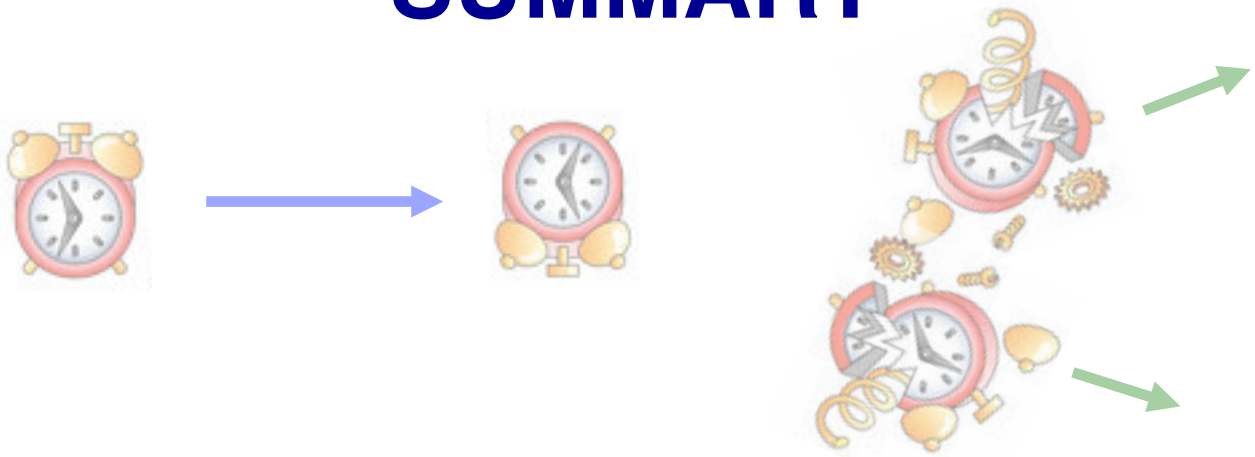
12th Interntional Conference on Nucleus-Nucleus Collisions

June 21-26, 2015, Catania Italy

SUMMARY

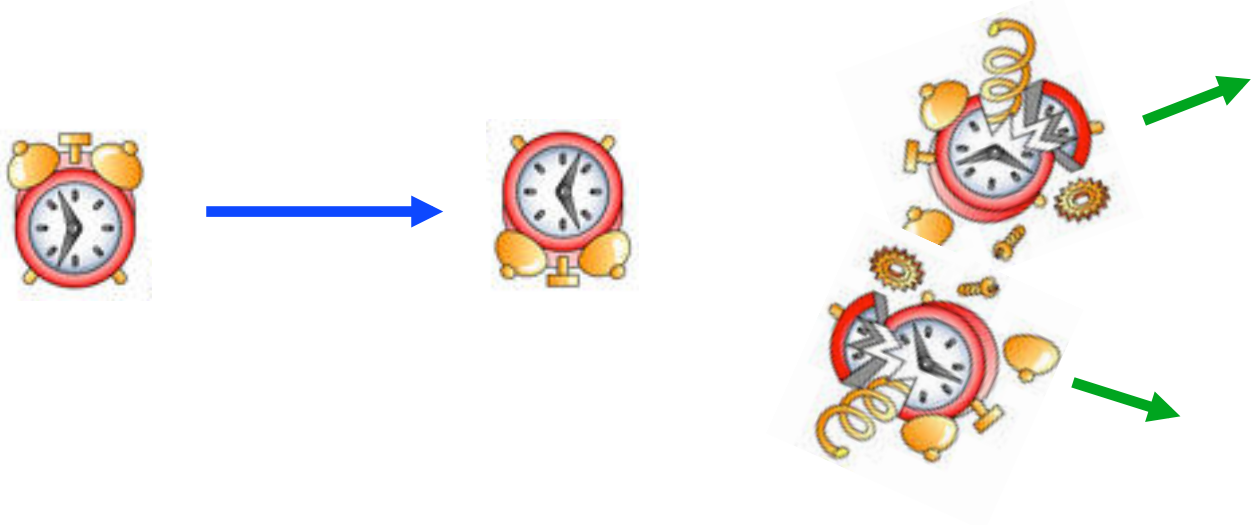


Tohru Motobayashi

RIKEN Nishina Center

Nucleus-Nucleus Collisions

What can we learn from clock-clock collisions? Nothing?
(By a Japanese leading scientist in 1960s)



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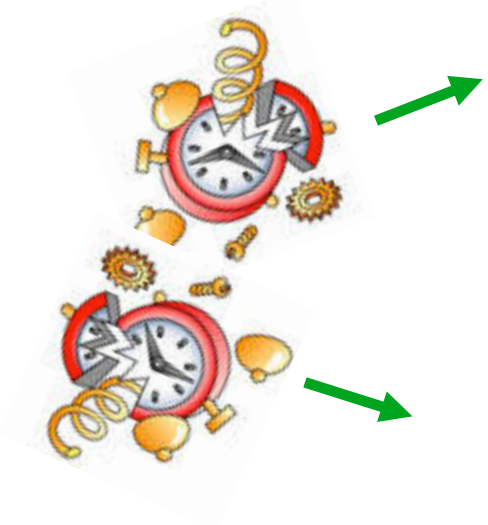

RIKEN's 1st H.I. cyclotron (1966-, 5-7 MeV/nucleon)

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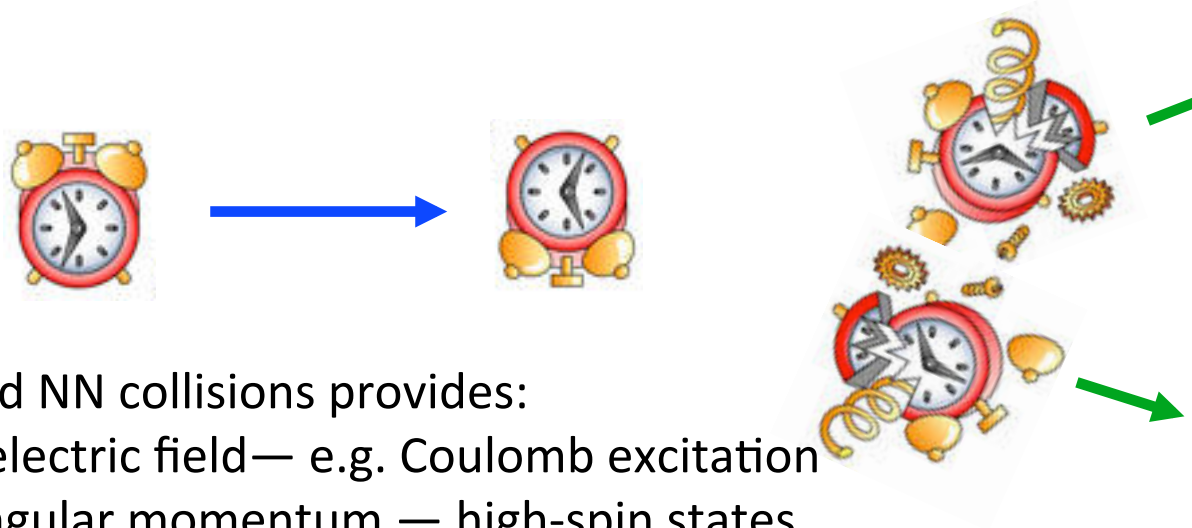


People found NN collisions provides:

- strong electric field— e.g. Coulomb excitation
- large angular momentum — high-spin states
- high temperature / density / friction .. –- nuclear matter
- ……

