



EURISOL NET
Physics & Instrumentation
TASK 2

Report on the Eurisol User Group activities

<http://www.eurisol.org/usergroup/>

The research leading to these results has received funding from the European Union Seventh Framework Programme FP7/2007- 2013 under Grant Agreement n. 262010-ENSAR. The EC is not liable for any use that can be made on the information contained herein.

Warsaw Town Meeting, June '13

Except from annex 1 of ENSAR (FP7)

TASK 2: Physics and Instrumentation for ISOL Facilities

This task will be committed to updating of the ISOL Physics case in collaboration with the user communities of the TNA partners and the EURISOL User Group. New ideas for related instrumentation arising from the technical advances developed within JRA04-INDESYS will be identified. All participants and associated partners will be invited to contribute to this task.

The activities of NA03-EURISOL NET will consist in topical meetings on the above subjects, which will be held in conjunction with the conferences of the EURORIB series, which are held every two years and are jointly organised by the major European RIB facilities. Two EURISOL town meetings will be organised (in the second and fourth years) to disseminate the information on the advances of the ISOL scheme and on the general progress of the EURISOL concept to the community at large. The deliverables will be

- 1 report on the technical R&D subjects summarising the progress made and the implementation of new techniques at the different facilities
- 1 report on the advances applicable to the next generation facility EURISOL.
- 1 report on the updated Physics and Instrumentation case for ISOL facilities and for EURISOL.

The coordinator and management will actively encourage and monitor the broad implementation of the techniques developed throughout the participating facilities. A web page, integrated in the ENSAR website will be set up to record and disseminate the technical advances. The deliverables will be largely distributed within the community.

The major part of the funding requested shall be used for travel between the facilities and attendance of the meetings. A small part will be devoted to the production of the reports, and the organisation of the town meetings.

Scientists from many associated partners, involved in ISOL research and encompassing a broad range of competences, will contribute to the network.

D3.1) Transfer of R&D accomplishments between ISOL facilities-Report: [month 32]
D3.2) Updated Physics and Instrumentation case for ISOL facilities: [month 44]
D3.3) Identification of technologies developed at ISOL facilities applicable at future facilities-Report: [month 48]

Schedule of relevant Milestones

Milestone number ⁵⁹	Milestone name	Lead beneficiary number	Delivery date from Annex I ⁶⁰	Comments
MS36	Setting up of working groups for each subject	6	4	List of subtask groups
MS37	1st working group meetings: identification of main common R&D issues	6	12	Minutes of meetings
MS38	1st EURISOL town meeting: input from associate partners and the community	6	18	Presentations
MS39	2nd working group meetings: monitoring the progress of R&D	6	30	Minutes
MS40	2nd EURISOL Town Meeting: dissemination of results and identification of physics and technologies	6	40	Presentations

List of deliverables

Deliverable Number ⁶¹	Deliverable Title	Lead beneficiary number	Estimated indicative person-months	Nature ⁶²	Dissemination level ⁶³	Delivery date ⁶⁴
D3.1	Transfer of R&D accomplishments between ISOL facilities-Report	6	10.01	R	PU	32
D3.2	Updated Physics and Instrumentation case for ISOL facilities	1	10.00	R	PU	44
D3.3	Identification of technologies developed at ISOL facilities applicable at future facilities-Report	1	10.00	R	PU	48
Total			30.01			

April 2014

ACTIVITIES

A town meeting every second year
and a topical meeting per year

First Workshop at GGI Florence, Jan. 2008.

1st Topical Meeting, LNS-Catania, Dec.2009

2nd Topical Meeting, Valencia, Feb.2011

*3rd Topical Meeting & **Town Meeting**, Lisbon, Oct. 2012*

4th Topical Meeting, Krakow, 1-3 July 2013

keep the physics case updated

- *Experimental/Technical update*
- *Theoretical state-of-the-art*

User Executive Committee

Dieter Ackermann (GSI, Darmstadt, Germany)

Bertram Blank (CEN, Bordeaux, France)

A B (INFN, Pisa, Italy)

Lidia Ferreira (IST, Lisbon)

Hans Fynbo (Uni. Aarhus, Denmark)

Ari Jokinen (Uni. Jyvaskyla, Finland)

Marek Lewitowicz (Ganil, Caen, France)

Adam Maj (Inst. Nucl. Phys., Kraków, Poland)

Paddy Regan (Uni. Surrey, Great Britain)

previously

Giacomo de Angelis (LNS-INFN), Robert Page (Liverpool),
Berta Rubio (Valencia), Michael Thoennessen (MSU).

