Scattering of ^{8}He on ^{208}Pb at energies around the Coulomb barrier

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Contents

Motivations: why ^{8}He?

^{8}He is the lightest skin nucleus. Its structure and dynamics is not very well known.

- Few scattering data at barrier energies is available at present.

- There is still a lack of information concerning collective aspects as characteristic nuclear excitations, coupling between different reaction channels and neutron-core correlations.

Previous works:
- A. Navin et al., Phys. Rev. C70, 044602 (2004)
- N. Keeley et al., Pyhs. Lett. B 646 (2007) 222-226
- A. Lemasson et al., Phys. Rev. C 82, 044617 (2010)
- A. Lemasson et al., Phys. Lett. B 697 (2011) 454-458

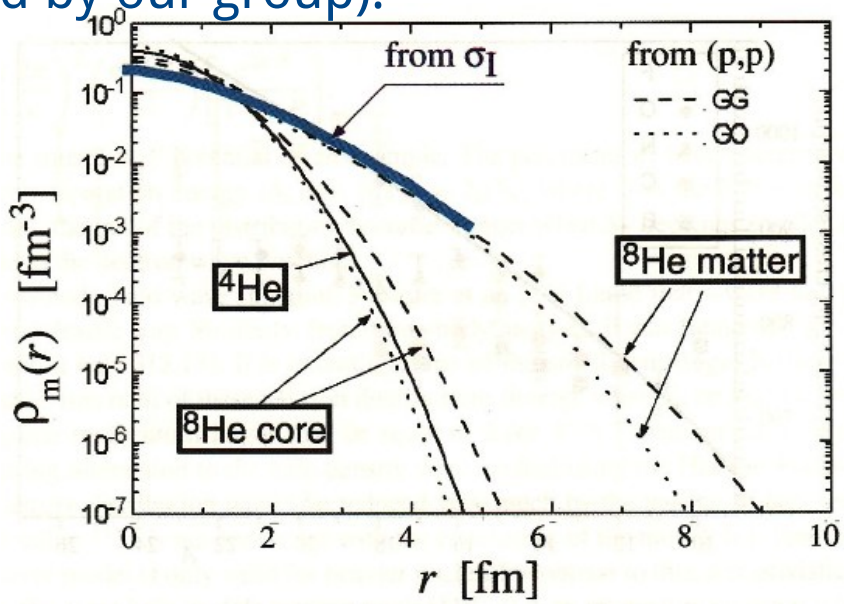
Motivations: why ^{8}He?

As compared to ^{6}He (previously studied by our group):

- Neutron layer larger but tighter.

RMS Radius (fm)			
Nucleus	Rn	Rp	Rm
4He	1.63±0.03	1.63±0.03	1.63±0.03
6He	2.59±0.04	1.72±0.04	2.33±0.04
8He	2.69±0.04	1.76±0.03	2.49±0.03

Tanihata et al., Phys. Lett. B 289 (1992) 261-266



- Binding energy for 1n and 2n systems are similar whereas in ^{6}He the breakup of the 2n system from the alpha core is energetically favored.

1n and 2n separation energies (MeV)		
Nucleus	S_{1n}	S_{2n}
^{6}He	1.71	0.98
^{8}He	2.53	2.13

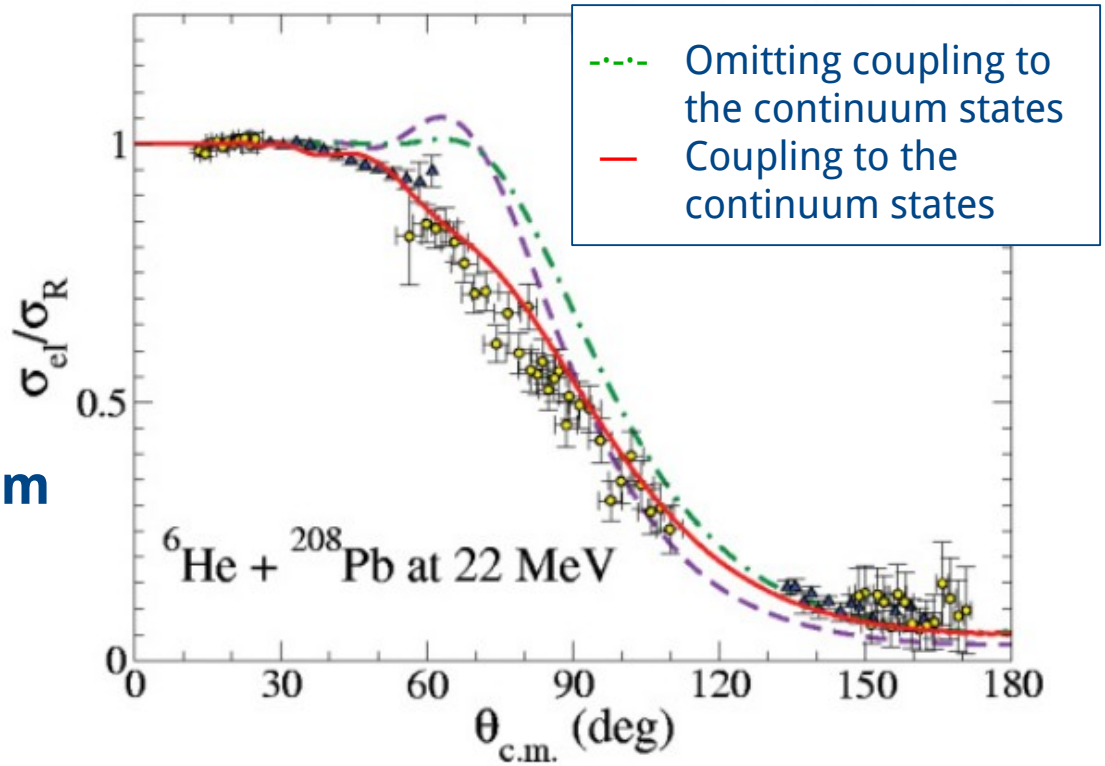
These differences in geometry and binding energies should be reflected in the elastic and reaction cross sections.

