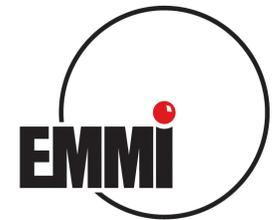


Fragmentation and Systematics of the Pygmy Dipole Resonance

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*ExtreMe Matter Institute EMMI
GSI*

*Oslo Workshop
- 2011 -*

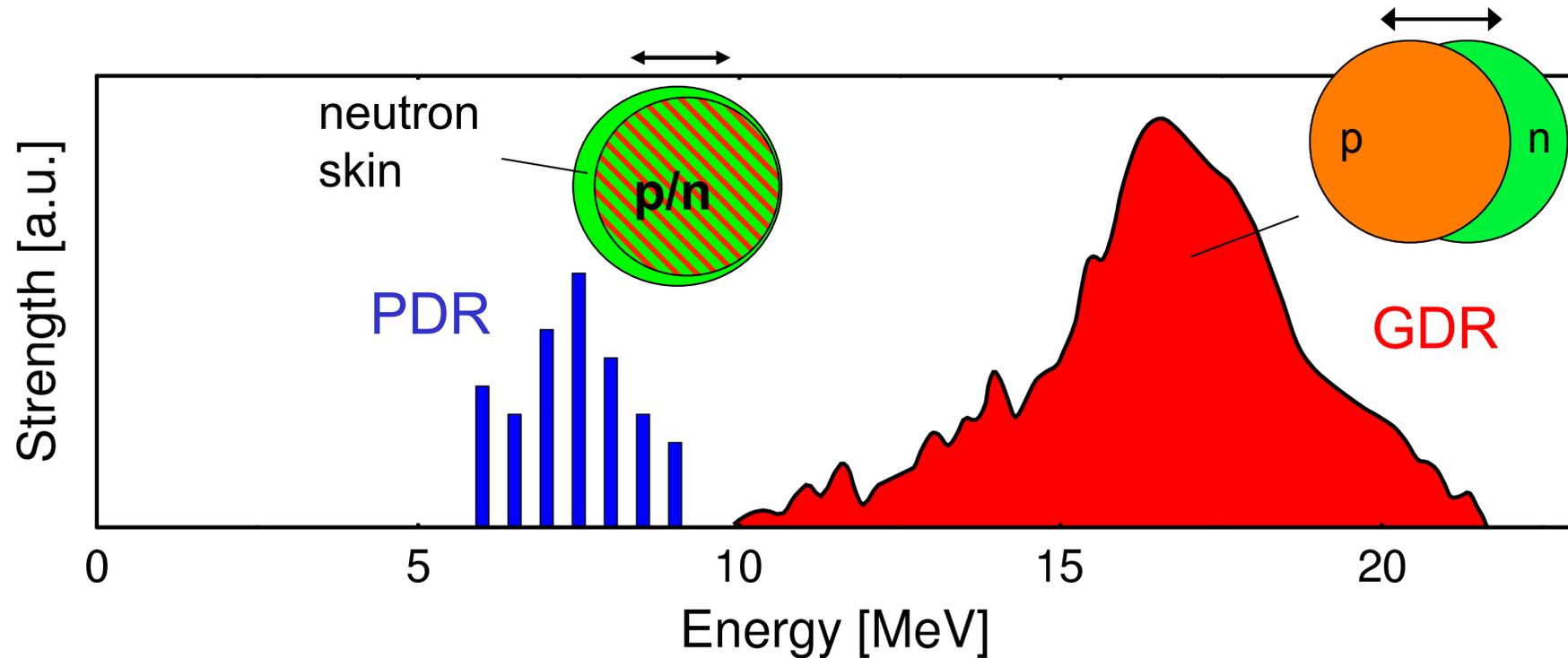
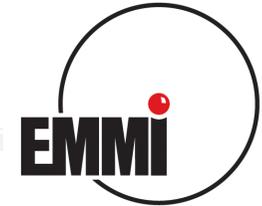


Contents



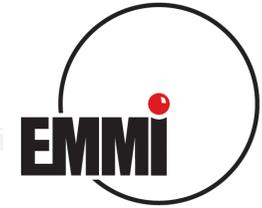
- Introduction: The Pygmy Dipole Resonance
- The PDR in real photon scattering
 - The PDR in the N=82 Isotones
 - Fragmentation and systematics
- The PDR neutron rich unstable nuclei
- Summary