1st NN Conf. in 1982 (MSU)

from Preface of the 1st NN proceedings

by G.F. Bertsch, C.K. Gelbke, D.K. Scott

In 1982

The 1st beam from the MSU Super Conducting Cyclotron

Studies below 20 MeV/nucleon:

collisions around the Coulomb barrier: “matured”

high angular momentum —> spectroscopy

energy and angular momentum dissipation: ”detailed knowledge”

element 109

Gap between 20 to 200 MeV/nucleon — Berkeley, CERN

10 years of Bevalac up to 2 GeV/nucleon

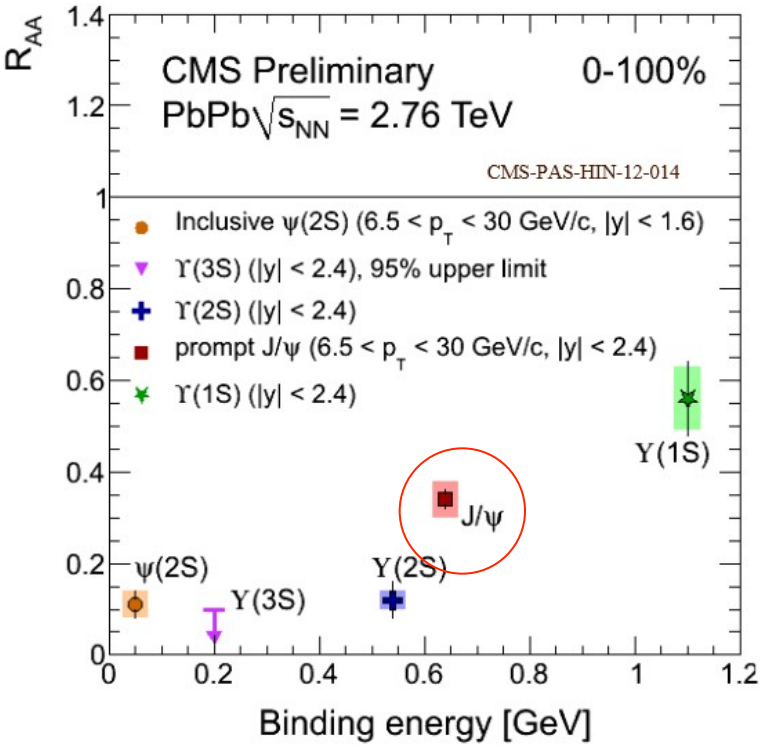
QGP: a dream

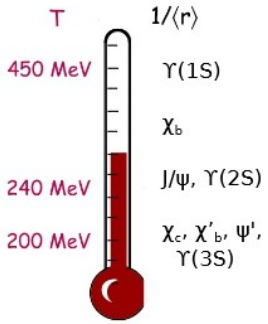
J/Ψ: found in 1974 (but not “used”)

RI beams: not yet

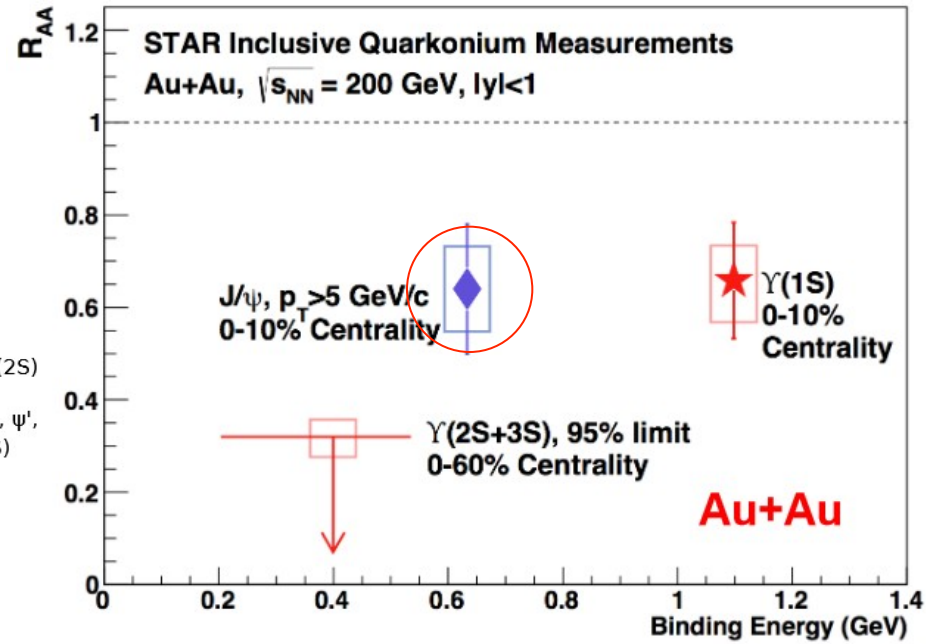
Quarkonia as Probe for Hot and Cold Nuclear Matter

LHC





RHIC



-Results of A+A support the idea of quarkonia dissocitation in hot QGP medium

-Y suppression pattern supports sequential melting

-but what about p+A?

-Why the dissociation pattern of J/ψ and Y(1S) is different in RHIC and LHC?.

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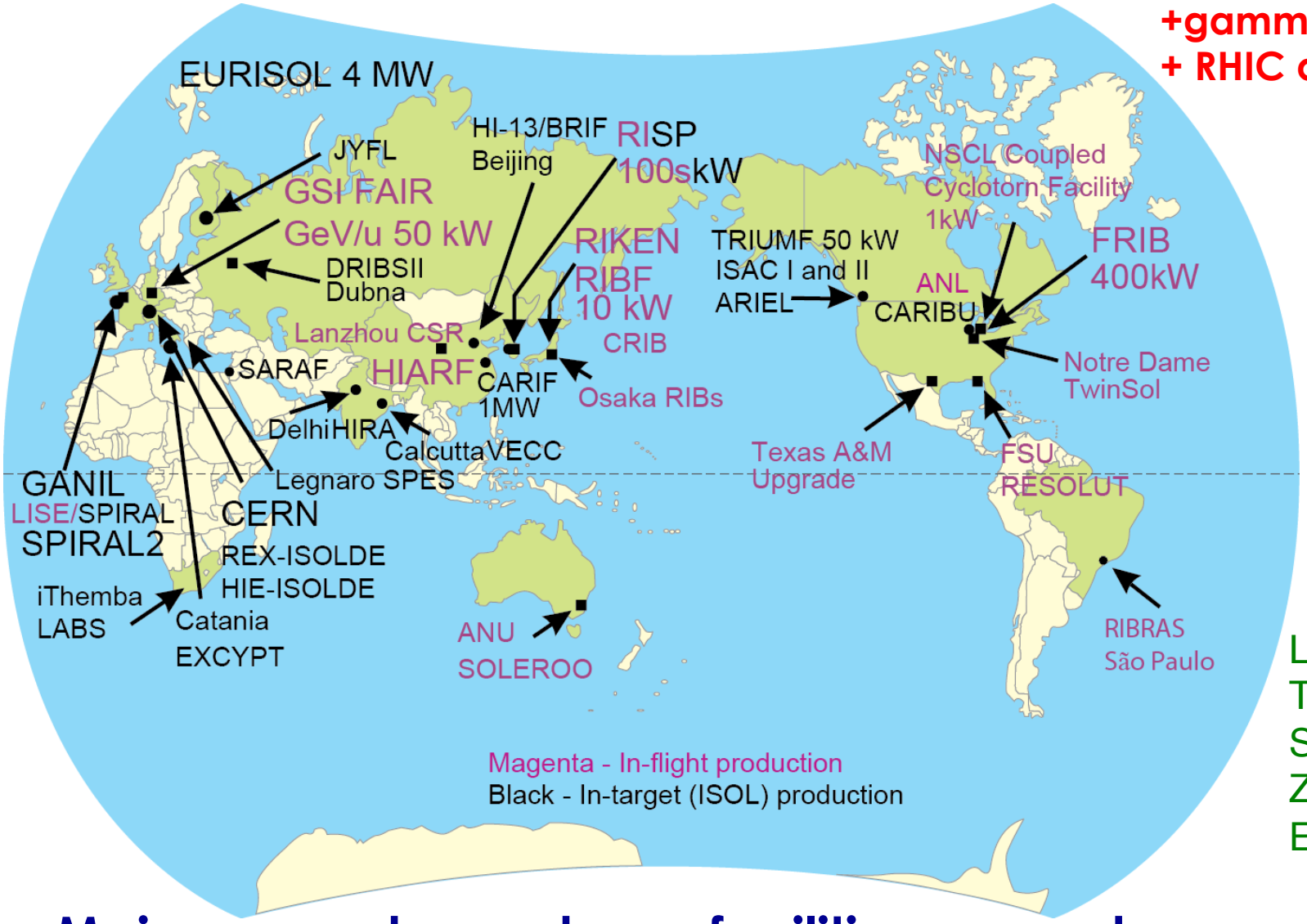
Nuclear Physics Laboratories around the world

+gamma beams
+ RHIC and ALICE



Lewitowicz
Tsang
Serafini
Zamfir
En'yo

Major upgrades and new facilities are under construction!