What are we expecting for ^{8}He?

- From energy and angular distribution of elastic scattered ^{8}He and ^{4}He and ^{6}He yields:

  - role of **transfer** and **breakup** channels

  - coupling to **continuum**

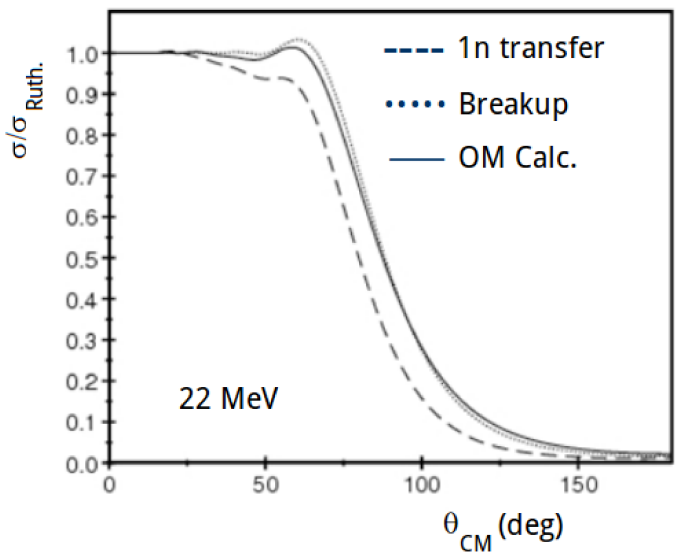


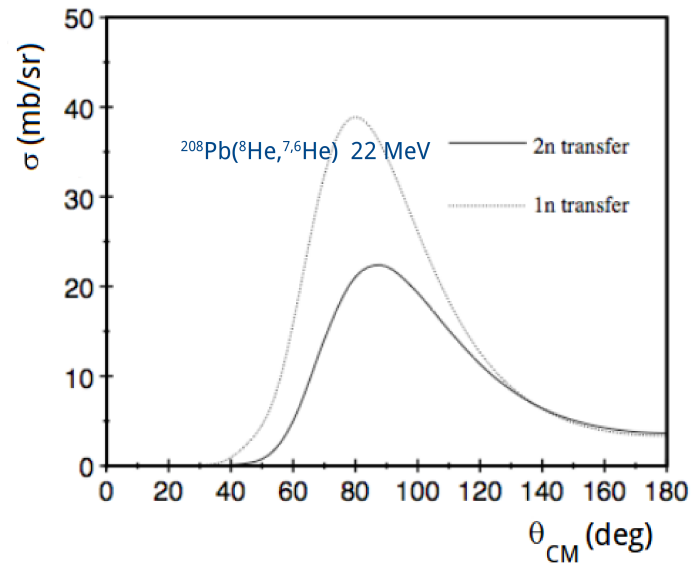
A.M. Sánchez-Benítez et al., Nucl. Phys. A 803, 30 (2008)
L. Acosta et al., Phys. Rev. C 84, 044604 (2011)

- Information about **spectroscopic factors** for 1n and 2n.

What are we expecting for ^{8}He?

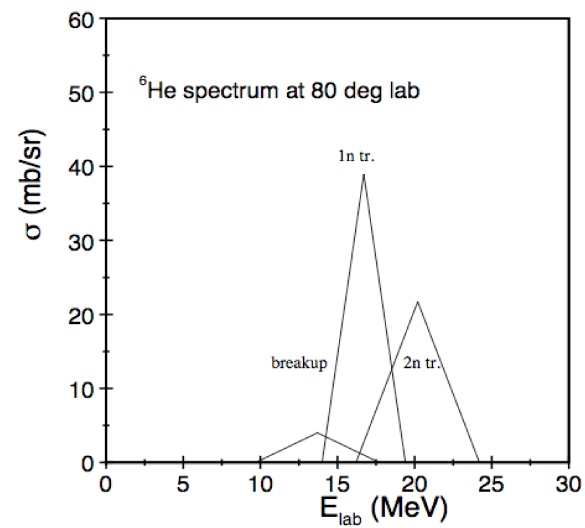
- Strong absorption in the elastic cross section at backward angles associated to 1n-transfer channel.





- Role of 2n transfer and breakup much smaller than ^{6}He case.

