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Istituto Nazionale di Fisica Nucleare
SEZIONE DI PISA

EURISOL User Group

EURISOL NET

Physics & Instrumentation

TASK 2

Report on the Eurisol User Group Topical Meetings

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.

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.

April 2014

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

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation 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			

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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

keep the physics case updated

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

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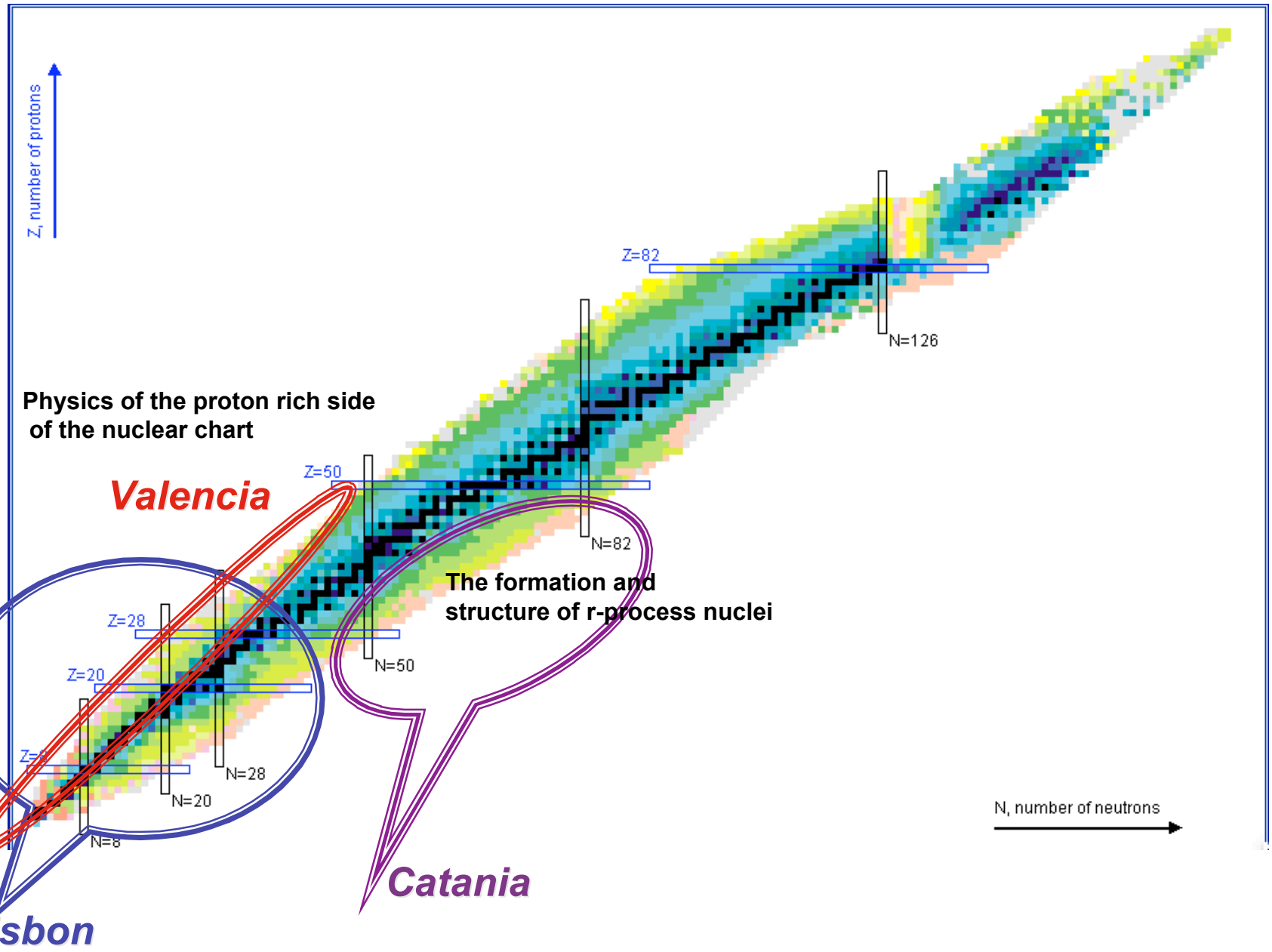
User Executive Committee

