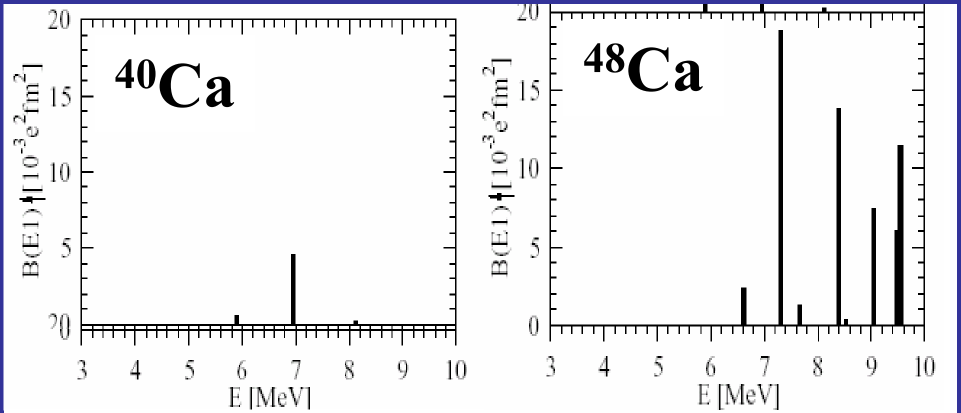
Coulomb excitation of ^{68}Ni at 600 MeV/A

- Pygmy Resonance
- Measurements in exotic nuclei
- Virtual photon scattering
- Rising preliminary data on ^{68}Ni
- Perspectives
- Conclusions

In neutron rich nuclei some E1 strength is shifted towards low energy



T. Hartmann PRL85(2000)274

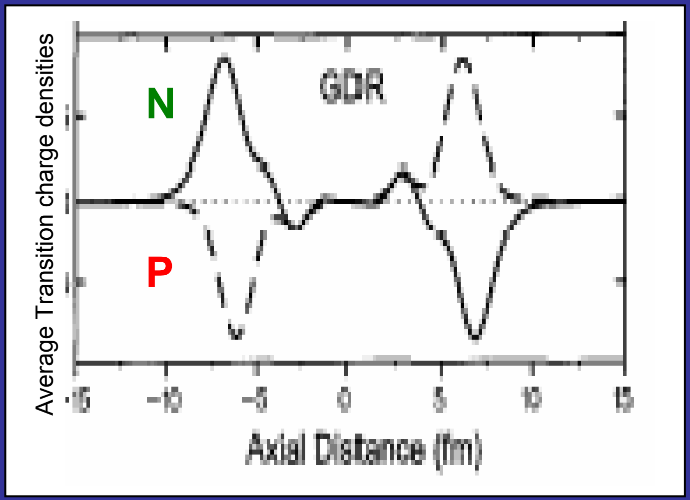
Photo-absorption measurement

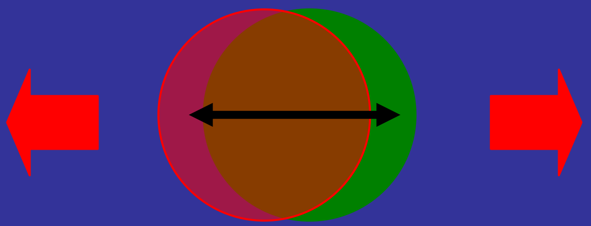
Such low lying E1 states might have either a collective or non collective nature

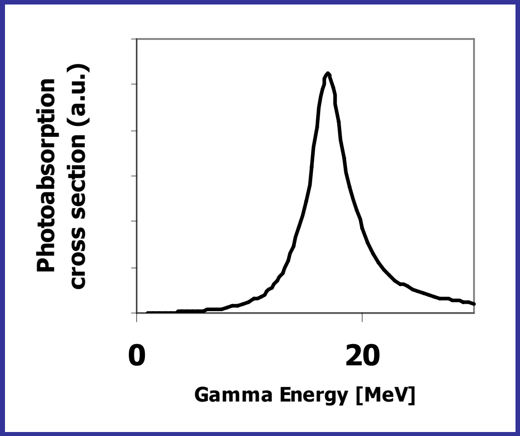
This low lying E1 strength is denoted as Pygmy or Soft Resonance

