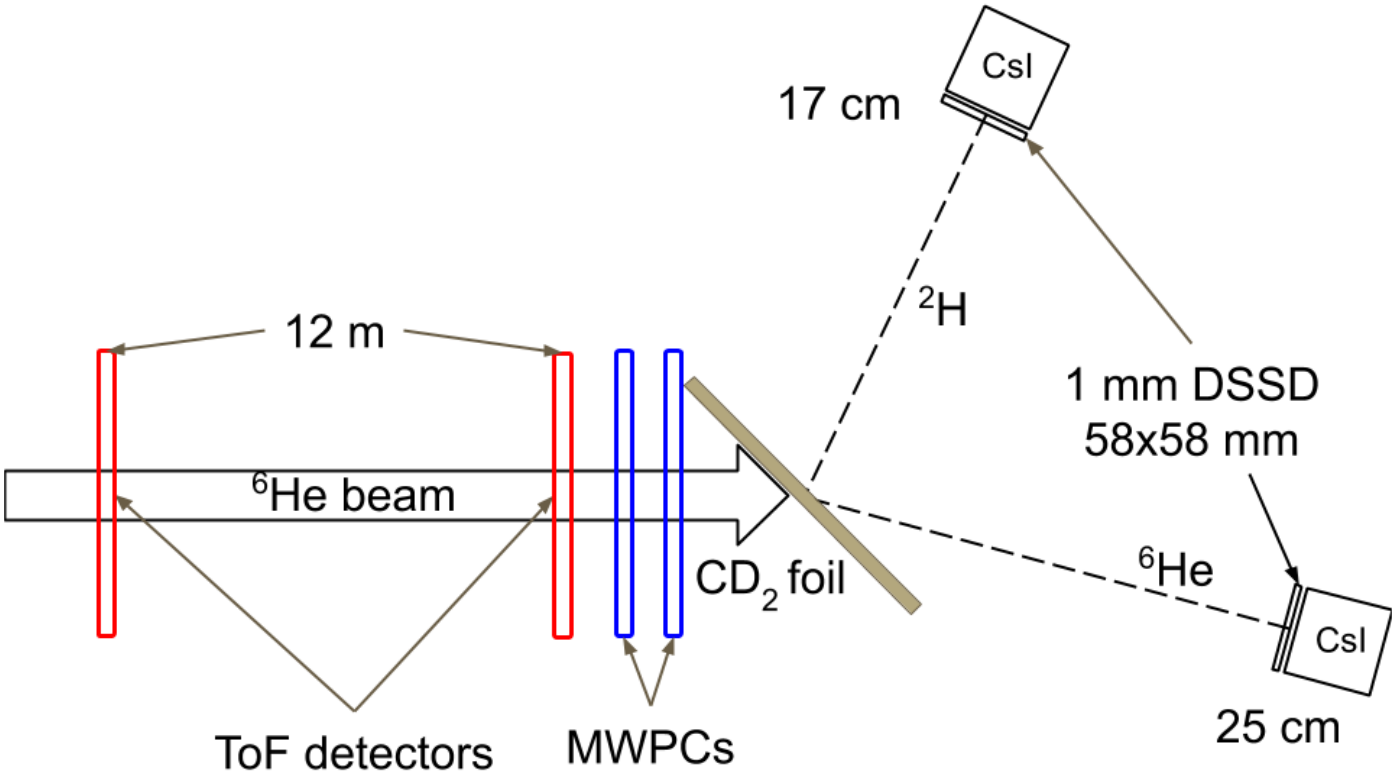
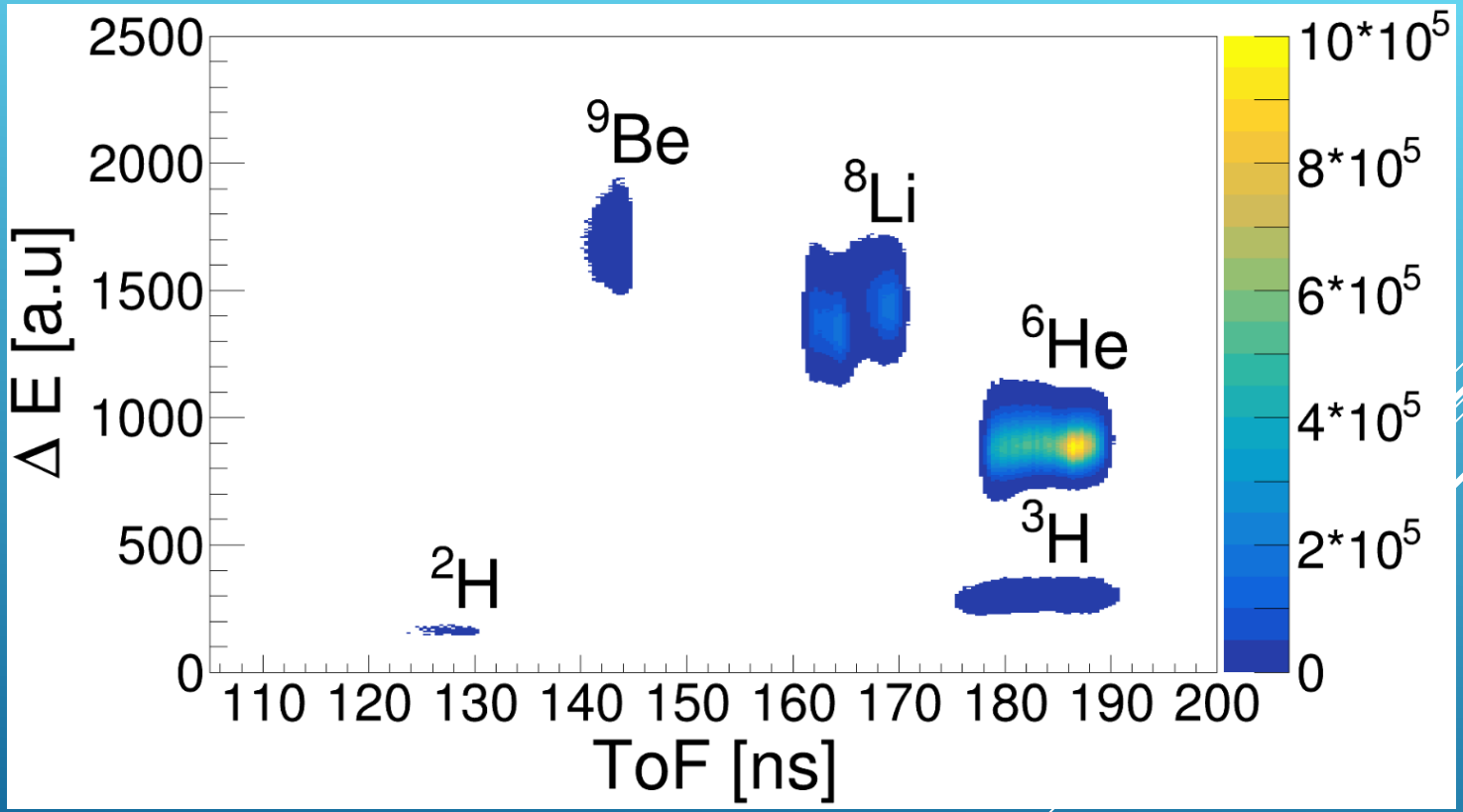
HIGHLY STABLE "MAGIC NUMBER" NUCLIDES
Heavy nuclei unstable to alpha decay
URANIUM Z=92
Uranium-238 (heaviest naturally occurring nuclide)
Thorium-232 (naturally fissile)
LEAD Z=82
Bismuth-209 (thought stable, now unstable)
N=126
β−
PARENT ATOM
SINGLE PROTON
β+
α
TWO PROTON
Different modes of radioactive decay lead nuclides different ways in the chart; γ decays leave them where they are
An excess of protons tends to lead to beta-plus decay
TIN Z=50
N=82
tends to lead to beta-minus decay
An excess of neutrons
Some very proton-rich nuclei decay by emitting a proton
Iron-45 (two-proton decay)
NICKEL Z=28
IRON Z=26
CALCIUM Z=20
Iron-56 (stablest nucleus)
N=50
N=28
N=20
OXYGEN Z=8
HELIUM Z=2
N=2
N=8
Lithium-11 (neutron halo)
Stability (measured in half-lives) decreases the further away you go from the central black "line of stability"
NUMBER OF PROTONS, Z
NUMBER OF NEUTRONS, N
NUCLIDE HALF-LIFE (SECONDS)
10^15
10^0
10^-15
Unknown
1 year (3.2x10^7s)
1 hour (3.6x10^3s)

ACCULINNA 2


CsI
17 cm
^{2}H
12 m
1 mm DSSD
58x58 mm
^{6}He beam
CD_2 foil
^{6}He
CsI
25 cm
ToF detectors
MWPCs

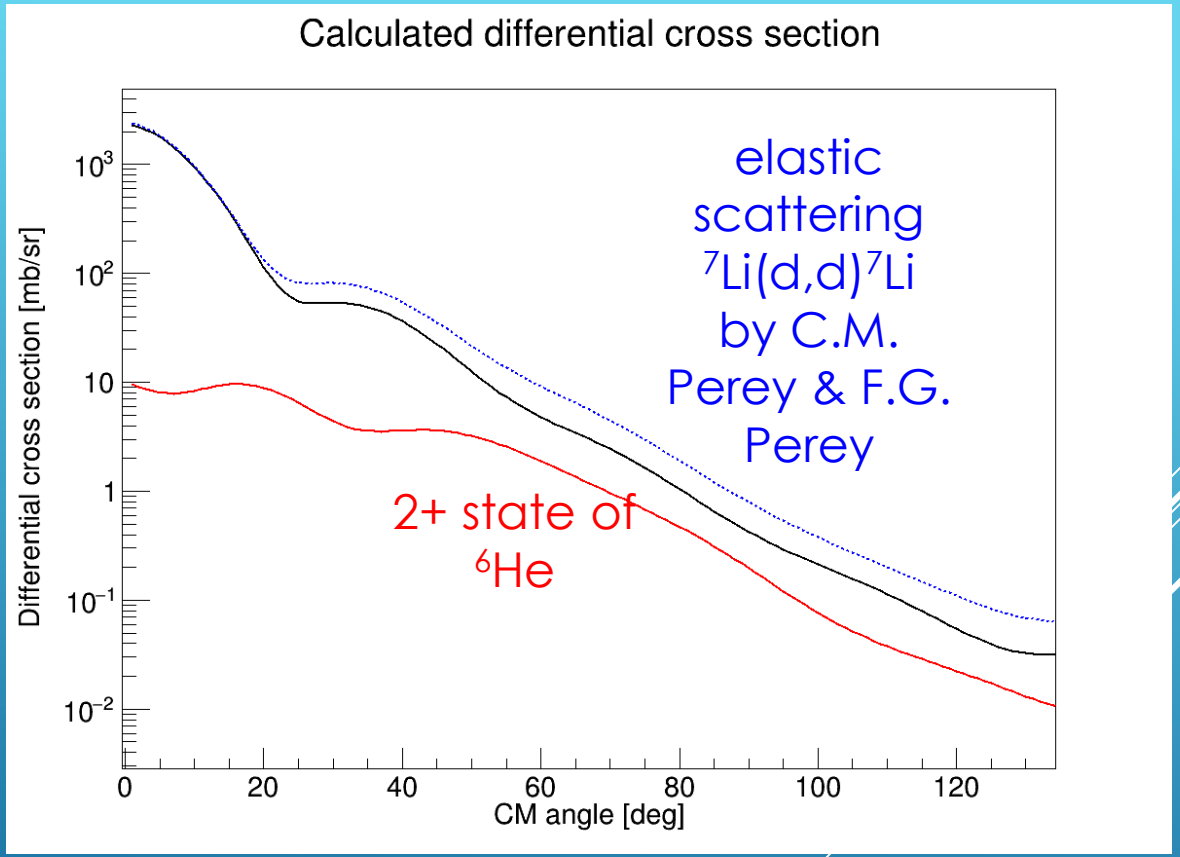
BEAM QUALITY

- 78% of ^{6}He
- 26 AMeV
- 10^{5} pps



Why ^{6}He And Deuterium?