Dieter Ackermann (GSI, Darmstadt, Germany)
Bertram Blank (CEN, Bordeaux, France)
A B (INFN, Pisa, Italy)
Lidia Ferreira (IST, Lisbon) - Chair
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)


Z, number of protons
Physics of the proton rich side
of the nuclear chart
Valencia
Z=82
N=126
Z=50
N=82
The formation and
structure of r-process nuclei
Z=28
N=50
Z=20
N=28
N=20
N=8
N, number of neutrons
Catania
Lisbon

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Report to be written L. Ferreira, AB

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

B. Jonson's questions

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? [€]

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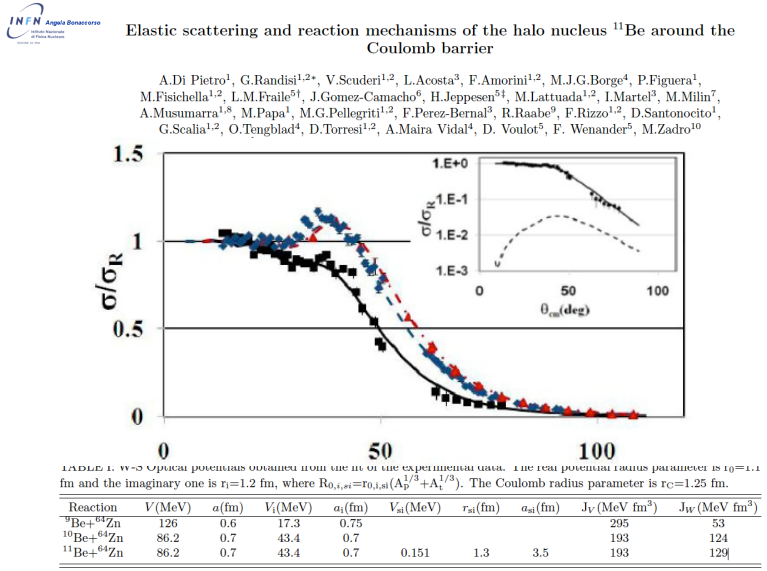
Importance of elastic scattering:

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



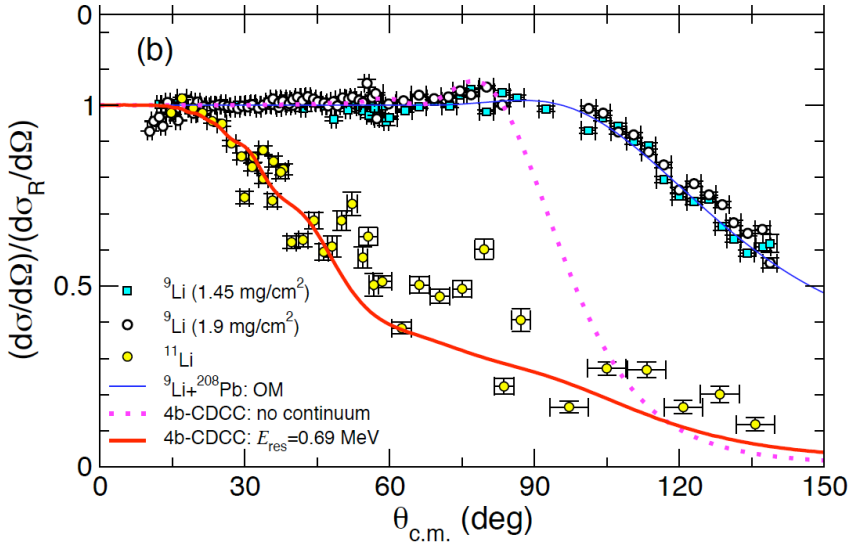
Elastic scattering and reaction mechanisms of the halo nucleus ^{11}Be around the Coulomb barrier