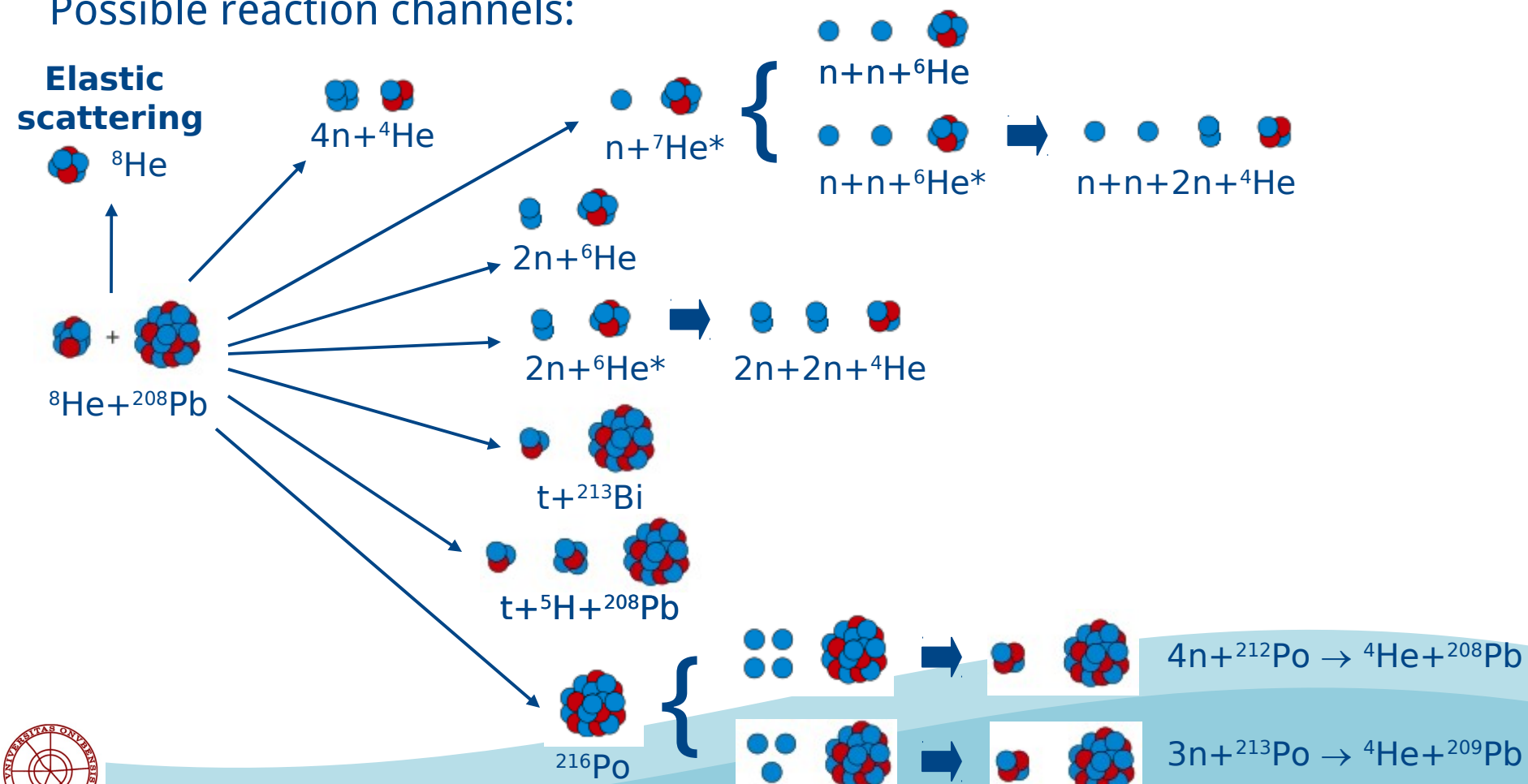
FRESCO preliminary calculations performed by K. Rusek. Private communication.



Scattering of $^{8}He+^{208}Pb$ at energies around the Coulomb barrier

Investigate the differences in the dynamics of skin (^{8}He) and halo (^{6}He) nuclei at energies around the Coulomb barrier.

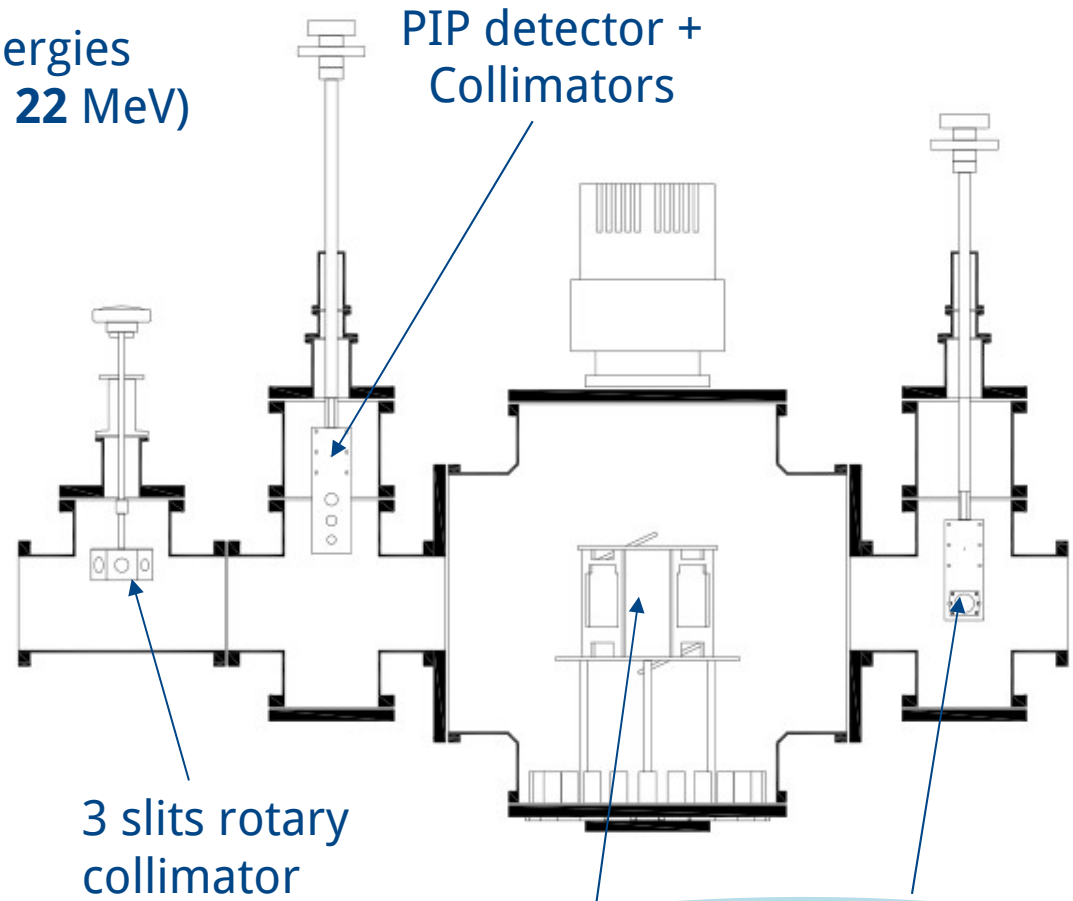
Possible reaction channels:



Experiment E587S – GANIL (I.Martel & K.Rusek)

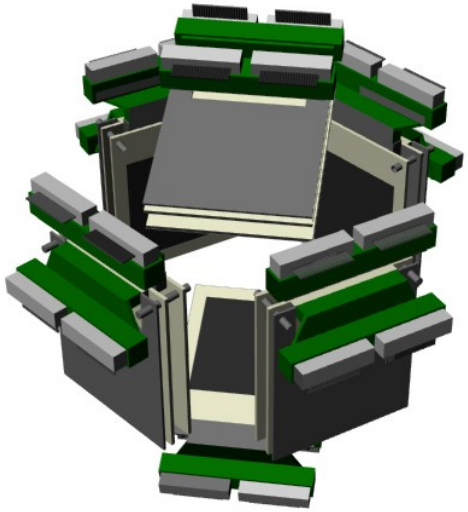
Study of the ^{8}He + ^{208}Pb system at energies around the Coulomb barrier (**18** and **22** MeV)

I ~ 10^5 pps
Target thickness ~ 1.7 mg/cm^2



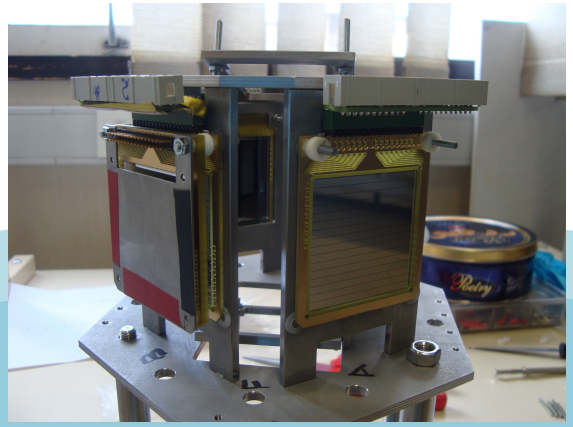
Detection system concept

Detection system developed at the University of Huelva (UHU) with the aim of studying structure and dynamics of exotic nuclei using nuclear reactions.



Design requirements:

- Symmetric position of telescopes (scattering angles / beam alignment)
- Maximum angular range
- Angular range overlapping between telescopes
- Large solid angle ⇒ Good angular resolution
- Small size ⇒ “Plug & Play” Concept