E1 strength in (spherical) atomic nuclei

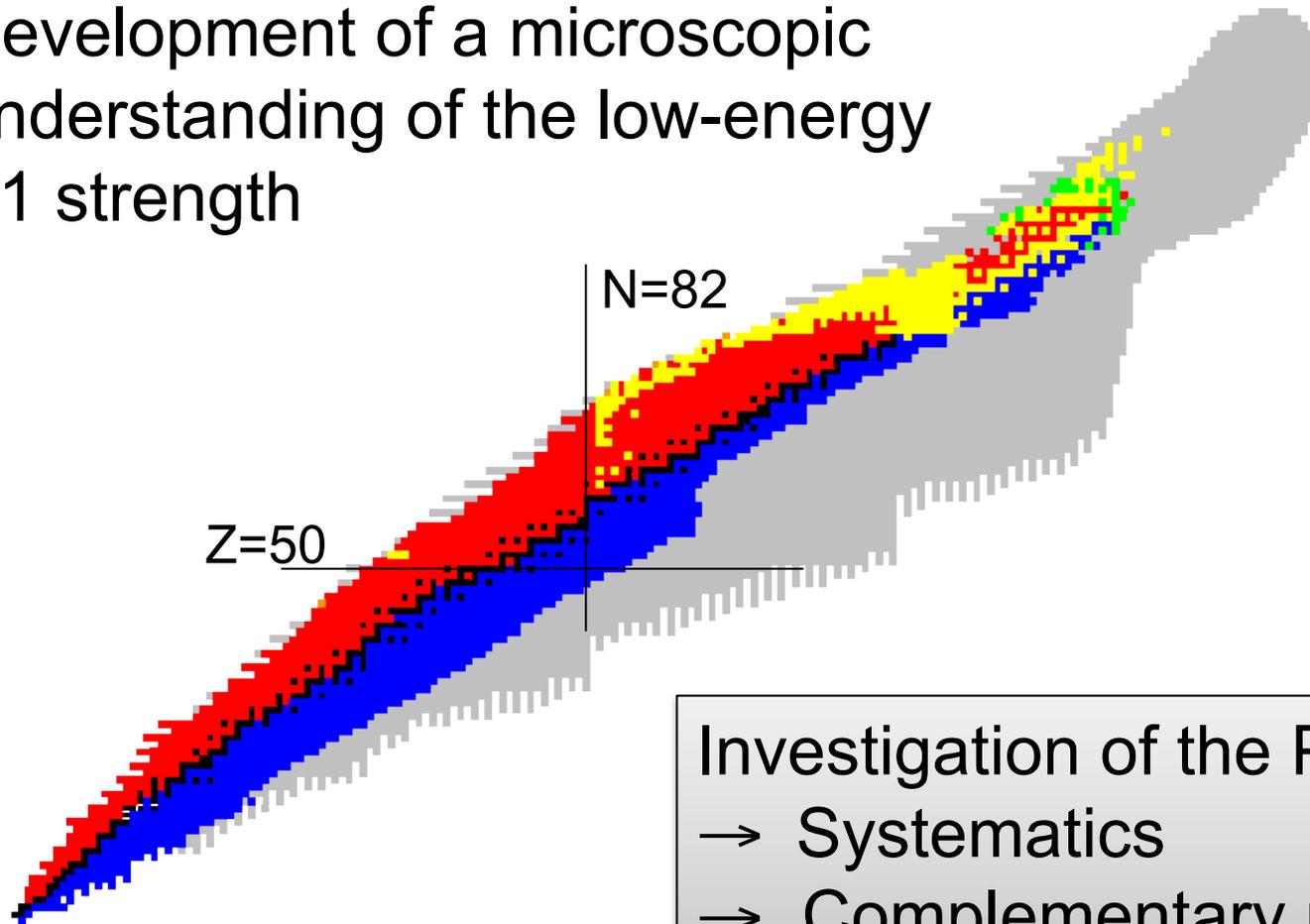


- Neutron skin / symmetry Energy
- Astrophysical reaction rates

Nature of the PDR



Development of a microscopic understanding of the low-energy E1 strength