From Keynote by Angela Bracco

from Preface of the 1st NN proceedings

by G.F. Bertsch, C.K. Gelbke, D.K. Scott

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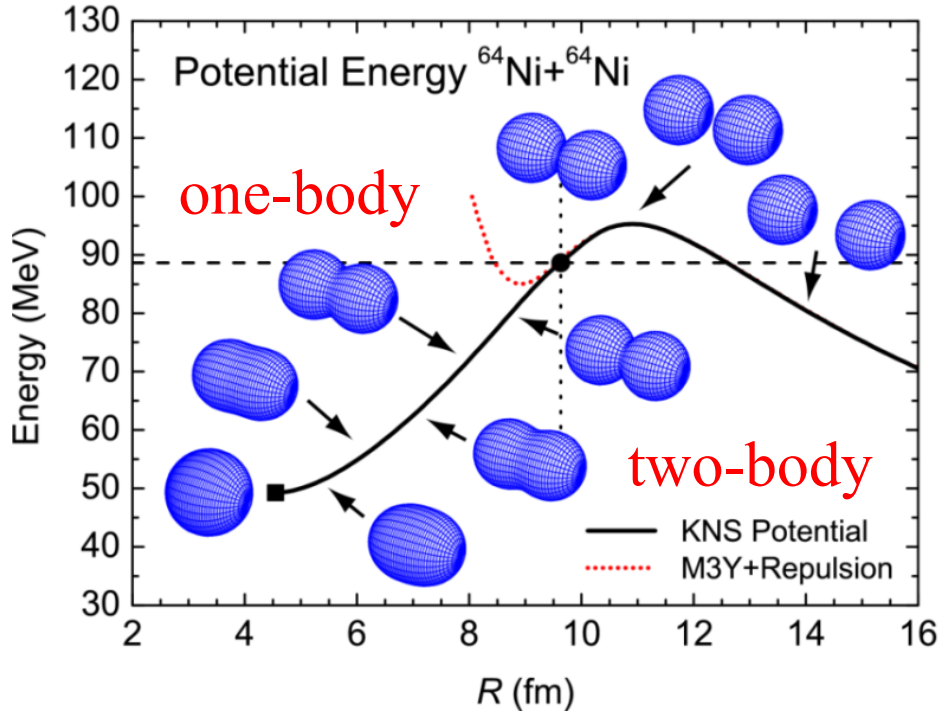
- *e.g.*

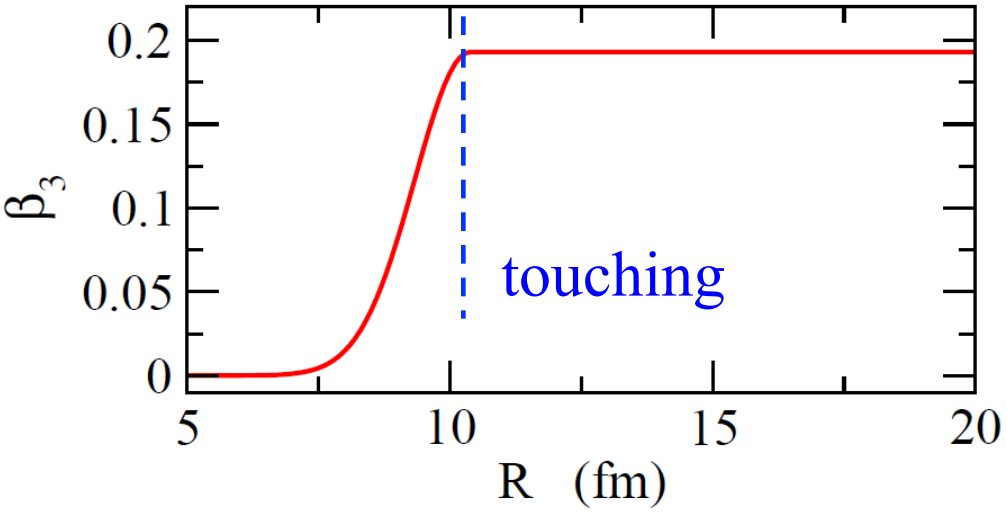
Sub-barrier fusion in late 1970s (Hagino, Montagnoli)

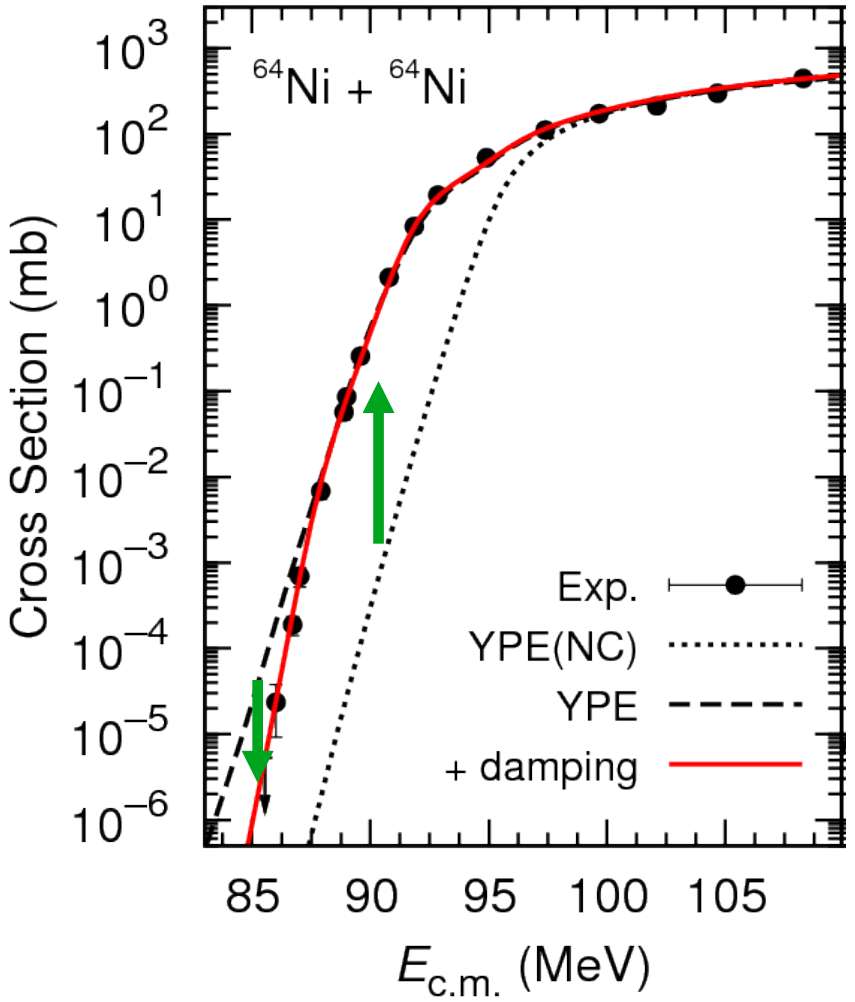
Deep inelastic collision (Kozulin, Yabana, Leoni)

strongly dumped collision / multi nucleon transfer / quasi fission

Adiabatic model for fusion hindrance (Ichikawa, **Hagino**, Iwamoto)







Experimental development (**Montagnoli**)
Weakly bound nuclei (**Diaz-Torres**)

