M.Taiuti

A (TOO) SHORT OVERVIEW OF THE EXPERIMENTAL NUCLEAR PHYSICS ACTIVITY IN ITALY

OUTLOOK

- Structure of the CSN3
- Current Activity
- Perspectives

The 4 Research Lines

Line 1 – 101 FTE

Quarks and Hadron Dynamics

(Jlab, LNF, German-Labs)

Line 2 – 158 FTE

Phase Transitions in Nuclear Matter (Alice)

CSN3

482 FTE

Line 4 – 80 FTE

Nuclear Astrophysics and Interdisciplinary Research

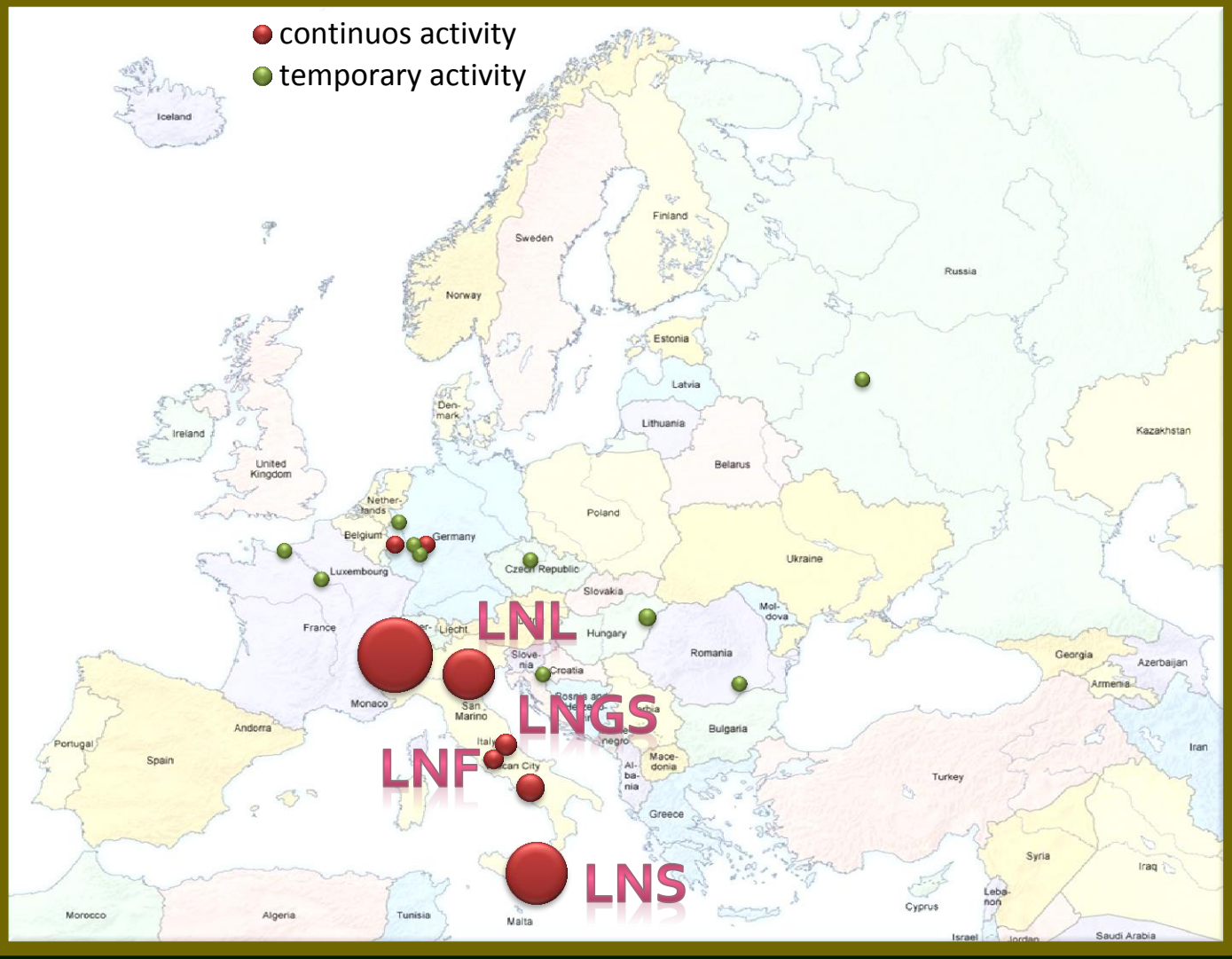
(LNGS, LNS)

Line 3 – 143 FTE

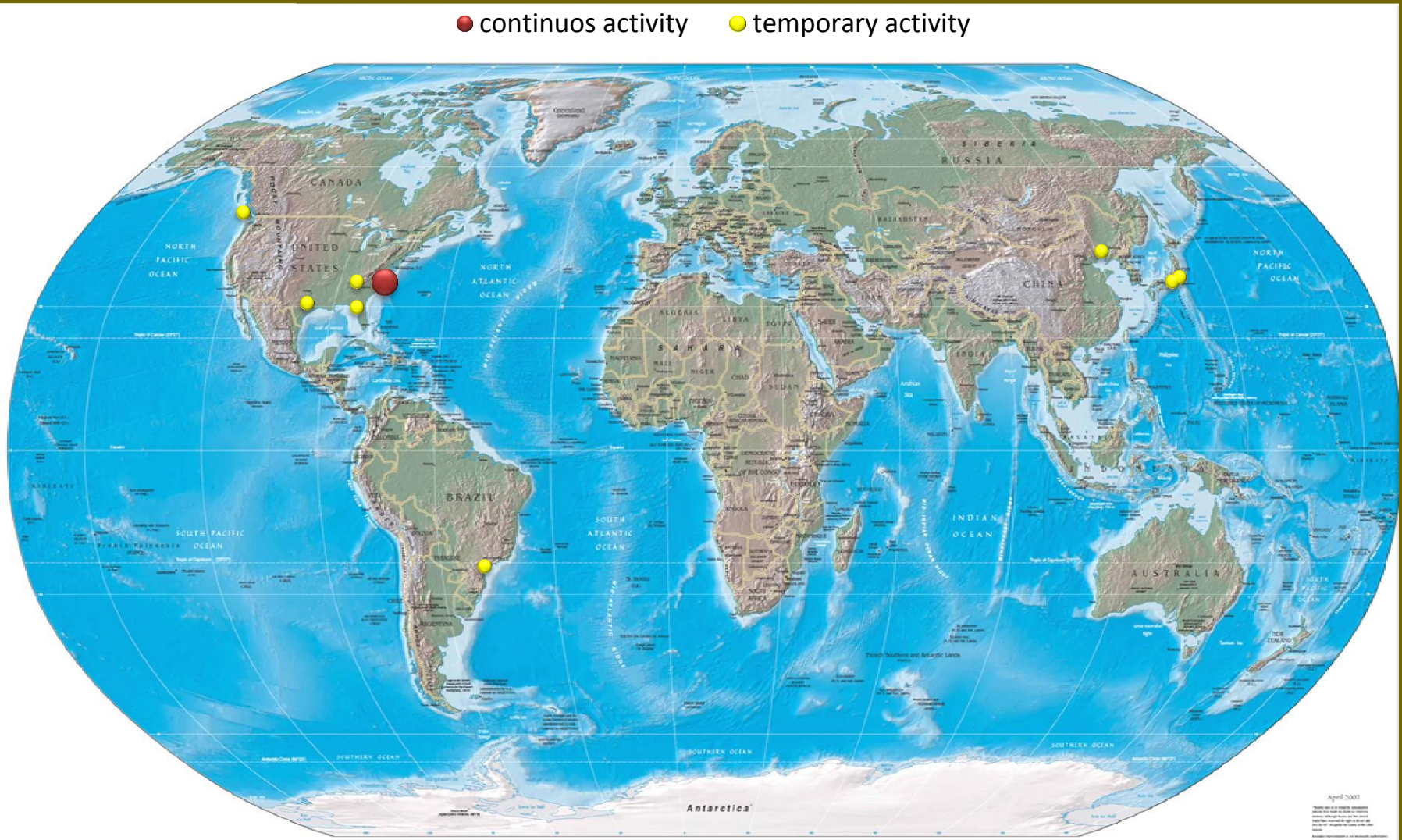
Nuclear Structure and Reaction Mechanisms

(LNL, LNS)

Facilities- european



Facilities– extra-european



L1 - Quarks and Hadron Dynamics

- Physics performed with Leptonic probes (Jlab, Bonn, Mainz) and Hadronic probes (DAPHNE@LNF)

- Non perturbative QCD (baryons and mesons)
- NLO pQCD
- Hadronization phenomena in nucler matter
- Strangeness physics in nuclear matter
- N-N correlations
- Spin physics