TOWN MEETING PROGRAM

Alberto Andrichetto (INFN/LNL, Padova, Italy) [*"Production Target developments for the SPES project"*](#)

José Benliure (Univ. Santiago de Compostela, Spain) [*"Reactions and yields for the production of nuclei far from stability"*](#)

Angela Bonaccorso (INFN, Pisa, Italy) [*"Report on the Eurisol User Group Topical Meetings"*](#)

Sebastien Bousson (IPN, Orsay, France) [*"Recent Developments on Superconducting Acceleration Technology relevant for EURISOL"*](#)

Angela Bracco (Univ. Milano, Italy) [*"The NuPECC long range plan update"*](#)

Luciano Calabretta (INFN/LNS, Catania, Italy) [*"The ISOBARIC separator of the SPES project"*](#)

João Guilherme Correia (ITN/IST, Lisbon and CERN) [*"New applications of radioactive ion beams at EURISOL"*](#)

Christine Darve (ESS, Lund, Sweden) [*"The European Spallation Source design impact for the Eurisol facility"*](#)

Jean-Christophe David (CEA Saclay - Irfu/SPhN, France) [*"Hg target - safety point"*](#)

Pierre Delahaye (GANIL, France) [*"Charge breeding of exotic isotopes for EURISOL: the EMILIE project"*](#)

Piet Van Duppen (Leuven, Belgium) [*Introduction to EURISOL*](#)

Tim Giles (CERN, Geneva, Switzerland) [*"Synergies between HIE-ISOLDE and EURISOL"*](#)

Yacine Kadi (CERN, Geneva, Switzerland) [*"High-Power Targets — Development and testing of spallation neutron sources"*](#)

Iain Moore (Univ. Jyväskylä, Finland) [*"Production and Manipulation of Radioactive Ion Beams"*](#)

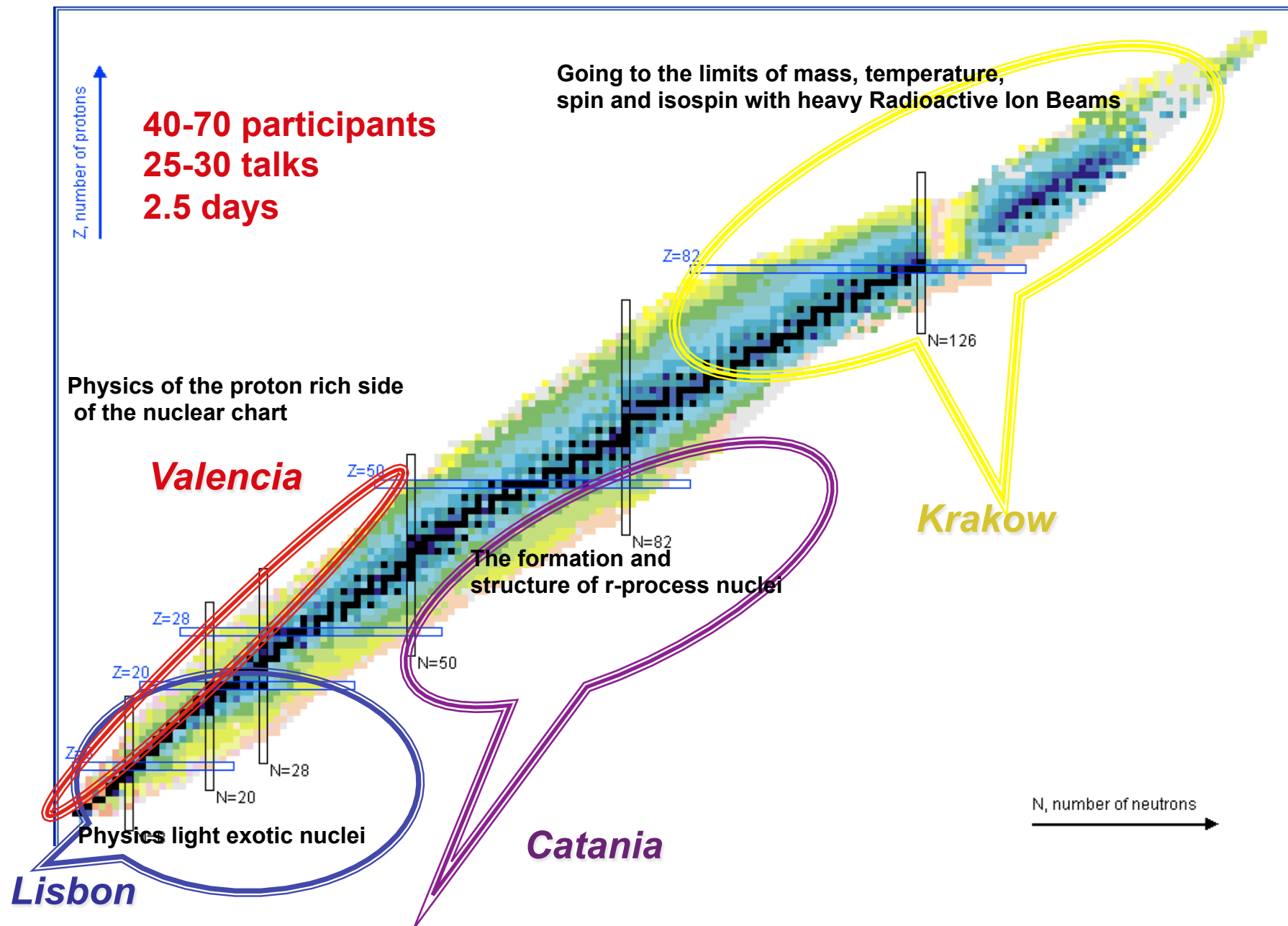
Alahari Navin (Ganil, France) [*"Smoking Gun-Discovery-Precision: Physics case of EURISOL"*](#)