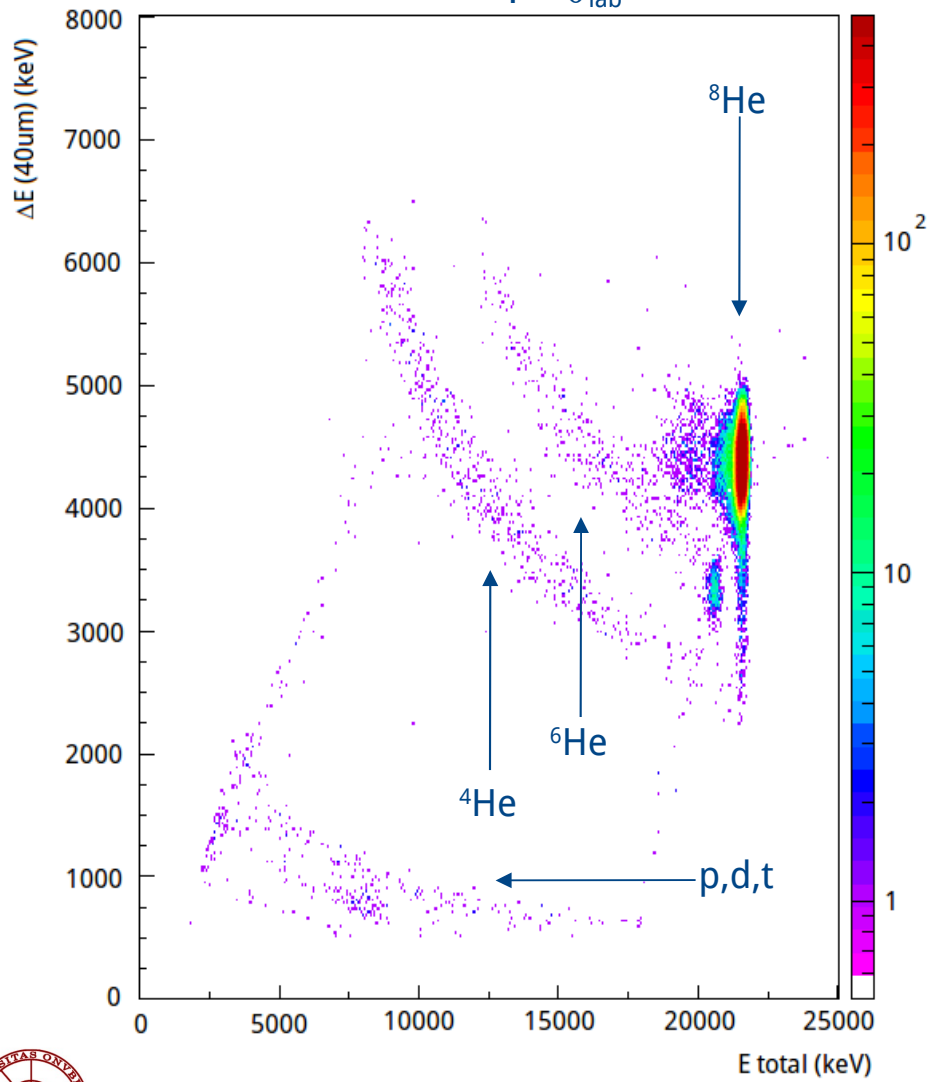


12 DSSSD Si detectors arranged in
6 particle telescopes (40 μm ΔE & 1 mm E)

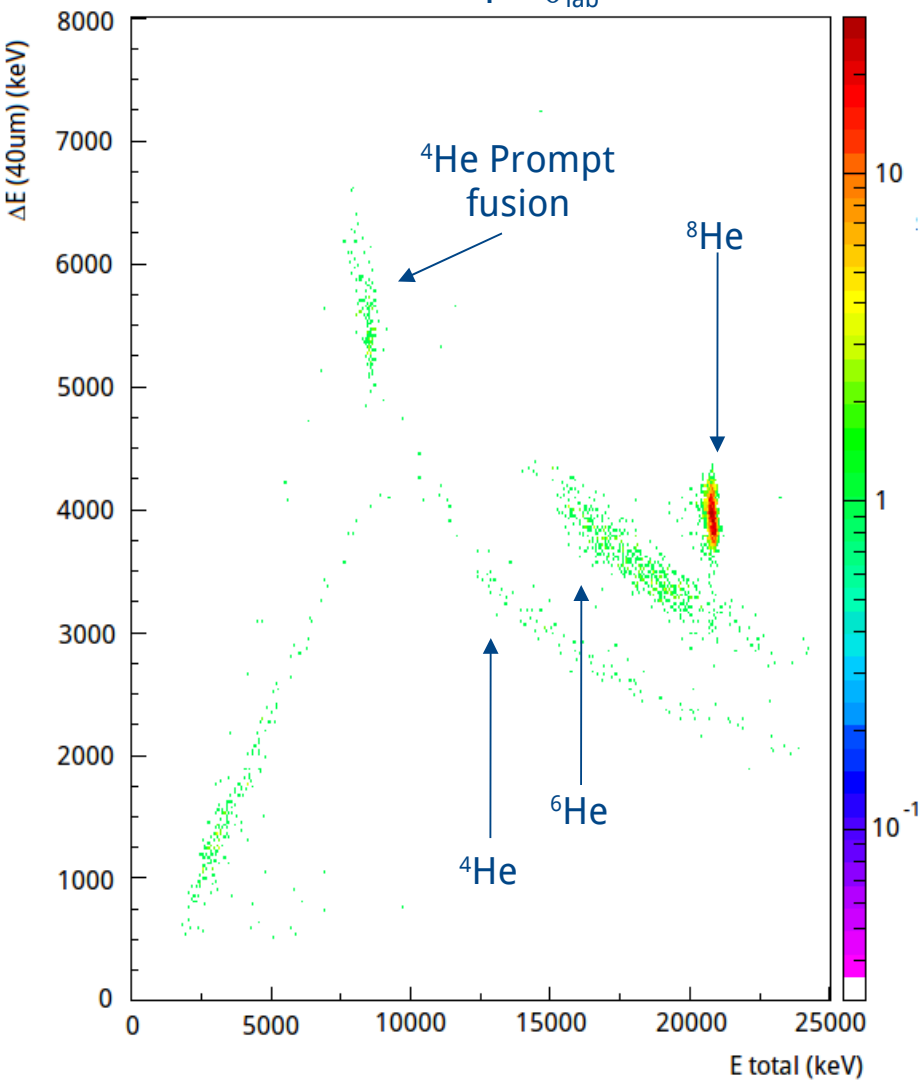
Total solid angle for the system: 26 % (4π srad)

Preliminary Results

Forward Telescope θ_{lab}=[21º,25º]