- **Two loosely bound nuclei**



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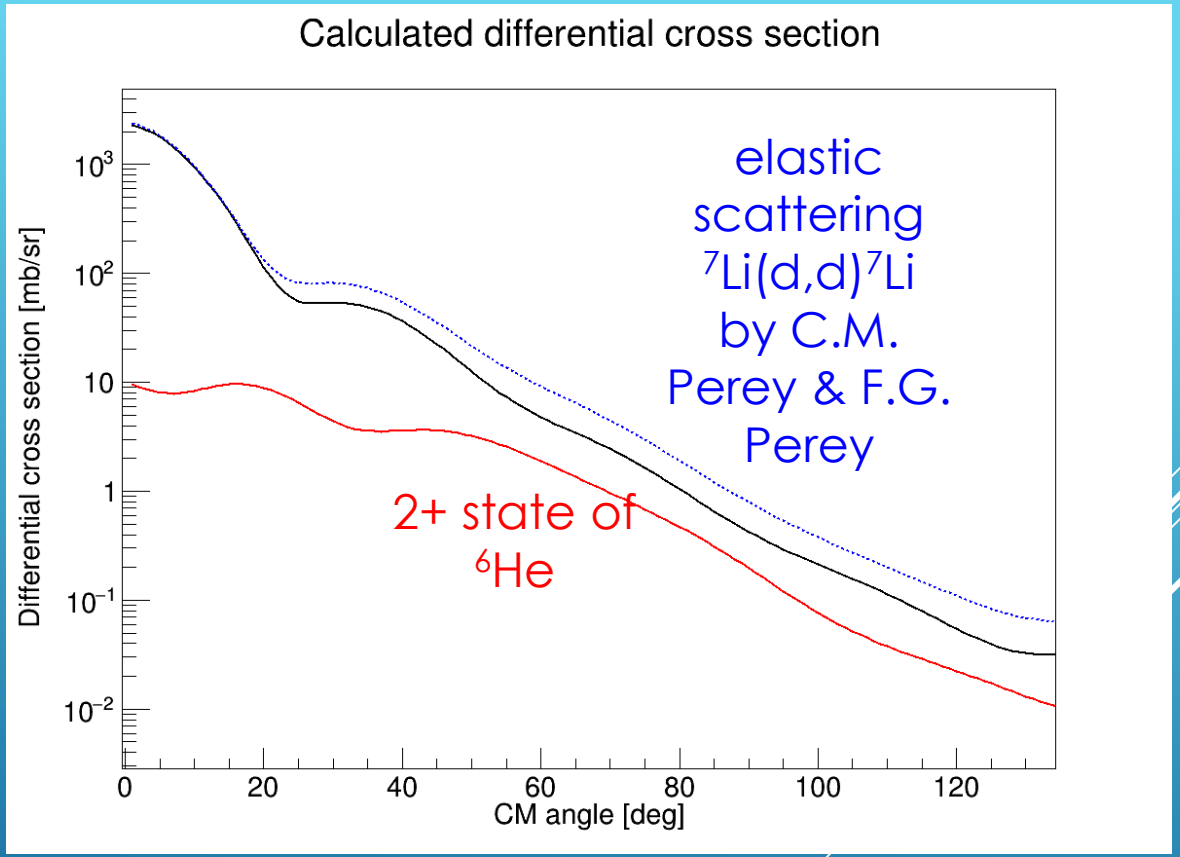

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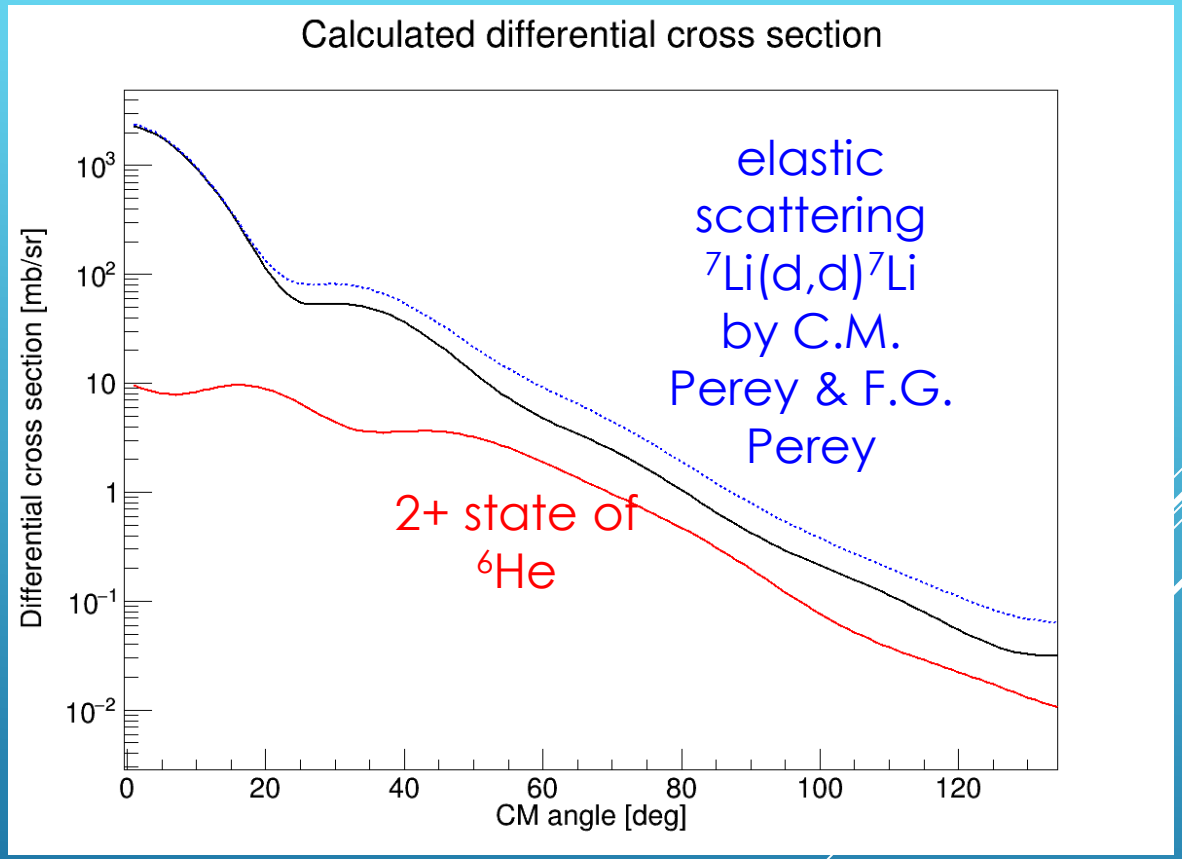
- Comparison with ^{7}Li(d,d)^{7}Li and with ^{6}He(p,p)^{6}He



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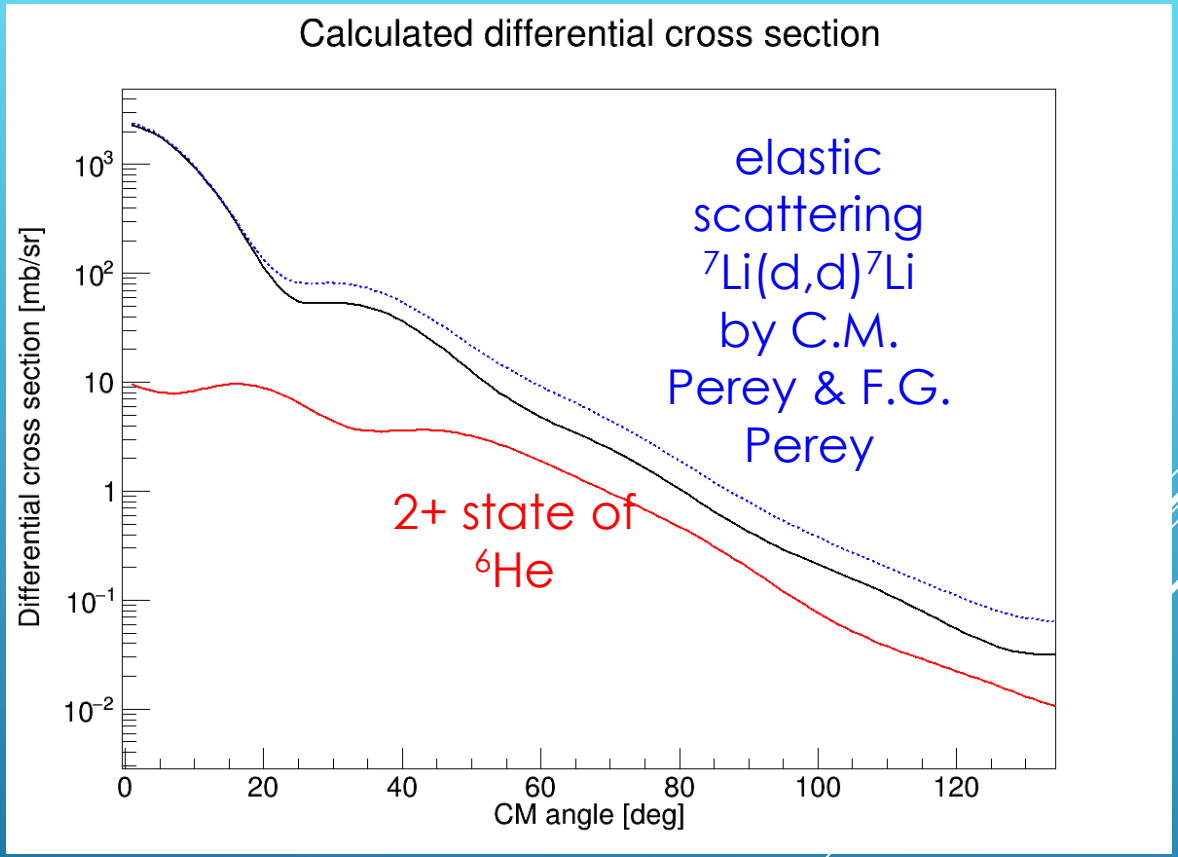