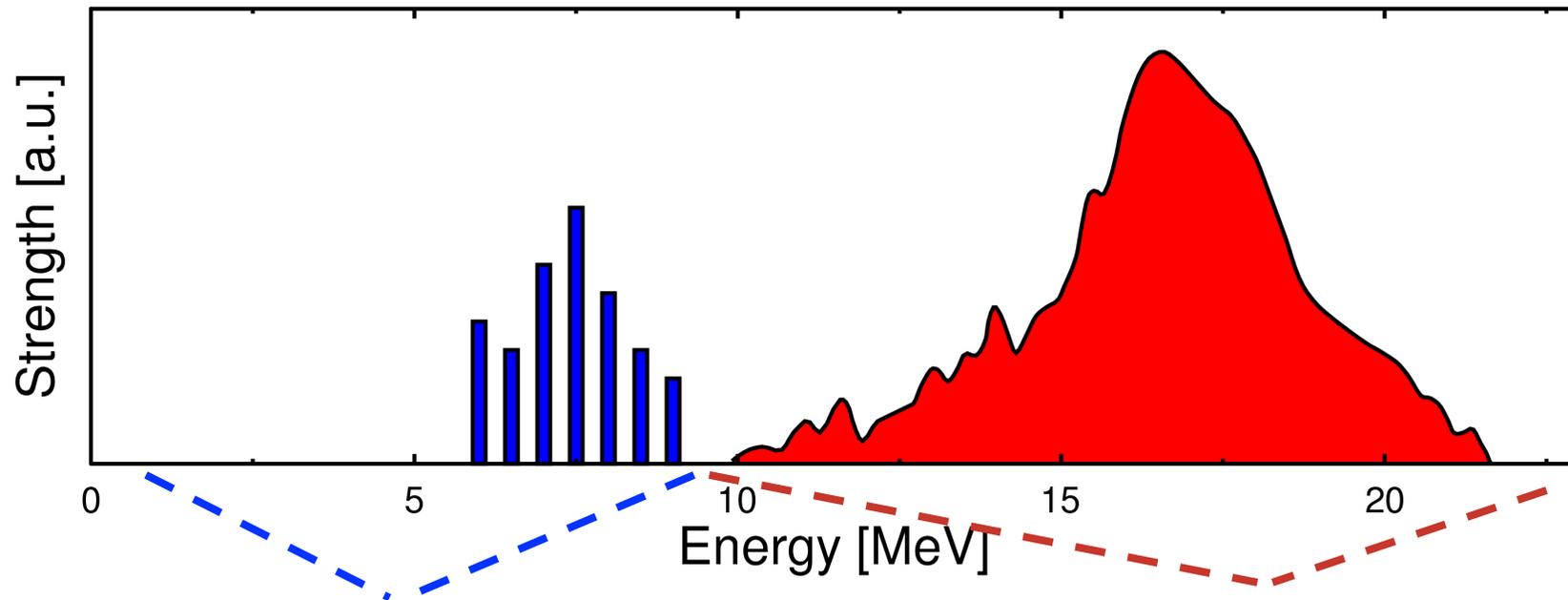


Investigation of the PDR using
→ Systematics
→ Complementary probes

Experiments with real photons



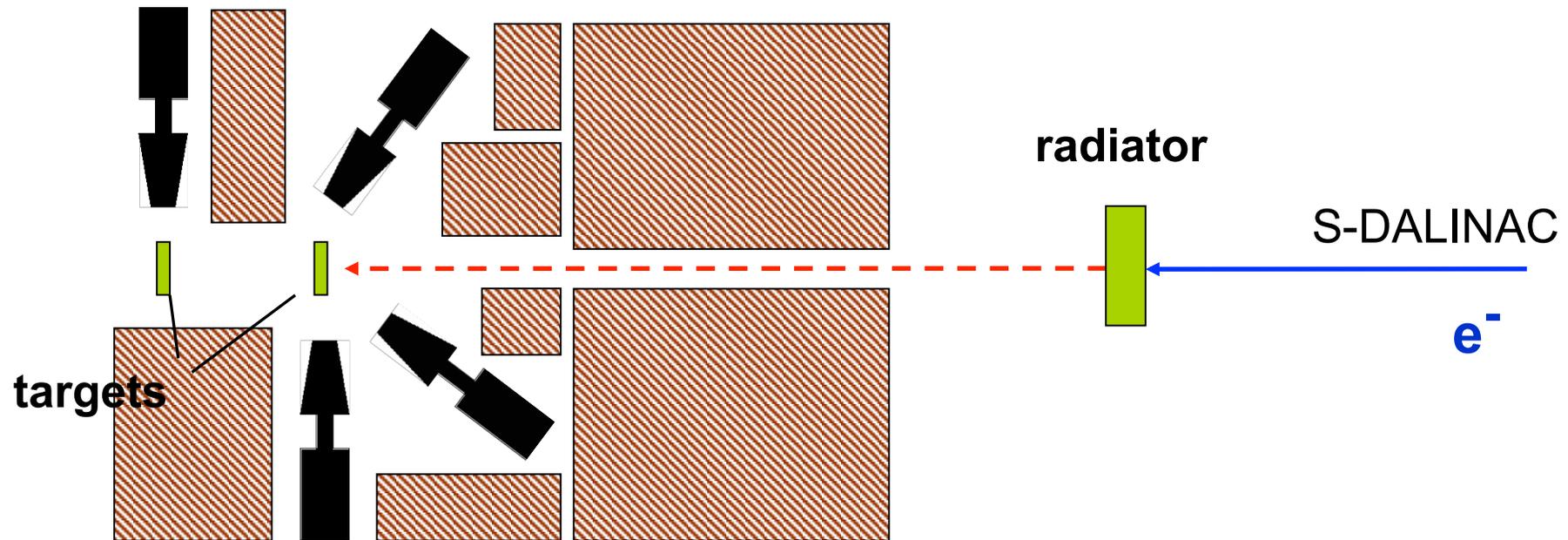
- High selectivity to dipole excitations
- Well-known excitation mechanism