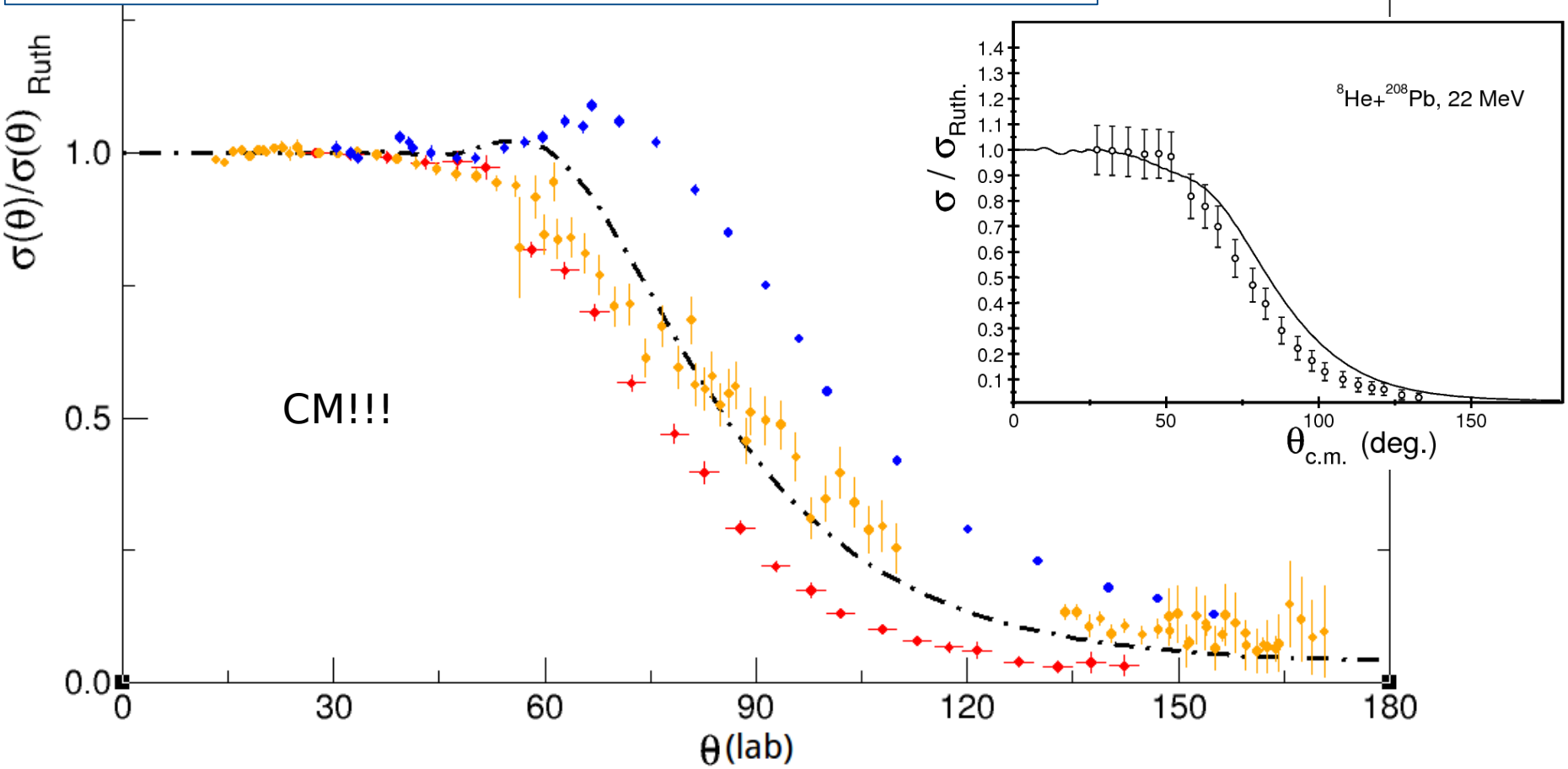
Bottom Telescope θ_{lab}=[73º,77º]