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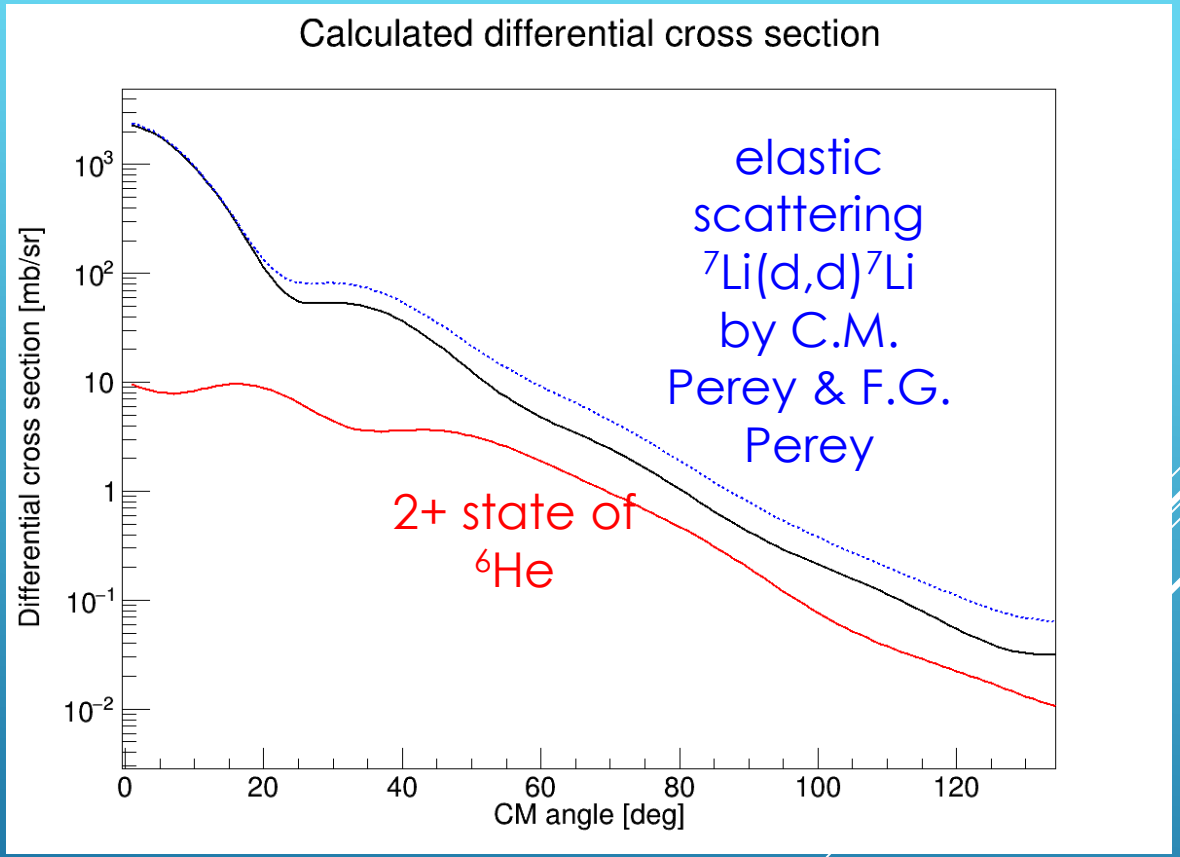
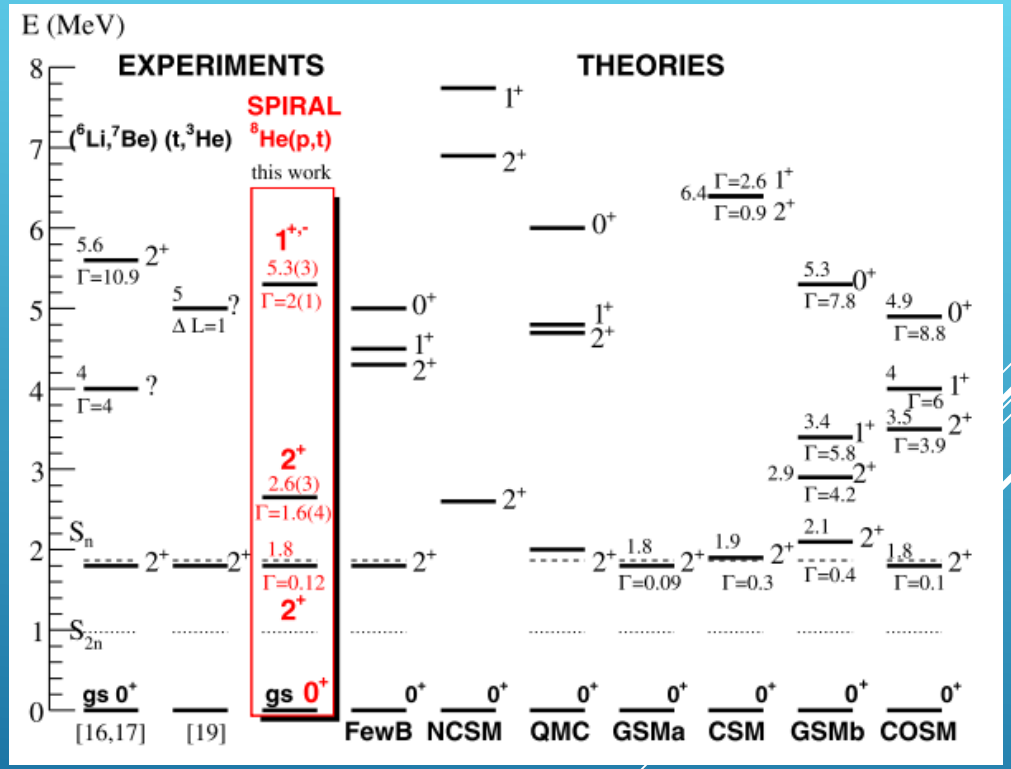
- No data yet



SEARCH FOR 2ND EXCITED STATE OF ^{6}HE

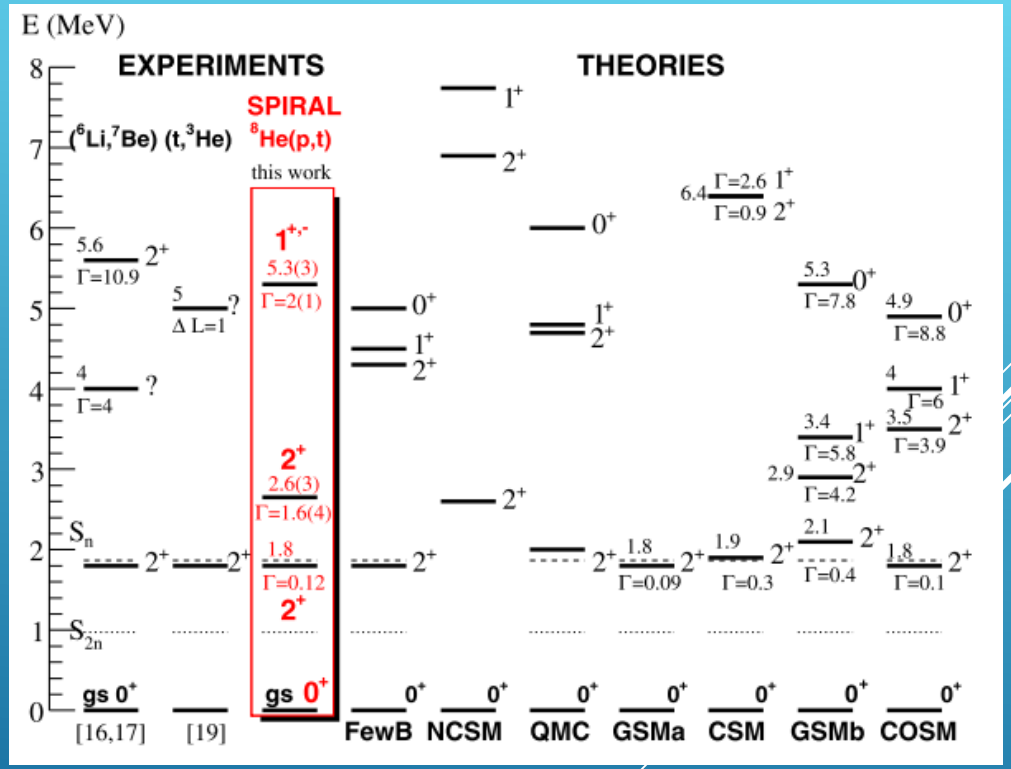
- **No agreement on 2nd excited state energy level**



X.Mougeot et al., Phys.Lett.B 718 (2012) pp. 441-446

SEARCH FOR 2ND EXCITED STATE OF ^{6}HE

- No agreement on 2nd excited state energy level
- Possibility to obtain spectrum of excited states



