# Measurement of γ Strength Function and Level Density of $^{138}$La

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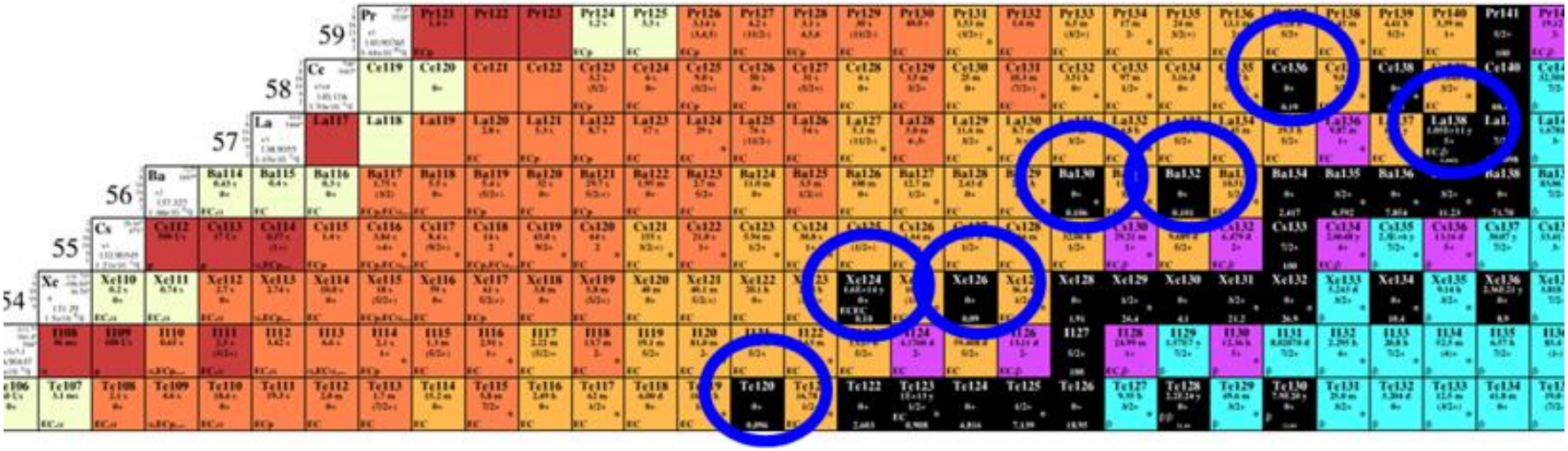
Energy Postgraduate Conference 2013

# Outline

- Introduction
- Experimental Setup
- Preliminary results
- Conclusions and Outlook

# Introduction
# The p-nuclei

- Most nuclei heavier than $^{56}$Fe are synthesized in stars by s- and r- processes
- However, 35 p-nuclei, including $^{138}$La , are shielded from s- and r- processes




- Photo-disintegration processes (γ,n), (γ,α) and (γ,p): main source for the heavier p-nuclei

T. Rauscher, Proceedings of Science, 059 (2010), S.E. Woosley et al., Ap. J. 356, 272 (1990).

# Introduction
# $^{138}$La is a special case

- Photo-disintegration cannot satisfactorily explain the observed abundance of $^{138}$La
- More exotic reactions e.g $^{139}$La(v, n)$^{138}$La or $^{138}$Ba + ve -->$^{138}$La must be considered


- Should Photo-disintegration processes be ruled out???????????
  - NO!!!!!!!!!!  Due to high errors in their rates predictions

- Which are due to limited knowledge and uncertainties in some of critical input parameters
  - nuclear level densities, γ-ray strength function and neutron optical potential