Lucia Popescu (CK-CEN, Mol, Belgium) [*"The ISOL@MYRRHA project at SCK·CEN; Synergies with EURISOL"*](#)

Hervé Savajols (GANIL, France) [*"Status of the SPIRAL2 facility Synergies with EURISOL"*](#)

Thierry Stora (CERN, Geneva, Switzerland) [*"High power targets for radioactive ion beams"*](#)

Pedro Vaz (IST, Lisbon, Portugal) [*The impact of radiological protection and Radiation Safety Requirements in the Next Generation, Emerging and Innovative Nuclear Technology Facilities.*](#)



Chair Lidia Ferreira

EURISOL User Group

Eurisol Topical and Town Meetings, Lisbon, 15th-19th October 2012



Physics of Exotic Light nuclei

Report written by Bjorn Jonson and AB

<http://cfif.ist.utl.pt/~eurisol/>

B. Jonson's questions

EURISOL User Group

Report on the third EURISOL User Group Topical Meeting ¹

Physics of Light Exotic Nuclei

Instituto Superior Técnico (IST), Lisbon, Portugal, 15-19 October 2012

The research leading to these results has received funding from the European Union Seventh Framework Programme FP7/2007- 2013 under Grant Agreement n. 262010 - ENSAR.
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What have we learnt (during these three days) that gives us new arguments for EURISOL?

Deviations between experiments and theory?

Are new experiments needed to guide theory?

Are new calculations needed to design better experiments?

Does it together lead to new buildings at the final facility? [€]

¹Coordinated by Angela Bonaccorso, INFN, Sez. di Pisa, Italy, Lidia Ferreira, IST, Lisbon, Portugal and Björn Jonson, Chalmers University of Technology, Göteborg, Sweden.

Importance of elastic scattering:

Borge, Figuera, Cardella, Gomes, Arellano, Descouvemont, Crespo, de Diego

Elastic scattering and reaction mechanisms of the halo nucleus ^{11}Be around the Coulomb barrier

A.Di Pietro¹, G.Randisi^{1,2*}, V.Scuderi^{1,2}, L.Acosta³, F.Amorini^{1,2}, M.J.G.Borge⁴, P.Figuera¹, M.Fischella^{1,2}, L.M.Fraile^{5,1}, J.Gomez-Camacho⁶, H.Jeppesen^{5,1}, M.Lattuada^{1,2}, I.Martel³, M.Miln⁷, A.Musumarra^{1,8}, M.Papa¹, M.G.Pellegri^{1,2}, F.Perez-Bernal³, R.Raabe⁹, F.Rizzo^{1,2}, D.Santonocito¹, G.Scalia^{1,2}, O.Tengblad⁴, D.Torresi^{1,2}, A.Maira Vidal⁴, D.Voulot⁵, F.Wenander⁵, M.Zadro¹⁰