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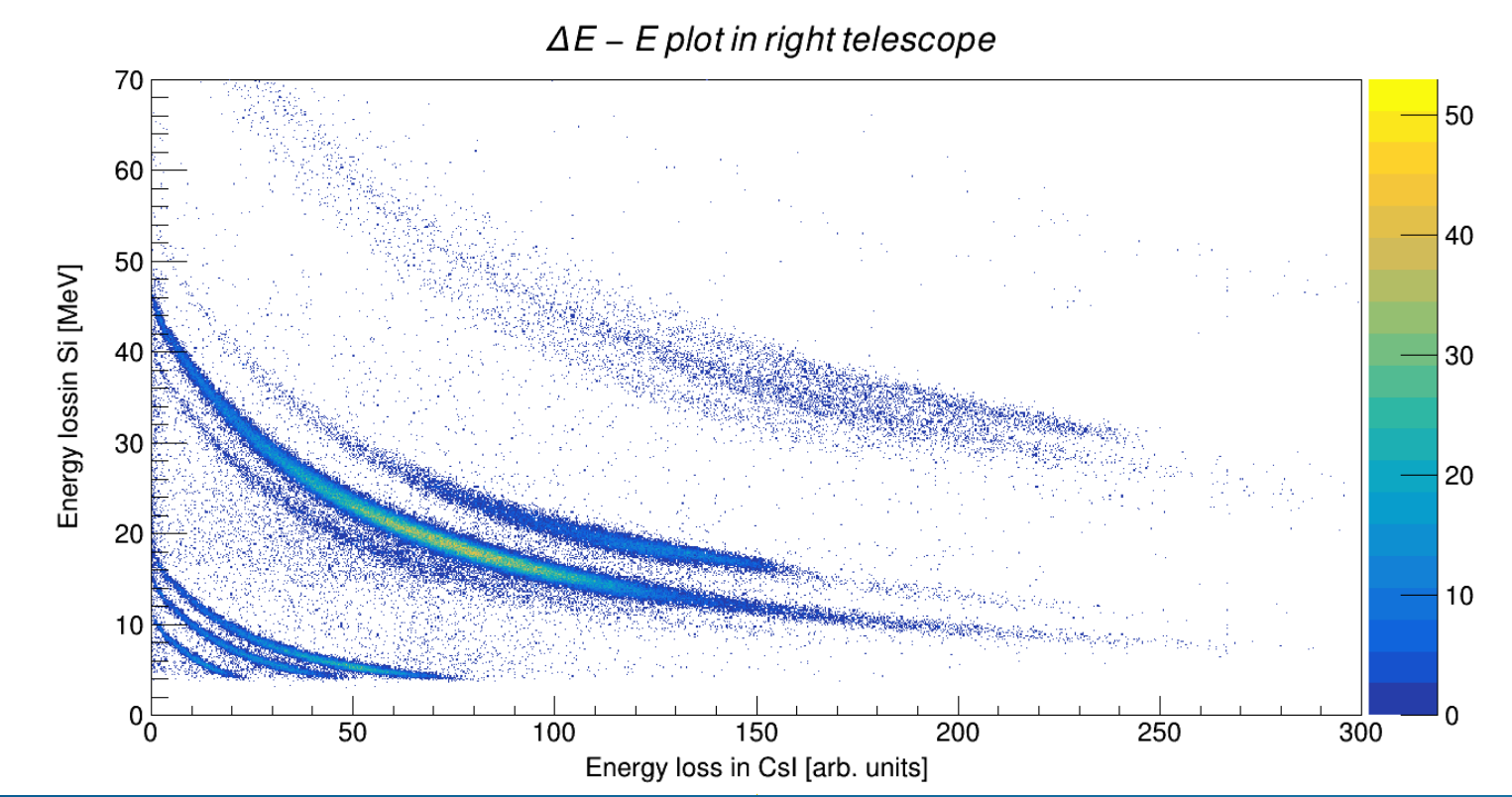
dE-E in the Right Telescope



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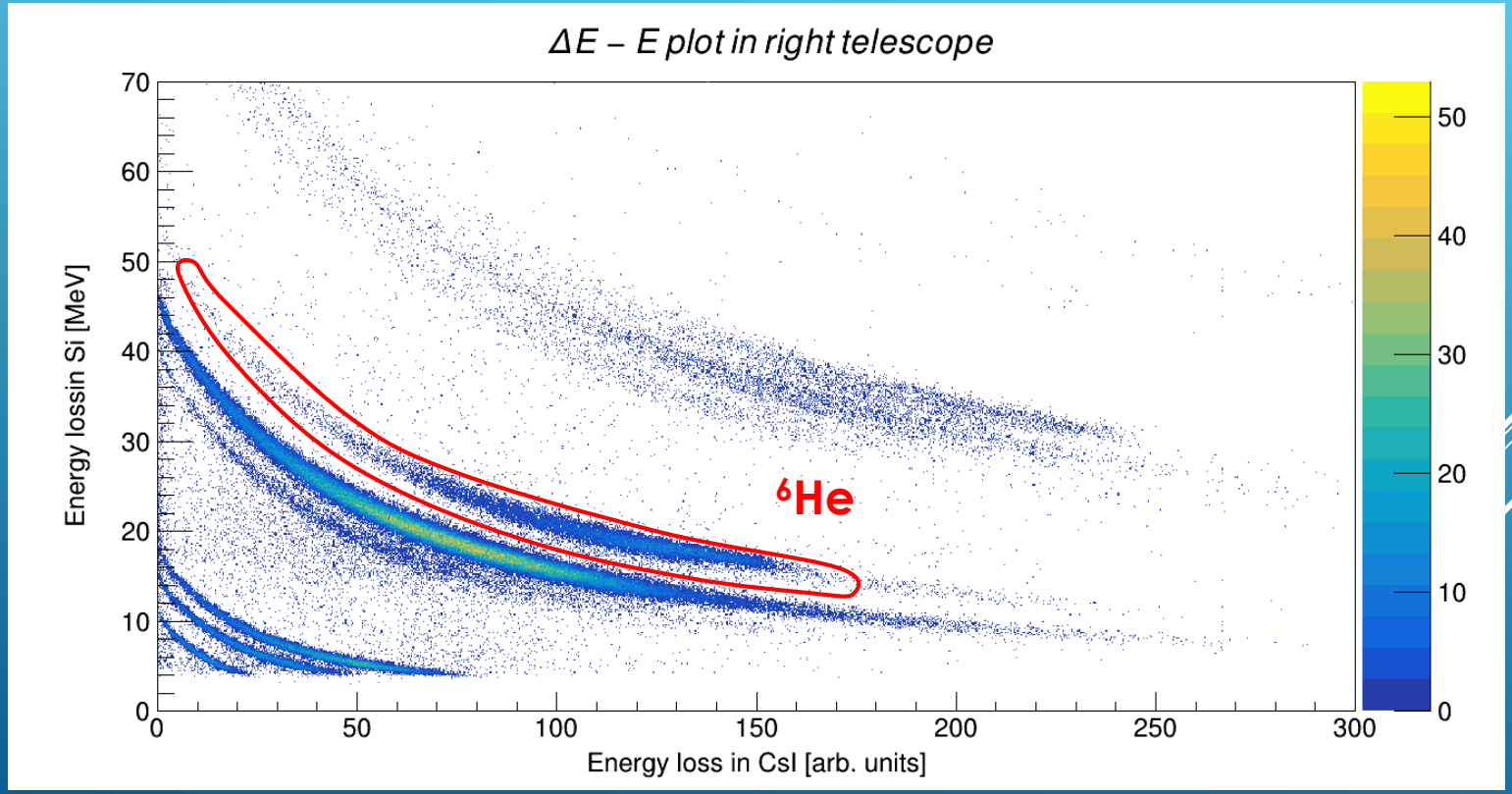