A.Di Pietro[1], G.Randisi[1,2*], V.Scuderi[1,2], L.Acosta[3], F.Amorini[1,2], M.J.G.Borge[4], P.Figuera[1], M.Fisichella[1,2], L.M.Fraile[5†], J.Gomez-Camacho[6], H.Jeppesen[5†], M.Lattuada[1,2], I.Martel[3], M.Milin[7], A.Musumarra[1,8], M.Papa[1], M.G.Pellegriti[1,2], F.Perez-Bernal[3], R.Raabe[9], F.Rizzo[1,2], D.Santonocito[1], G.Scalia[1,2], O.Tengblad[4], D.Torresi[1,2], A.Maira Vidal[4], D. Voulot[5], F. Wenander[5], M.Zadro[10]

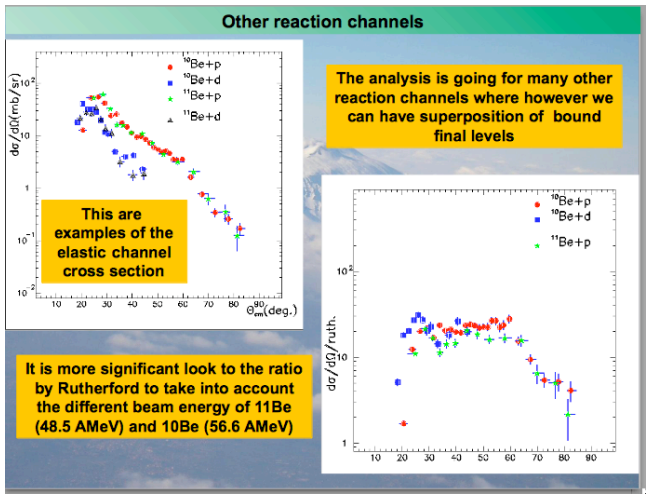
TABLE I. WS Optical potentials obtained from the fit of the experimental data. The real potential radius parameter is r_0=1.1 fm and the imaginary one is r_I=1.2 fm, where $R_{0,i,si}=r_{0,i,si}(A_p^{1/3}+A_t^{1/3})$. The Coulomb radius parameter is r_C=1.25 fm.

Reaction	V(MeV)	a(fm)	V_i(MeV)	a_i(fm)	V_{si}(MeV)	r_{si}(fm)	a_{si}(fm)	J_V(MeV fm^3)	J_W(MeV fm^3)
^{9}Be+^{64}Zn	126	0.6	17.3	0.75				295	53
^{10}Be+^{64}Zn	86.2	0.7	43.4	0.7				193	124
^{11}Be+^{64}Zn	86.2	0.7	43.4	0.7	0.151	1.3	3.5	193	129

Figuera



Borge

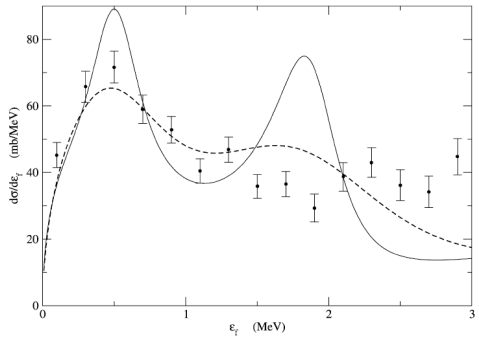


Cardella

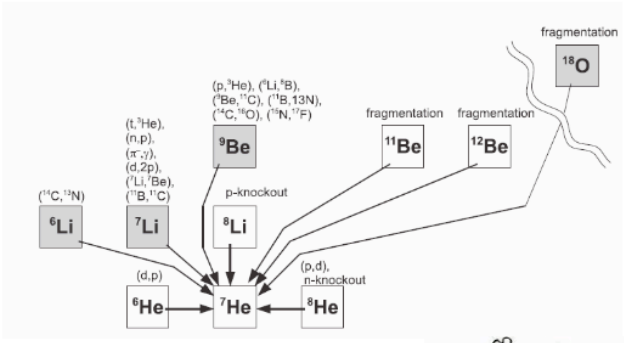
Predicted by a microscopic OP calculation