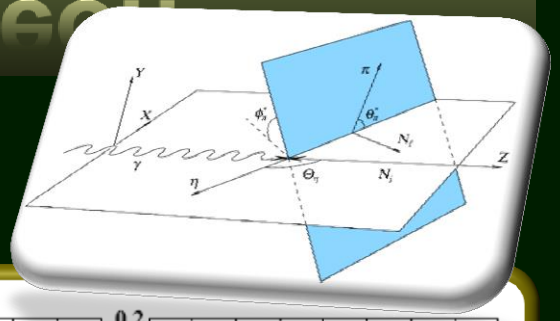
The Structure of the Nucleon

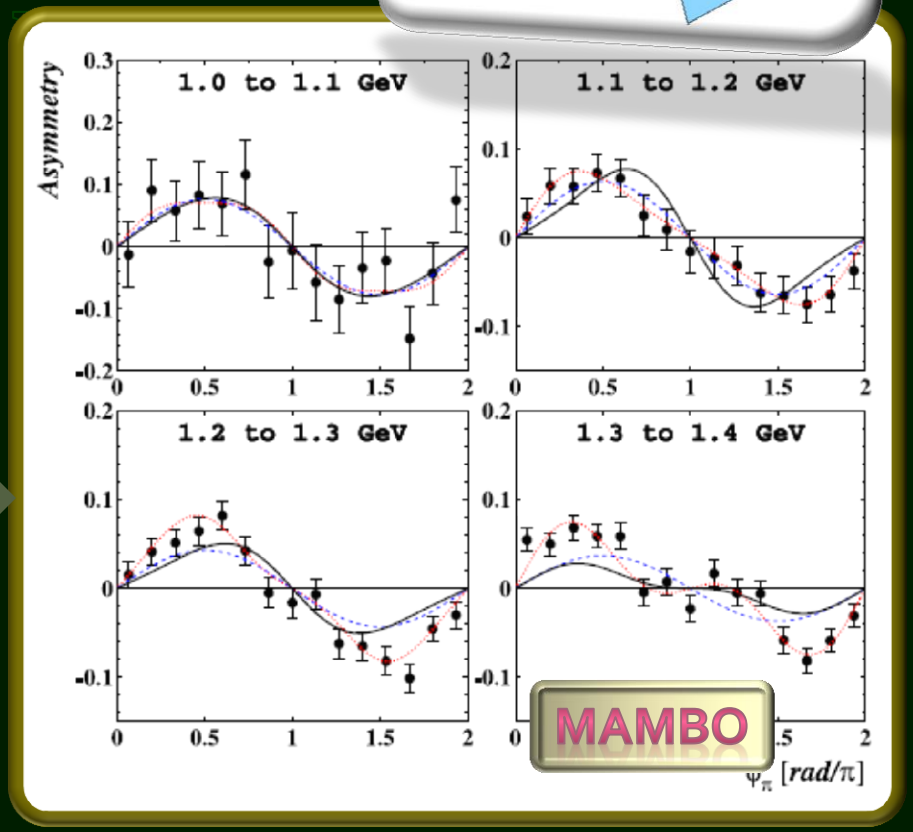
- Proton and neutron e.m. form factors
- Study of Baryonic Resonances

  W ~ 1.5 GeV – 3 GeV

  First measurement of the circular beam asymmetry in the $\gamma p \rightarrow \pi^0 \eta p$ reaction

- Search for exotic mesons
- Few body systems

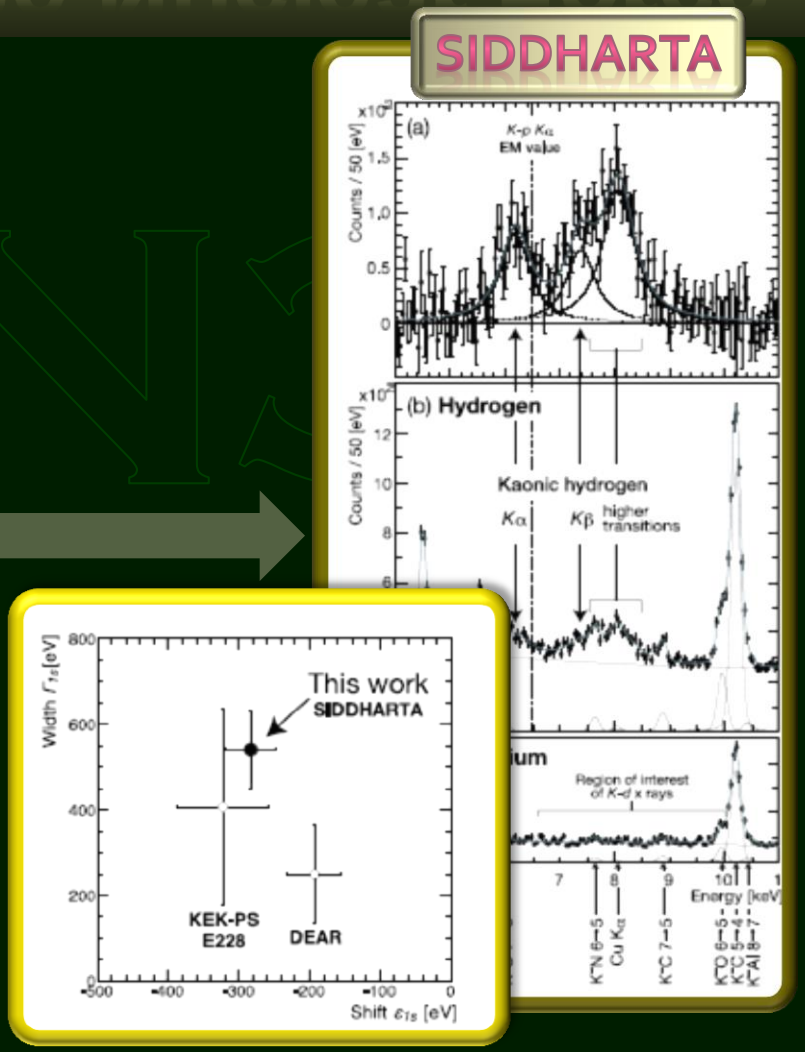




Strangeness and the Nuclear Force

- @LNF
- Kaonic atoms

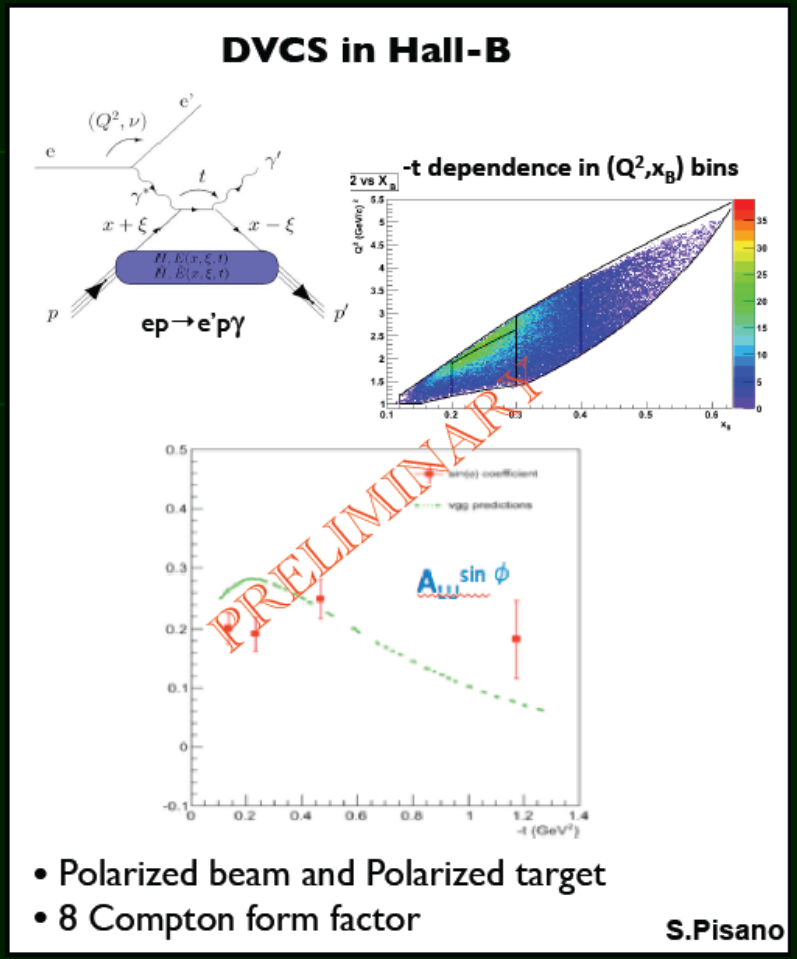
Measurement of the energy for the level 1s for the hydrogen kaonic atom