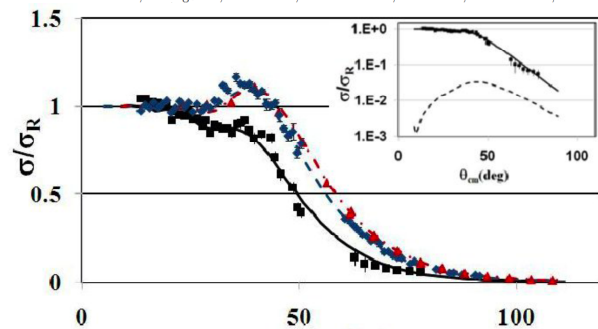
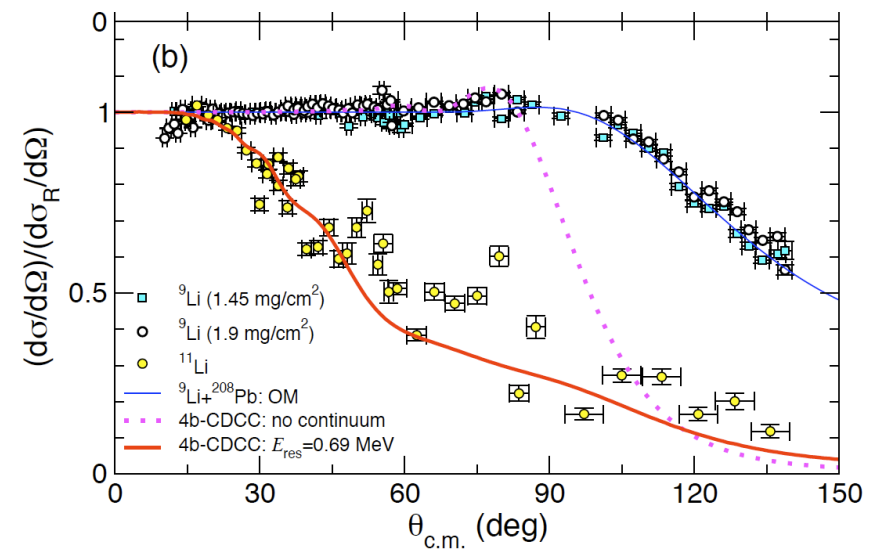


TABLE I. $V=0$ optical potentials obtained from the fit of the experimental data. The real potential radius parameter is $r_0=1.1$ fm and the imaginary one is $r_1=1.2$ fm, where $R_{0,i,el}=r_{0,i,el}(A_p^{1/3}+A_t^{1/3})$. The Coulomb radius parameter is $r_c=1.25$ fm.

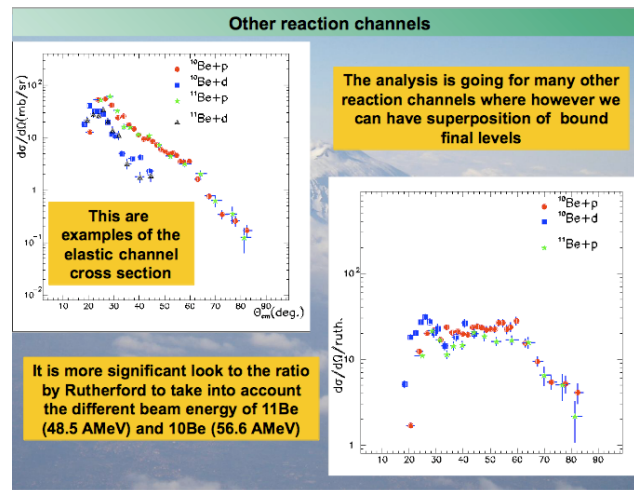
Reaction	V (MeV)	a (fm)	V_i (MeV)	a_i (fm)	V_{ai} (MeV)	r_{ai} (fm)	a_{ai} (fm)	J_V (MeV fm ³)	J_W (MeV fm ³)
$^{11}\text{Be}+^{64}\text{Zn}$	126	0.6	17.3	0.75				295	53
$^{10}\text{Be}+^{64}\text{Zn}$	86.2	0.7	43.4	0.7				193	124
$^{11}\text{Be}+^{64}\text{Zn}$	86.2	0.7	43.4	0.7	0.151	1.3	3.5	193	120



Borge

Figuera

Cardella



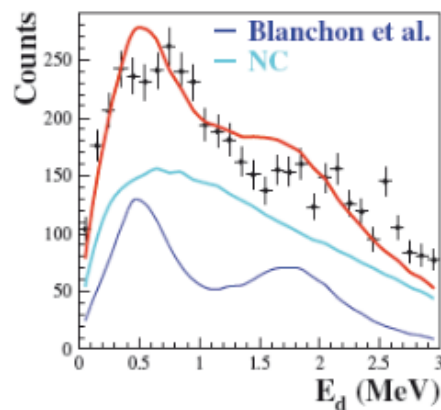
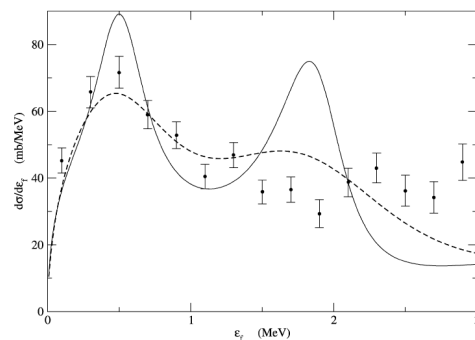
Predicted by a microscopic
OP calculation
AB, F.Carstou, NPA706 (2002)