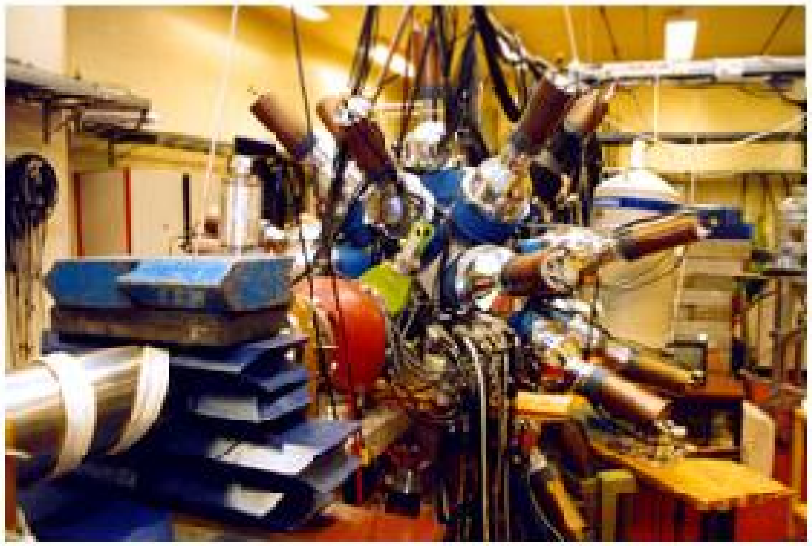
**Hence we measured the first two using Oslo Method**

S. Goriely et al., A&A 375, 35 (2001).

# Experimental Setup

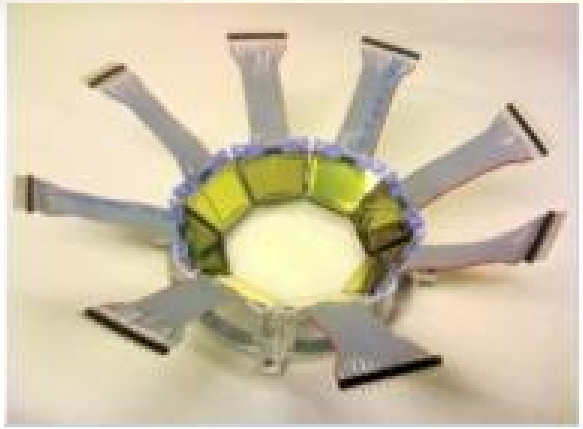
- Beam time: first half of February 2013