Photon scattering (γ, γ')

**Photodissociation
(γ, n), (γ, p), ...**

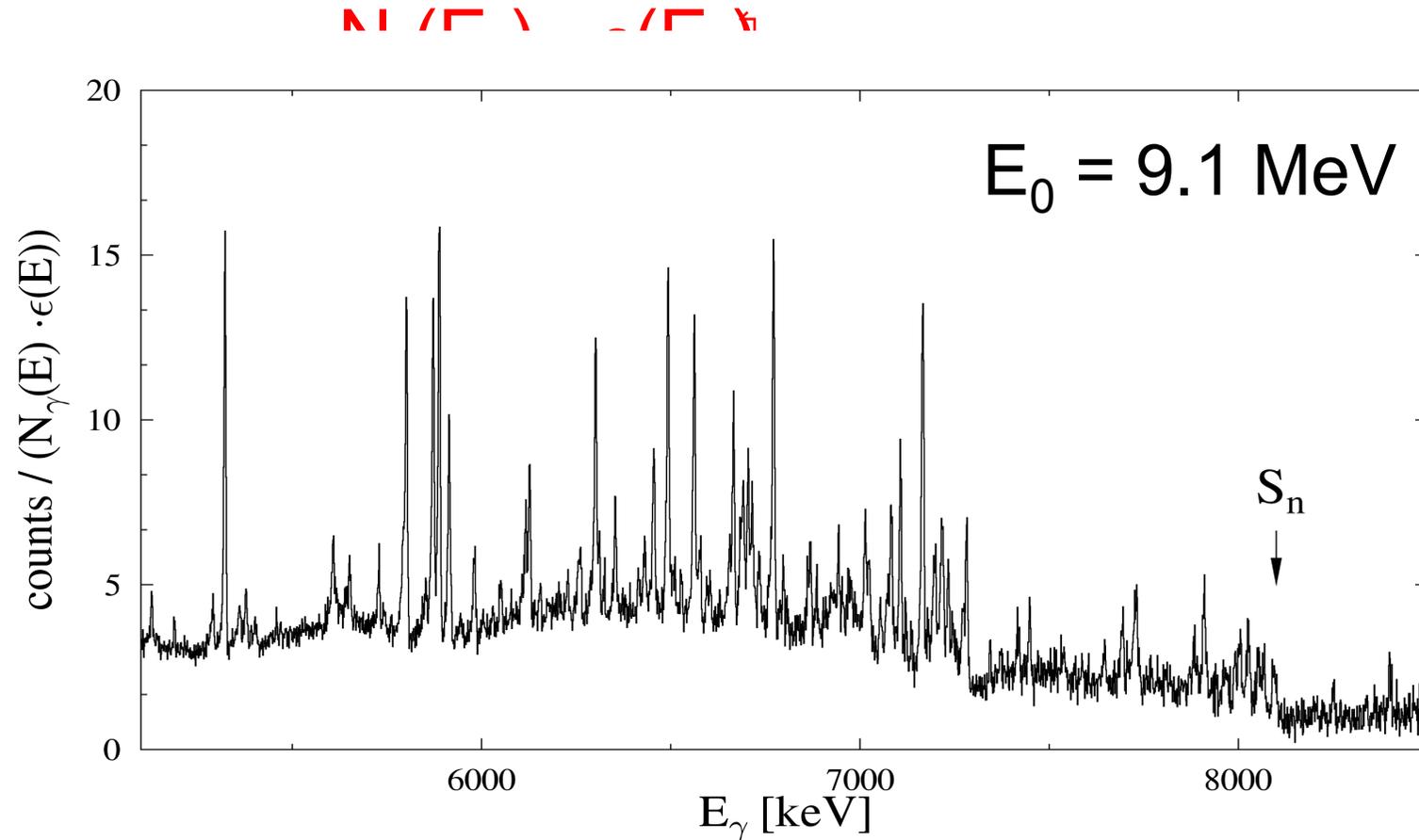
High Intensity Photon Setup (HIPS)