Physics at the dripline: Unbound nuclei

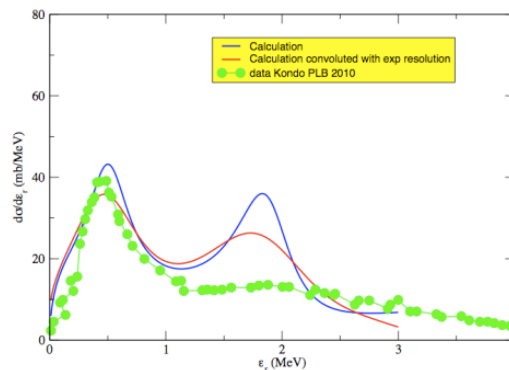
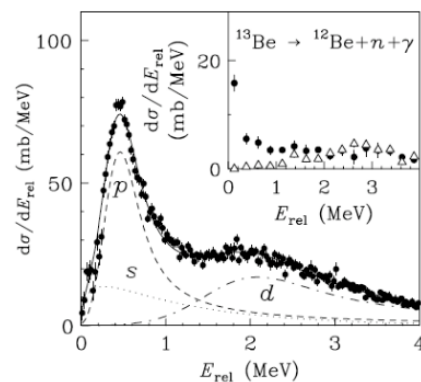
A typical example ^{13}Be

An unresolved case ^{21}C

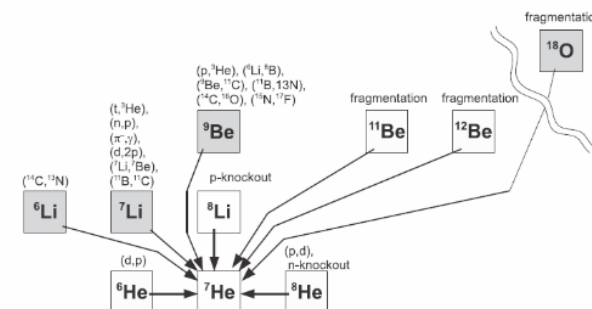
H.Simon et al, 2007



Randisi, Orr et al, 2012



Kondo et al, 2010



- Momentum distributions
- Angular correlations
- Relative energy spectra
- Energy and angular correlations
- Profile function analysis



Common topics attacked from different points of view at the three meetings

Pigmy and dipole resonance in general: Vretenar, Colò, Lanza, Bracco, Boretzky, Lo Iudice

Clusterization: a threshold phenomenon? M. Freer, Feldmeier, Ploszajczak

Structure models, ab initio, GF: Barbieri, Forssen, Schwenk. En. dens.funct
Dobaczewski

Breakup and transfer, resonances: Bertulani, Obertelli, Assie, Crespo, Nakamura, Simon, Galaviz, Maglione

Nuclear Astrophysics, direct and indirect measurements: Montes (separator for capture reactions, De Oliveira Santos (Wien filter for p,gamma), (see also Cocolios, van Duppen), Chen, Spitaleri, Laird. **REMEMBER: need for radioactive beam purity**

One-, two- and three-proton radioactivities

E. Maglione, I. Mukha, P. Woods

$N \approx Z$ Nuclei

J.J. Valiente Dobón, A. Macchiavelli, P. van Isacker,
Y. Fujita and T. Faestermann.

Special $N=Z$ nuclei subtopic:

**Superaligned Fermi decays, precise $T_{1/2}$, branching ratios
and Q values**

by J. Giovinazzo, T. Eronen, M. Kowalska

Nuclear Astrophysics

F. Montes, F. De Oliveira Santos, A. A. Chen.

Other Reaction Experiments: Coulex and transfer

J. Cederkall and D. Jenkins

Other Reaction Theory

C. Bertulani and H. Arellano

Atomic Physics for Nuclear Physics

R.D. Herzberg, P. van Duppen, T. Cocolios, M. Kowalska

Ground State Shapes from beta decay

A. Algara and A. Petrovici

Exotic excitations in proton rich nuclei and clusterisation

D. Vretenar, M. Freer, G. Verde

Report written by B. Rubio, A.B.