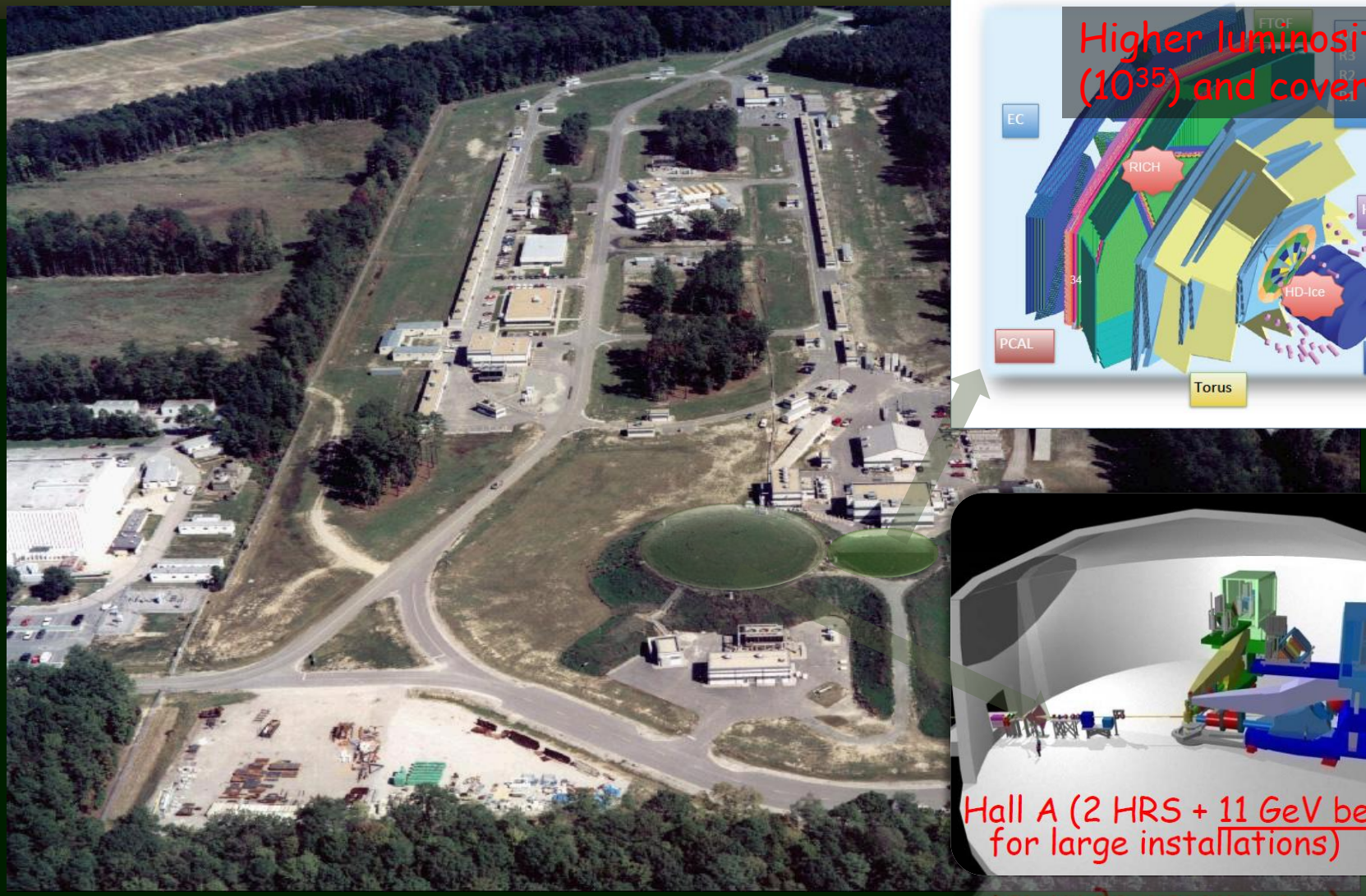
- Next measurement:
  - deuterium

JLAB12

- JLAB collected an integrated luminosity 10^6 greater than SLAC@DIS era
- This allows exclusive reaction studies
- i.e. Deeply Virtual Compton Scattering for 3d mapping of the quark momenta distribution



Upgrade to JLAB@12 GeV



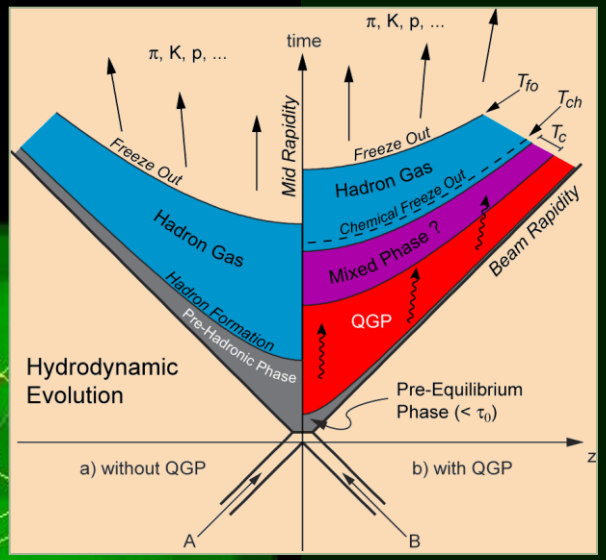
PANDA

- Potentially a great opportunity for the nuclear physics community
- BUT
- Strong impact on the overall budget
- Agreement with the German management not yet defined

L2 – Phase Transitions in NM

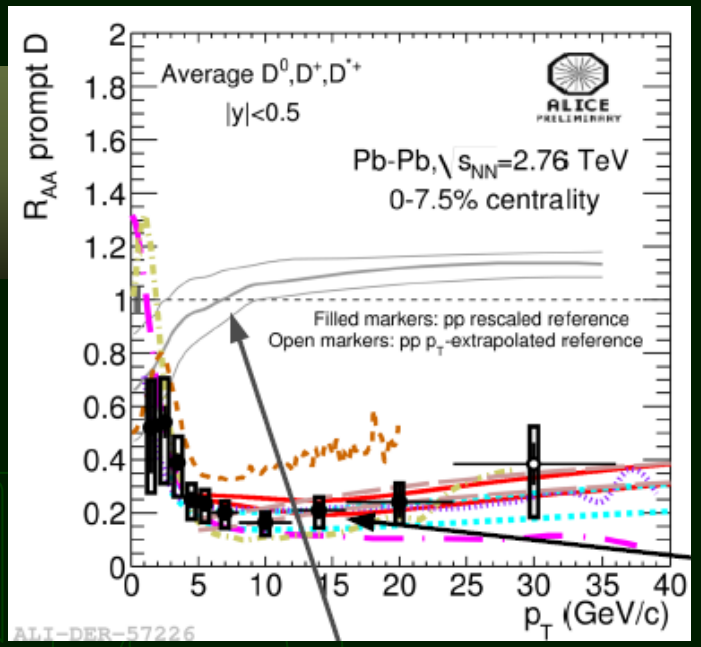
- Global observables and collective effects :
  - Multiplicities, elliptic flow …
- Degrees of freedom vs. T

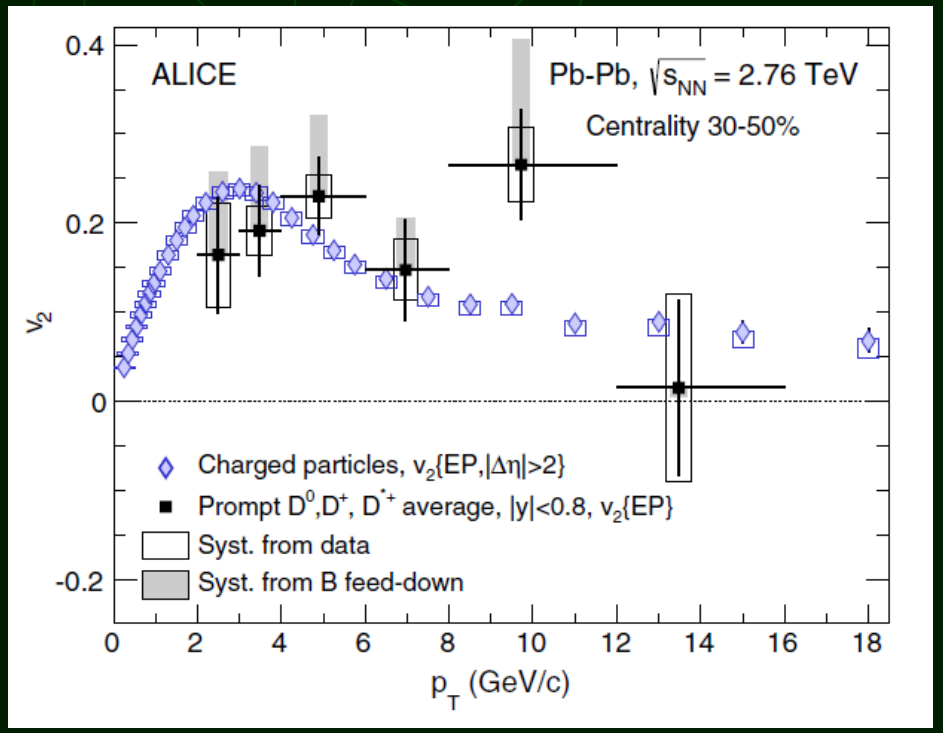
  Fluctuations and critical behaviours
  - hadron ratios and spectra, dilepton continuum, direct photons….
- Partonic energy loss in quark-gluon plasma
  - jet quenching, high p_T spectra, open charm and open beauty
- Deconfinements and chiral symmetry restoration:
  - charmonium and bottonium
  - neutral to charged ratios, resonances
- **At LHC the longest lifetime of quark-gluon plasma**