Giant Dipole Resonance

Collective oscillation of neutrons against protons

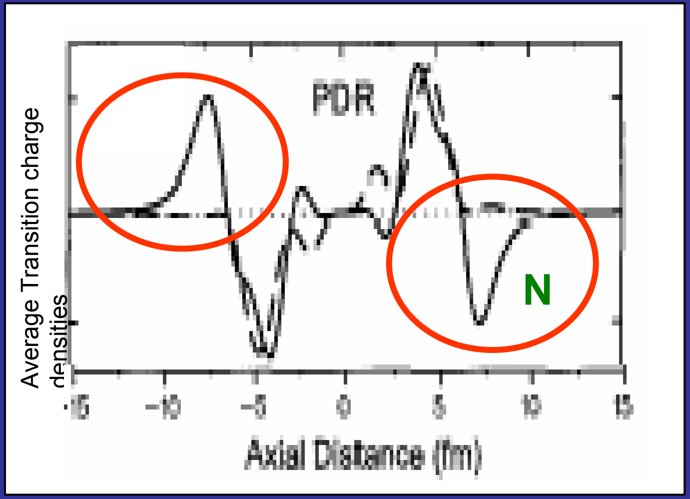


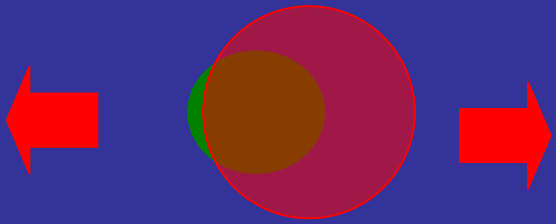


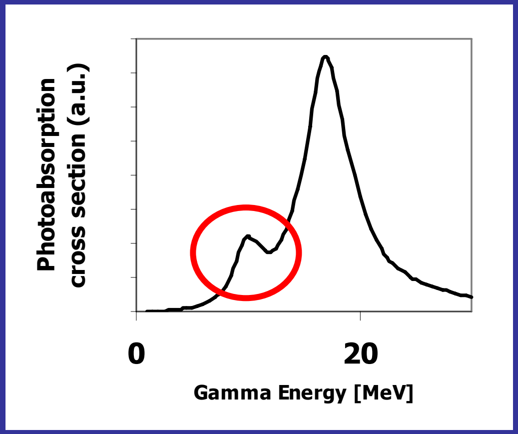


Pygmy Resonance

Collective oscillation of neutron skin against the core



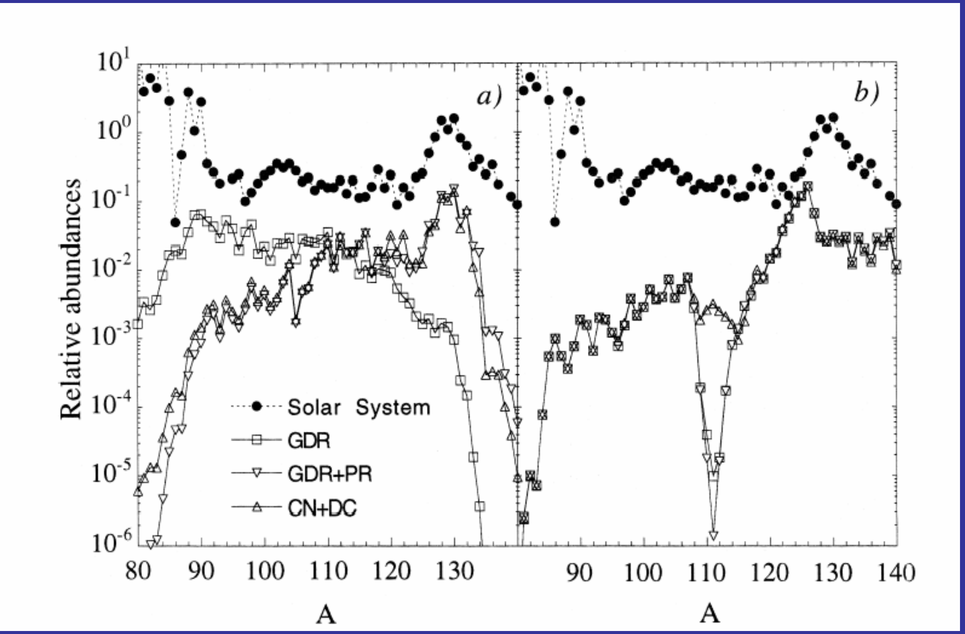




Richter NPA 731(2004)59

Why Pygmy Resonance is important ?

Pygmy Resonance has an important
impact on the r-process nucleosynthesis



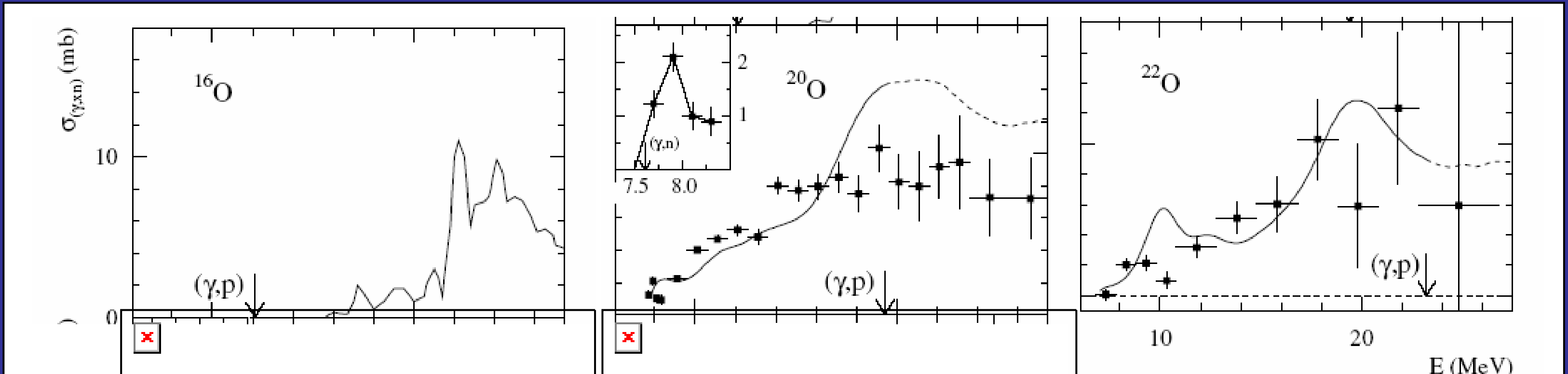
Goriely et al PLB436(1998)10

Different mean field approaches give different predictions in terms of collectivity, strength and line-shape of the pygmy resonance