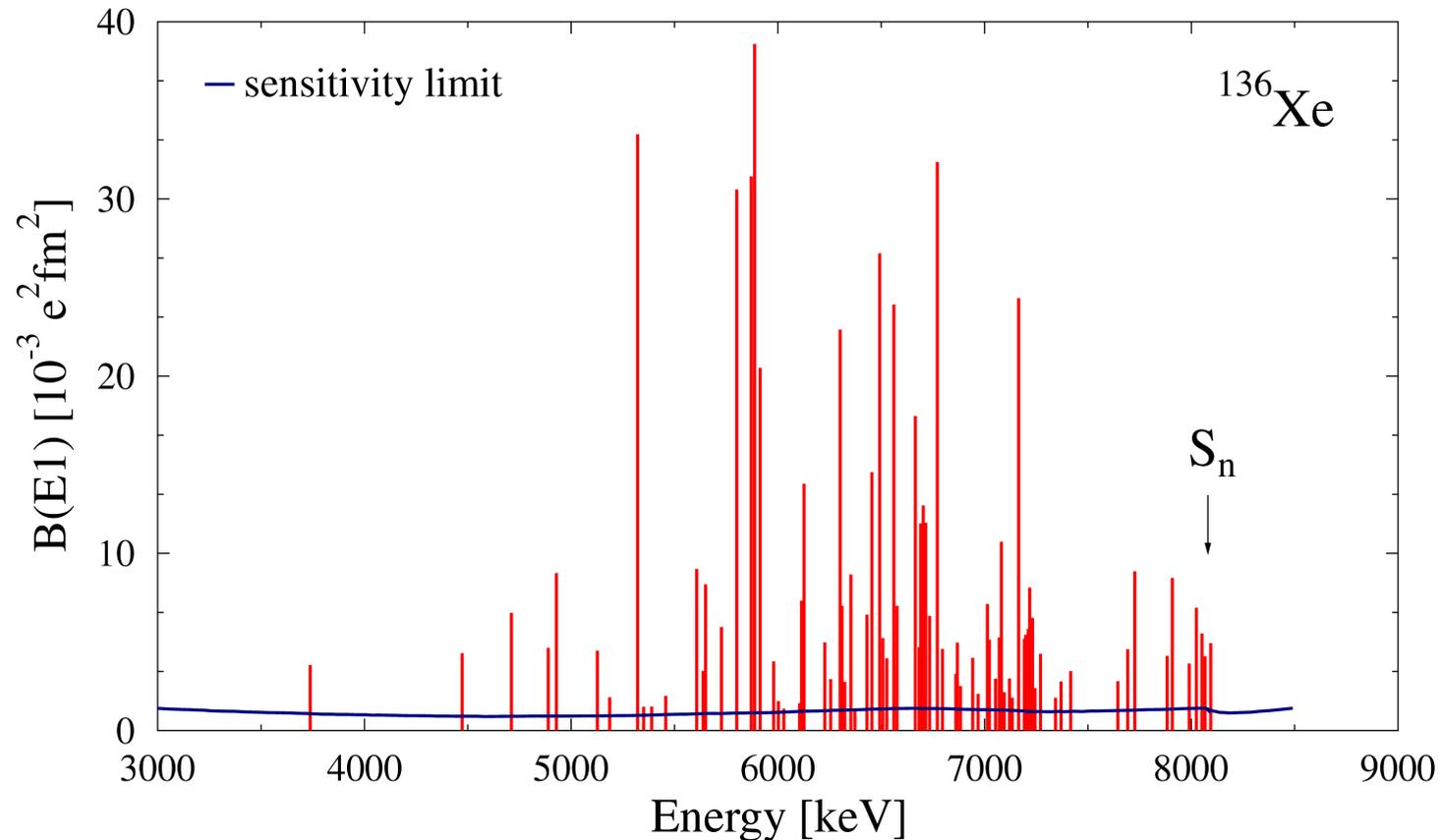
- Production of bremsstrahlung
- Photon energies: up to 10 MeV
- High photon intensity: $10^6 \gamma \text{ s}^{-1} \text{ keV}^{-1} \text{ cm}^{-2}$