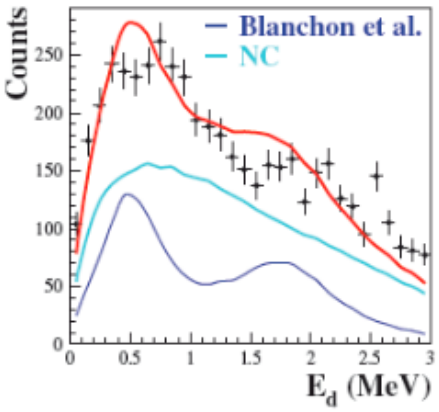
AB, F.Carstoiu, NPA706 (2002)

Physics at the dripline: Unbound nuclei



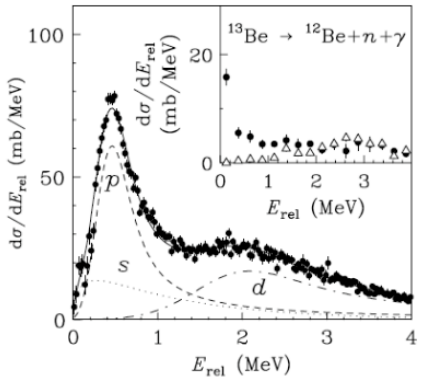
H.Simon et al, 2007

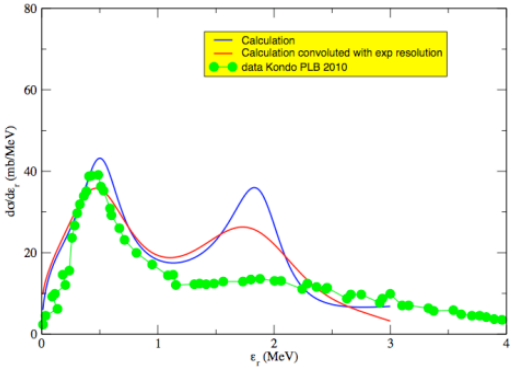




Randisi, Orr et al, 2012

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





Kondo et al,2010

ab initio methods

- **VMC** - Variational Monte Carlo
- **GFMC** - Green's Function Monte Carlo
- **NCSM** - No-Core Shell Model
- **NCSM/RGM** - No-Core Shell Model with Resonating Group Method
- **CC** - Coupled-Cluster Method
- **EIHH** - Effective Interaction Hyperspherical Harmonics
- **FMD** - Fermionic Molecular Dynamics
- **LEFT** - Lattice Effective Field Theory
- **SCGF** - Self Consistent Green's Function

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

Report written by B. Rubio, A.B.

One-, two- and three-proton radioactivities
E. Maglione, I. Mukha, P. Woods

N≈Z Nuclei
J.J. Valiente Dobón, A. Macchiavelli, P. van Isacker, Y. Fujita and T. Faestermann.

Special N=Z nuclei subtopic: Superallowed 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. Algora and A. Petrovici

Exotic excitations in proton rich nuclei and clusterisation
D. Vretenar, M. Freer, G. Verde

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Topical Meeting Valencia

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

Highligths

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 nucleosyntesis) :
origin of ^{26}Al need ^{25}Al(p, γ)^{26}Si or ^{26m}Al(p, γ)^{27}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***

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

Transfer and Coulex*: from 100Sn to 132Sn…in (p,d) need to get ang dist. of high energy outgoing proton (~70MeV)*