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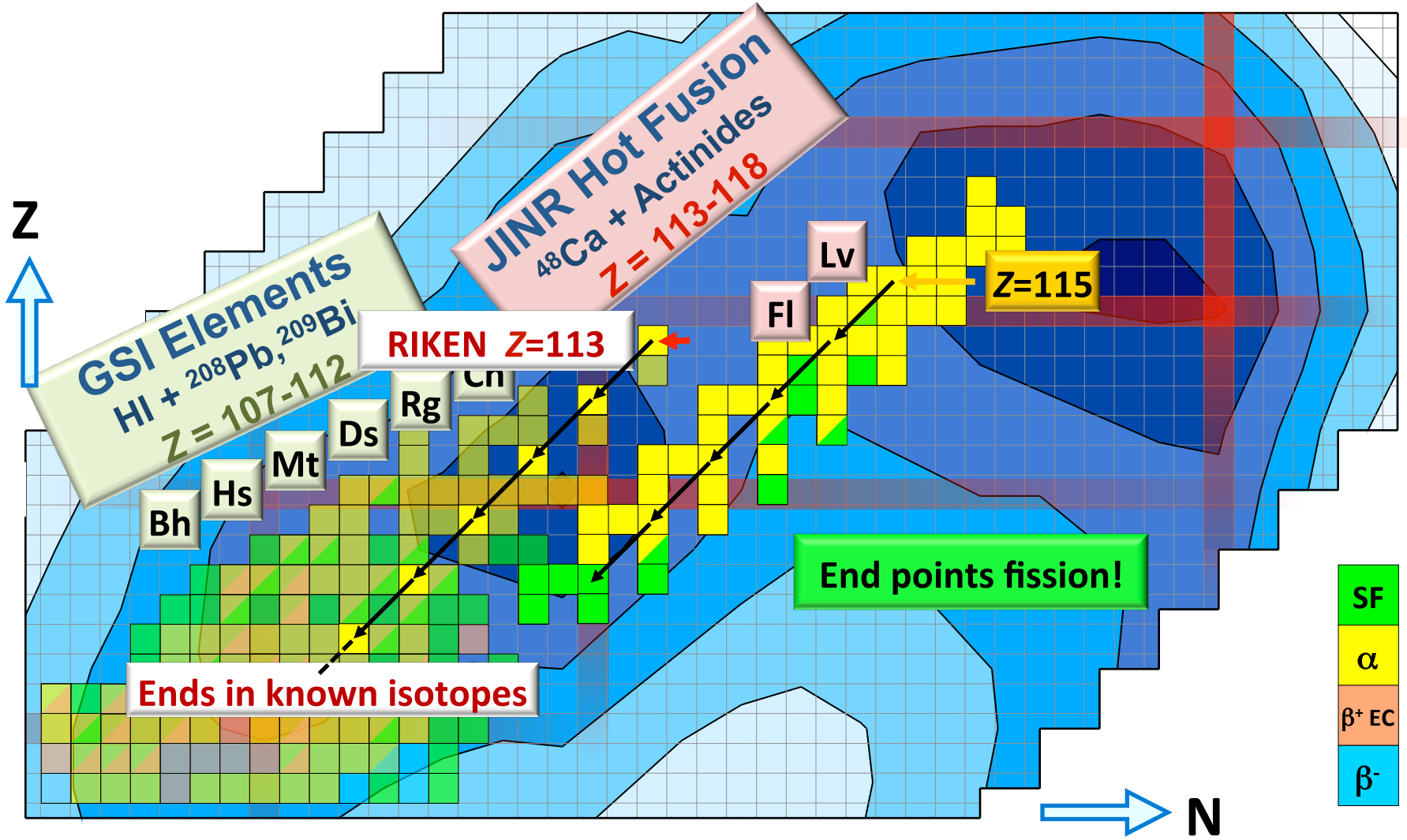
Identification of $Z > 112$ elements



Detailed spectroscopy, reaction mechanism (**Kozulin**)
High-presision mass measurements (**M. Block**)

D. Rudolph

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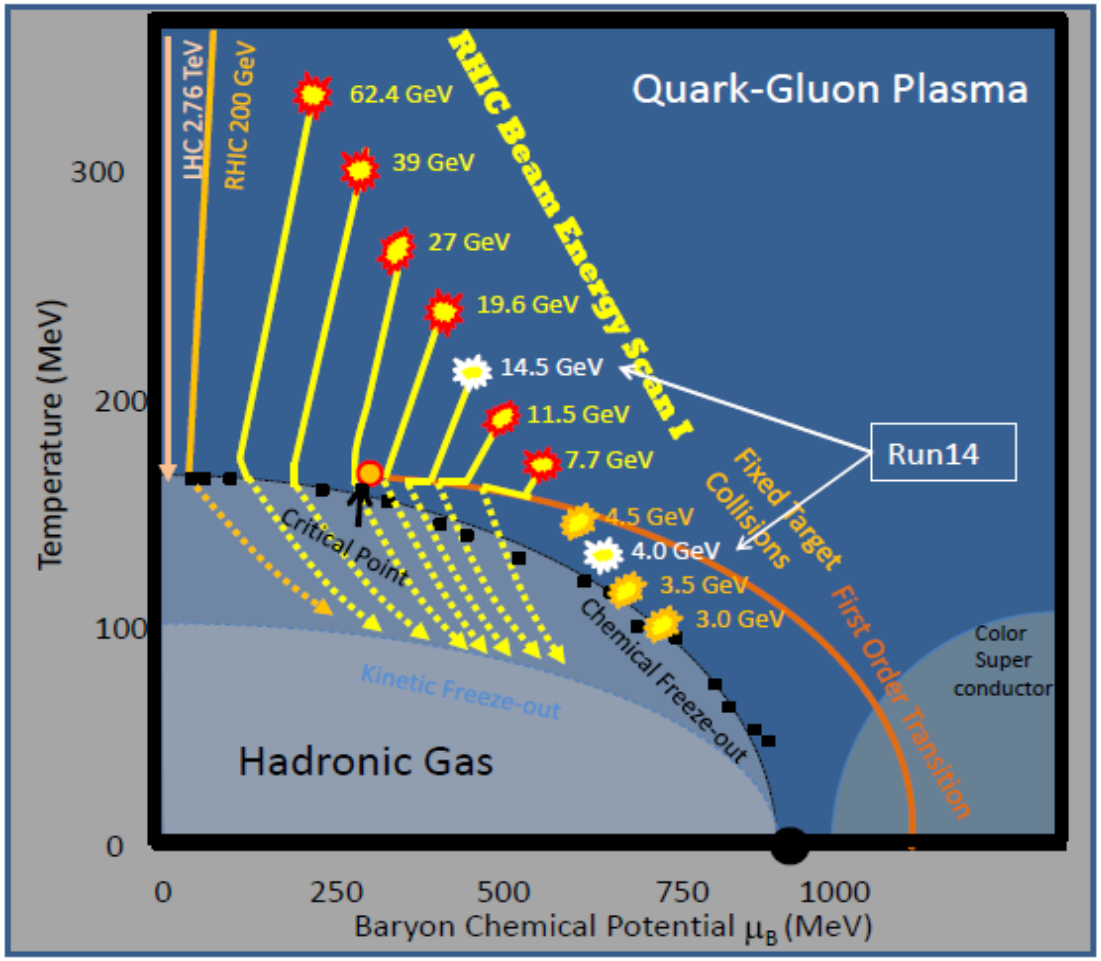
Phases of QCD matter

- How do we map the QCD phase diagram?



QGP studies at LHC (**Stachel**)
Dynamical development of QGP (**Csernai**)
QGP by correlation and fluctuation (**Bellwied**)
Hadron formation (**Becattini**)
QCD medium properties (**Mouicer**)

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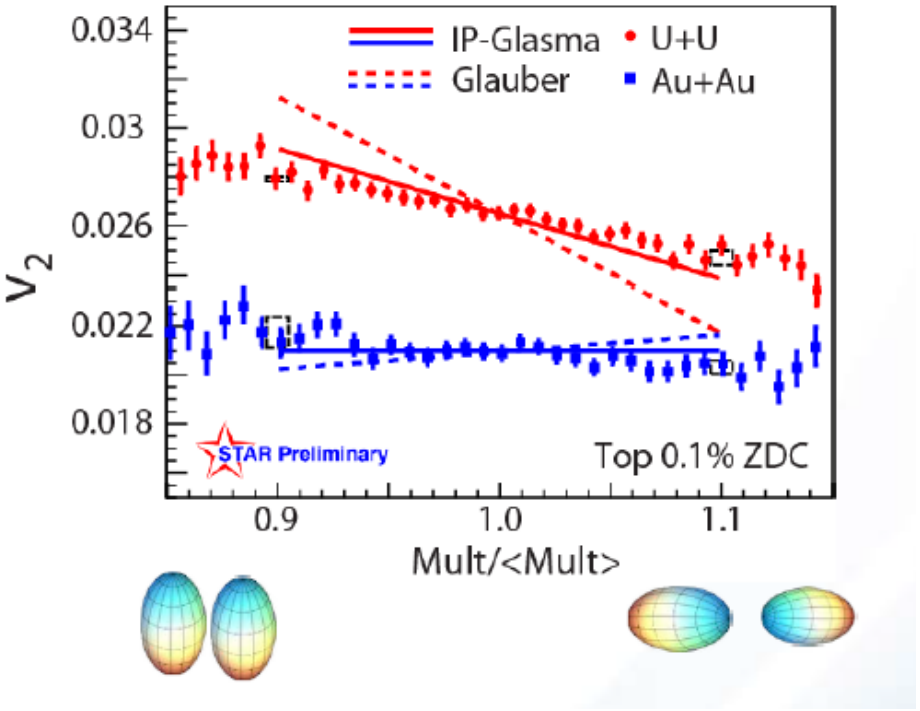
"Use" of nuclear deformation in relativistic HI collision studies.