K. Sonnabend et al., Nucl. Instr. and Meth. **A640** (2011) 6

$^{136}\text{Xe}(\gamma, \gamma')$

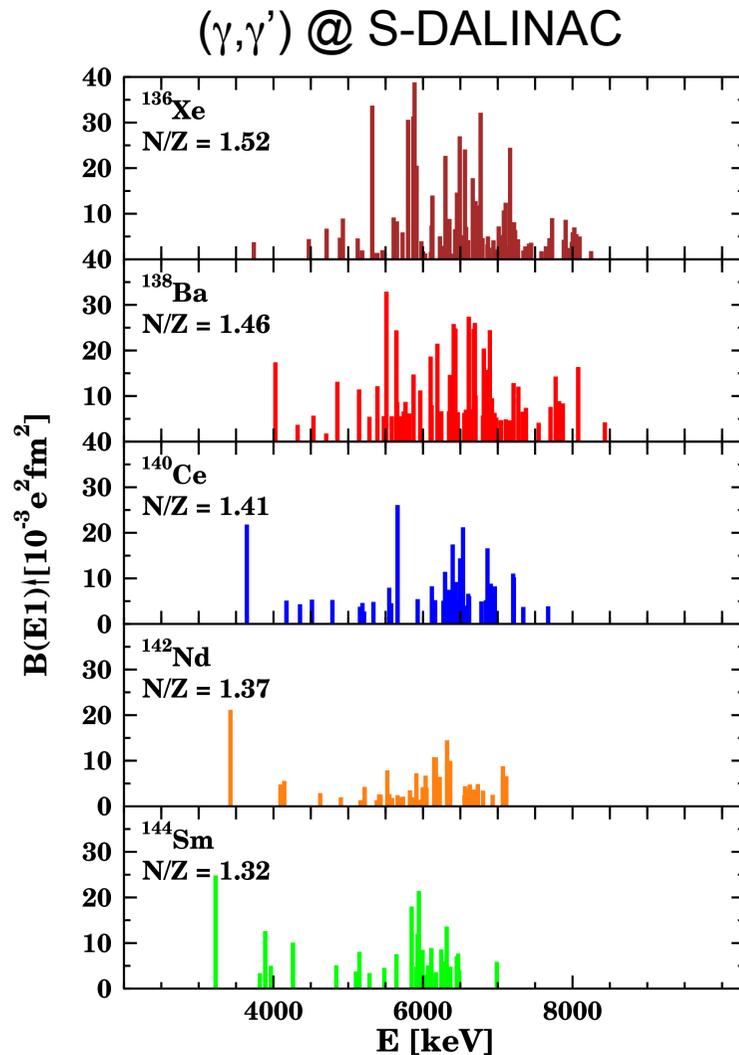


B(E1) strength distribution in ^{136}Xe



- State-to-state analysis: Investigation of fine structure
- Observation of all states with $B(E1) > 3 \times 10^{-3} e^2 \text{fm}^2$

Systematics in stable N=82 isotones

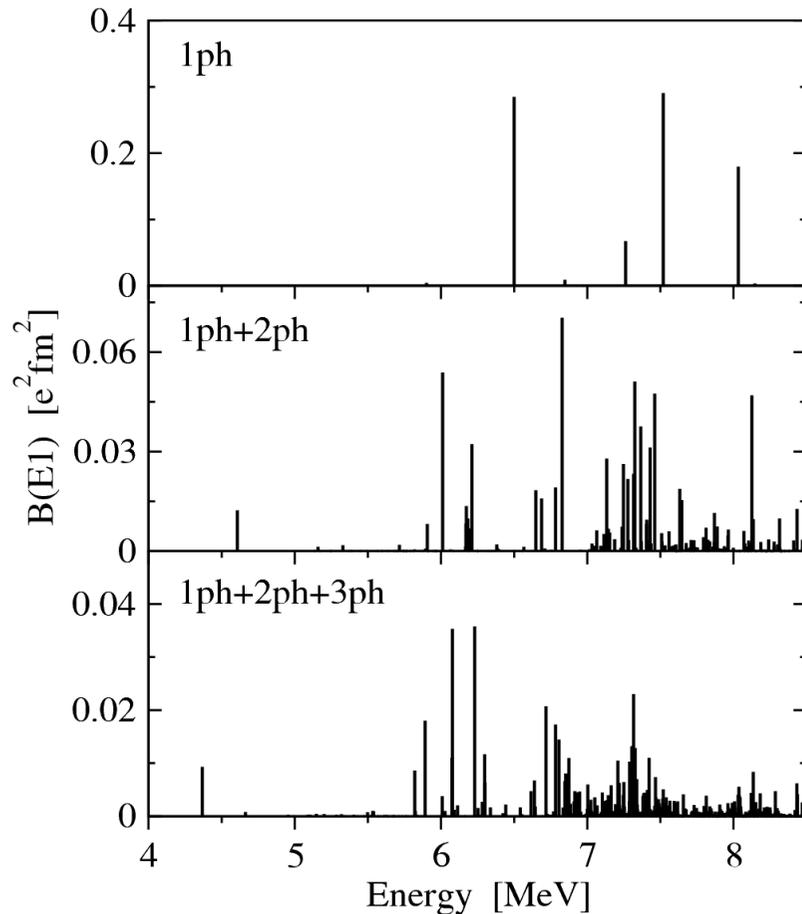


Compare to theory in

- fragmentation
- Integrated strength

A. Zilges et al., Phys. Lett. B **542** (2002) 43
S. Volz et al., Nucl. Phys. **A779** (2006) 1
D. Savran et al., PRL **100** (2008) 232501