Isovector properties of nuclear force

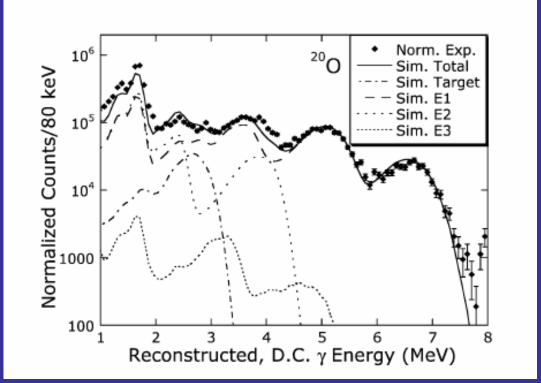
Pygmy/Soft Resonance in Exotic Nuclei

- Systematic study in Oxygen neutron rich isotopes



A. Leistenshneider et al. Phys. Rev. Lett. 86(2001)5442

- Part of the E1 Strength is shifted at low energy
- A clear separation into two domains (pygmy and GDR) is not observed
- Theory assign this low lying E1 strength to single neutron p-h excitations



E.Tryggestad et al. Phys. Lett. B541(2002)52

Pygmy/Soft Resonance in Exotic Nuclei

- Systematic study in Sn neutron rich isotopes

- Part of E1 Strength is shifted at low energy
- A clear separation into two domains
  (pygmy and GDR) is observed

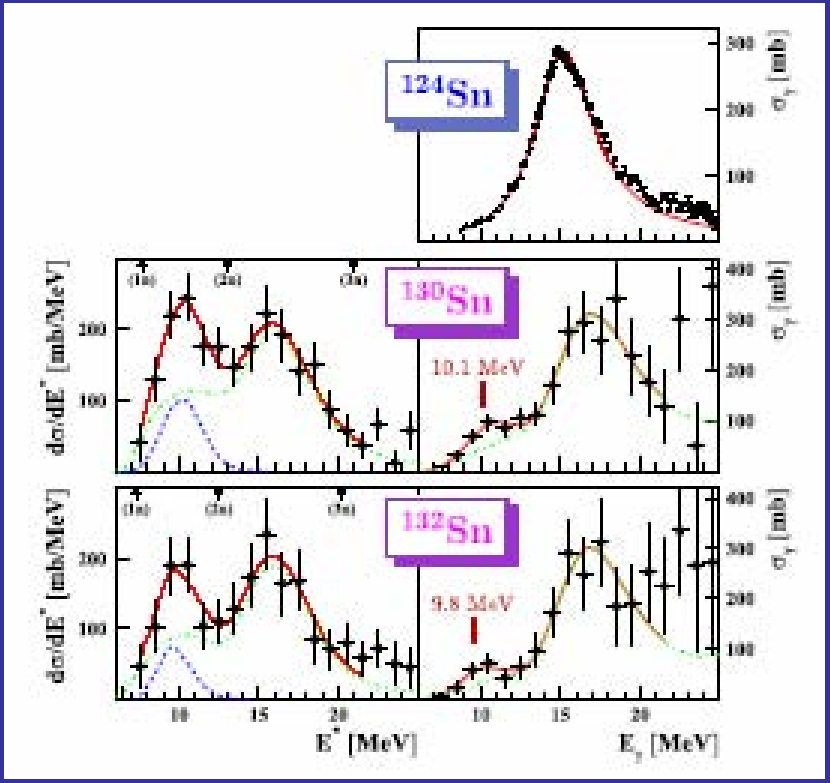
- The nature of such low lying E1 strength
  is not yet clear

  - A relativistic mean field approach assign
    a collective nature

    - D.Vretnar et al - Nucl. Phys. A692(2001)496

  - A RPA approach assign a non collective
    Nature

    - D.Sarchi et al. Phys. Lett. B601(2004)27



Adrich et al. PRL 95(2005)132501

Measurement of the E1 strength in ^{68}Ni

Virtual photon scattering technique

- Peripheral heavy-ion collision on a Au target at relativistic energies
- Virtual photon excitation and decay

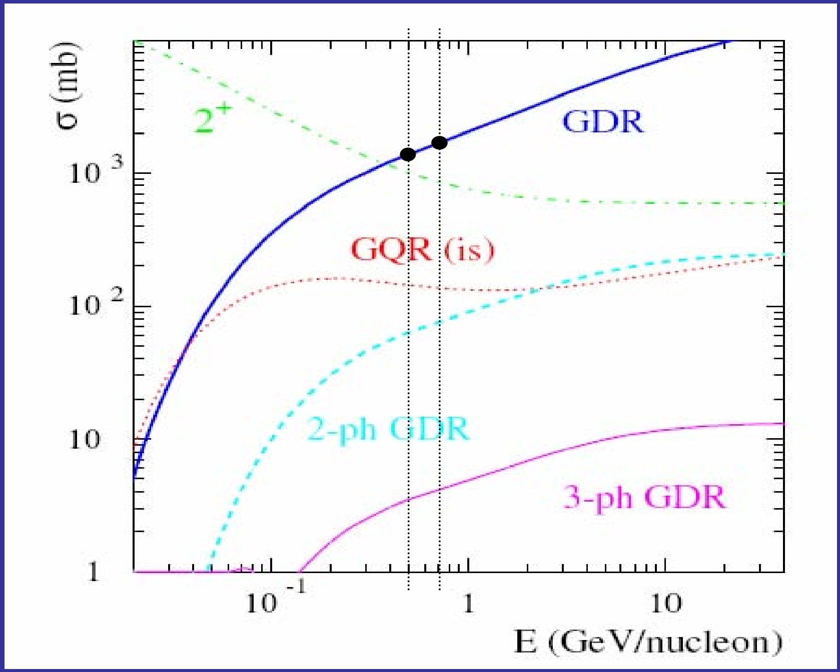
$$ {}^{A}_{N}X({}^{197}\mathrm{Au},{}^{197}\mathrm{Au})X^{A}_{N} + \gamma $$