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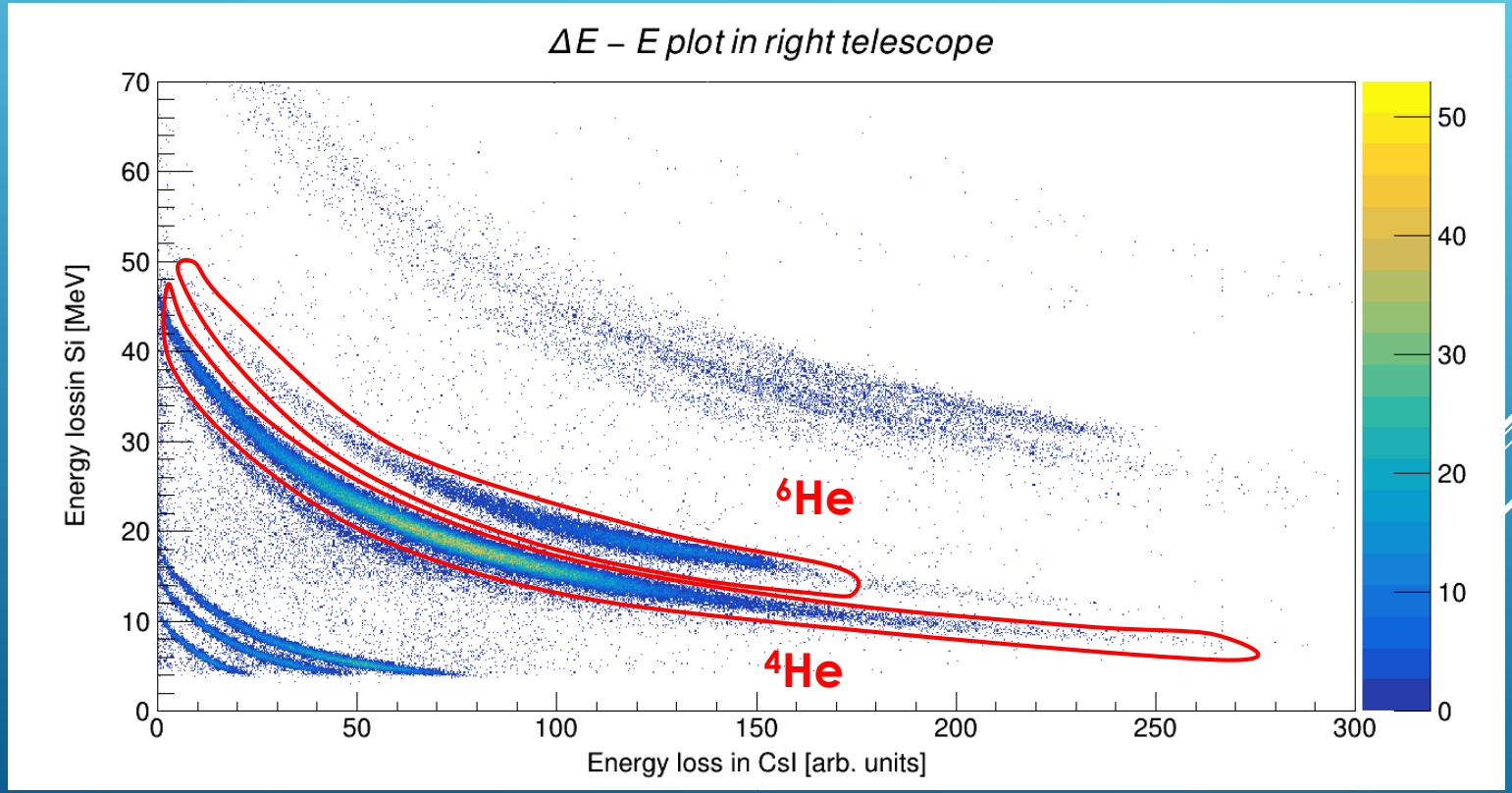
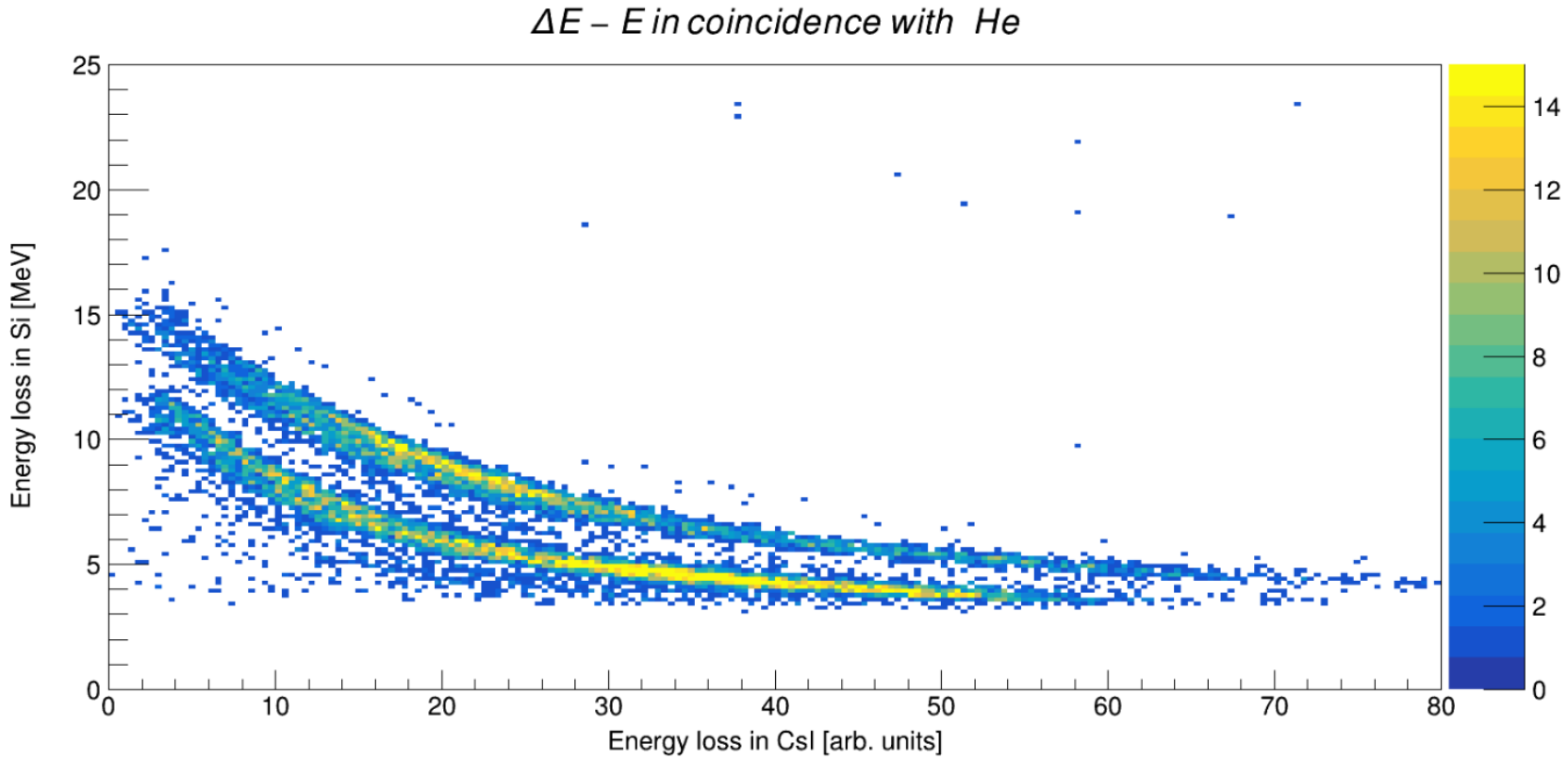
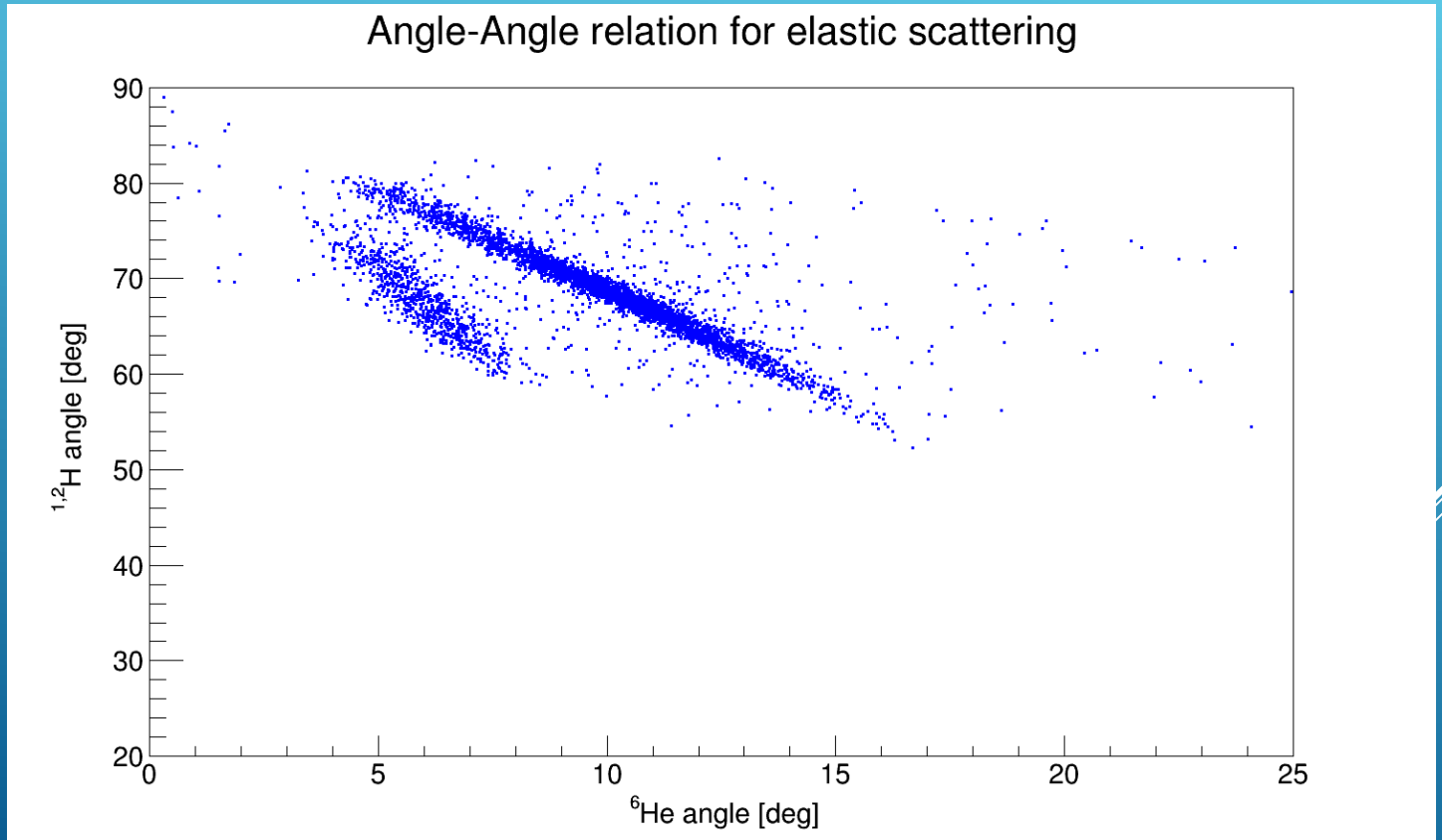
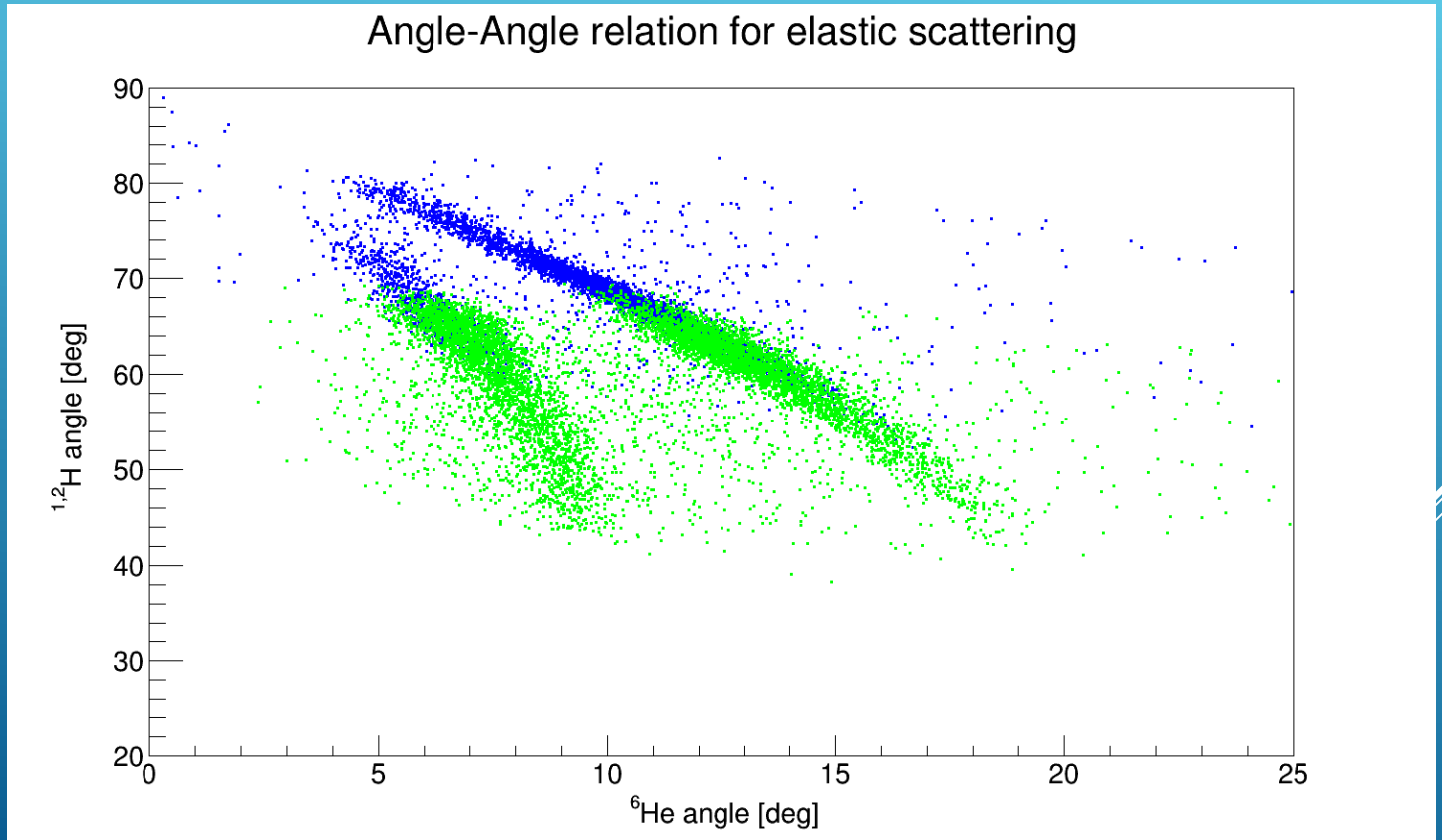


