A Direct Measurement of the $^{17}O(\alpha,\gamma)^{21}Ne$ reaction

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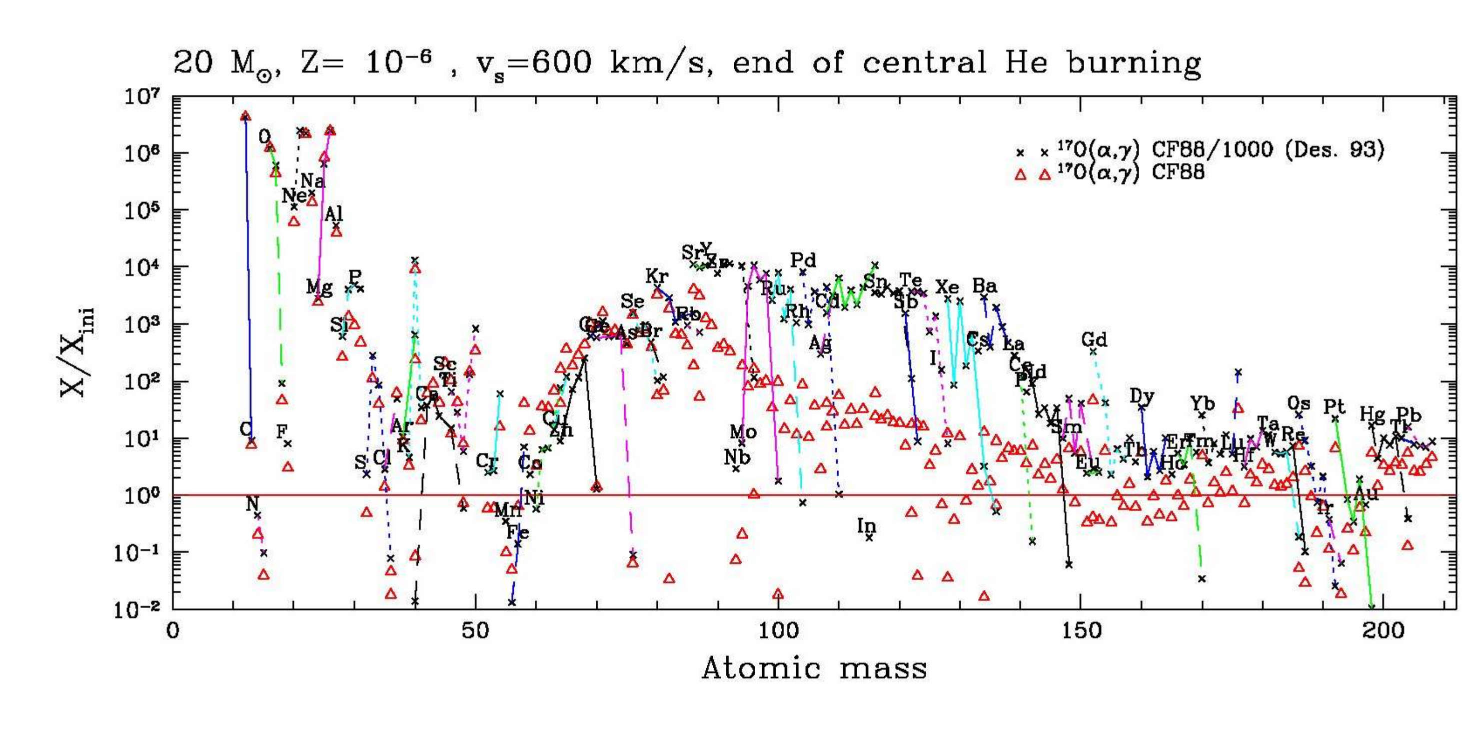
(DRAGON collaboration)

Astrophysical Motivation

The weak s-process and the effect of ^{16}O



^{17}O(α,γ) determines whether ^{16}O is only the strongest neutron absorber or it is the strongest neutron poison