- The measurement of the high energy γ-rays and of the elastic scattered ^{68}Ni directly provides the E1 strength distribution

GDR - PYGMY Excitation

- 400 MeV/u ^{68}Ni (2004) + ^{197}Au
- 600 MeV/u ^{68}Ni (2005) + ^{197}Au

$$\sigma(GDR) \approx +30\%$$
$$\sigma(2^+) \approx -20\%$$



T.Aumann et al EPJ 26(2005)441

GDR - PYGMY Decay

GDR Ground state decay branching ratio $\Rightarrow$ 2%

- measured on ^{208}Pb - J.Beene et al PRC 41(1990)920

GDR low lying E1 strength expected around 10 MeV

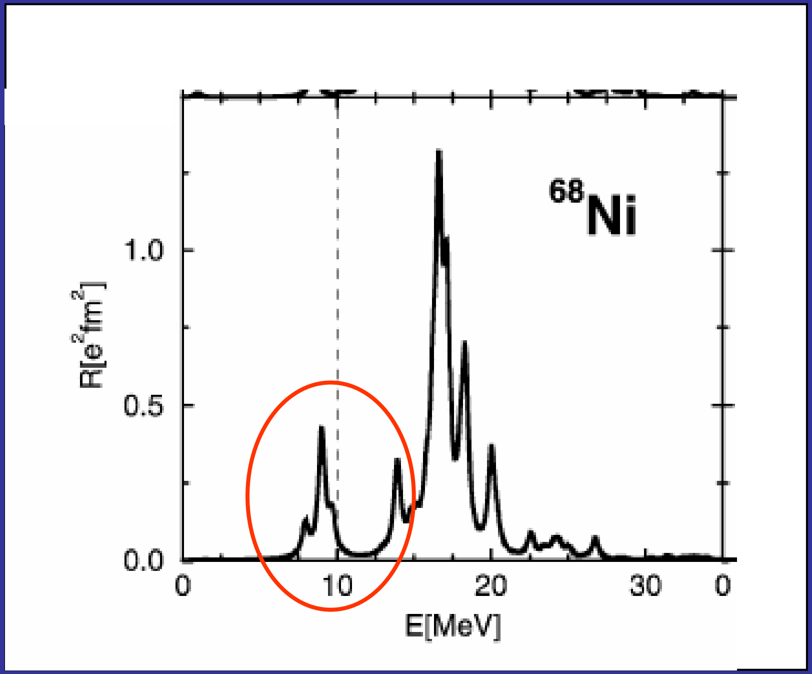
Gamma sources

Doppler shifted

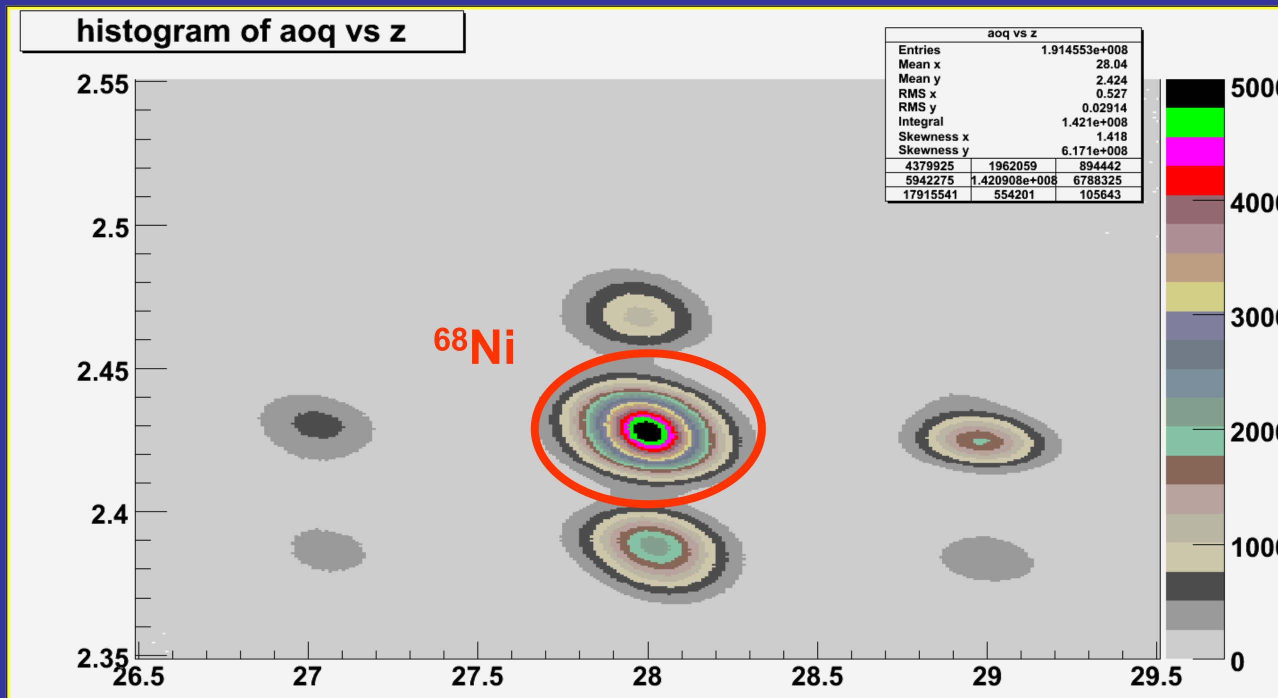
- **Direct GDR decay from ^{68}Ni**
- **Hot CN decay from ^{68}Ni**