DEUTERIUM IDENTIFICATION




Angle-Angle relation for elastic scattering
90
80
70
60
50
40
30
20
0
5
10
15
20
25
^{1,2}H angle [deg]
^{6}He angle [deg]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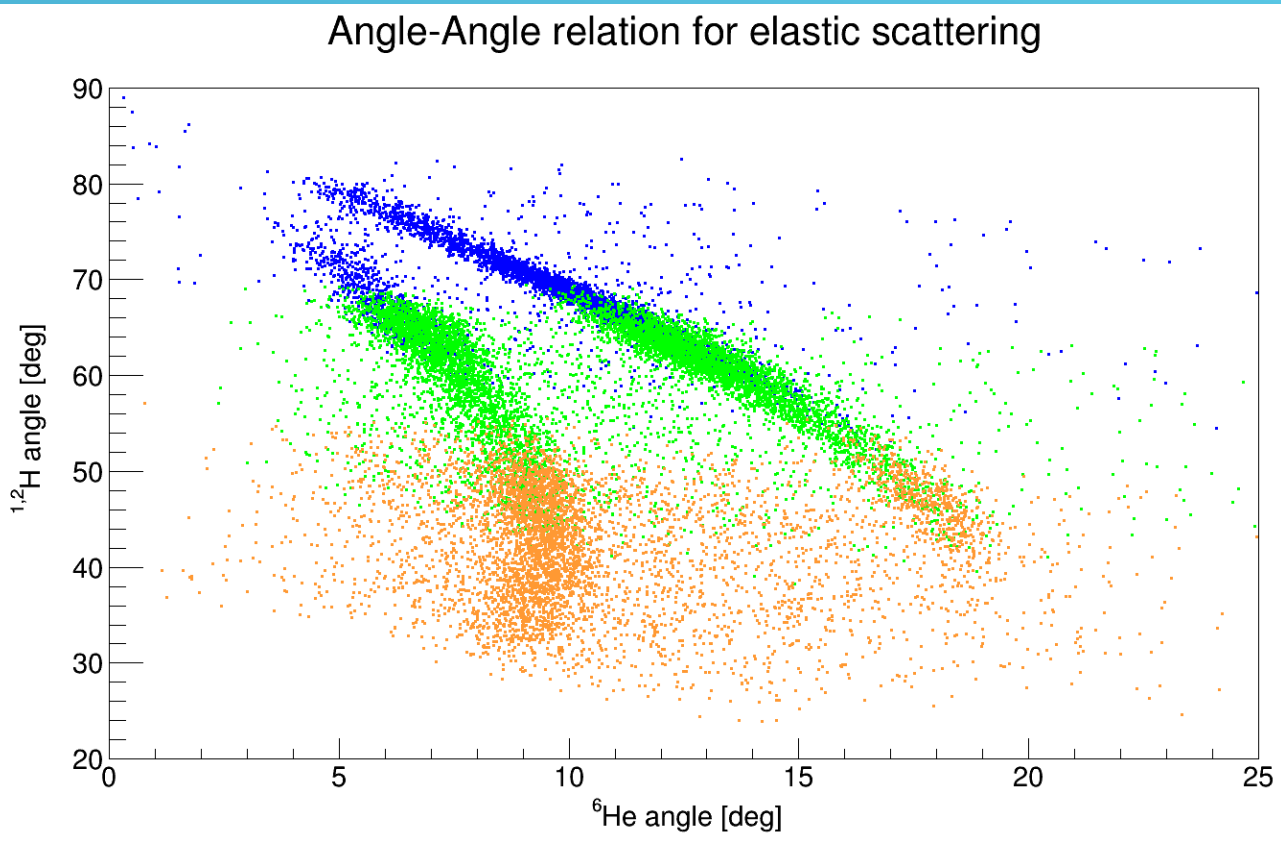
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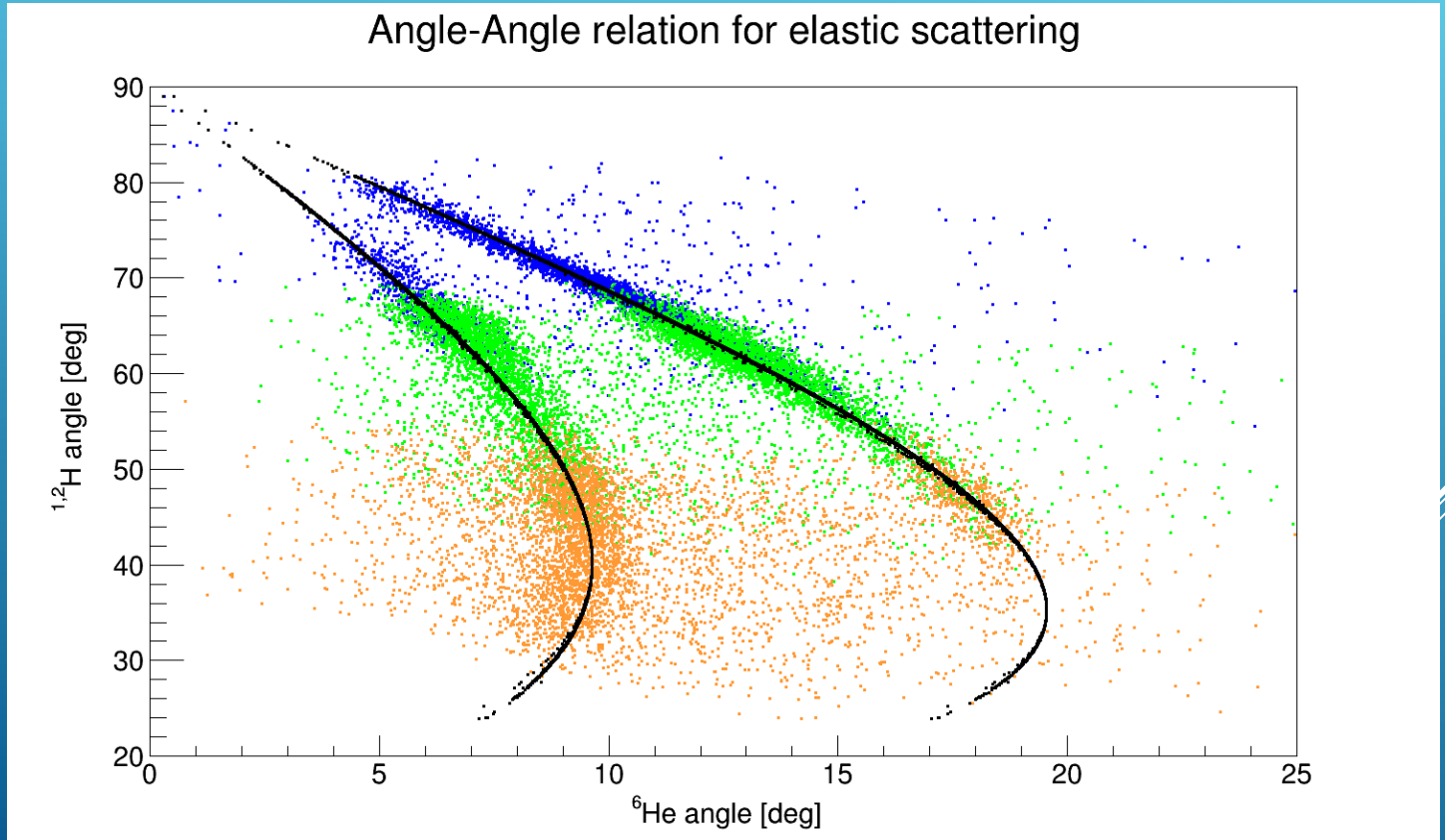
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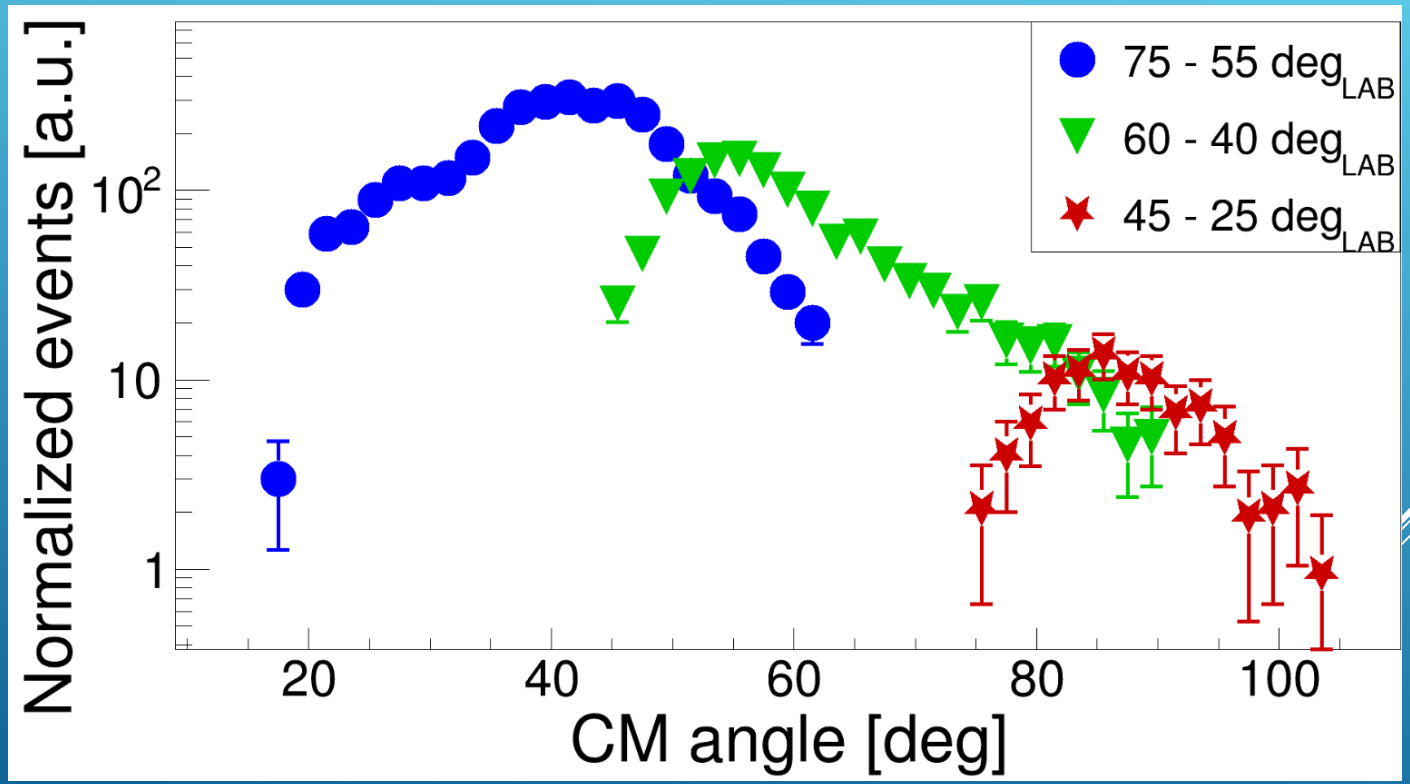
COUNTS PER ANGLE