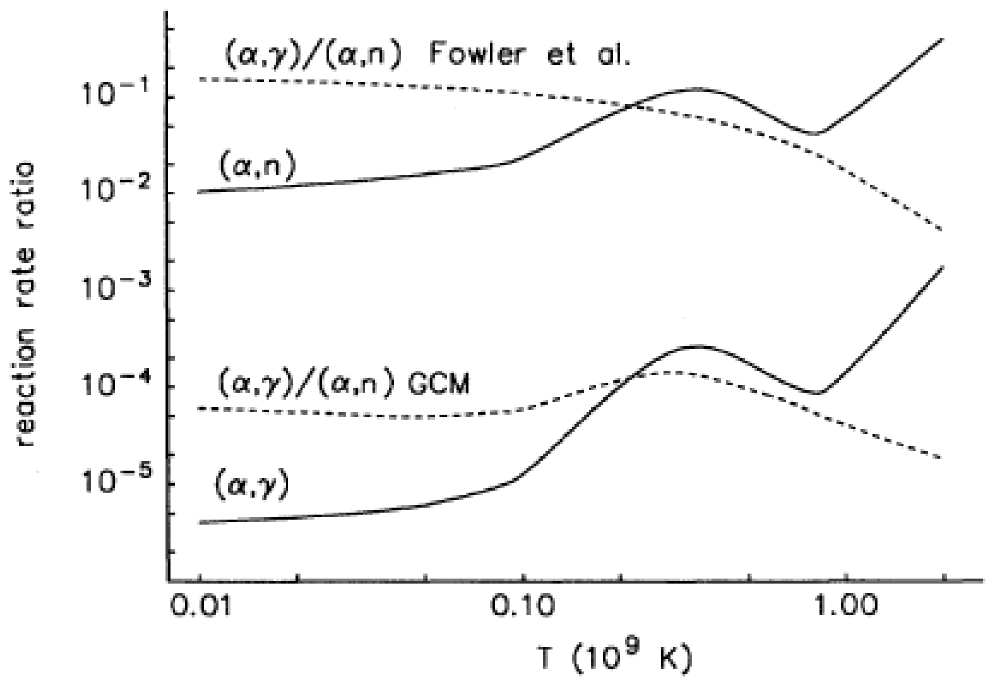
Calculations with different ^{17}O(α,γ) rates produce extremely different quantities of elements between Sr and Ba.

Competing predictions of the reaction rate ratio

There are currently two predictions of the reaction rate ratio found in the literature: CF88 and Descouvemont 93.

These ratio predictions differ by a factor of 1000 (see below)

This uncertainty has a significant impact on the astrophysical models in terms of neutrons available for the s-process



Ratios of the Descouvemont (α,γ) and (α,n) reaction rates with the values of Caughlan and Fowler (solid lines). The (α,γ)/(α,n) ratios are plotted as dashed lines. (Figure taken from (Phys. Rev. C, 48, 2746 (1993).)