Non Doppler shifted

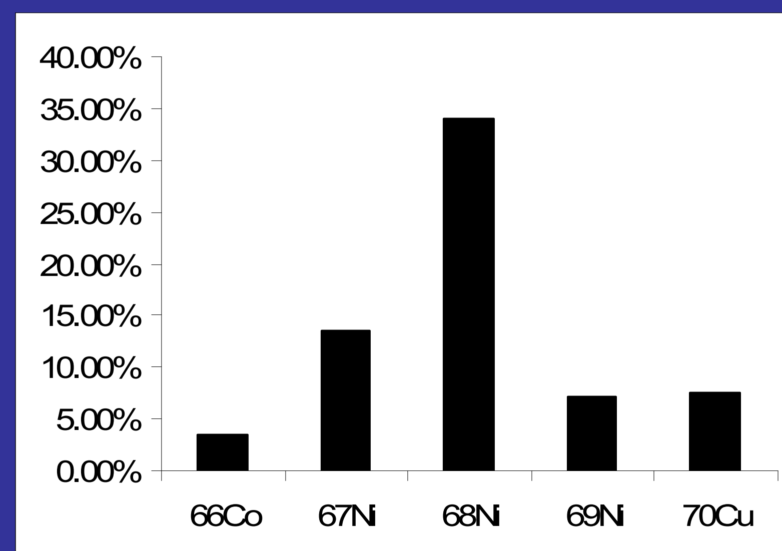
- **Direct GDR decay from ^{197}Au**
- **Hot CN decay from ^{197}Au**



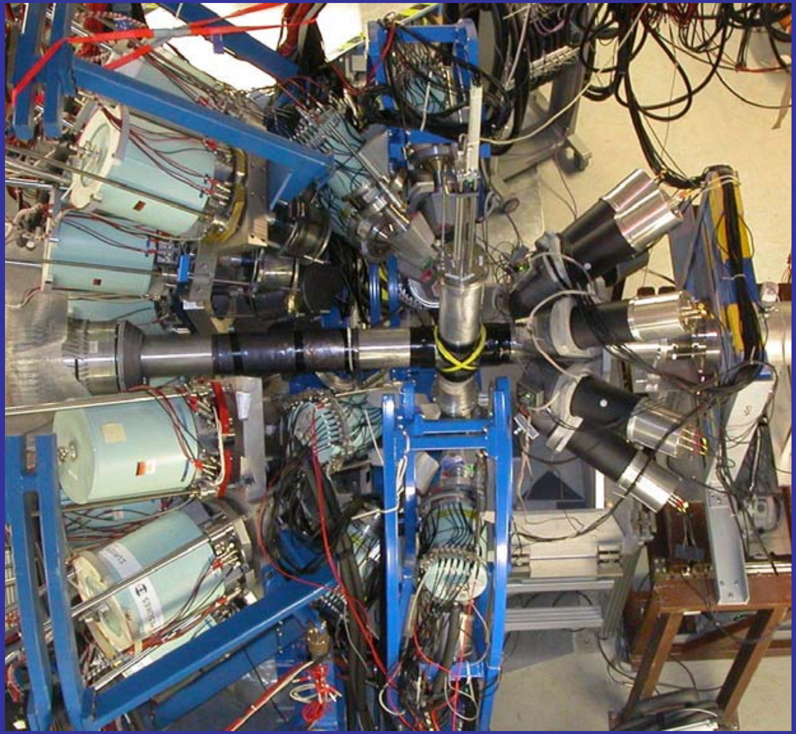
D. Vretnar et al. NPA 692(2001)496



- ~ 6 Days of effective beam time
- ~ 400 GB of data recorded
- ~ 3 10^8 Events recorded
- ~ 1 10^8 ^{68}Ni recorded
- ~ 3 10^7 ‘ good ^{68}Ni events ‘ recorded



Experimental details



Euroball 15 Clusters

Located at 16.5°, 33°, 36° degrees
Energetic threshold ~ 100 keV
57% of good data

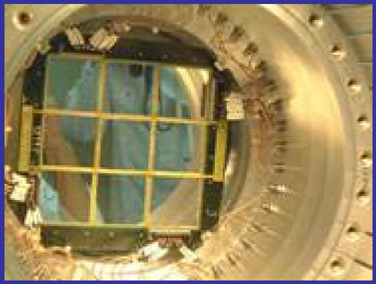
Hector BaF_2

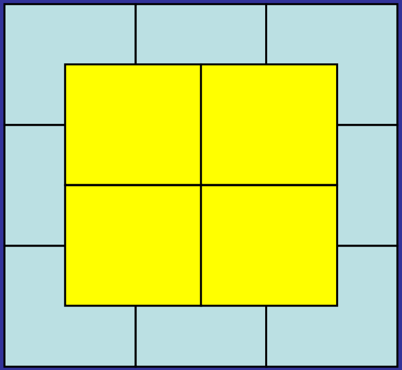
Located at 142° and 90° degrees
Energetic threshold ~ 1.5 MeV
6 % of good data

Miniball segmented detectors

located at 46°, 60°, 80°, 90° degrees
Energetic threshold ~ 100 keV
37 % of good data