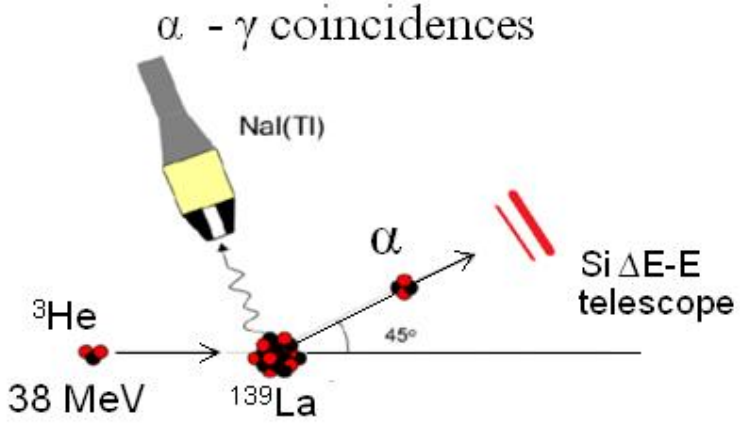
OCL
Oslo Cyclotron Laboratory



- CATUS array, 26 NaI γ-ray detectors

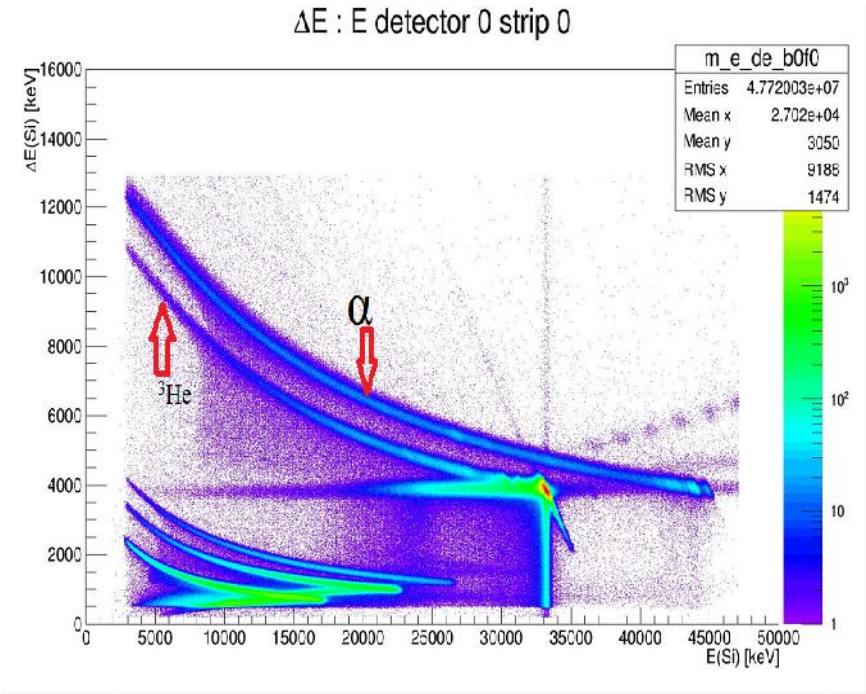
- SIRI array, 64 Si telescope detectors (particle identification)