Existing data on $^{17}O(\alpha,n)^{20}Ne$ reaction

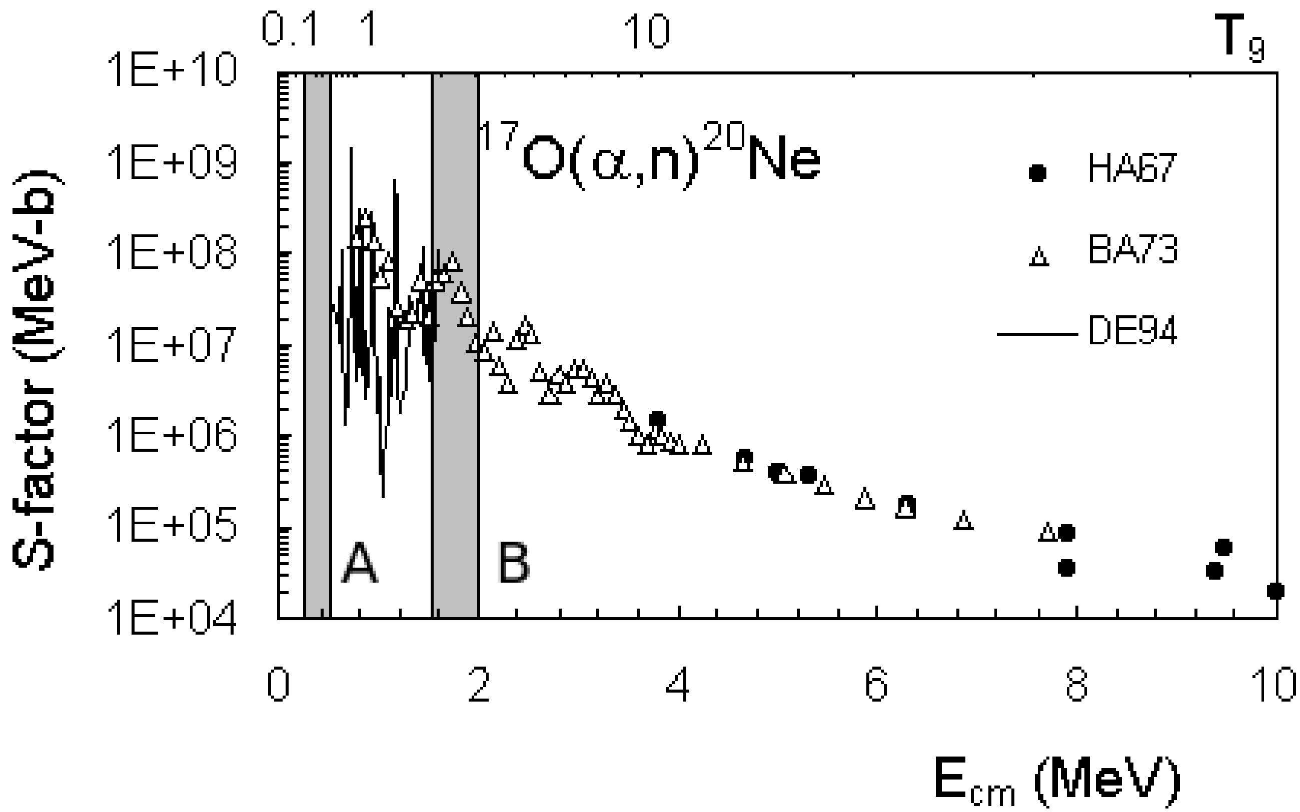
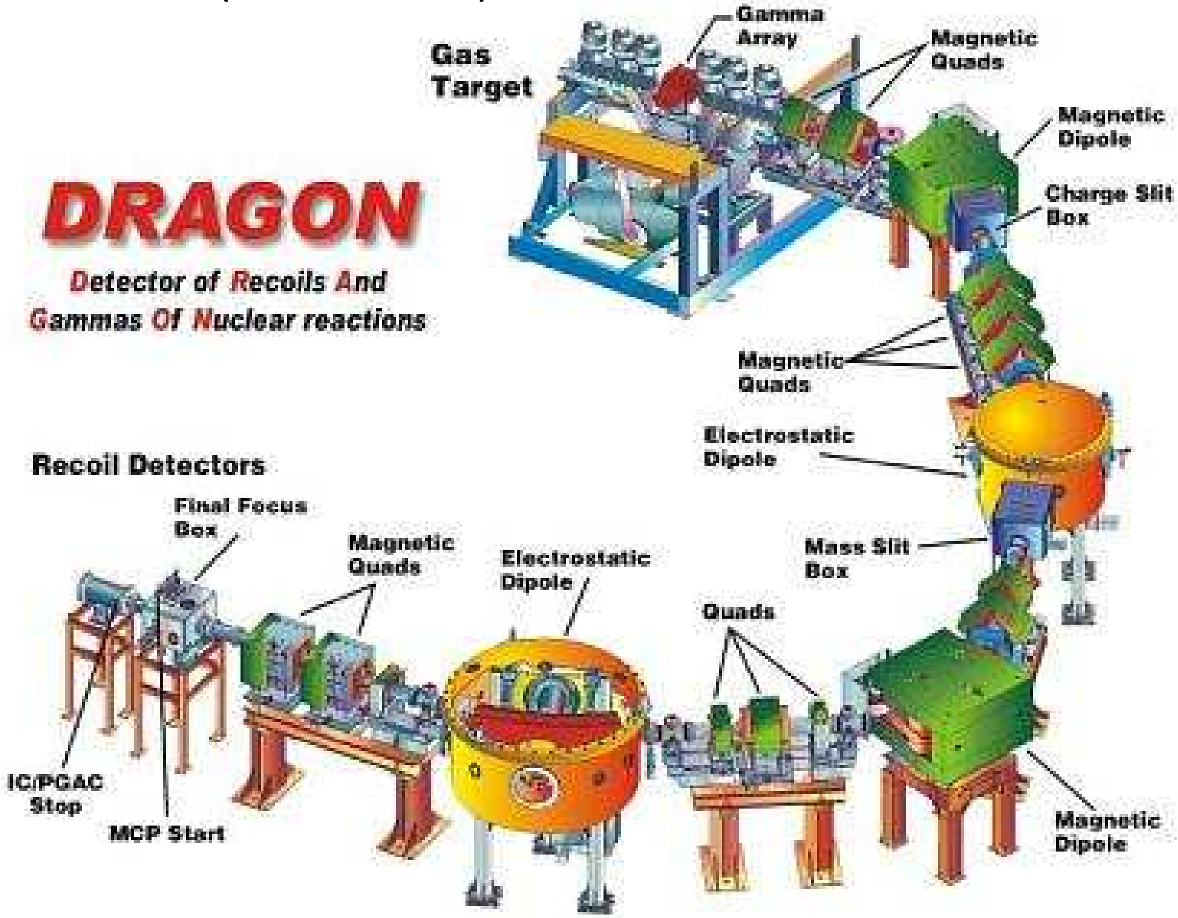