D Mesons

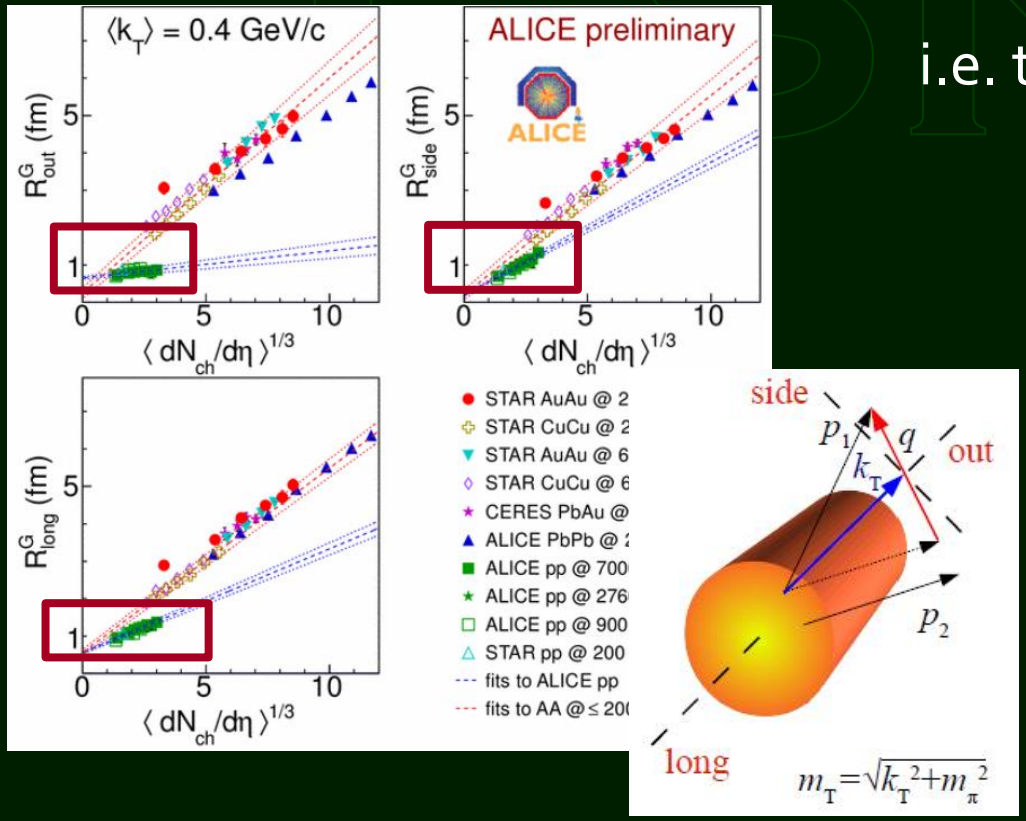
- D meson production nuclear modification
- First measurement of D meson elliptic flow

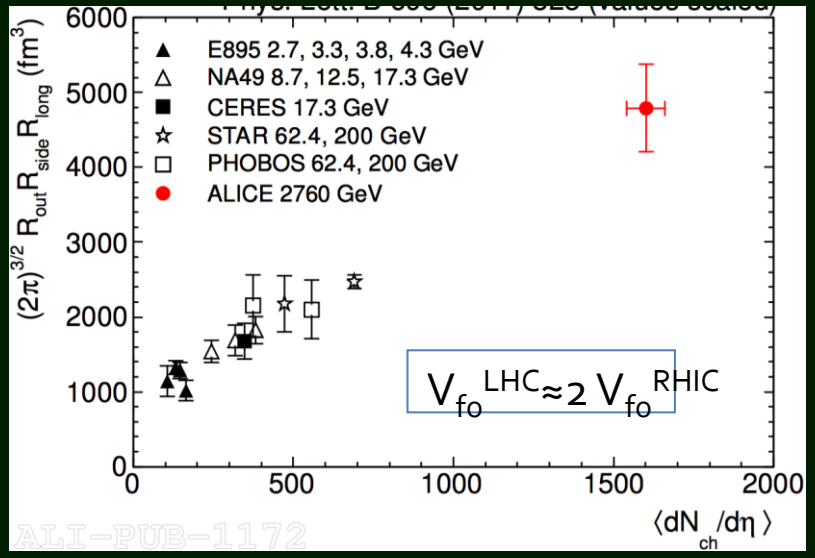




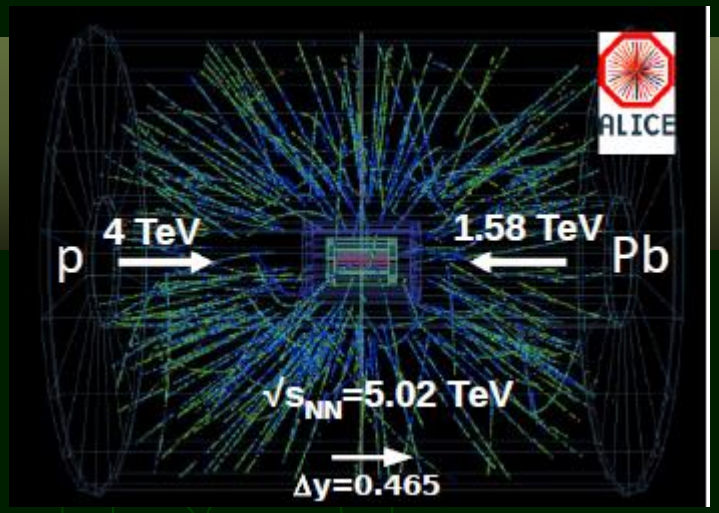
- Beside the publication of results on individual channel, there are attempts to give an overall description of the QGP