EURISOL



Report on the second EURISOL User Group Topical Meeting ¹

Neutron deficient exotic nuclei and the Physics of
the *proton rich side* of the nuclear chart.

Colegio Mayor Rector Peset, Valencia, Spain, 21-23 February 2011.

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The workshop was partially supported by CPAN and IFIC (CSIC-Univ. of Valencia), Spain.

¹Coordinated by Berta Rubio, IFIC, Valencia, Spain and Angela Bonaccorso, INFN, Sez. di Pisa, Italy.

EURISOL User Group

Topical Meeting Valencia

Neutron deficient exotic nuclei and
the Physics of the "proton rich side" of the nuclear chart

Highlights

*Ground state properties: mass measurements, $T_{1/2}$, gamma widths...
and fundamental symmetries.*

*These are important for our science in general and will have a relevant
place in the final EURISOL NET report.*

*Laser spectroscopy is a very promising methodology which is particularly
interesting for the synergies with other fields of Physics.*

*Direct measurement for nuclear astrophysics (example for stellar nucleosynthesis) :
origin of ^{26}Al need $^{25}\text{Al}(p, \gamma)^{26}\text{Si}$ or $^{26\text{m}}\text{Al}(p, \gamma)^{27}\text{Si}$... dedicated target station...low energy*

Theoretically: study of resonances in p-scattering...optical potential of Arellano?

*Clustering: M Freer exp point of view see **LISBON***

EURISOL User Group

Topical Meeting Valencia

Neutron deficient exotic nuclei and
the Physics of the "proton rich side" of the nuclear chart

$N=Z$ nuclei...shell model still good (...even for the very rare **^{100}Sn**) (p,d) would need post accelerated EURISOL beams: high energy target station.

Transfer and Coulex: from ^{100}Sn to ^{132}Sn ...in (p,d) need to get ang dist. of high energy outgoing proton ($\sim 70\text{MeV}$)

Isospin symmetry: Mirror Energy Differences, measured $^{67}\text{Se}, ^{67}\text{As}$

np pairing...Transfer to $0+, 1+$, measure strength of $T=0, 1+$ pairing force..

very exotic ^{88}Ru ? ^{92}Pd (ok isoscalar $T=0$ pairing correlation?)

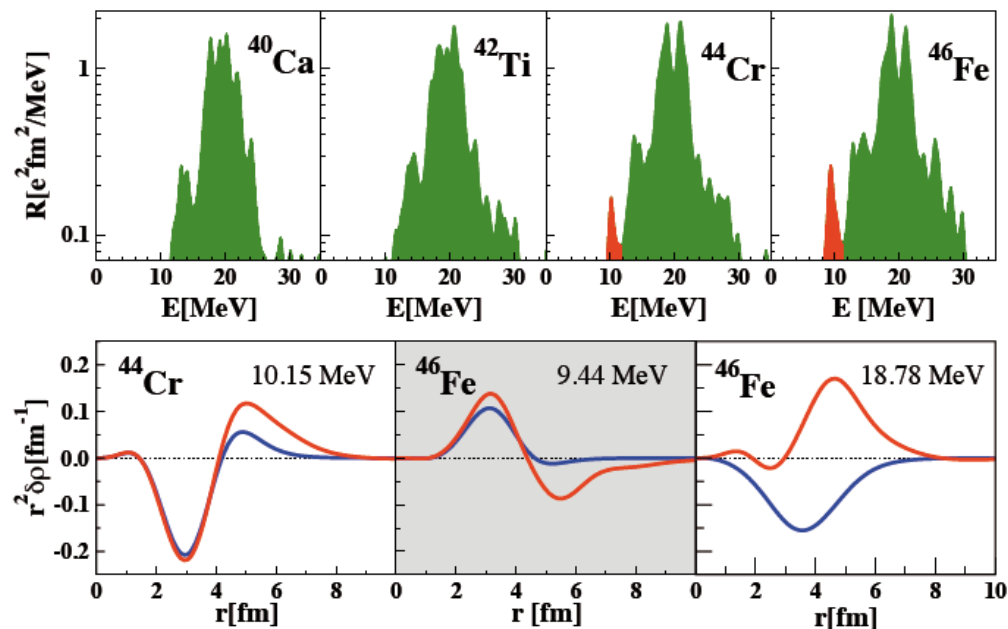
...go for ^{100}Sn ... best incident energy? need γ and n detectors (cf AGATA, NEDA)