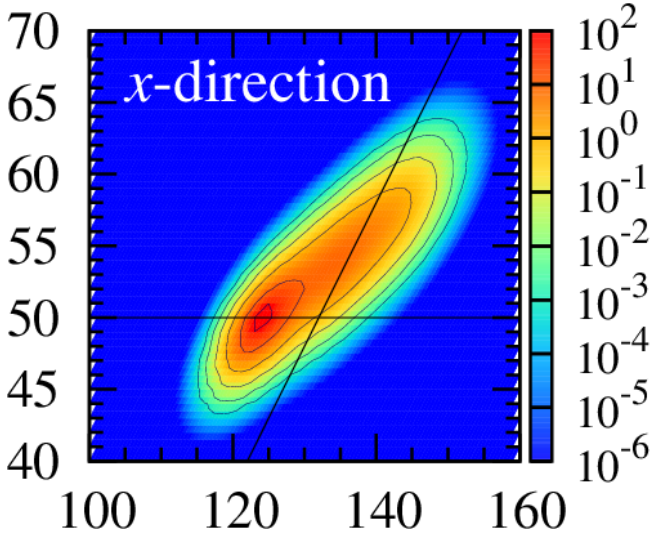
IP-Glasma more consistent with U+U data than Glauber

Initial State fluctuations occur at parton level

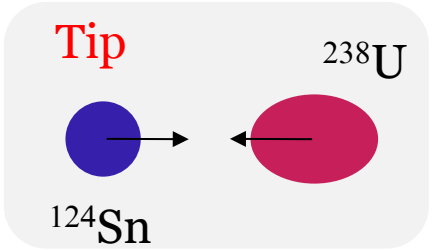
Can we resolve the number of sub-nucleonic scattering centers in small systems?

Effects of nuclear deformation in quasi-fission

$^{238}U + ^{124}Sn$ at E_{lab}=**5.7 MeV/A**



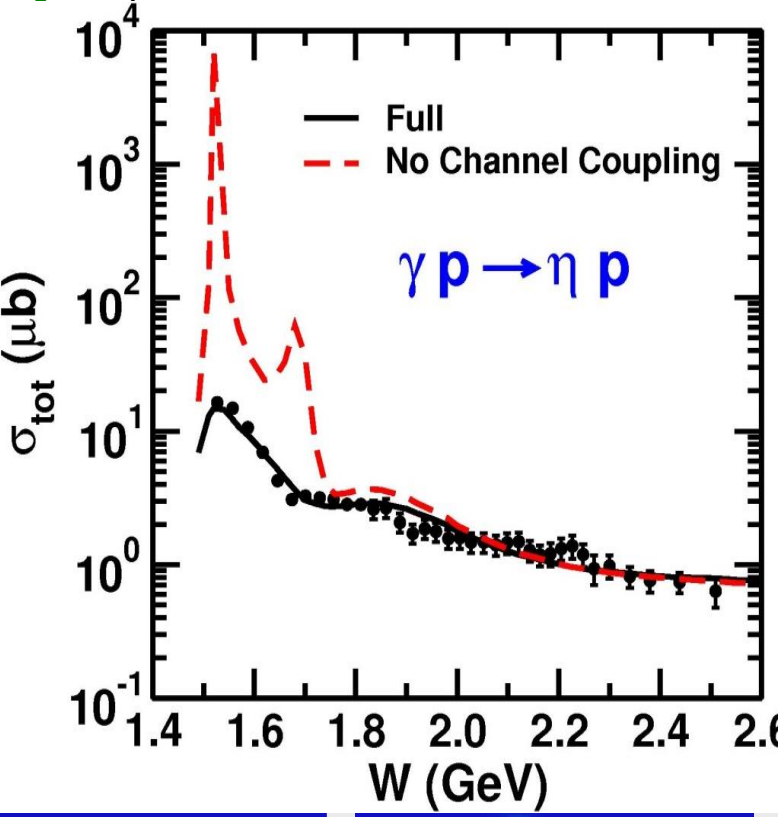
TDHF calc. Kazuhiro Yabana



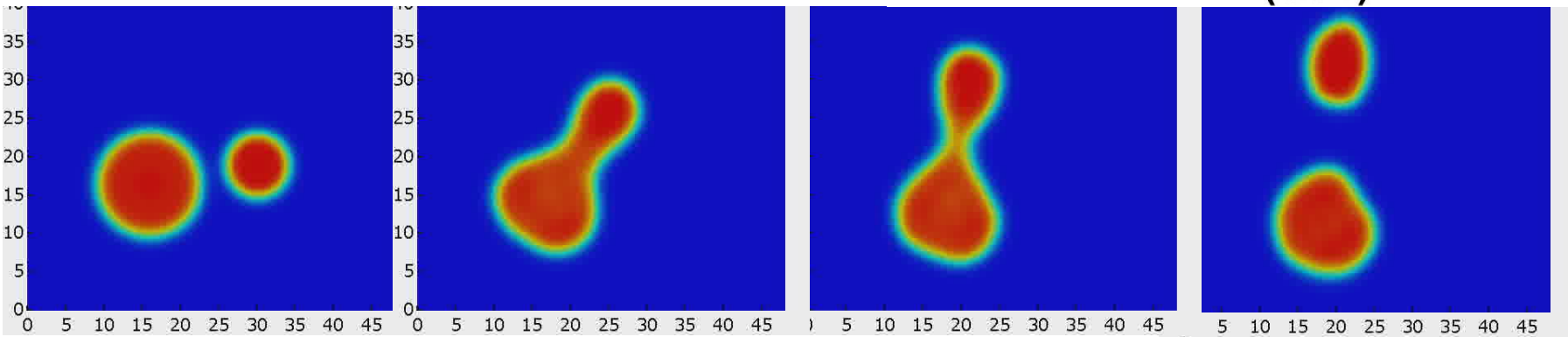
Developments of various reaction theories

Effective Lagrangian model for η / Ξ production (**Shyam**)
Direct reaction theory – CDCC… (**Moro**)
TDHF for MNT / quasi-fission (**Yabana**)
Microscopic theory / R-matrix (**Descouvement**)
ANC and Trojan Hourse (**Mukhamedzhanov**)

Photon induced
η production (Shyam)



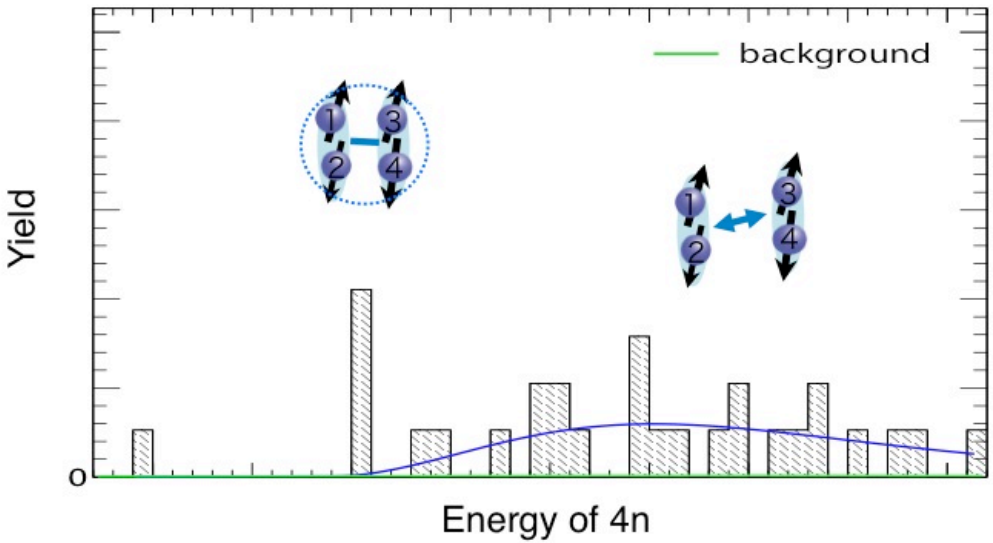
Transfer by neck formation and breaking (Yabana)