CONCLUSIONS

- Clean beam with high intensity (higher soon!)
- Early results in agreement with theoretical predictions
- ACCULINNA 2 group ready for future, more complicated experiments

BEAM COMPOSITION

2H - 0,11%

4He - 0,06%

7Li - 0,15%

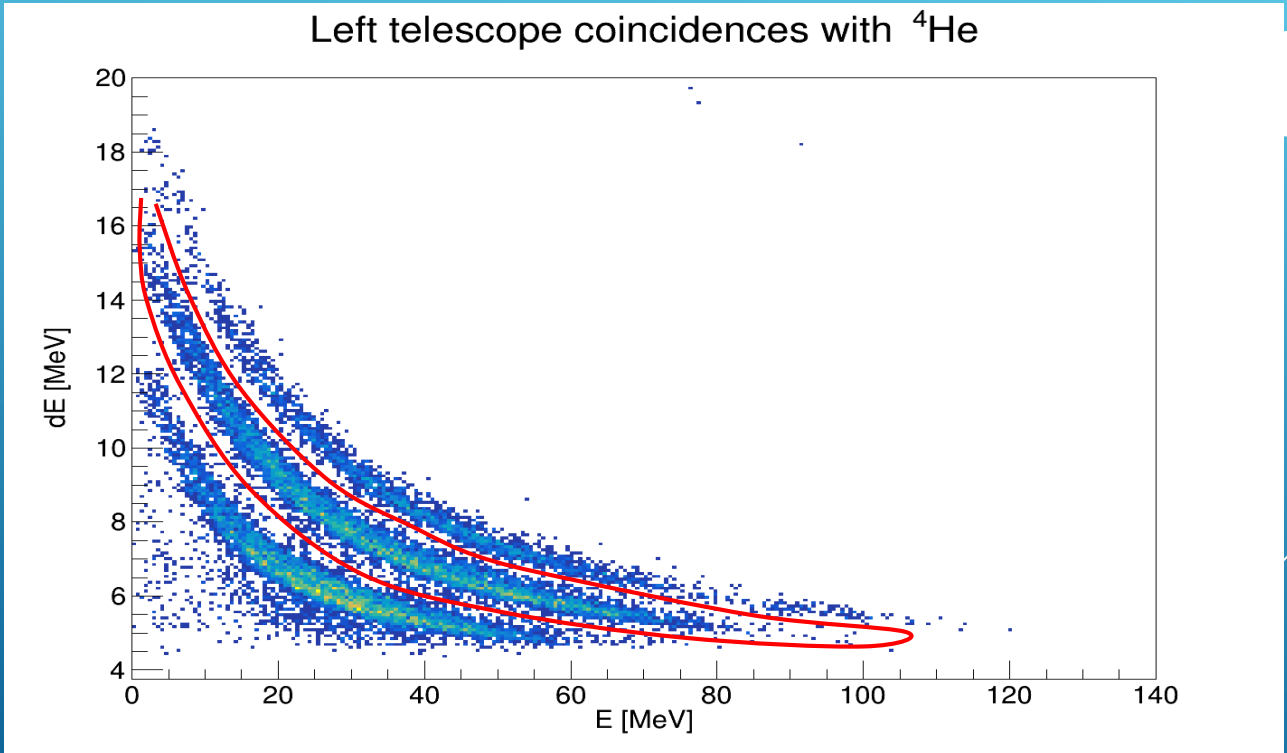
8Li - 18%

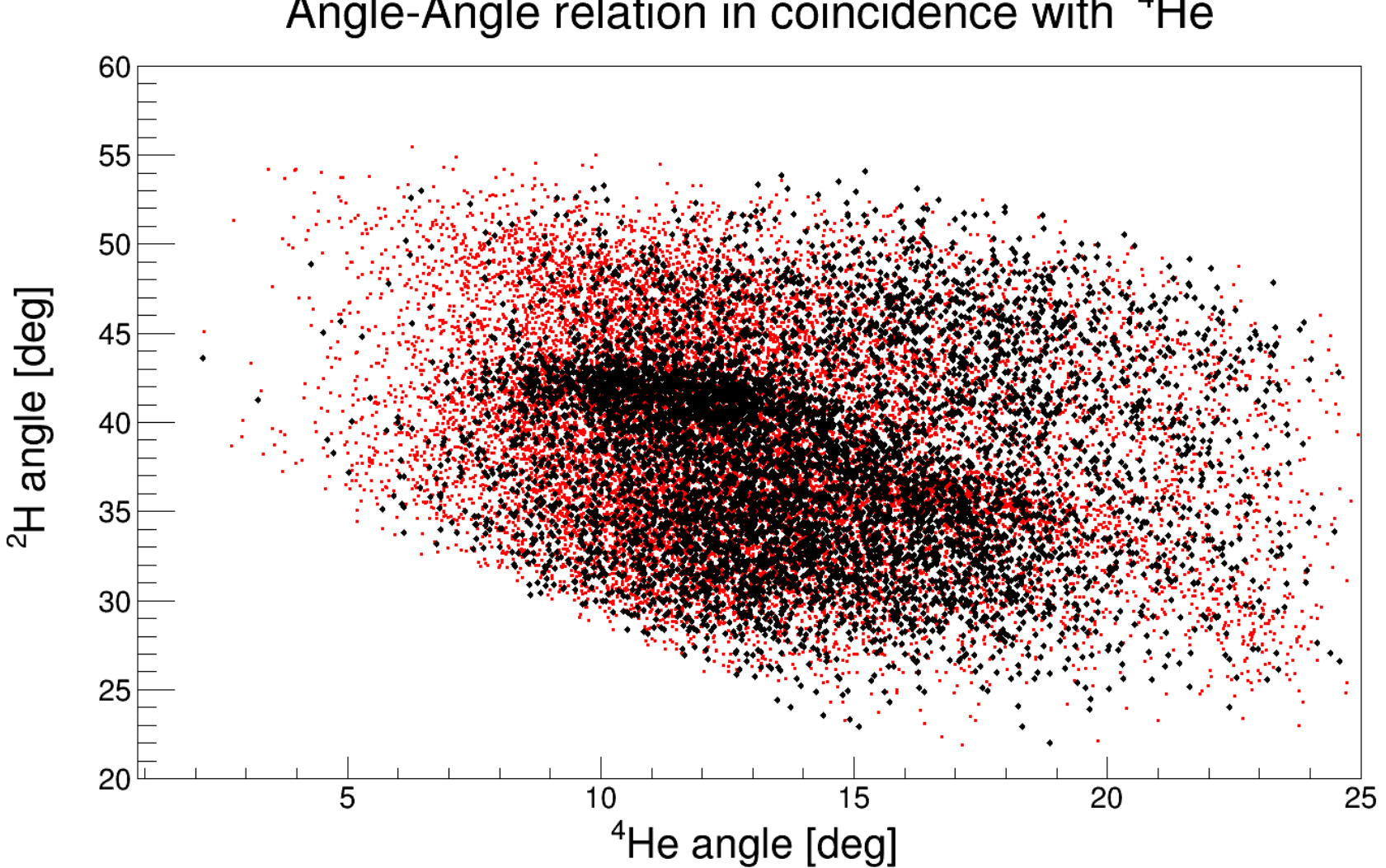
9Be - 1%

3H - 2%

6He - 78%

COINCIDENCE WITH ^{4}HE

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^{2}H angle [deg]
^{4}He angle [deg]
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45
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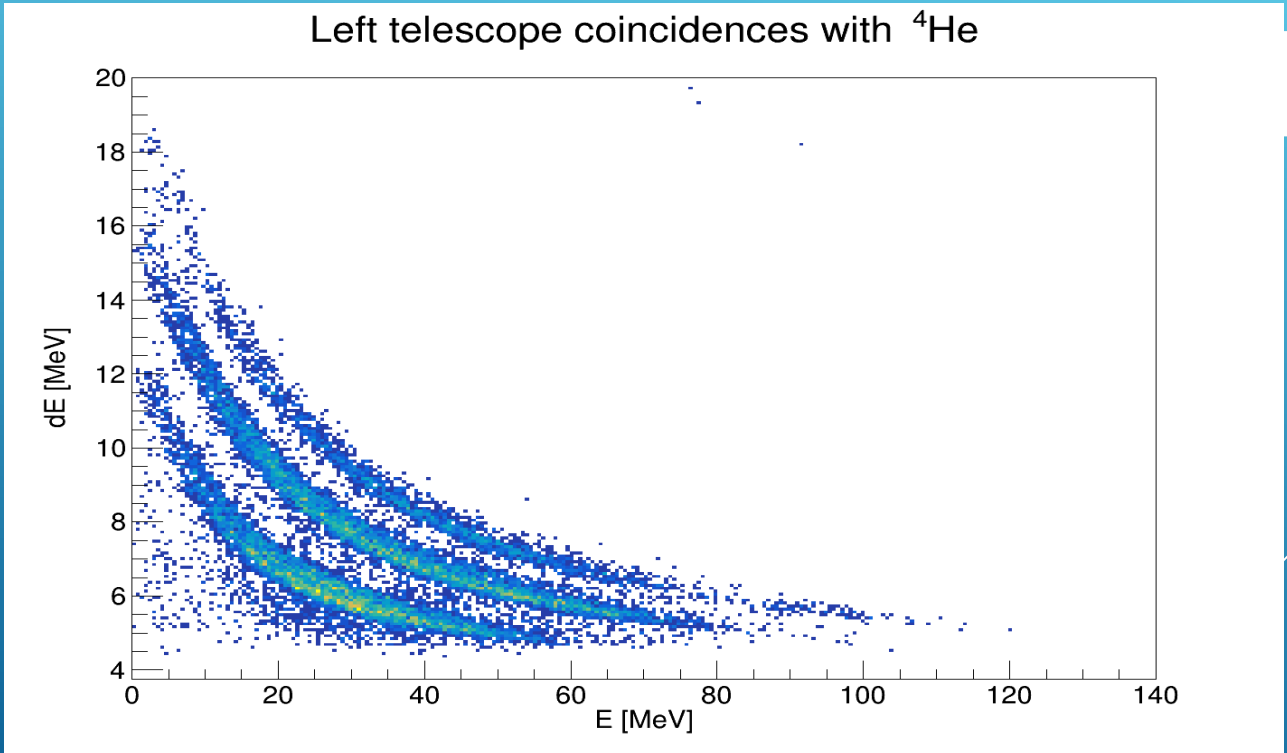