i.e. the size



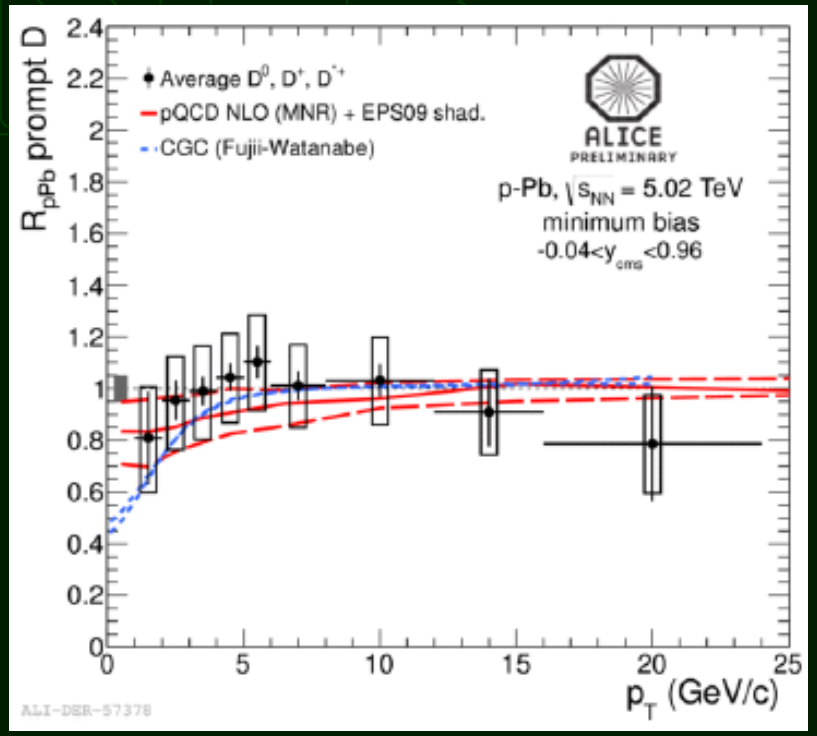


Recent Activity

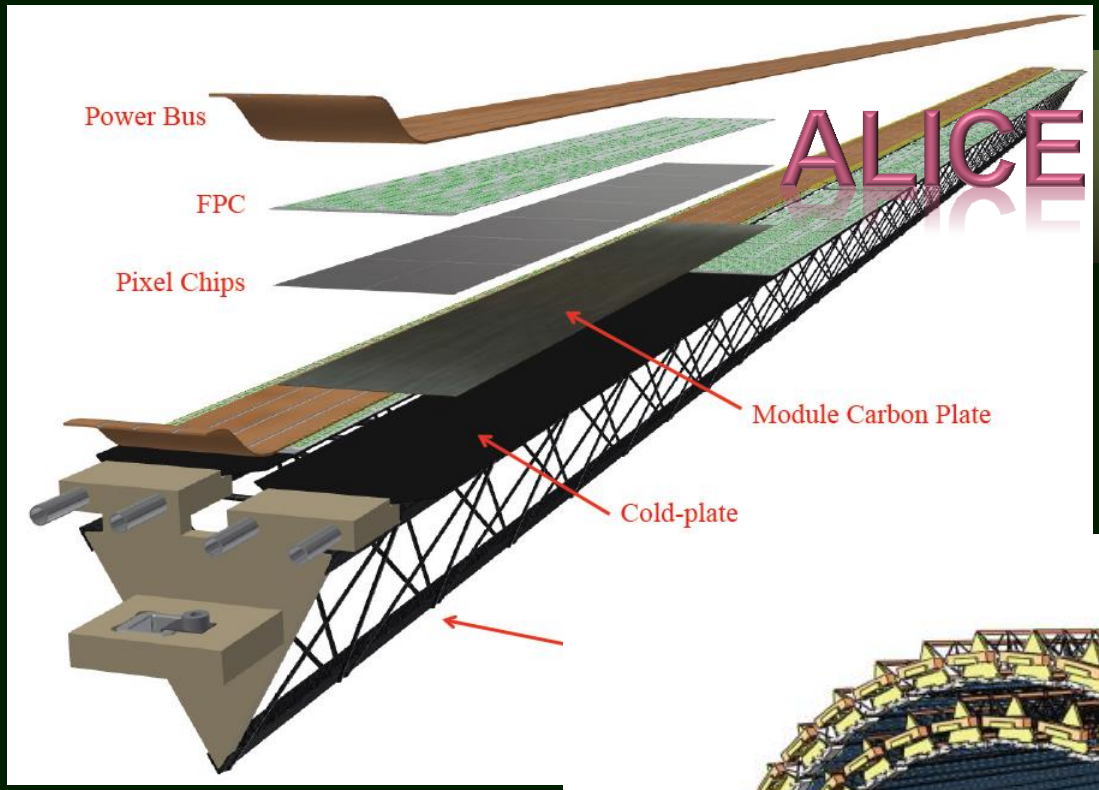


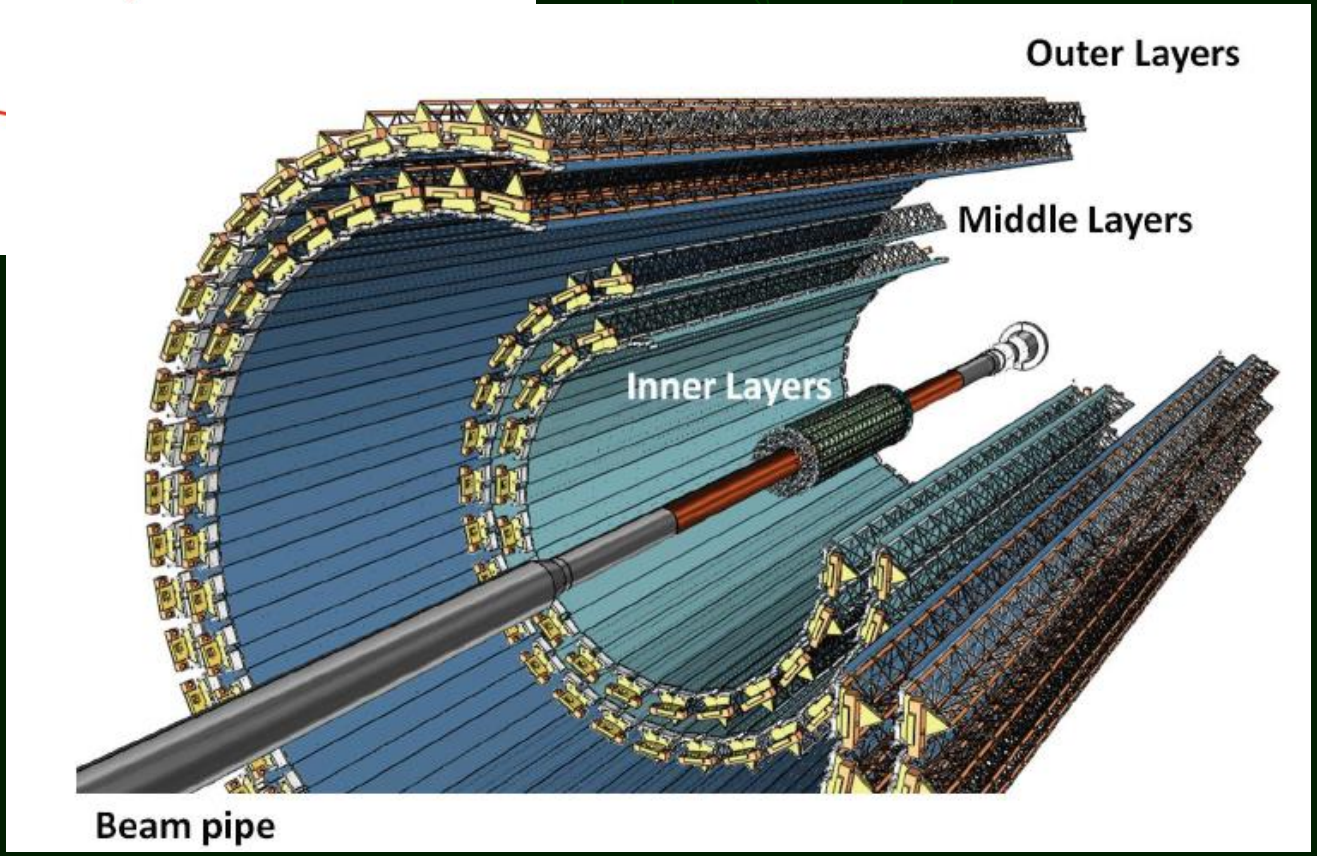
- Early 2013 p-Pb run

- p-Pb as control experiment: first assessment of cold nuclear matter effects
  → important for the interpretation of nuclear modification factors measured in Pb-Pb

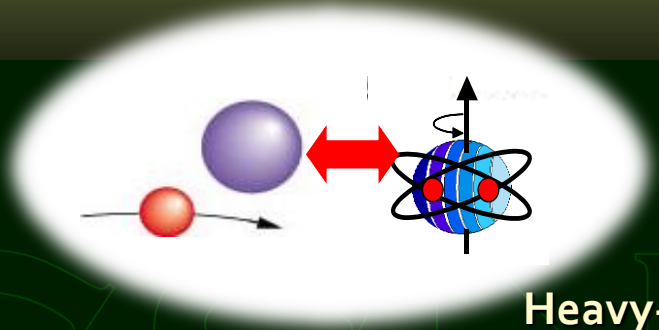


ALICE – the Upgrade



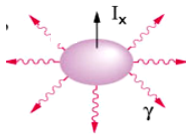


L3 - Nuclear Structure and Reaction Mechanisms



5-10 MeV/A — Heavy-ions — 50 MeV/A

Decays
(in beam)



Shell structure
Collettive modes-shape vs N/Z

Symmetries

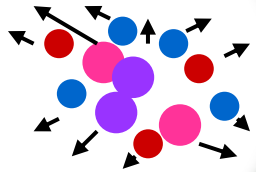
Reactions

peripheral

Nuclear structure

Termodynamics
Viscosity-high spin

Multi-framm



Equation of state

GAMMA- PRISMA- EXOTIC- NUCLEX

DREAMS - LNS_STREAM - EXOCHIM

Overview

- LNL
  - ~140 researchers
  - ~ 100 FTE
- LNS
  - ~ 210 researchers
  - ~ 150 FTE

- ~ 30% of the CSN3 researchers have experiments @ LNL and LNS
- Availability of RIB "cocktail beams"