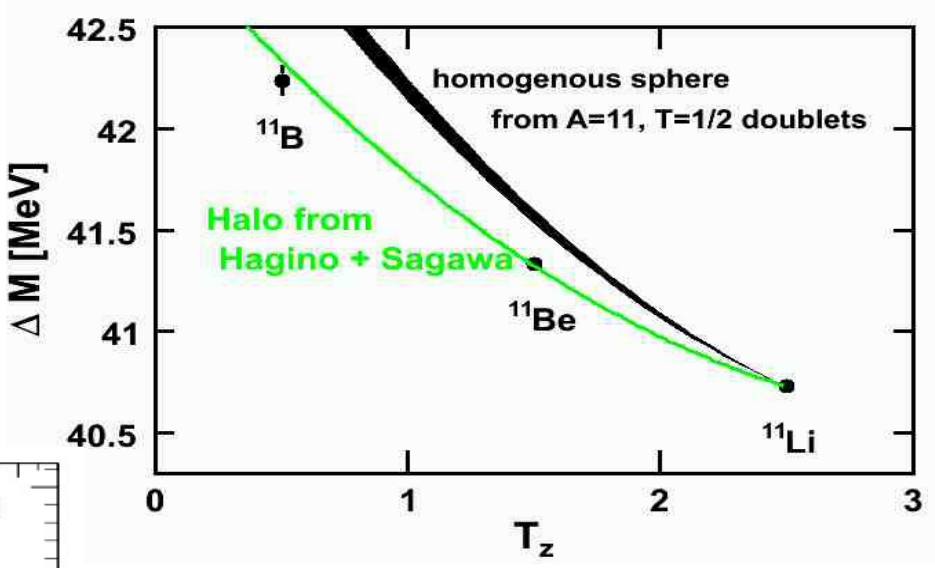


New experimental attempts

Double CEX for $(GT)^2$ / 4n state (**Uesaka**)
^{8}Be, ^{12}C, ^{16}O resonances by β-decay (**Fynbo**)
Spectroscopy of continuum states (**Charity**)
Excitation of multi-a states (**Freer**)

tetra neutron resonance? Uesaka





IASs of ^{11}Li **Charity**

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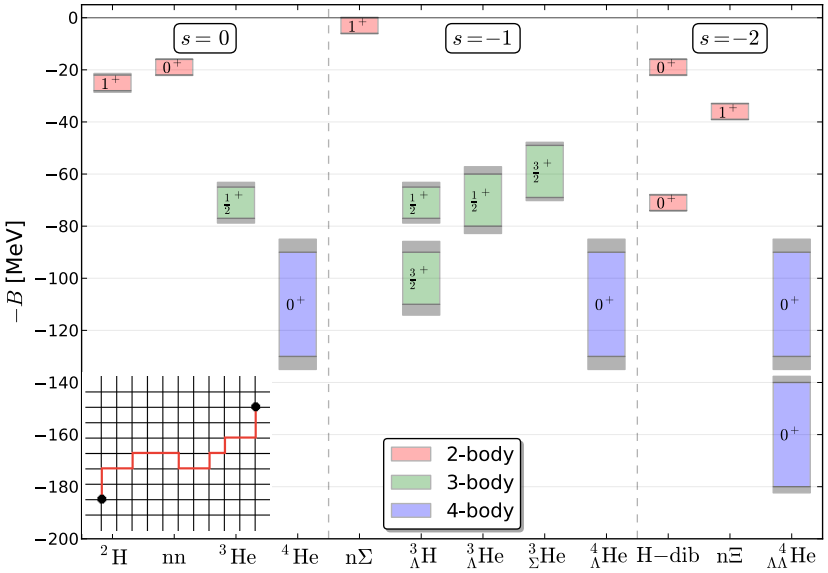
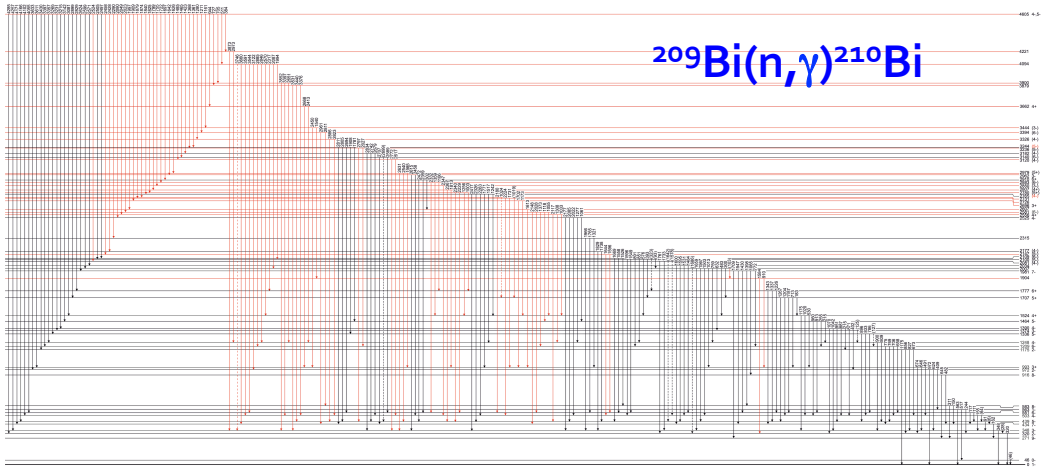
Light nuclei and hypernuclei from Lattice QCD with Monte Carlo path integral (**Parreno**)
Structure by chiral nucleon-nucleon forces (**Coraggio**)
Shape phase transition by the EDF thoery (**Vretenar**)
Fermionic Molecular Dynamics: a common method for structure and reaction (**Neff**)
Roles and effects of pairing in nuclear reactions (**Lacroix**)
Particle phonon coupling in nuclei around double shell closures (**Leoni**)