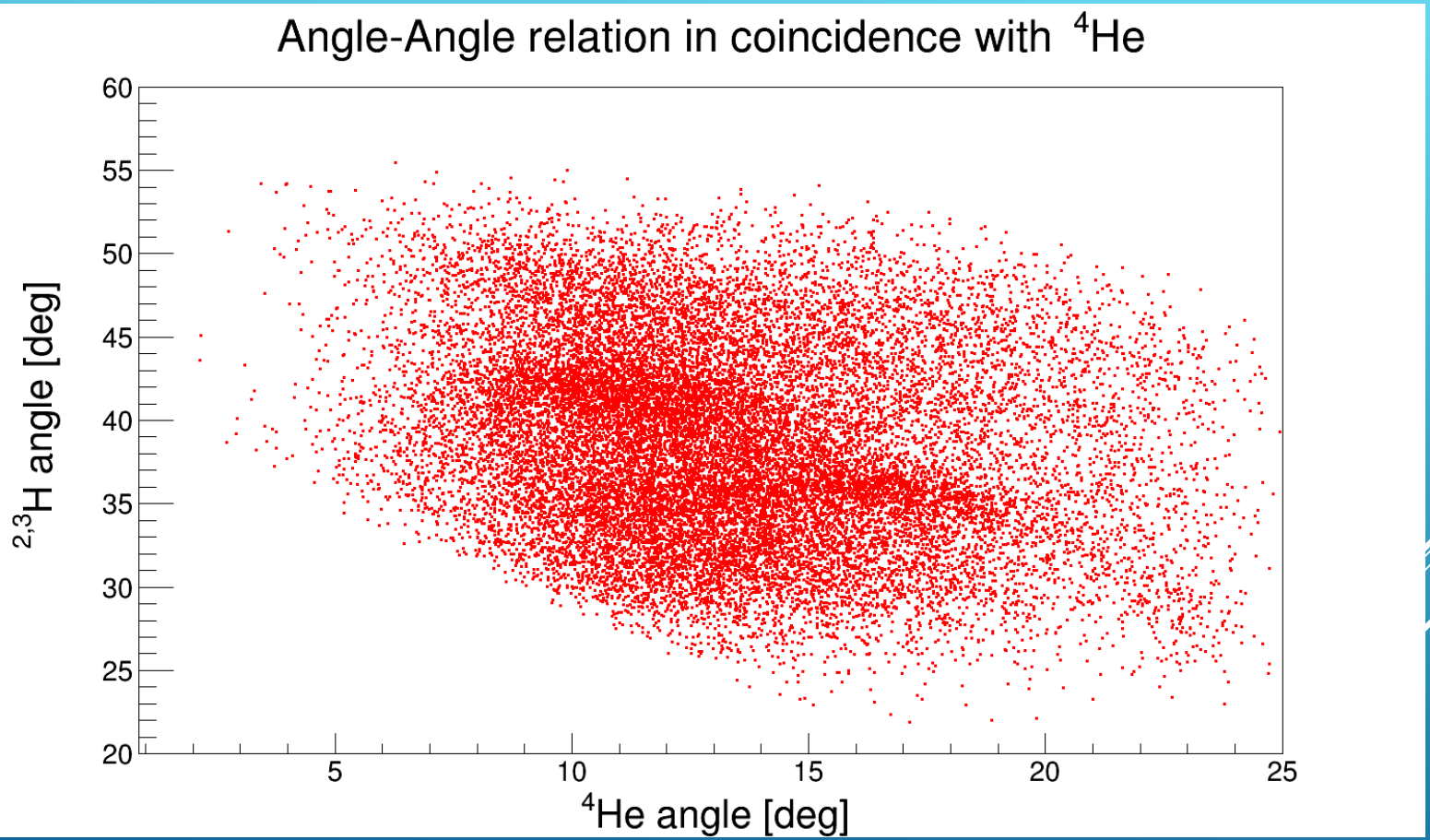
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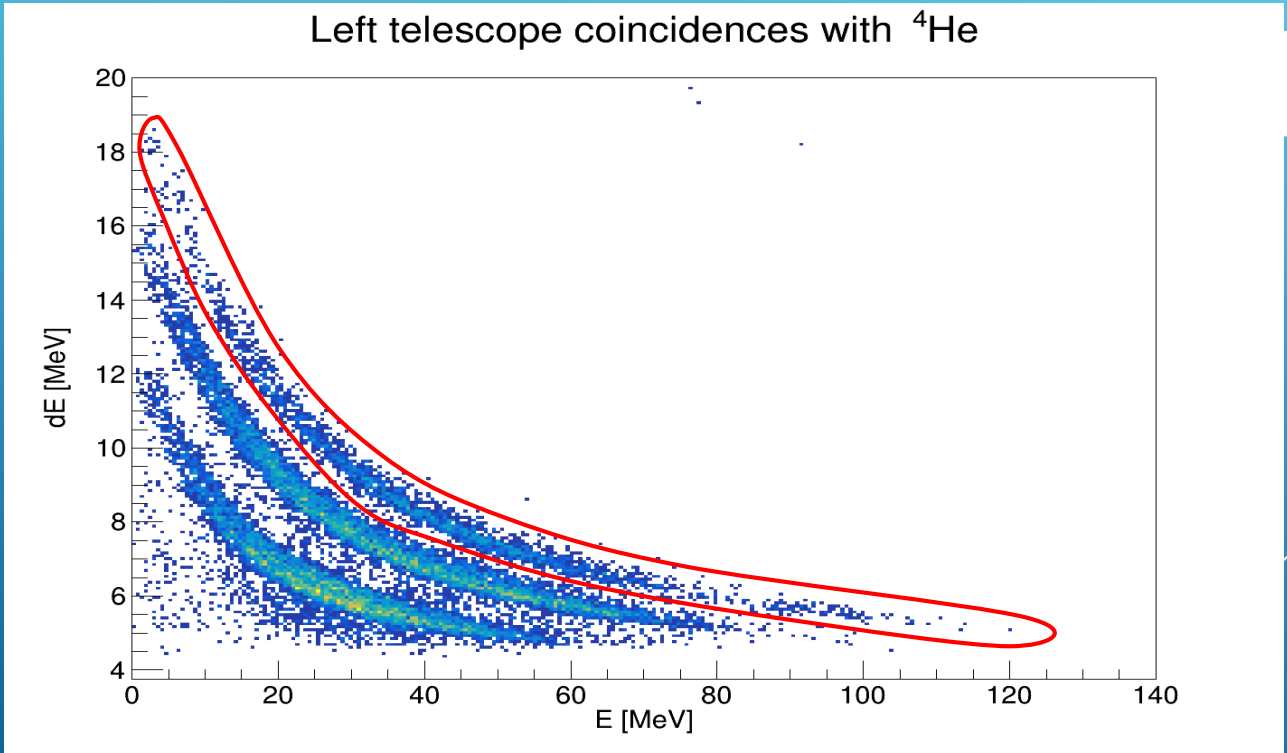

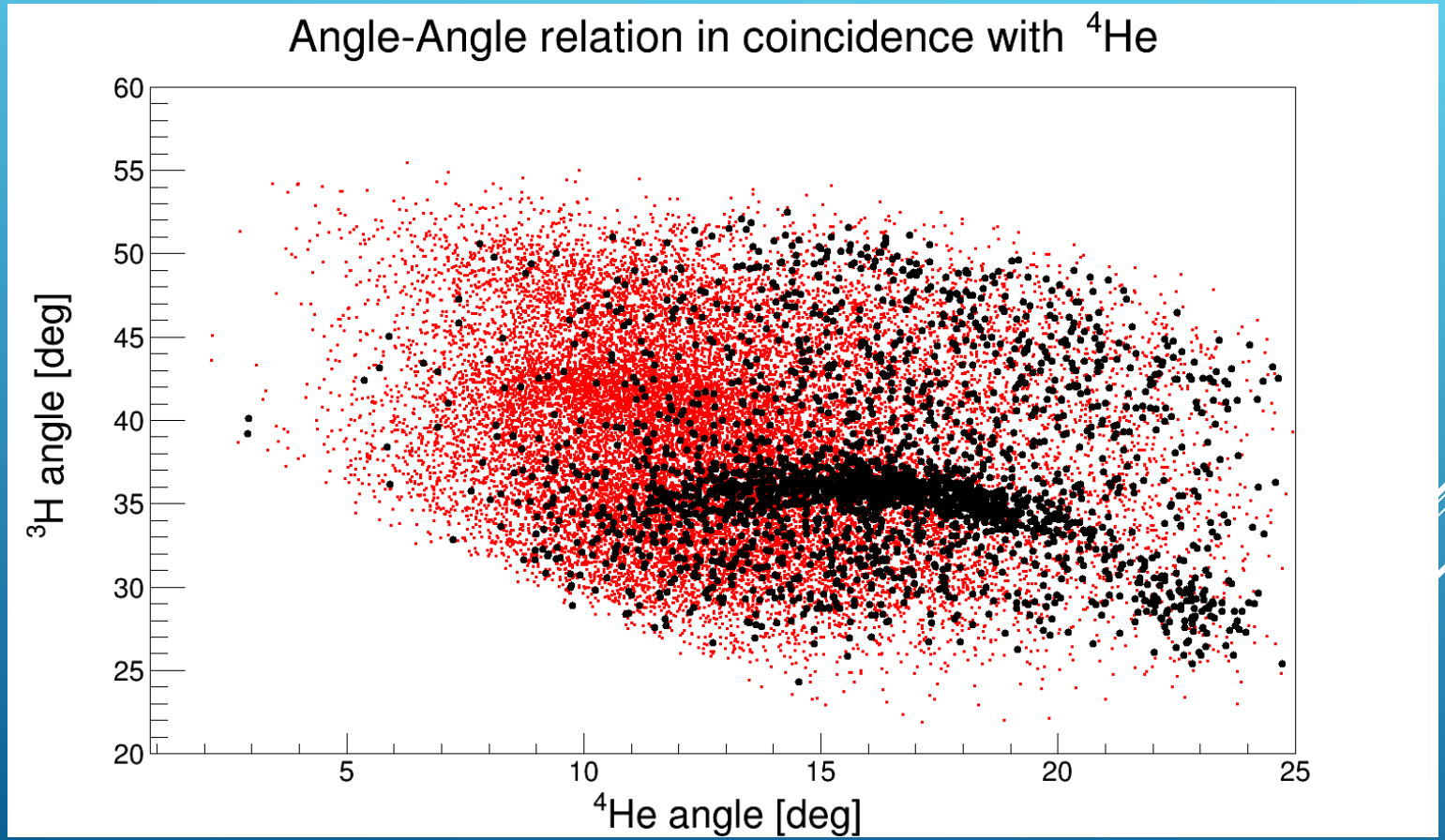
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^{3}H angle [deg]
^{4}He angle [deg]
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