Figure above shows existing data on the $^{17}O(\alpha,n)^{20}Ne$ reaction, from three references, as presented in the NACRE compilation.
Band A shows the astrophysically relevant energy range.
Band B shows the proposed measurement energy range.

Experimental Technique: DRAGON

The measurement will use the standard DRAGON technique:

- inverse kinematics: ^{17}O beam (from supernanogam) on helium gas target
- detection of prompt gammas in BGO array (not necessary but could provide additional information)
- selection of ^{21}Ne recoils through separator
- detection of recoils in end detector (ion chamber)



Requested beam time

The calculations of the required number of shifts are based on:

- the cross section calculations of Descouvemont (relative to (α,n) channel)
- the $^{17}O(\alpha,n)^{20}Ne$ cross section data from NACRE
- a beam intensity of 10^{11} pps
- a helium target of 4 Torr
- a 40% charge state fraction
- a 40% BGO efficiency

Energy (MeV)	σ (α,n) (b)	σ (α,γ) (b)	Yield (reac/ion)	Yield (s^{-1})	Time for 1000 counts (hr)	No of shifts
1.5	1.10E-03	1.10E-07	1.56E-13	0.00249	111.44	10
1.58	4.60E-03	4.60E-07	6.51E-13	0.01042	26.65	3
1.66	8.70E-03	8.70E-07	1.23E-12	0.01971	14.09	2
1.74	1.90E-02	1.90E-06	2.69E-12	0.04305	6.45	1
1.82	1.40E-02	1.40E-06	1.98E-12	0.03172	8.76	1
1.9	1.20E-02	1.20E-06	1.70E-12	0.02719	10.22	1
1.98	9.00E-03	9.00E-07	1.27E-12	0.02039	13.62	2
2.06	1.00E-02	1.00E-06	1.42E-12	0.02266	12.26	2
						22