Parreno

Leoni



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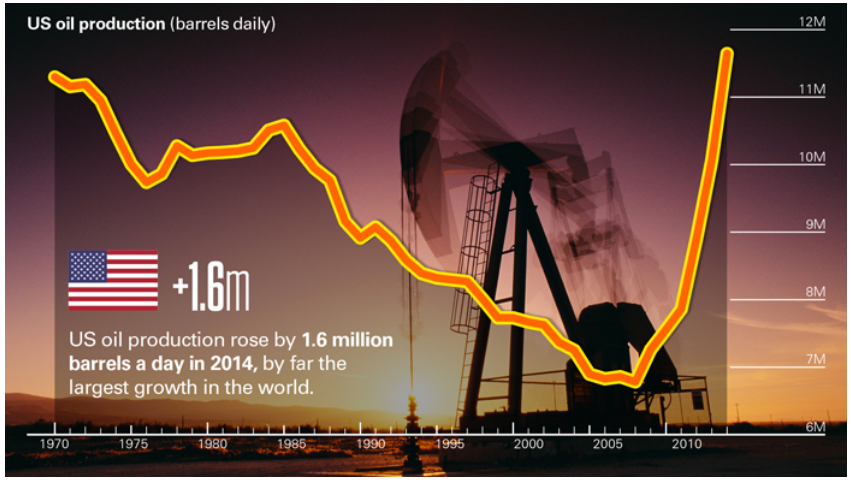
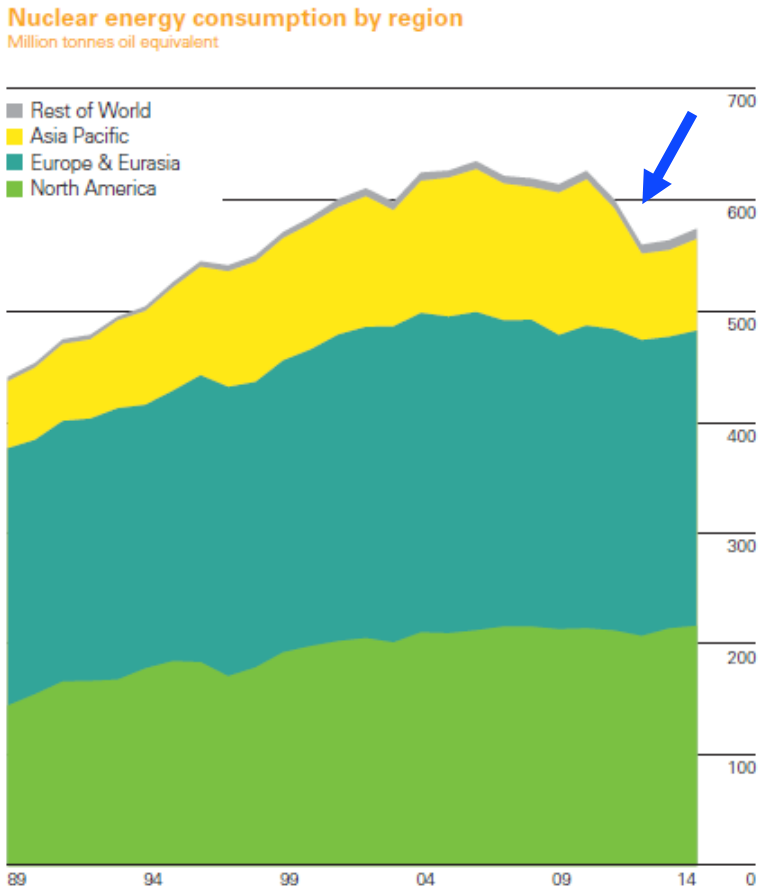
NUCLEAR ENERGY

- The growth expected ten years ago has not happened:
  - Fukushima accident
  - Shale oil “revolution”

Sylvie Leray



Source: BP statistical review of world energy 2015



+ particle therapy by **Battistoni**

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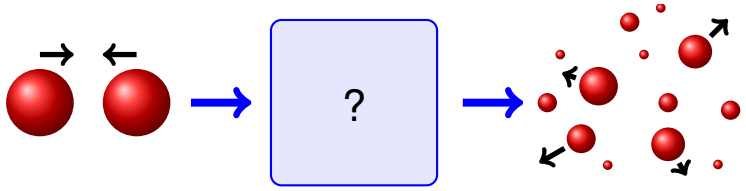
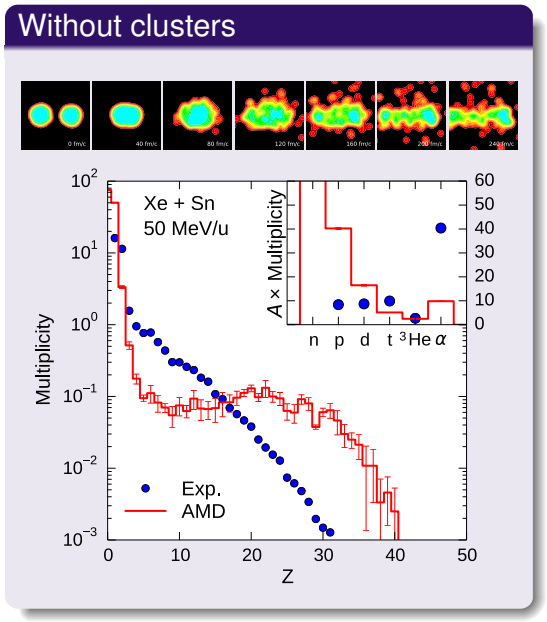
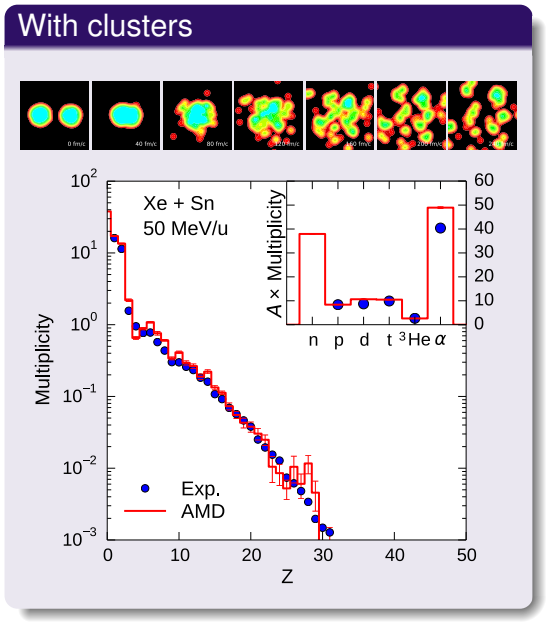
Constraints on the EOS of asymmetric nuclear matter (**Yennello**)
EOS studies in future (**Zhang**)
Cluster production in intermediate-energy HI collisions (**Ono**)







Ono

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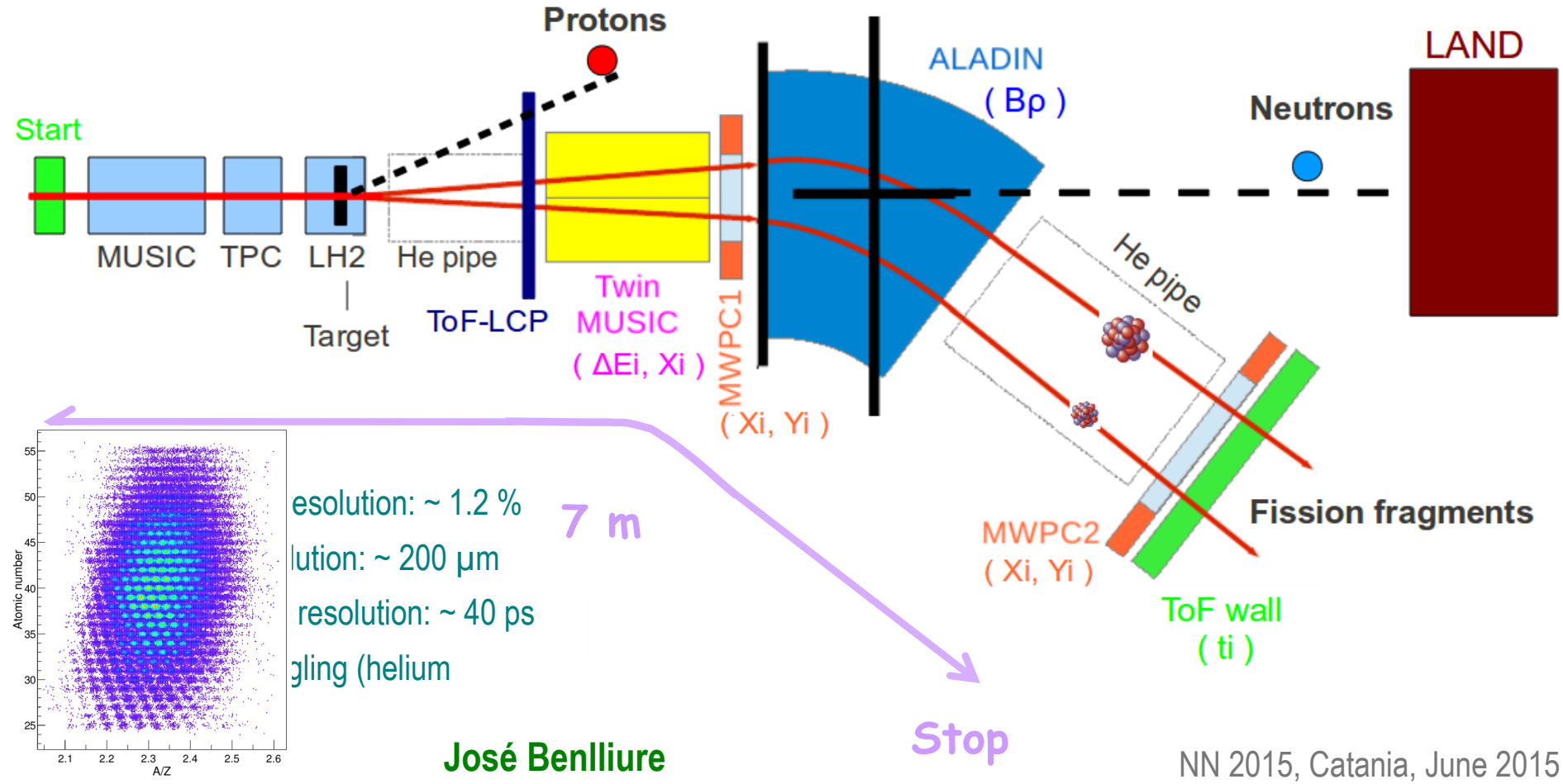
Experiments at GSI