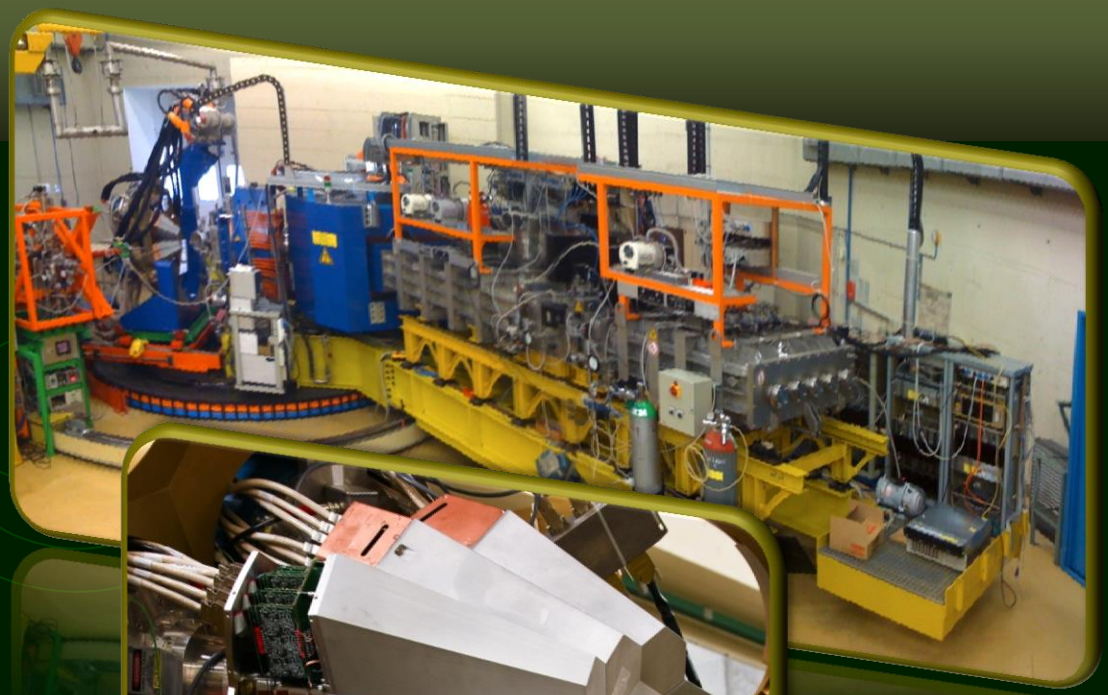
  EXOTIC @ LNL, FRIBS @ LNS
- SPES

@ LNS

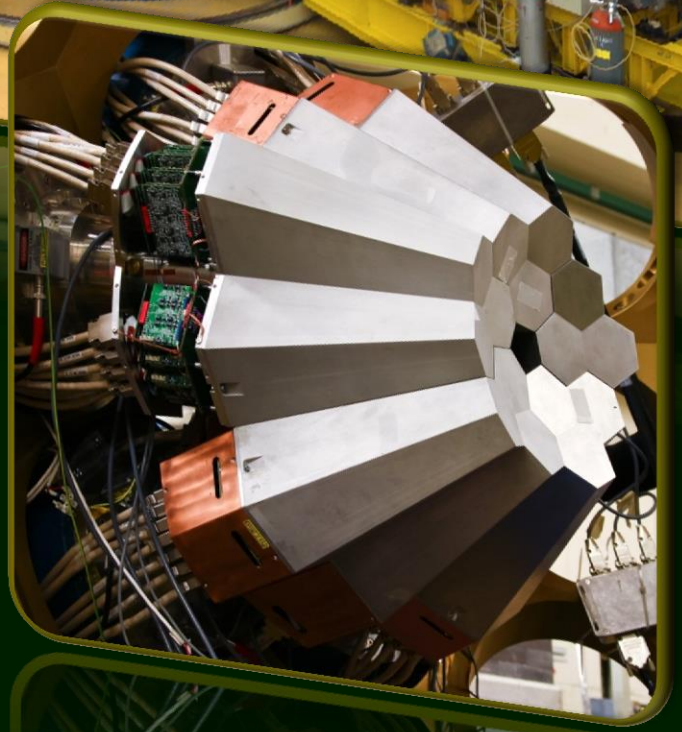
- CHIMERA
- MAGNEX
  + EDEN
- MEDEA

@ LNL

- PRISMA

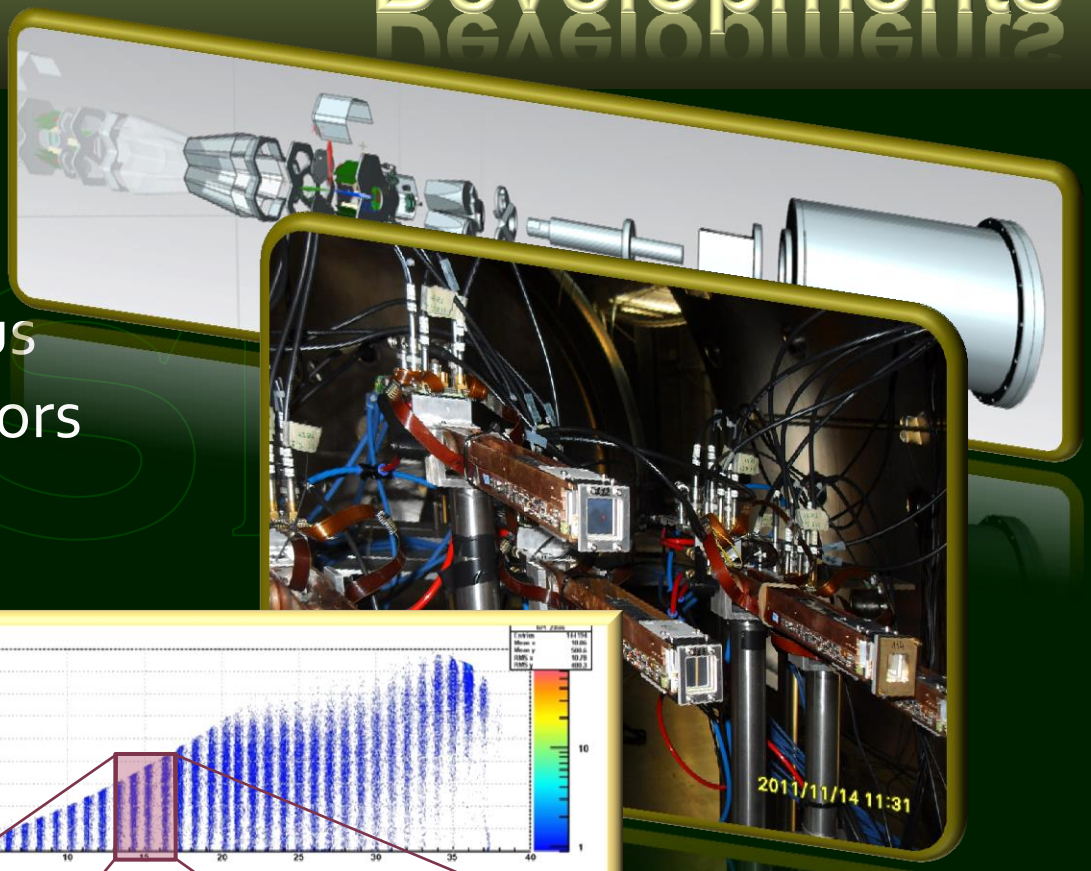


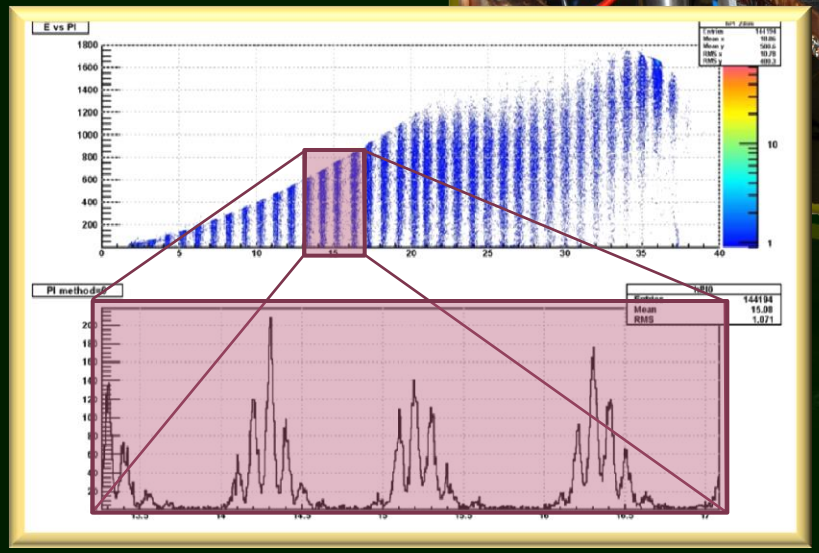
- AGATA
  - Presently @GSI



Developments

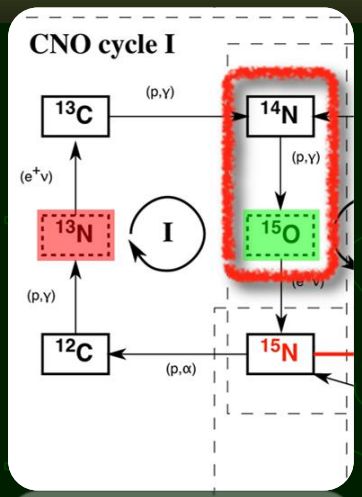
- GALILEO
  - From previous GASP detectors
- FAZIA