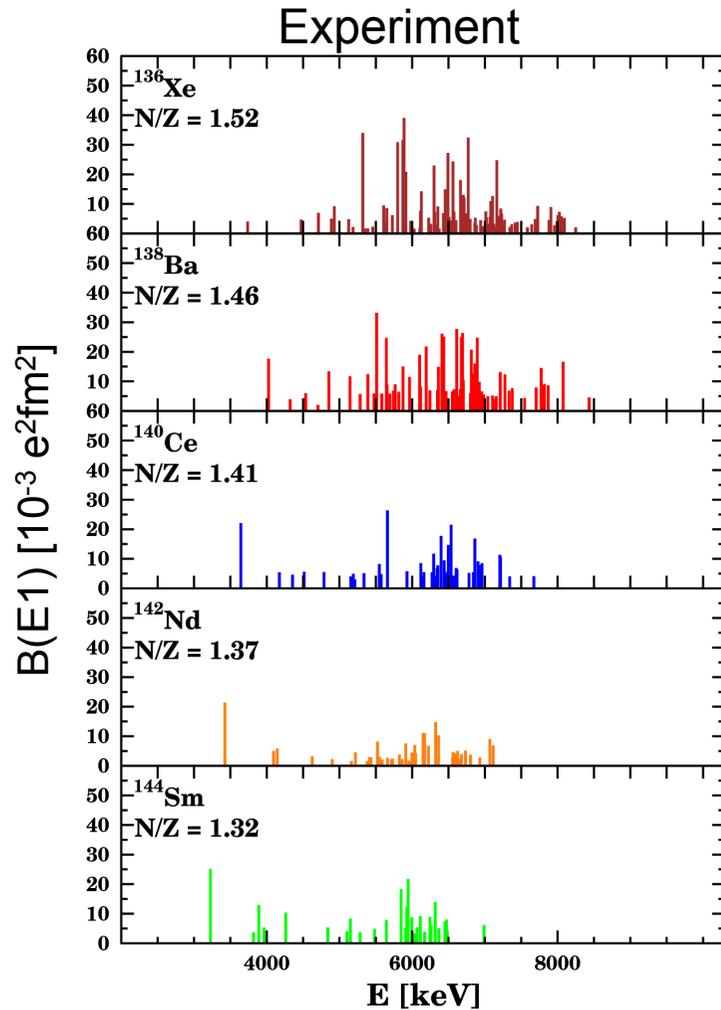
Fragmentation in QPM calculations



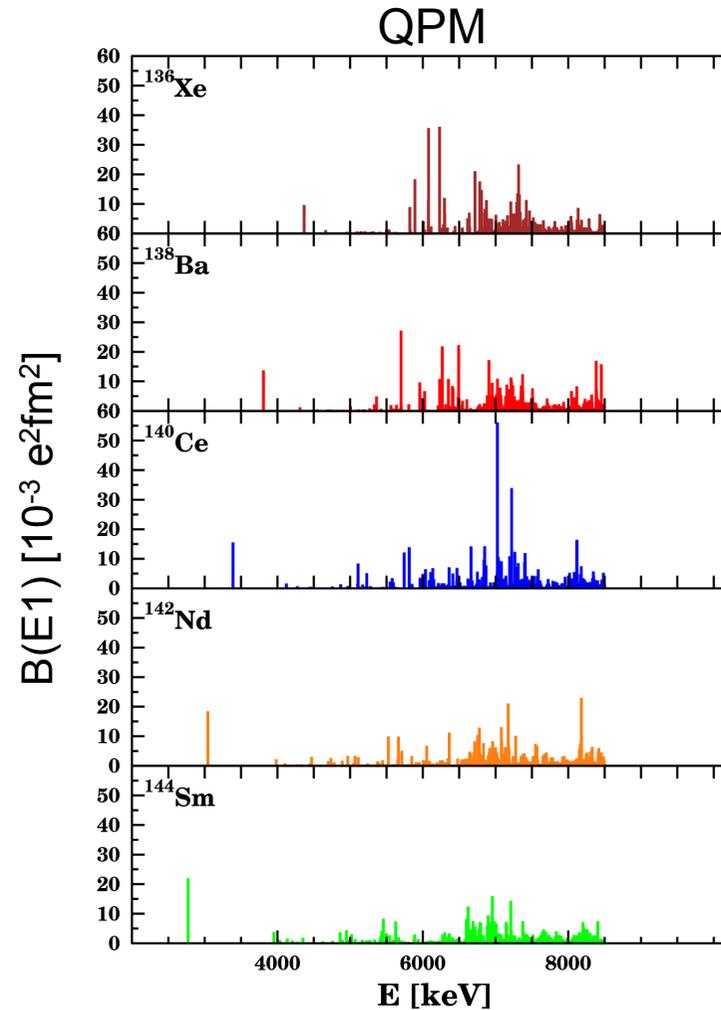
- Coupling to complex configuration produces fragmentation
 - $B(E1)$ nearly completely carried by in 1ph part
 - 1ph, 2ph, 3ph up to 8.5 MeV
 - Lowest 4ph 1^- at 7.2 MeV
- ⇒ Model space nearly complete up to 8.0 MeV