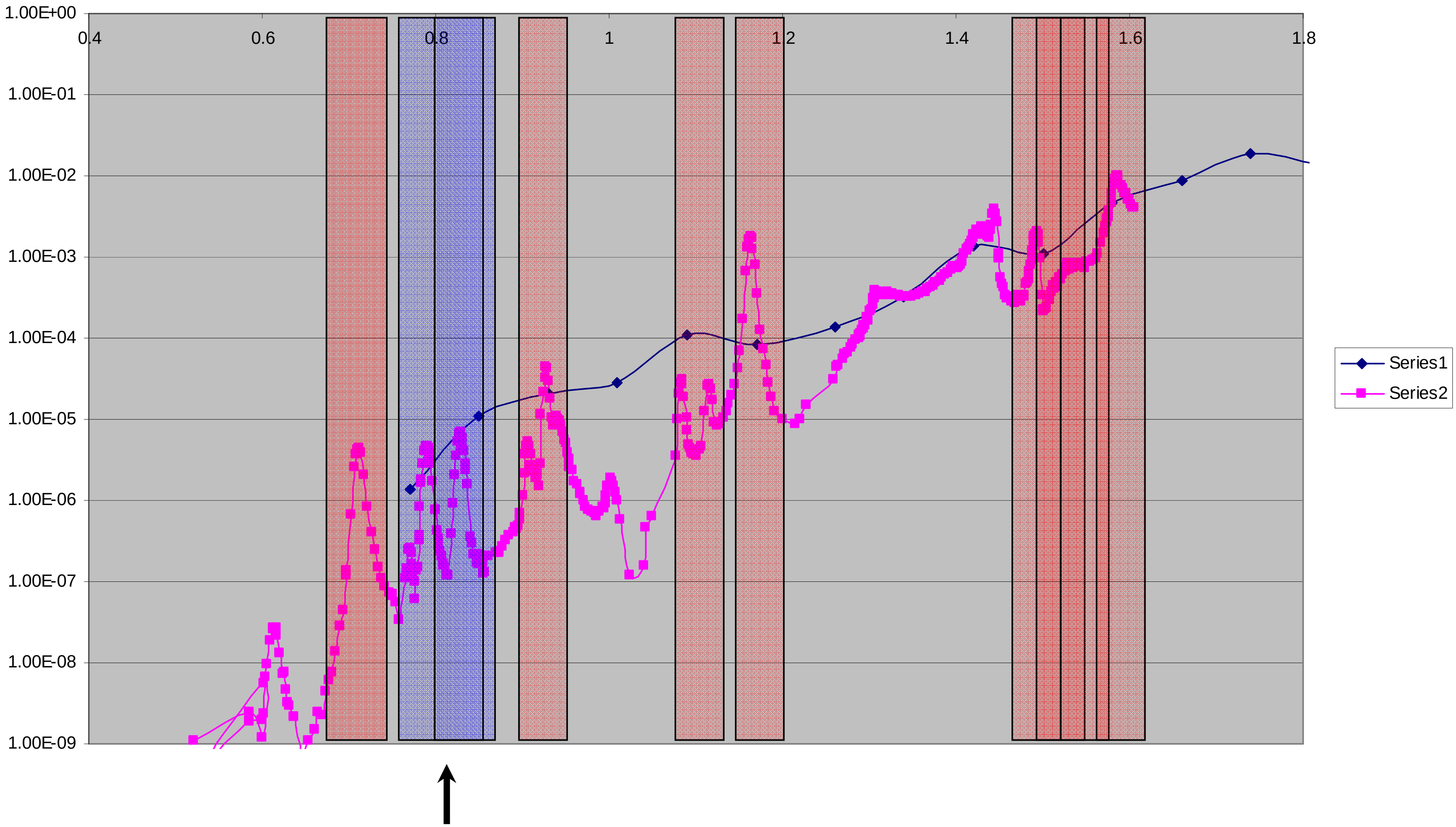
Total number of shifts requested = 22

Comments on run

- This was Plan B due to lack of ^{18}F intensity for scheduled run
- Beam intensities of up to 150 enA (~3 x 10^{11} pps)
- Due to high yield observed and according to recommendations of the EEC, the measurements were pushed down to lower energies towards astrophysically important range
- Sudden (unanticipated) increase in yield around 0.8 MeV Ecm – small energy steps
- When tuned to mass 20 could also see yield from (α,n) channel
- Used ~ 17 shifts

- Currently scheduled for September – important to look again at high yield region, cover other regions (could also be high yield), and push to lower energies.