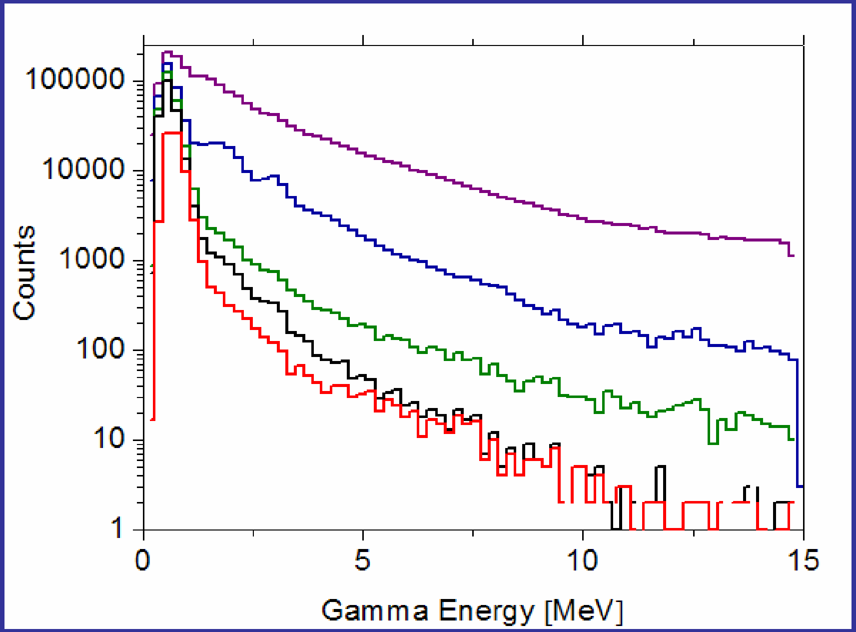
New Calorimeter Telescope

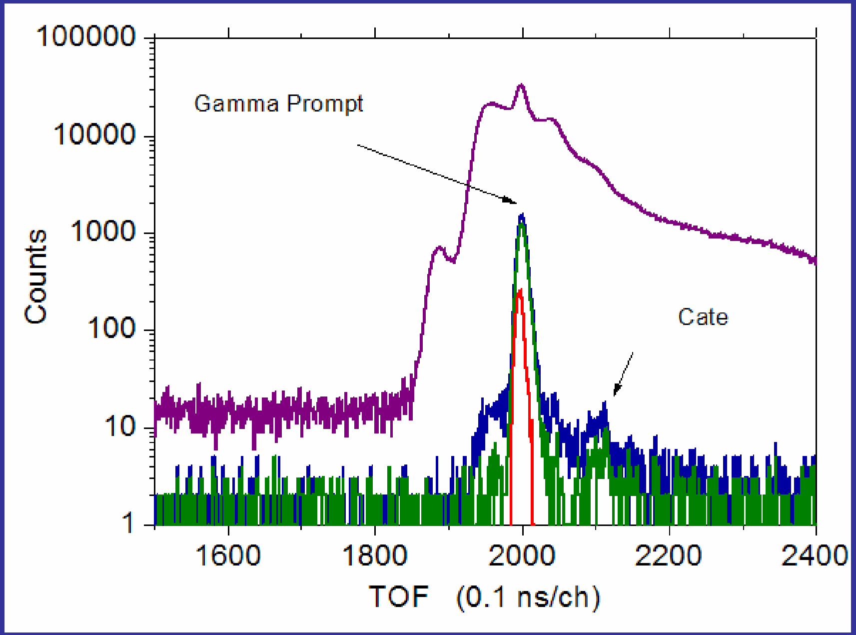




4 CsI
9 Si

BaF_2 Spectra





Time of flight – Gated on ^{68}Ni in incoming projectile

Time of flight -- Gated on ^{68}Ni in incoming projectile and on Ni in Cate

Time of flight -- Gated on ^{68}Ni in incoming projectile and on Ni in Cate and Mγ = 1

(+TOF in Energy spectra)