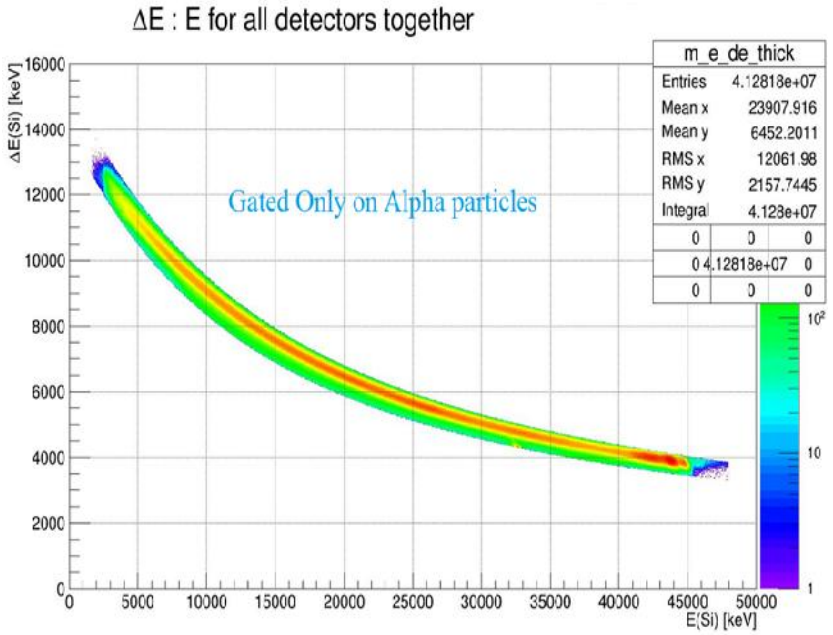


# Analysis

## Ungated ΔE vs E

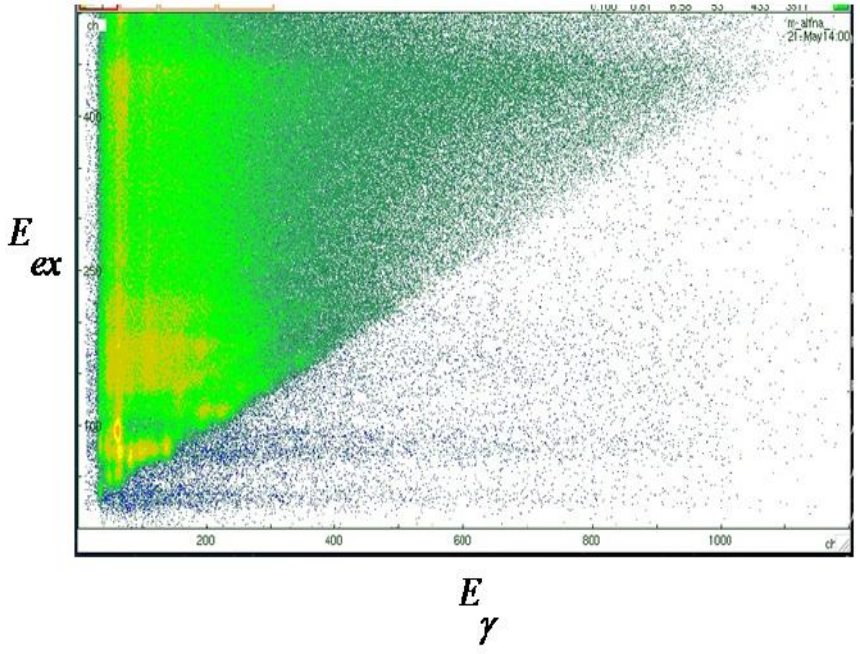



## Gated ΔE vs E



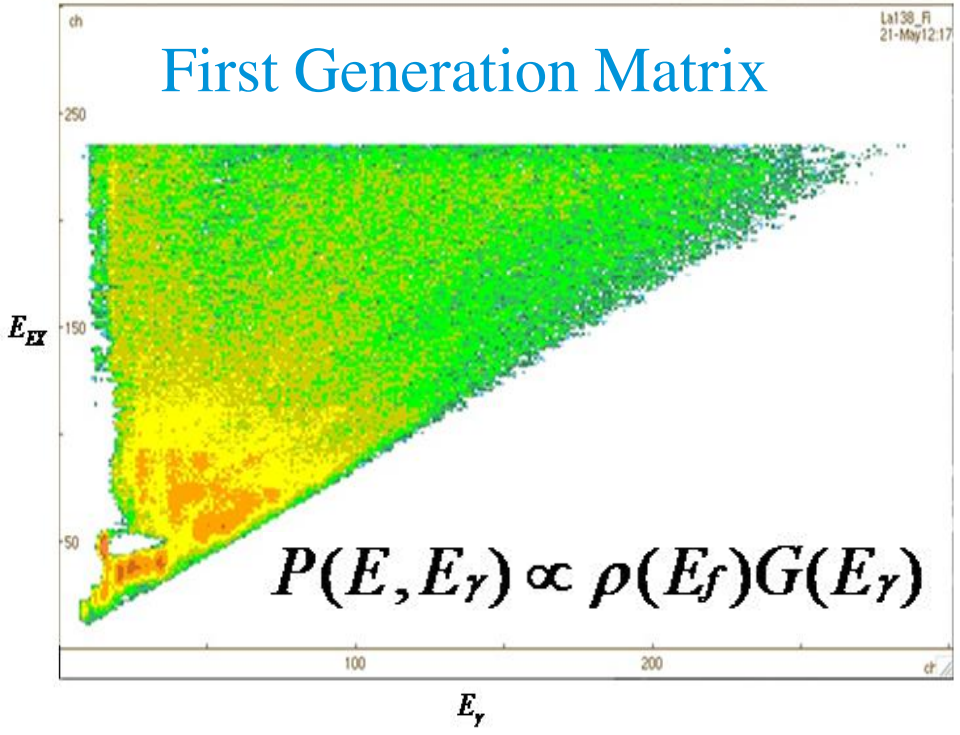
# Analysis
# Extraction of Primary γ-rays

## Particle – γ coincidence matrix




- Gammas in coincidence with α - particles
- From Q-value and kinematics of reaction

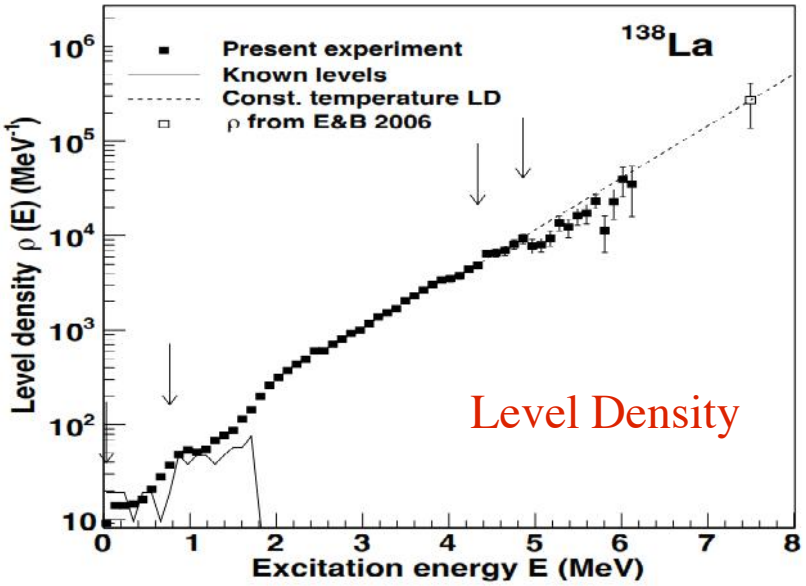
## First Generation Matrix




Oslo Method:

- Unfolding
- Extraction of primary gammas

# Preliminary Results

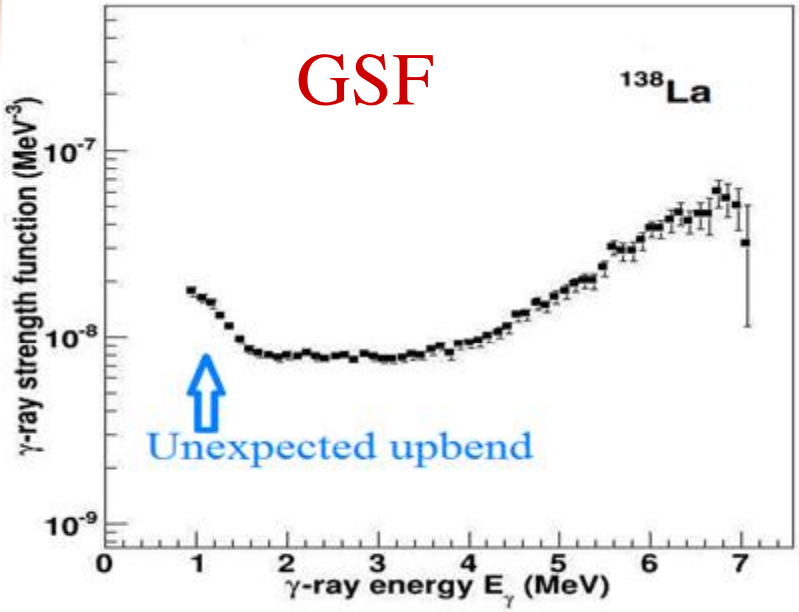



• $\rho(S_n)$ calculated using BSFG model:

$$\rho(S_n) = \frac{\exp\left[2\sqrt{a(S_n - E_1)}\right]}{12\sqrt{2}\sigma \ast a^{1/2}(S_n - E_1)^{5/4}}$$

$$\sigma^2 = 0.0146 A^{5/3} \frac{1 + \sqrt{1 + 4a(U - E_1)}}{2a}$$

T. von Egidy and D. Burcurescu, PRC 72, 044311(2005)




• Pronounced low energy enhancement

• ***First observation of the low-energy enhancement above mass A~106!!!!!!!***

# Conclusions and outlook

- More precise $^{138}$La production rates have to be determined: PSF and LD
- A $^{139}$La($^{3}$He, $\alpha$)$^{138}$La experiment has been successful at OCL Oslo Cyclotron Laboratory
- Preliminary results on PSF and LD have been extracted
  - an unexpected low energy enhancement in the PSF
  - first time in nuclei heavier than ***A~106***!!!
- Next steps:
  - comparison with more experimental data and models
  - PSF and LD for $^{139}$La via the ($^{3}$He, $^{3}$He$\gamma$) reaction: Analysis in progress!!
  - Plans to extract PSF via TSC analysis.

# Acknowledgements


- Cyclotron Laboratory of Oslo University
- N.Y. Kheswa[1] for making the target
- NRF for funding
- The following people for participating on the experimental work:

B.V. Kheswa[1,3], M. Wiedeking[1], F. Giacoppo[2], P. Papka[3], M. Guttormsen[2], A. Görgen[2], A. C. Larsen[2], T. Renstrøm[2], S. Siem[2], P. E. Koehler[2], T. K. Eriksen[2], E. Sahin[2], T. Tornyi[2], M. Klintefjord[2], T. W. Hagen[2], S. Rose[2], F. Bello[2]



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Thank You All