Full identification in A, Z of both fission fragments together with light-charged particles and neutrons

J. Taieb, CEA (France)



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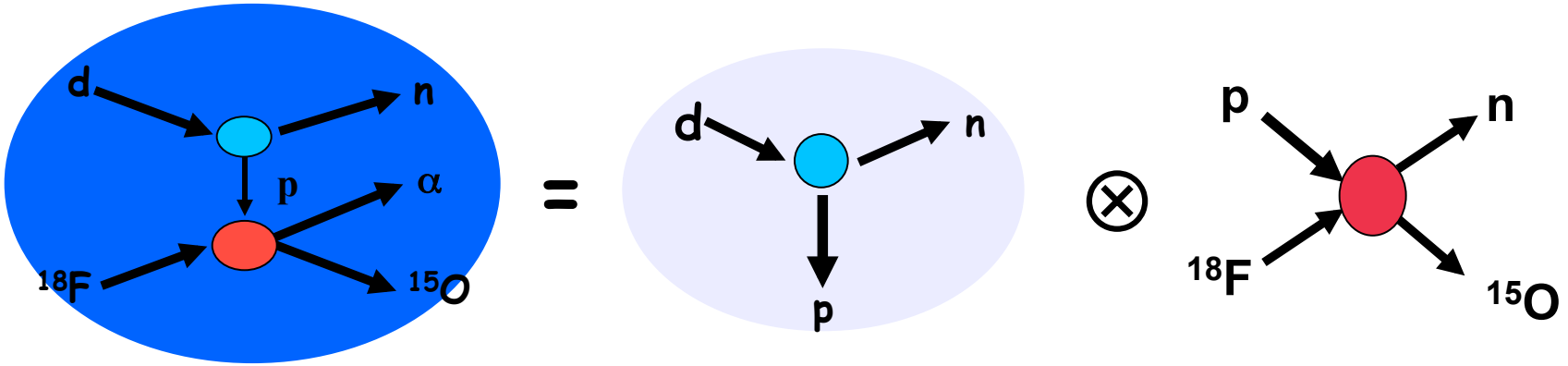
Reaction models (Descouvement)
Theoretical ground of ANC and THM (Mukhamedzhanov)
Nuclear inputs to r-process path – sensitivity tests and future (**Apprahamian**)
Experimental efforts for reactions in explosive hydrogen burning (**Woods**)

Trojan Horse Method -- Spitalieri



3-body Reaction **Virtual Decay** **Virtual reaction (astrophysical process)**

Challange of THM to $^{12}C+^{12}C$ or NN collisions

Cherubini *et al.* 2014

Final concluding remarks

My presentation addresses only few of the interesting results
Apologies…. Hope a flavor is given for a very lively field!!

For this week we are looking forward for:

- Presentations of the interesting ongoing work
- Discussions for the future plans
- Active participation of students and young researchers

Many thanks to the organizers

and enjoy the NN2015 conference!!!

From Keynote by Angela Bracco

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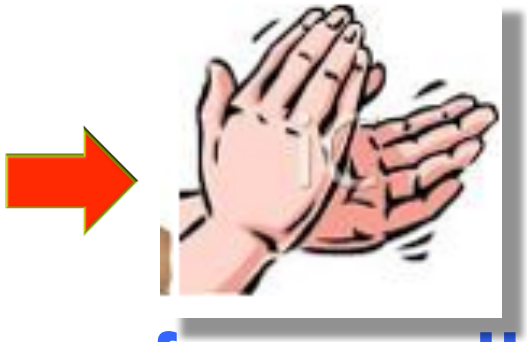
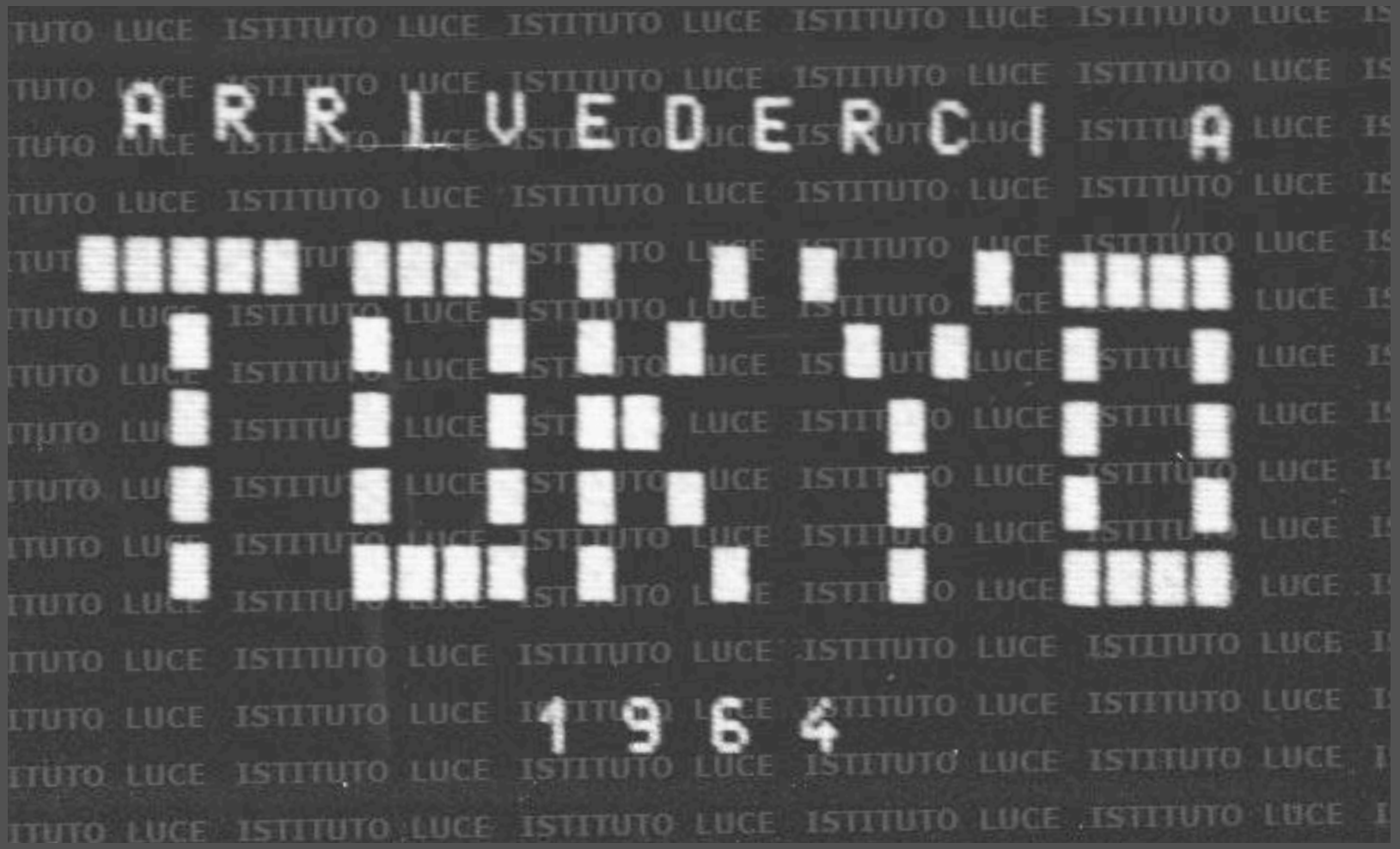


We enjoyed the NN2015 conference!!!

From Keynote by Angela Bracco



The last message of the 17th Olympic Games in Rome (1960).

The last message of the NN2015 Summary in Catania (2015).