Access **Giant GT by β -decay (Fujita)** need 100A MeV

Dedicated target station...high energy, for charge-exchange &/vs beta decay

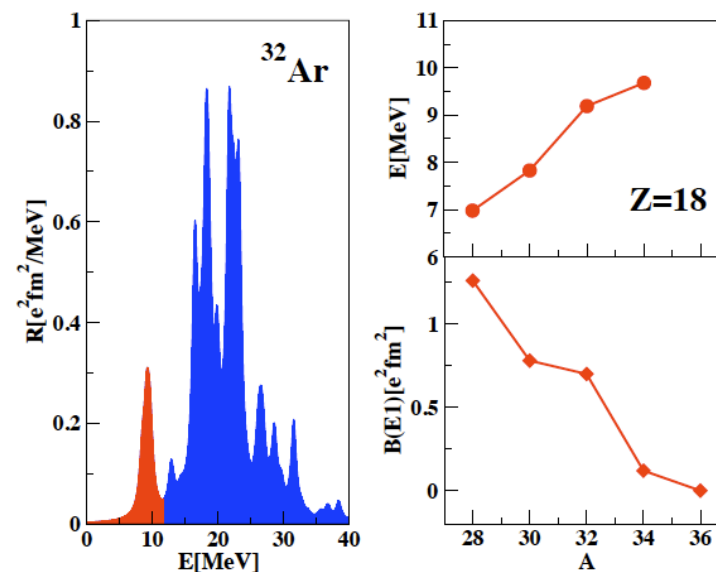
Exotic excitation modes: effect of Coulomb barrier on protons...(discussed in several talks...) Separation between PDR&GDR increases as the nucleus becomes more proton rich (**Vretenar**)

$$R(E) = \sum_i B(E1, 1_i \rightarrow 0_f) \frac{\Gamma/2\pi}{(E - E_i)^2 + \Gamma^2/4}$$



PPDR

mass dependence of the centroid



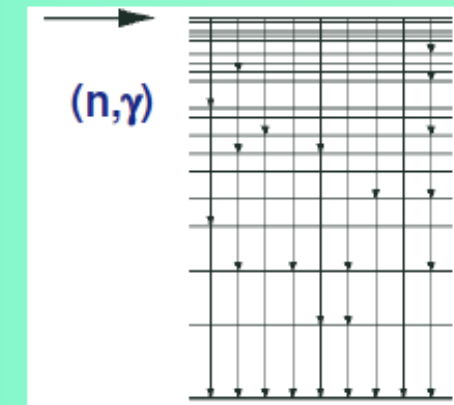
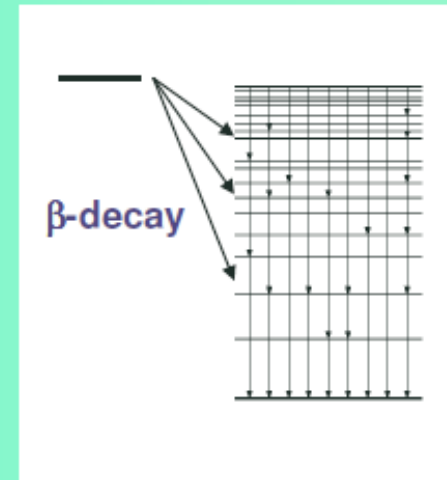
integrated strength below 12MeV

Dario Vretenar
University of Zagreb

Neutron MC simulations for Total Absorption Gamma-ray Spectroscopy

- Total Absorption Spectroscopy is the **best** method **to measure** beta **strengths** in β -decay (the only valid one far from stability)
- It is also a **powerful** method **to measure** neutron **capture cross-sections** (the only useful for rare or radioactive samples)
- A **major** source of systematic **error** is **contamination/ background** signals

TAS: large 4π scintillation detector



EURISOL User Group

Topical Meeting Valencia

Neutron deficient exotic nuclei and
the Physics of the "proton rich side" of the nuclear chart

Conclusions

- An area for stopped beams (decay studies, mass measurements and other ground state properties, including traps and laser ionisation...). A hall similar to the present ISOLDE hall or the planned DESIR hall.
- A low energy area for reactions of astrophysical interest. Similar to ISAC in TRIUMF, but one should also look at the dedicated effort at MSU.
- Coulex and transfer at low energy. One could take REX-ISOLDE as an example adding a recoil spectrometer.
- In-beam, gamma, electron spectroscopy and decay tagging station. The set-up at Jyväskylä is a good example but with the state-of-the-art in Gamma arrays and including the possibility to measure neutrons (for channel selection purposes).
- Intermediate energy regime. Ideally with a high resolution spectrometer such as the one at RCNP in Osaka.

The logo for the EURISOL User Group, featuring the text "EURISOL User Group" in a stylized, multi-colored font (red, orange, yellow, green, blue, purple) with a slight 3D effect.