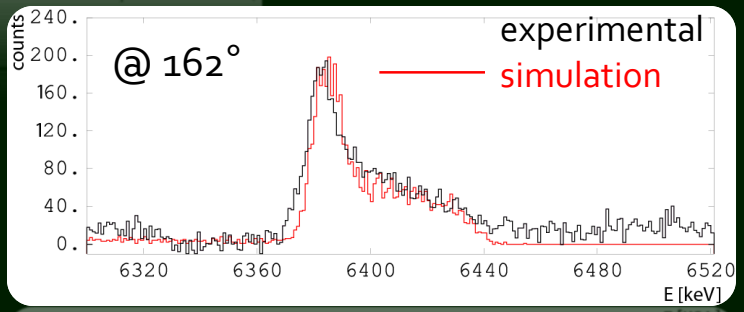


Lifetime Measurement with AGATA

- Stellar burning rates and $^{14}N(p,\gamma)^{15}O$ reaction
- The sub-threshold resonance corresponding to the first excited 3/2+ state in ^{15}O (6.79 MeV) is predicted to play a dominant role when extrapolating the cross-section to the Gamow peak region
- @fs nuclear level lifetime



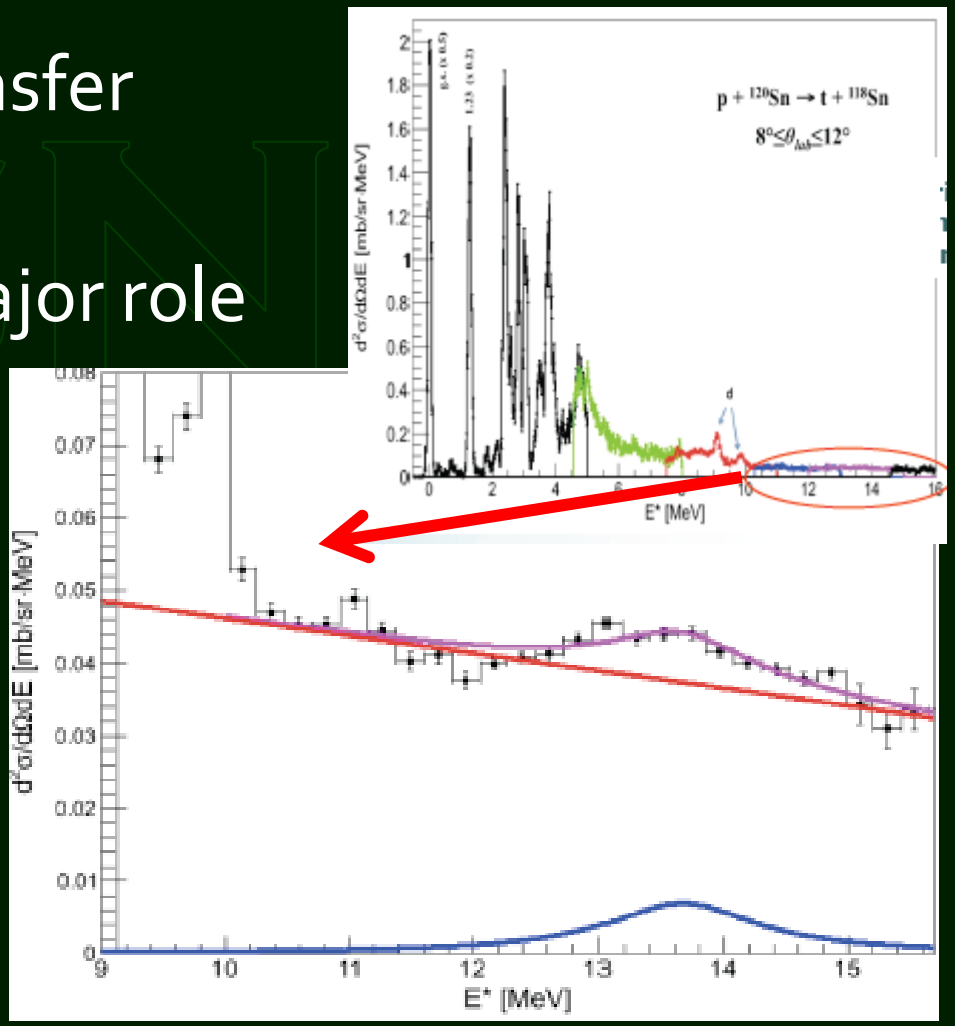
$^{14}N(^{2}H,n)^{15}O$ reaction @ 32 MeV (XTU LNL Tandem)



Giant Pairing Vibration

- Search with 2n transfer process
- MAGNEX play a major role

- $^{120}Sn(p,t)^{118}Sn$

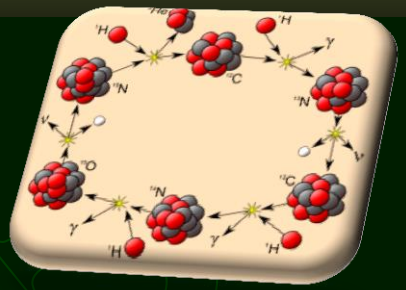


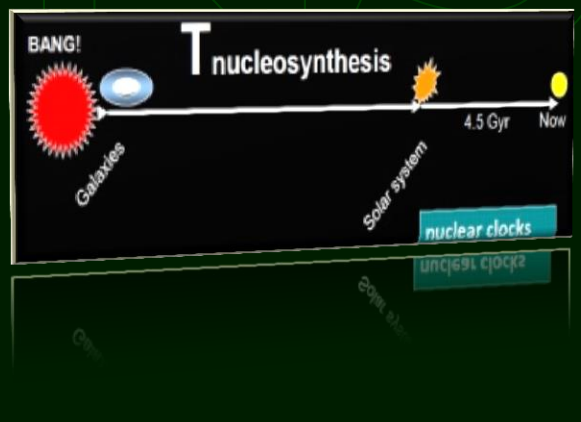
Toward SPES – 1 day meetings

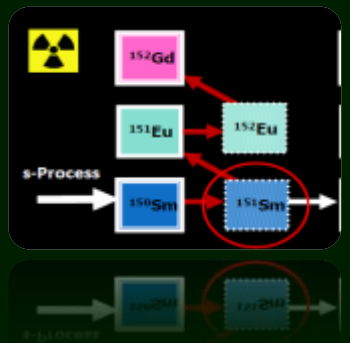
- 1° Spes One day WS @ Napoli :
  Transfer reactions with RIBs April 2012
- 2° Spes One day WS @ Firenze:
  Coulomb Exitation with RIBs Sept 2012
- 3° Spes One day WS @ Catania:
  Isospin on reaction mechanism with RIBs Oct.2013
- 4° Spes One day WS @ Milano:
  Collective excitations in exotic nuclei Dic 2013
- 5° Spes One day WS @ LNL:
  Fusion reaction with RIBs