Preliminary Results: Elastic scattering

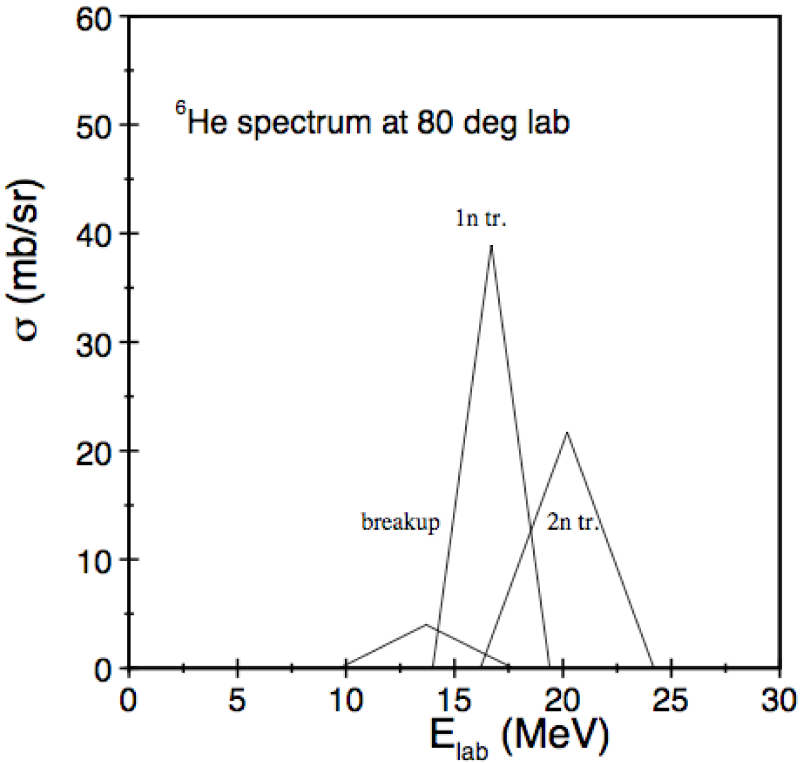
-·-·- OM

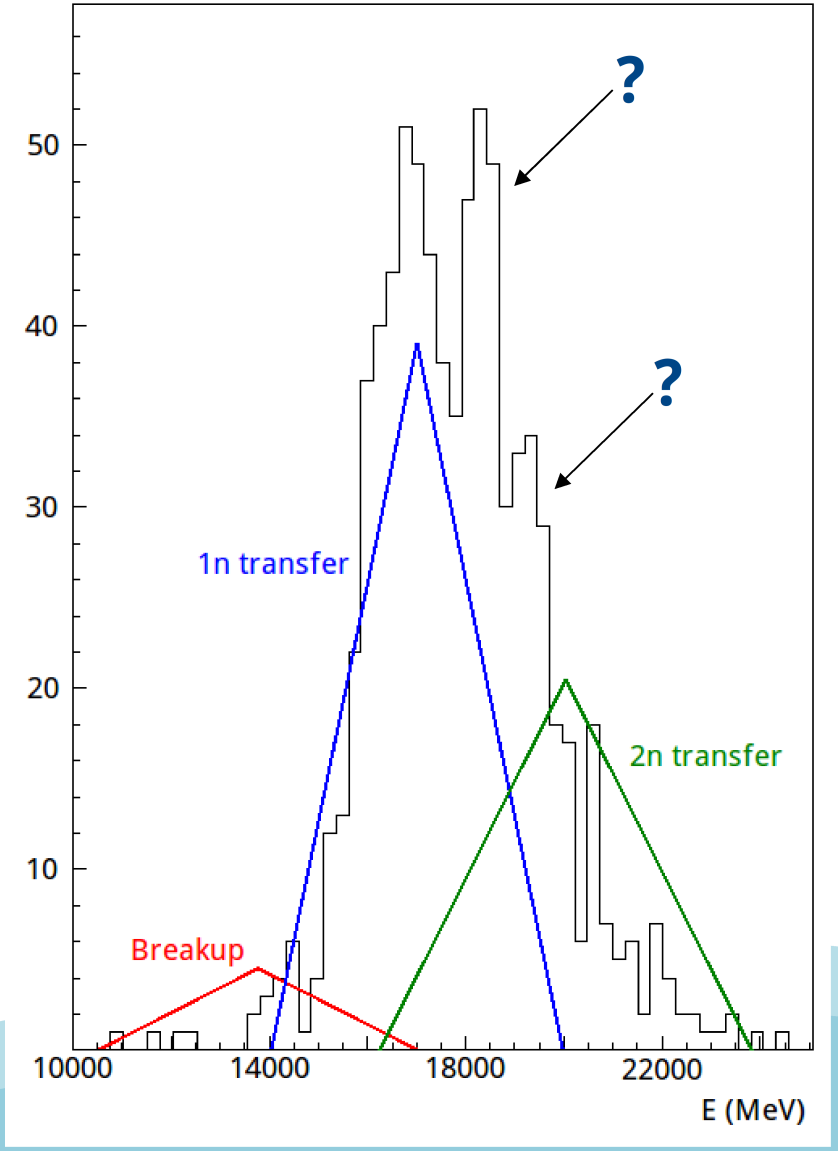
- $^{4}He+^{208}Pb$ @ 23.5MeV J.S. Lilley NPA 342 (1980) 165.
- $^{6}He+^{208}Pb$ @ 22Mev A. Sánchez-Benítez et al. NPA 803 (2008) 30 / L. Acosta et al. PRC 84, 044604 (2011)
- $^{8}He+^{208}Pb$ New data!!