The first EURISOL UG topical meeting - The formation and structure of r-process nuclei, between $N=50$ and 82 (including ^{78}Ni and ^{132}Sn areas)

9-11 December 2009 Catania, INFN-LNS, Conference Hall

<http://agenda.ct.infn.it/conferenceDisplay.py?ovw=True&confId=236>

Report written by A.B.

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Report on the first EURISOL User Group Topical Meeting ¹

The formation and structure of r-process nuclei, between $N=50$ and 82 (including ^{78}Ni and ^{132}Sn areas)

INFN-Laboratorio Nazionale del Sud, Catania, 9 -11 December 2009.

¹Coordinated by Angela Bonaccorso, INFN, Sez. di Pisa, Italy.

Generalities on the r-process

Stéphane Goriely The r-process: a longstanding mystery with still many nuclear and astrophysics pending questions

Olivier Sorlin Experimental studies on the r-process at SPIRAL2

Gabriel Martinez Pinedo The role of nuclear physics in r-process nucleosynthesis

Rene Reifarth Experiments close to stability contributing to our understanding of the r-process

Bradley Cheal Optical techniques for r-process nuclei

Mass Measurements and Calculations. β -decay

Jacek Dobaczewski New ideas in the nuclear energy density functional approach

Ari Jokinen Exploring the structure of neutron-rich nuclei by direct mass measurements

Alexander Herlert Mass measurements on neutron-rich nuclei at ISOLTRAP: Present status and future perspectives

David Verney Structure of nuclei "North and Northeast of ^{78}Ni ": contribution from beta-decay

Dimitry Testov Delayed multiple neutron emission from photo-fission fragments.

Light nuclei astrophysics

Marco La Cognata Solving the large discrepancy between inclusive and exclusive measurements of the $^8\text{Li} + ^4\text{He} \rightarrow ^{11}\text{B} + n$ reaction cross section at astrophysical energies.

Silvio Cherubini Nuclear Astrophysics research in Catania

Coulomb excitations, dipole strength, pigmy resonance

Angela Bracco The Pygmy Dipole Resonance in the neutron rich nucleus ^{68}Ni

Kostanze Boretzky Dipole strength in neutron-rich Ni and Sn isotopes

Thorsten Kroell Coulomb excitation of neutron-rich nuclei around ^{132}Sn at REX-ISOLDE

Jan Diriken Coulomb excitation of ^{73}Ga with MINIBALL at REX-ISOLDE

Edoardo G. Lanza On the nature of the Pygmy Resonances

Gianluca Colò Single-particle and collective strength in neutron-rich nuclei using non-relativistic effective forces

Structure around N=82

Magdalena Gorska Structure of heavy Cd and In isotopes up to N=82

Angela Gargano Neutron-Rich Nuclei around Closed Shells: Nuclear Forces and Shell Structure

Gary Simpson Current status of gamma-ray spectroscopy data in the ^{132}Sn region

Steven Pain Neutron transfer measurements around the doubly-magic ^{132}Sn

Calin Ur Study of neutron-rich nuclei with PRISMA-CLARA. Future perspectives with EURISOL

Maria Colonna Testing the low density behavior of neutron-rich systems

MISSING: Neutron capture cross sections i.e. $^{59}\text{Fe}(n,\gamma)^{60}\text{Fe}$ and $^{60}\text{Fe}(n,\gamma)^{61}\text{Fe}$ ^{107}Pd

Conclusions

Beam properties

Low-energy high purity beams for decay studies and mass measurements, Coulomb barrier energies for Coulex (see low energy Valencia) and high energy beams for Coulomb dissociation.

Detection

Penning trap mass spectrometer for mass measurements (see e.g. ISOLTRAP).

Laser ion-source for purification purposes (e.g. RILIS at ISOLDE).

Multi-coincidence set-up with various detection systems, in particular for neutrons and gammas. (see also clustering and the FARCOS project at Valencia meeting).

Theoretical support

Energy functional method for mass calculations.

Modern nuclear structure models for the nuclear mean field. Capabilities for large-scale shell-model calculations (needs the development of appropriate residual interactions to be employed in studies of nuclei far from stability).

Coulomb dissociation method.

RPA methods to study the nature of resonances.

Full dynamical calculation of r-process nucleosynthesis with inclusion of the nuclear physics input obtainable from the experimental data.

Thanks! ...

***and see you at the next topical meeting in
Krakow and the town meeting in 2014 at (?)***



Special thanks to our Polish, Portuguese, Spanish and Sicilian colleagues for hosting the meetings

<http://www.eurisol.org/usergroup/>