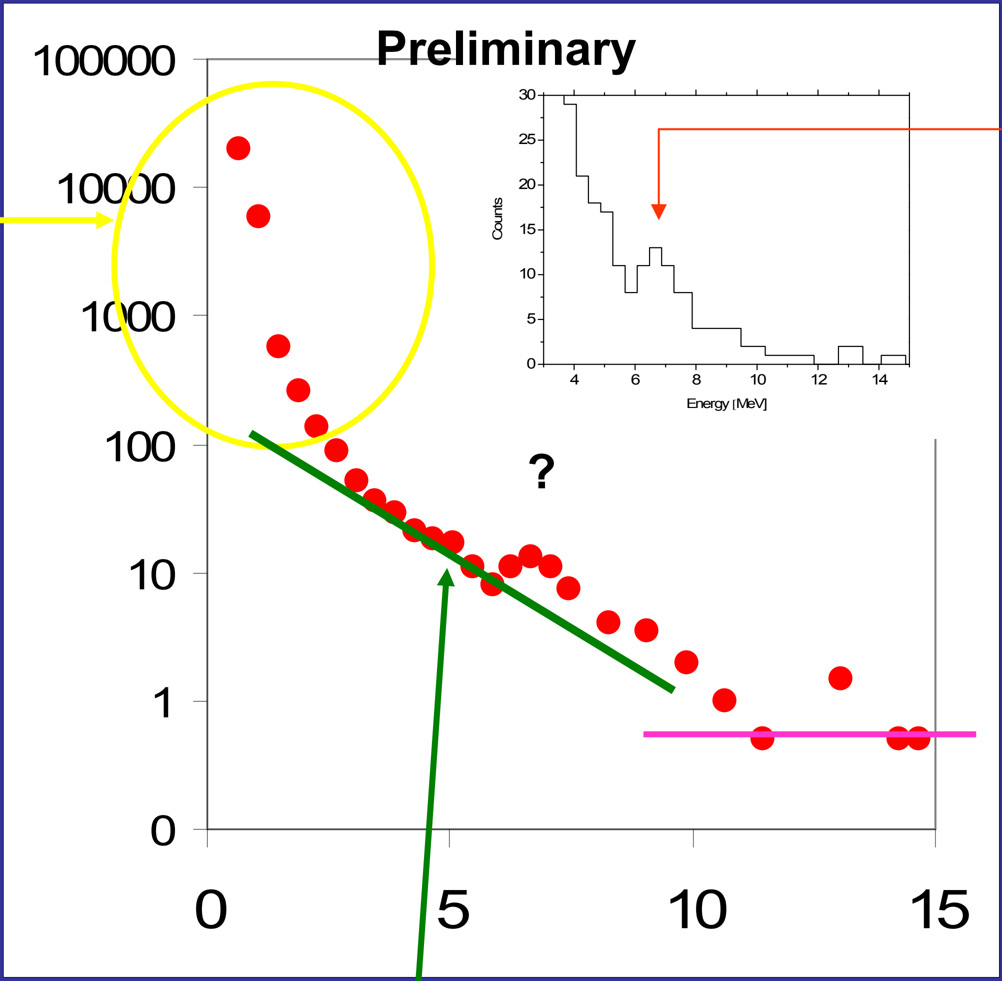
Time of flight -- Gated on 68Ni in incoming projectile and on Ni in Cate and Mγ = 1

Time of flight -- Gated on 68Ni in incoming projectile and on Ni in Cate and Mγ = 1 and PSA

BaF_2 spectra measured at 90° (2 crystals)

No Doppler correction

Low Energy Emission



E_{lab} ~ 6.7 MeV
E_{CM} ~ 10.7 MeV

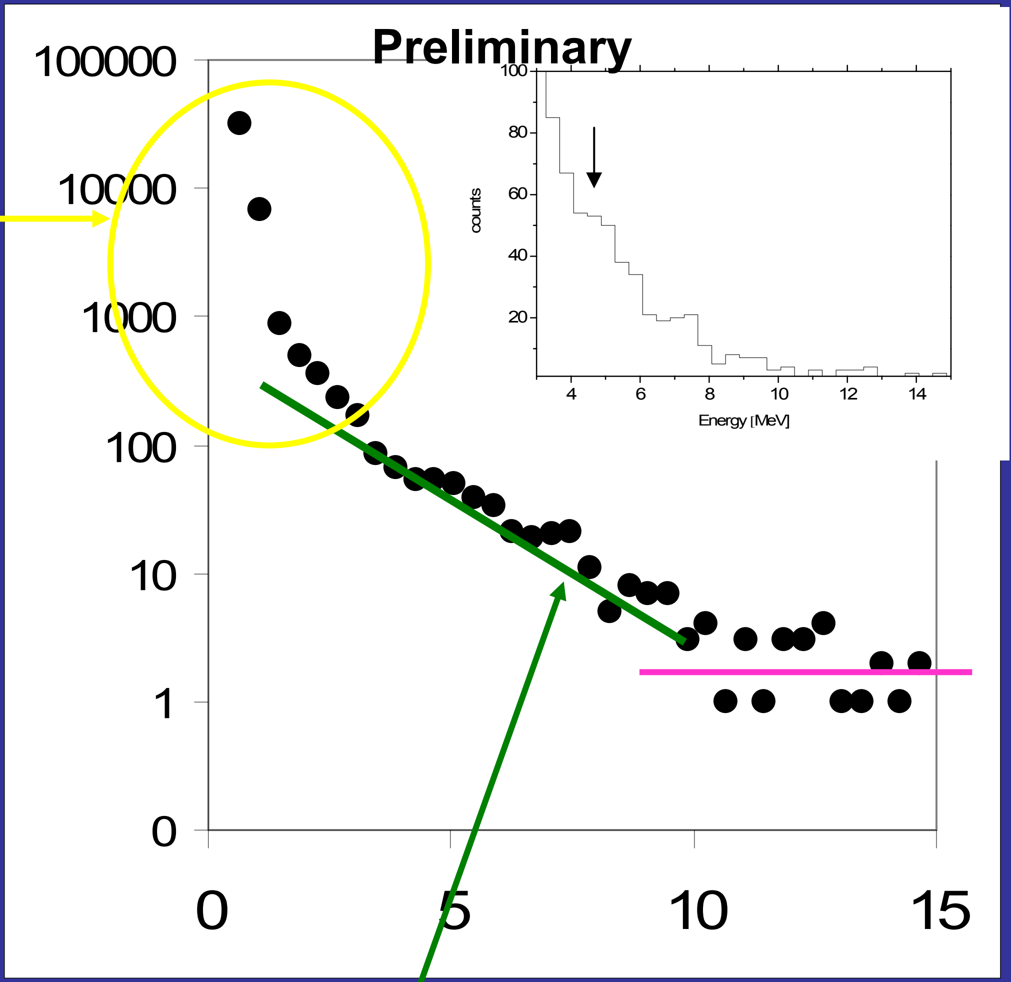
Zero

Exponential Shape (tipycal from CN emission) – Hot 197Au

BaF_2 spectra measured at 142° (6 crystals)