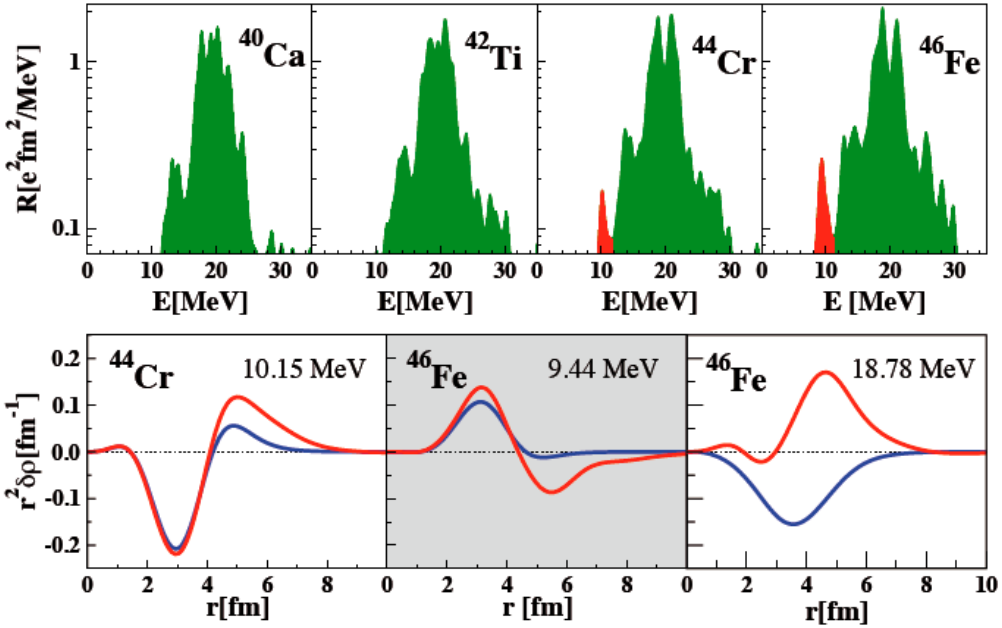
Isospin symmetry*: MirrorEnergyDifferences, measured* ^{67}*Se,*^{67}*As*

np paring*…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 100AMeV*
Dedicated target station…high energy, for charge-exchange &/vs beta decay

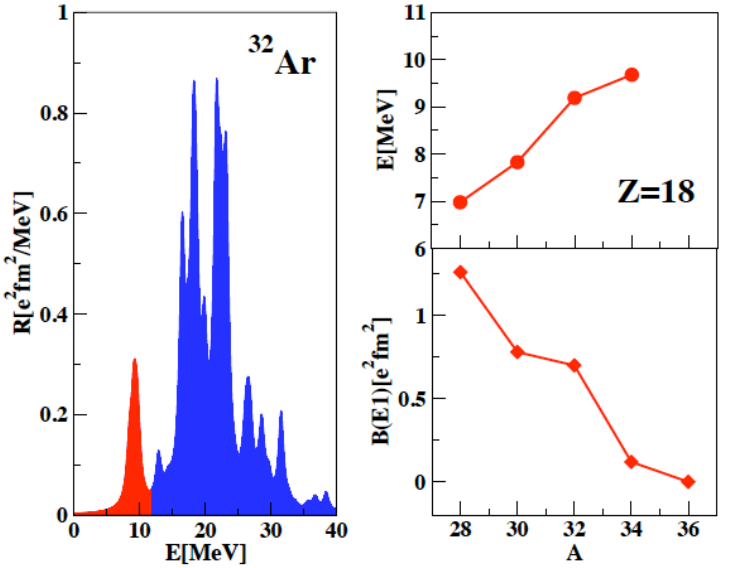
*Exotic excitation modes: effect of Coulomb barrier on protons…(discussed in several talks…) Separation between PDR&GDR increases as the nucleus becomes more proton rich (****Vretenar****)*