L4 - Nuclear Astrophysics and Interdisciplinary Research

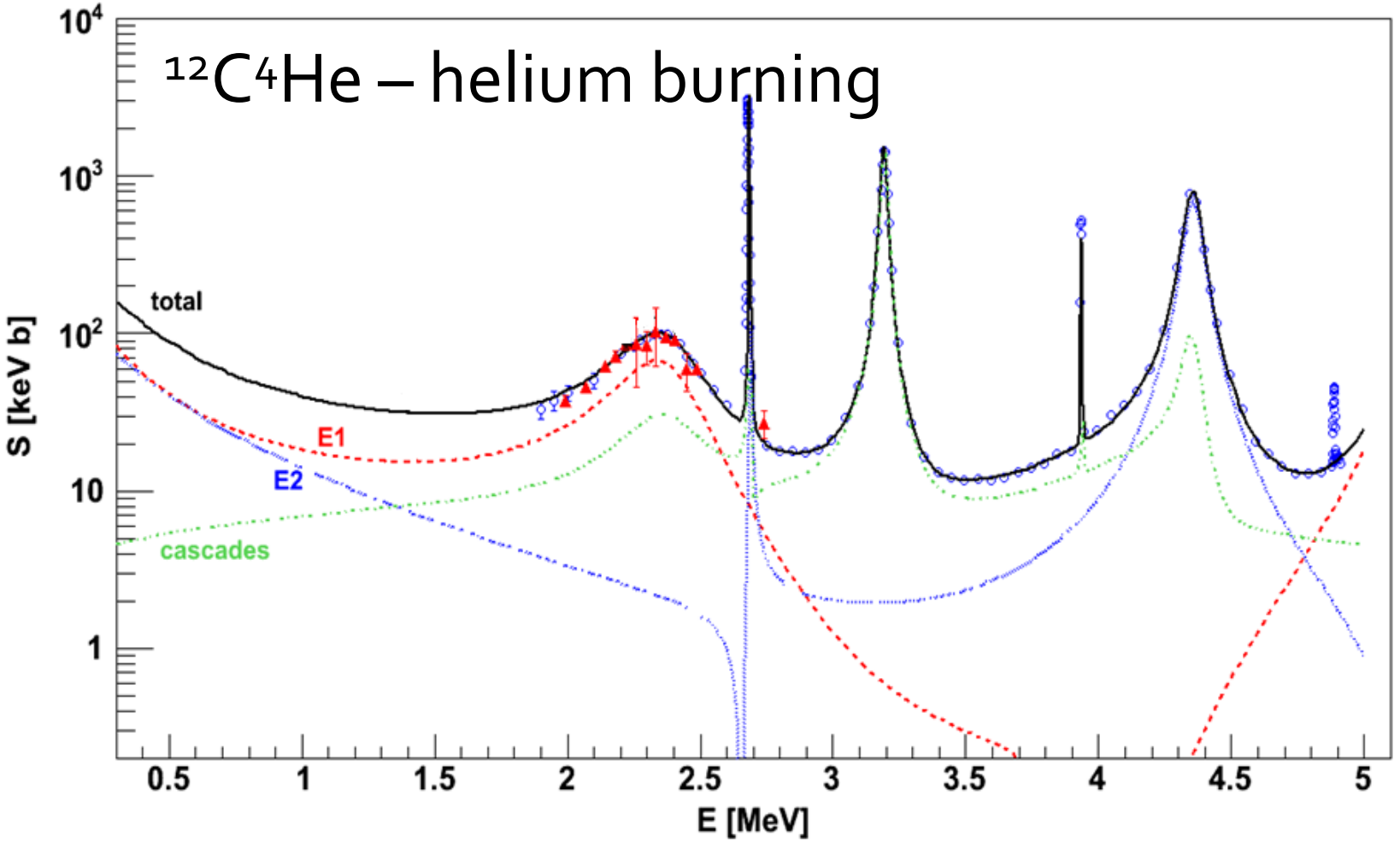
- Reactions @ stellar energy
  - Nucleosynstesis
  - LUNA@LNGS, ASFIN@LNS and ERNA
- n-capture for astrophysics and reactor applications
  - N_TOF @CERN
- Annihilation of anti-protons in nuclei in nuclei 5keV – 5 MeV region of cosmological interest
  - ASACUSA @CERN
- Pauli principle violation in atomic transitions
  - VIP @LNGS
- Gravity effects on antimatter
  - AEGIS @CERN



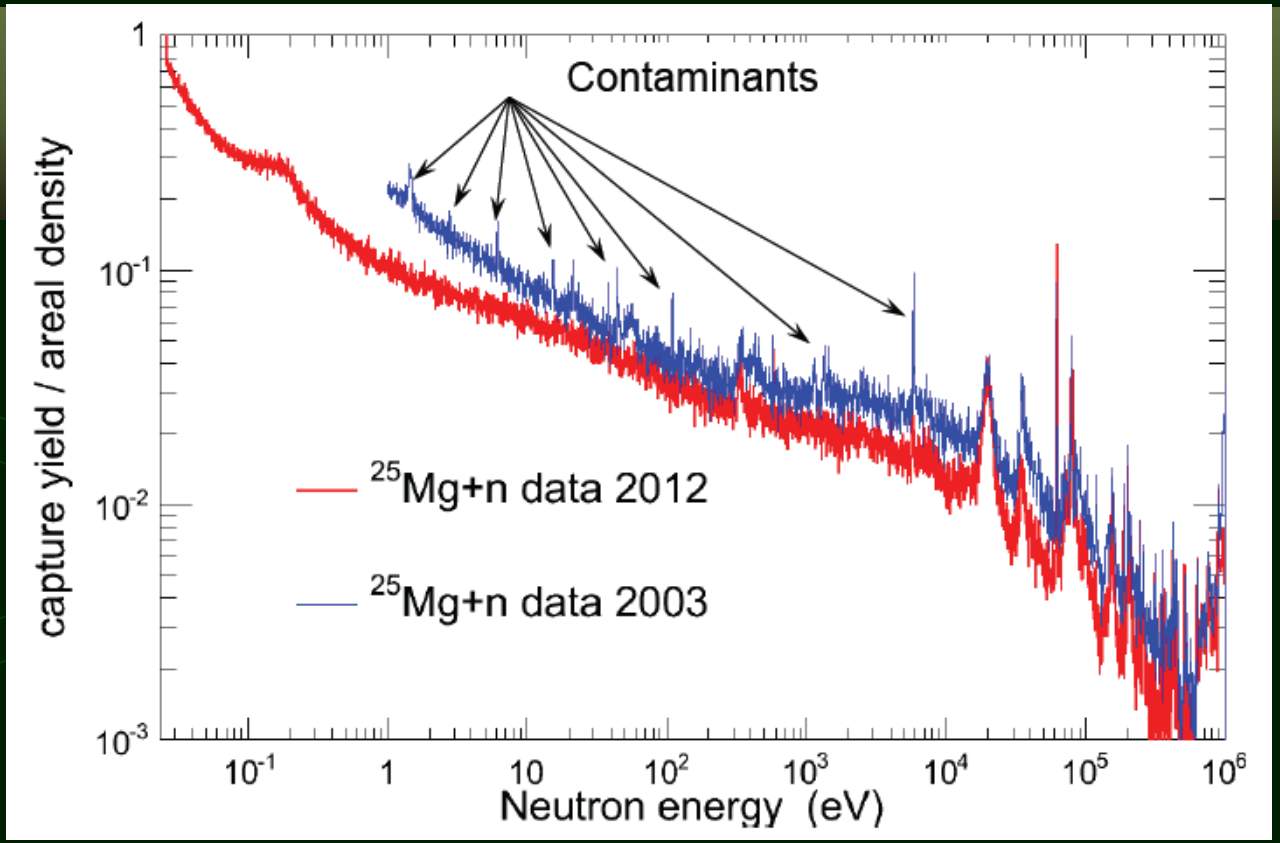




ERNA


$^{12}C^{4}He$ – helium burning
total
E1
E2
cascades
S [keV b]
E [MeV]
10^4
10^3
10^2
10
1
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

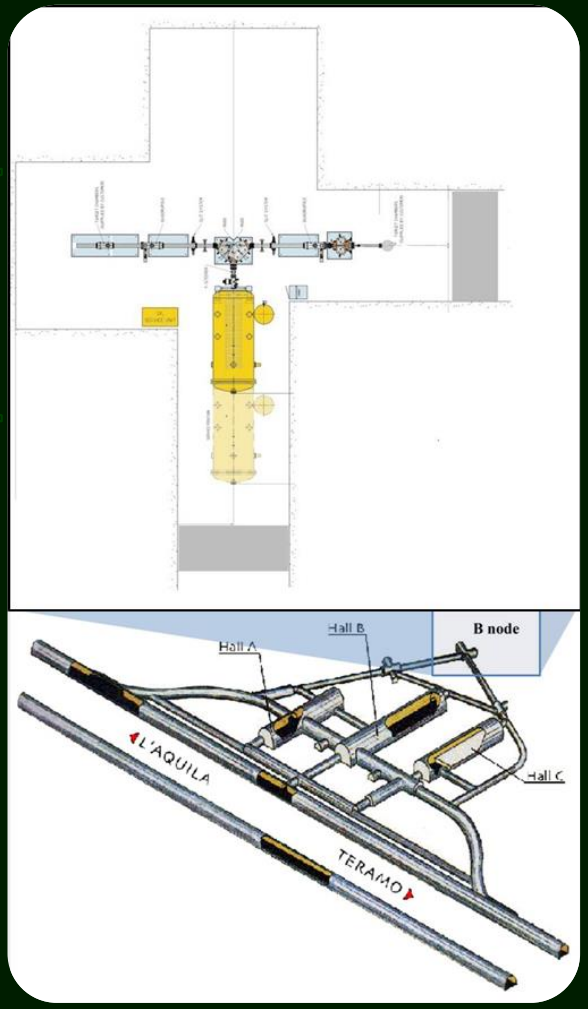
N_TOF



- ^{25}Mg is crucial for s-process both as involved as a **neutron poison** and in **neutron production**
- Elements abundance strongly depends on the n+Mg cross sections

LUNA-MV @ LNGS

- A 3.5 MV accelerator to measure key reactions of the Helium burning and neutron sources for the s-process:
  - $^{12}C(\alpha,\gamma)^{16}O$
  - $^{13}C(\alpha,n)^{16}O$
  - $^{22}Ne(\alpha,n)^{25}Mg$
  - (α,γ) reactions on $^{14,15}N$ and ^{18}O
- Relevant at higher temperatures (larger energies) than reactions belonging to the hydrogen-burning studied so far at LUNA



Conclusions

- The Italian Nuclear Experimentalists are very active
- The role of the four National Laboratories is strategic for the success of our researchs
- The upgrade programs will permit to study new very interesting problems