Energy regions covered by $^{17}O(\alpha,\gamma)^{21}Ne$ measurements

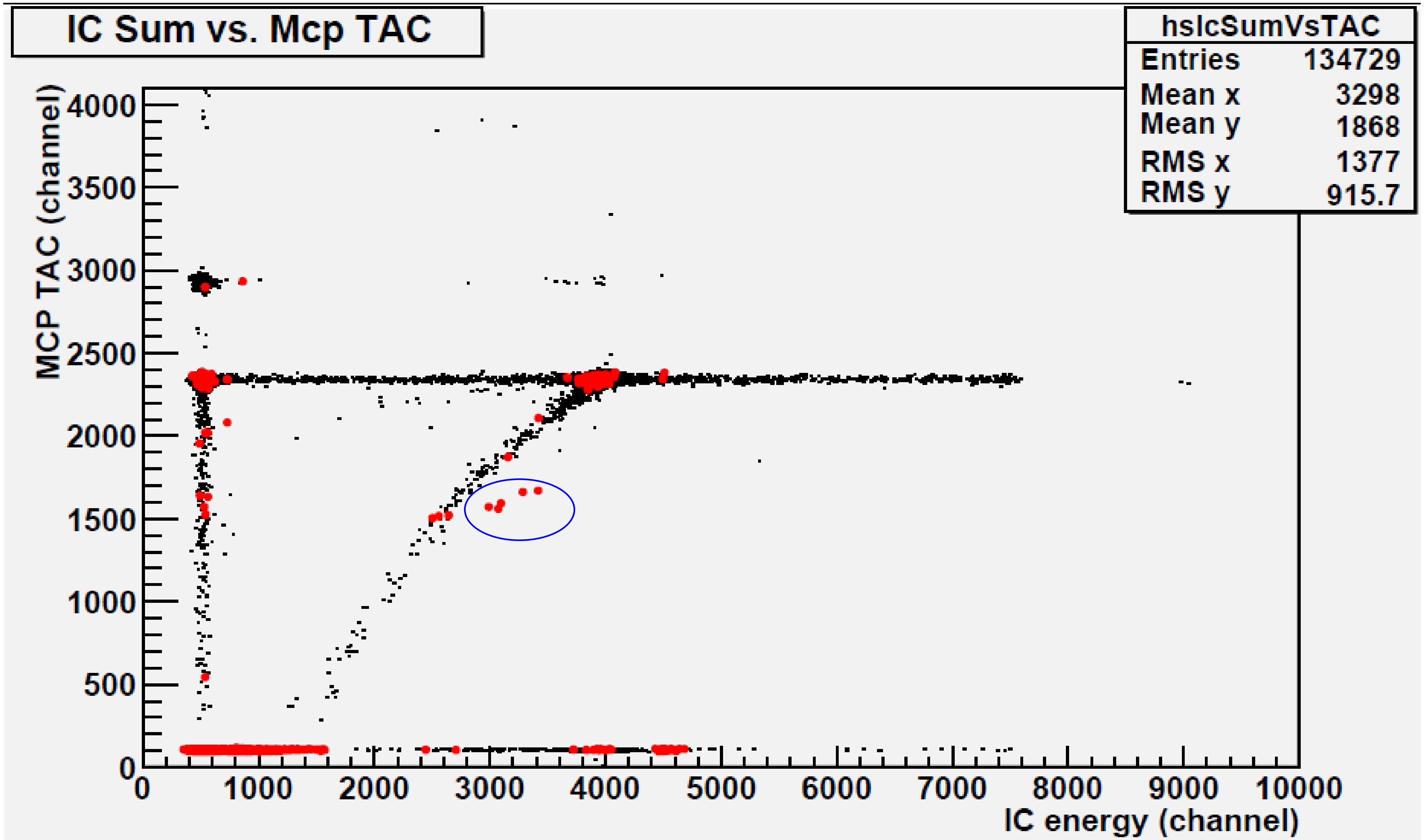


Region of higher than expected yield

470 keV/u after gas (4T) -> 1.53 MeV centre of mass

BLACK: attenuated beam run

RED: singles in recoil mode



Thank you for your attention.