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



PPDR

mass dependence of the centroid

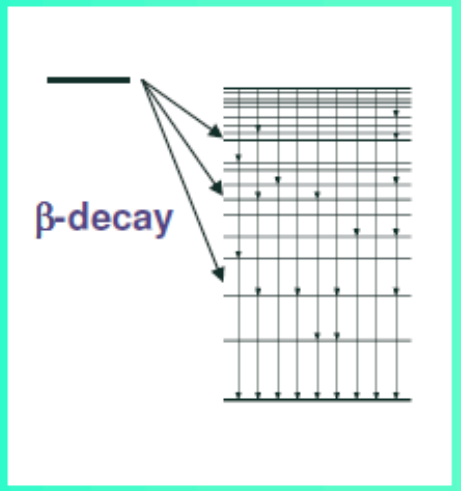


integrated strength below 12MeV

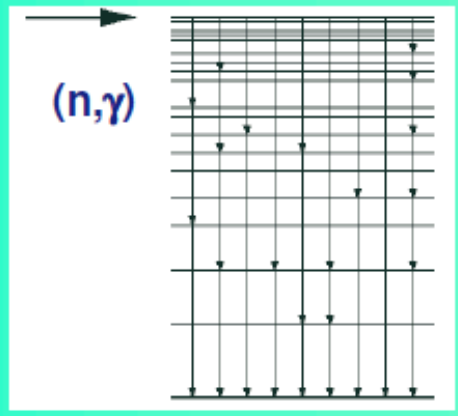
Dario Vretenar
University of Zagreb

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 mayor source of systematic error is contamination/ background signals



TAS: large 4π scintillation detector



CSIC IFIC Institut de Física Corpuscular

Berta Rubio, A. Algora et al.

D. Jordan & Jose L. Tain @ **IFIC-Valencia**

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.

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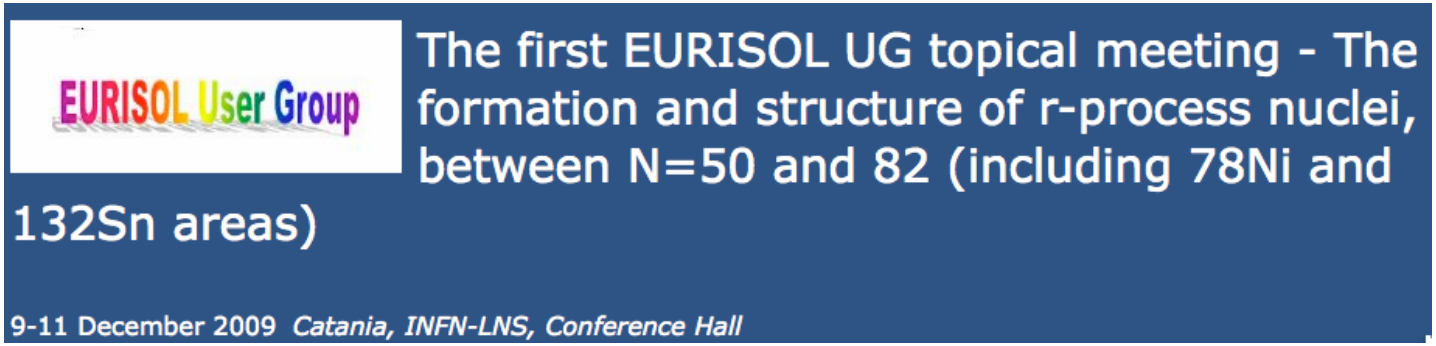

http://agenda.ct.infn.it/conferenceDisplay.py?ovw=True&confId=236

Report written by A.B.

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

Generalities on the r-process

Stèphane 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 pespectives

David Verney Structure of nuclei "North and Northeast of 78Ni": 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 Li +4He ->11B+ 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 68Ni

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

Thorsten Kroell Coulomb excitation of neutron-rich nuclei around132Sn at REX-ISOLDE

Jan Diriken Coulomb excitation of 73Ga 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 132Sn region

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

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. $^{59}Fe(n,\gamma)^{60}Fe$ and $^{60}Fe(n,\gamma)^{61}Fe$ **^{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.

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Thanks! …

and see you at the next topical meeting in 2013

Special thanks to Lidia and our Portougese colleagues for hosting the 2012 meetings

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

Please remember to send your contribution ASAP