No Doppler correction

Low Energy Emission

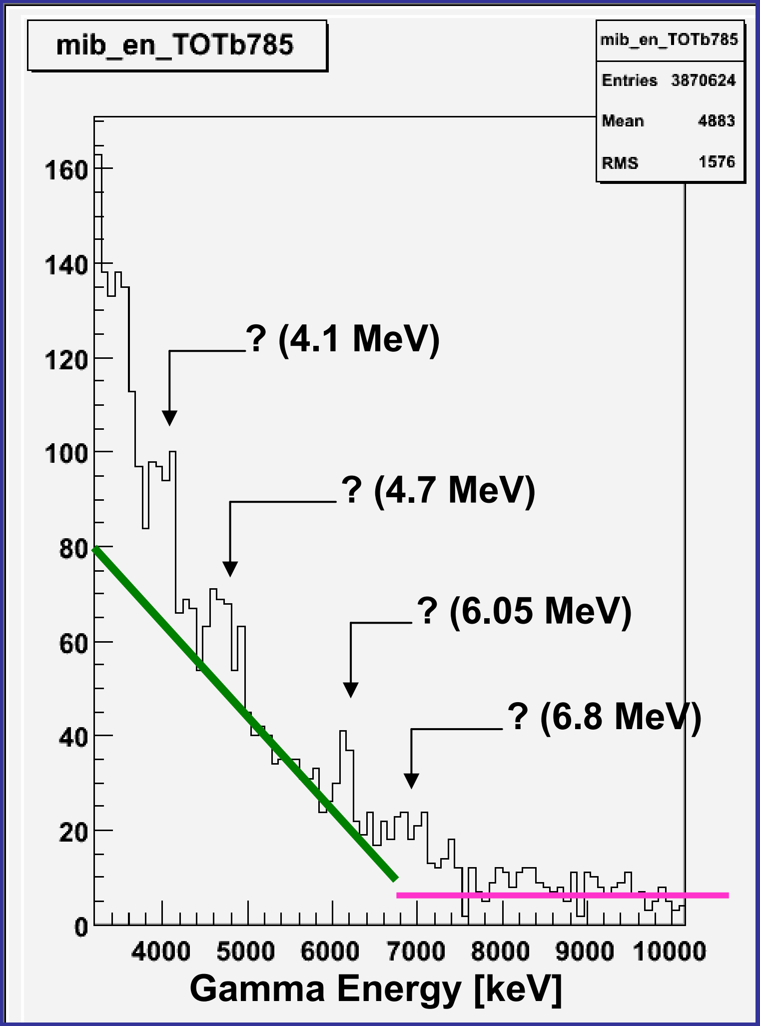


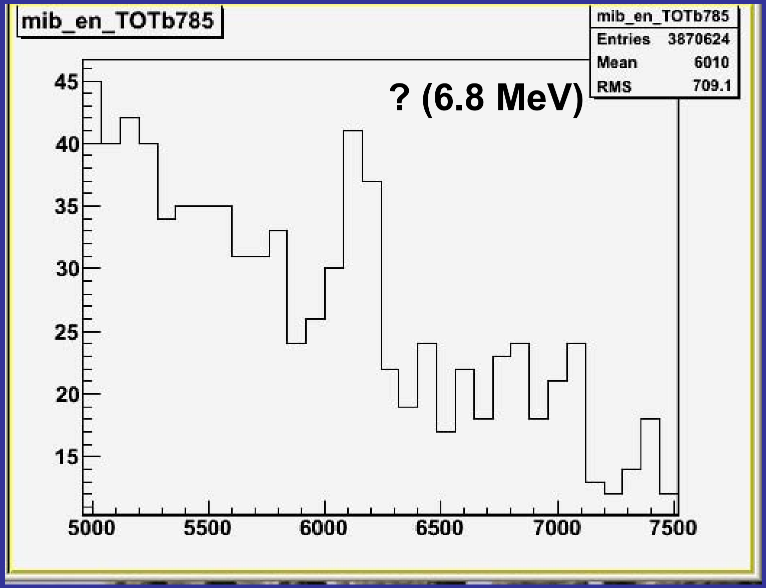
Zero

Exponential Shape (tipycal from CN emission) – Hot 197Au

Miniball Data (preliminary)

Doppler corrected (No PSA) β = 0.785





The work is in progress

- Data analysis is not finished yet.
  - Energy spectra from cluster not yet fully analyzed
  - 30% of statistics is not yet included.
  - Background reduction can be improved
    - CATE data analysis must be improved.
      - Correction due to interaction positions.
      - Correction due to Beam velocity profile.
    - Measurement of Coulomb scattering angle has not yet done.
    - In BaF_2 spectra one must improve Fast vs Slow gates.
    - Miniball Pulse Shape Analysis is not yet done.
  - Geant consistency check
  - BE1 not yet extracted
- Analysis on ^{67}Ni is not yet done.

Conclusions

- We have measured high energy γ-rays from the Coulomb excited ^{68}Ni at 600 MeV/u.
- Incoming and outgoing beam have been tracked on an event by event basis.
- Statistics is low but there is some evidence for γ-rays emission in the expected energy region of the Pygmy resonance (4-12 MeV).
- The large Doppler-shift makes the different gamma detector sensitive to different energy region, cross checks are very difficult.
- The data are very preliminary and the analysis is not yet finished.
- Still lot of work to do.

Perspective (new fast beam campaign)

- Milano is planning similar measurements in Calcium and Oxygen mass region

Rising collaboration

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