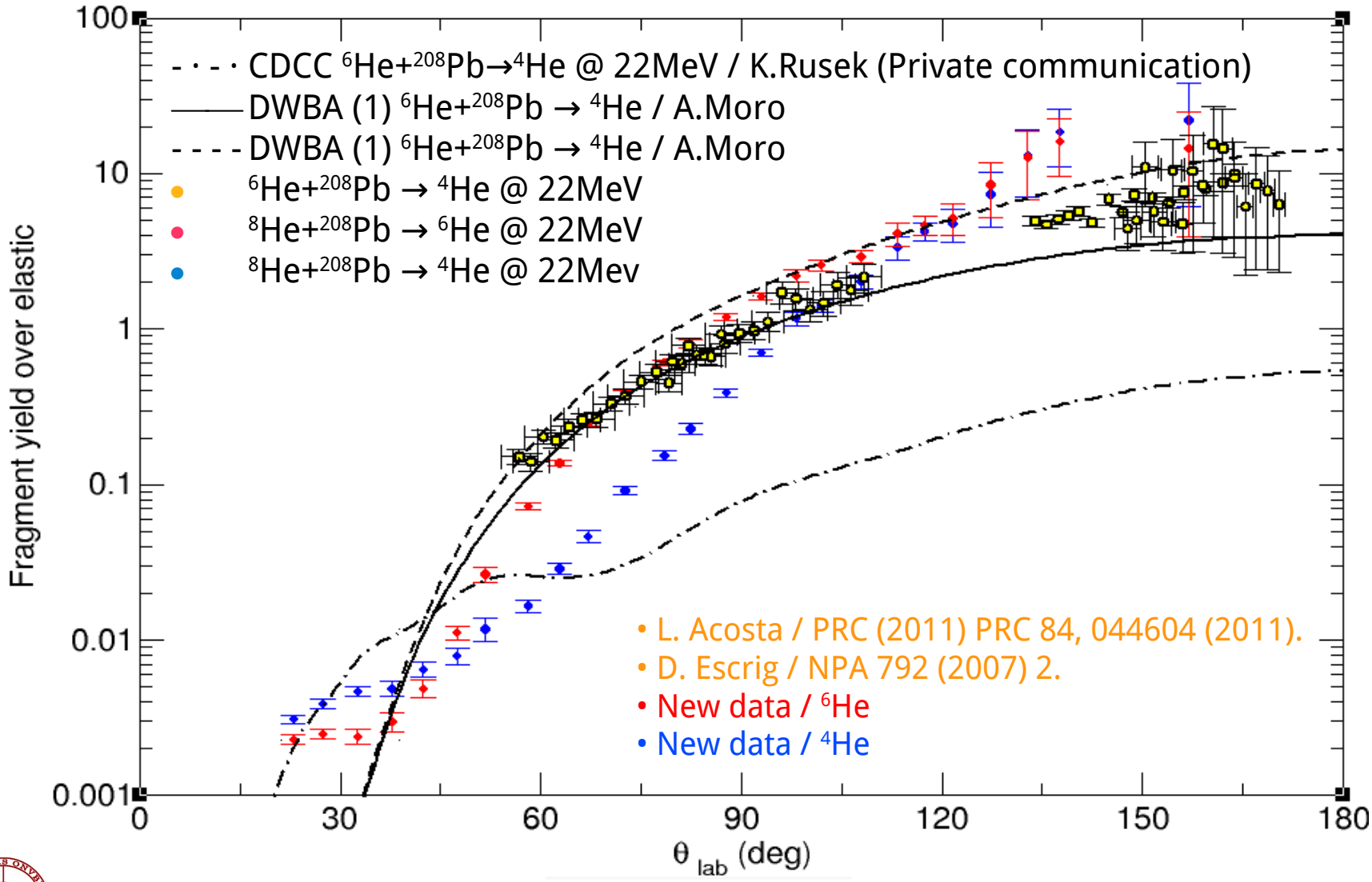
Preliminary Results: ^{6}He production

Preliminary calculations
in FRESCO (K.Rusek)
Private communication





Preliminary Results: ^{4}He and ^{6}He yields



Summary and Conclusions

In order to investigate the ^{8}He dynamics we studied the reaction ^{8}He+^{208}Pb at energies around the Coulomb barrier at SPIRAL/GANIL in October 2010.

A new detection system developed at the University of Huelva for the study of nuclear reactions induced by exotic nuclei was used for the first time during the experiment showing excellent performances.

The preliminary analysis of the data shows:

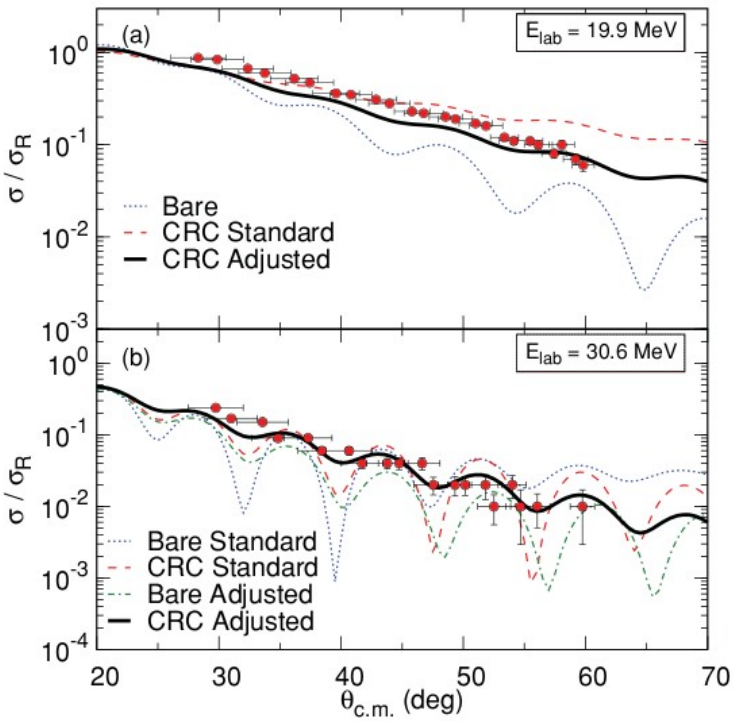
- Strong absorption up to small angles which can be interpreted as a signature of long range reaction channels.
- Large production of ^{6}He and ^{4}He fragments via neutron transfer and breakup.
- Breakup channel seems to dominate at very forward angles whereas neutron transfer operates in most of the angular range.

Thanks to the E587S collaboration

I. Martel[1], K. Rusek[5], L. Acosta[1], M.A.G. Álvarez[2], R. Berjillos[1], M.J.G. Borge[3], A. Chbihi[4], C. Cruz[3], M. Cubero[3], J. Dueñas[1], J.P. Fernández García[2], B. Fernández Martínez[2], J.L. Flores[1], J. Gómez Camacho[2], N. Keeley[5], J.A. Labrador[2], G. Marquínez-Durán[1], M. Marques[6], M.Mazzocco[7], A. Pakou[8], V.V. Parkar[1], N. Patronis[8], V. Pesudo[3], D. Pierroutsakou[9], R. Raabe[10], A.M. Sánchez-Benítez[1], R. Silvestri[9], L.Standylo[5], I. Strojek[5], N.Soic[11], O. Tengblad[3], R. Wolski[12], A.H. Ziad[2]

[1]University of Huelva (Spain), [2]CNA, Sevilla (Spain), [3]CSIC, Madrid (Spain), [4]GANIL (France), [5]University of Warsaw (Poland), [6]LPC, Caen (France), [7]INFN-LNL, Legnaro (Italy), [8]University of Ioannina (Greece), [9]INFN Napoli (Italy), [10]Instituut voor Kern-en Stralingsfysica, Leuven (Belgium), [11]Rudjer Boskovic Institute (Croatia), [12]Institute of Nuclear Physics (Poland)

Previous works



Lemasson et al., PRC 82, 044617 (2010)