V. Yu. Ponomarev

E1 strength in stable N=82 isotones

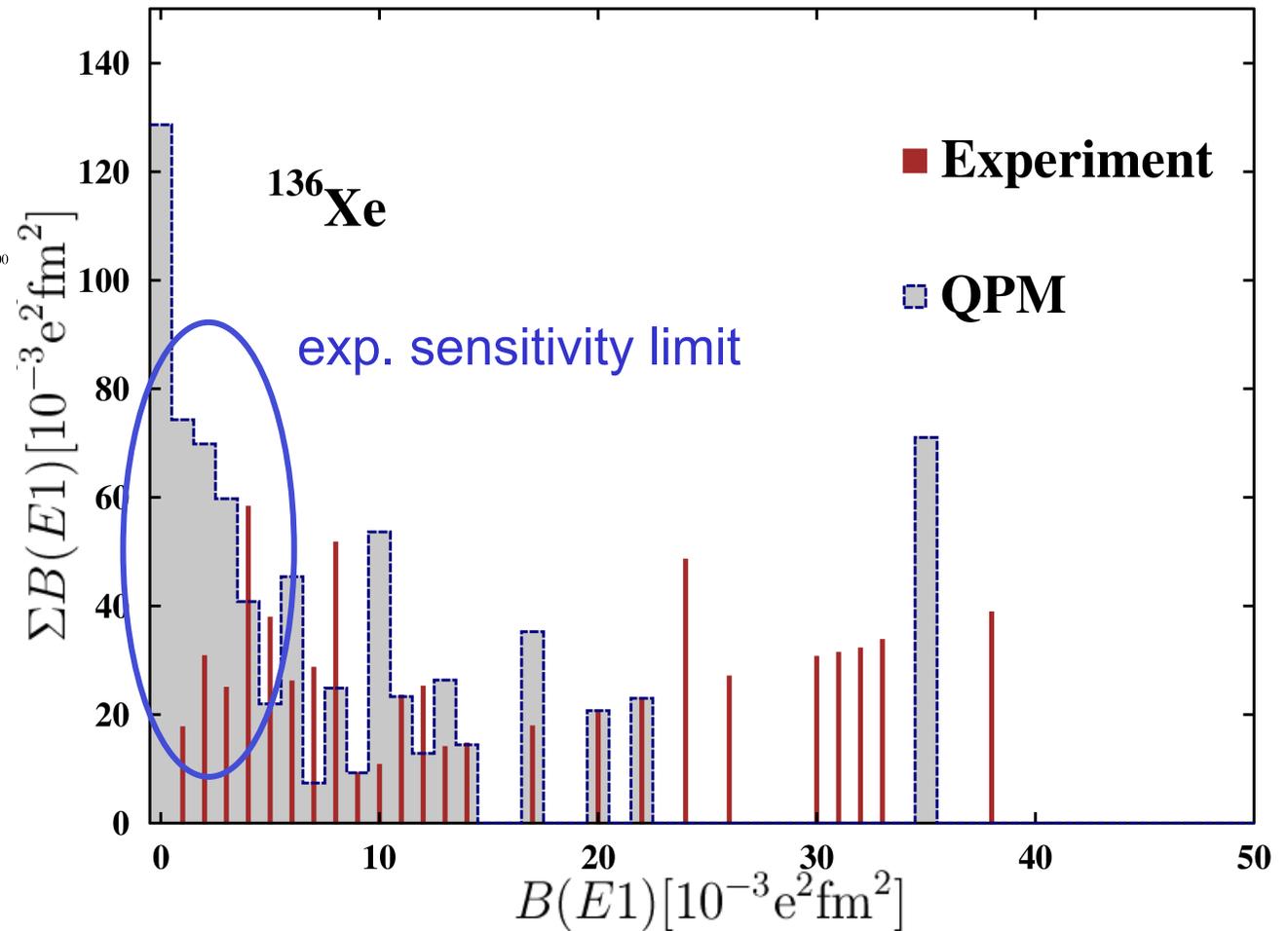
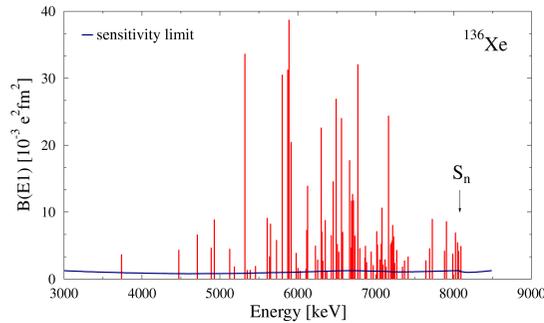


S. Volz et al., Nucl. Phys. **A779** (2006) 1



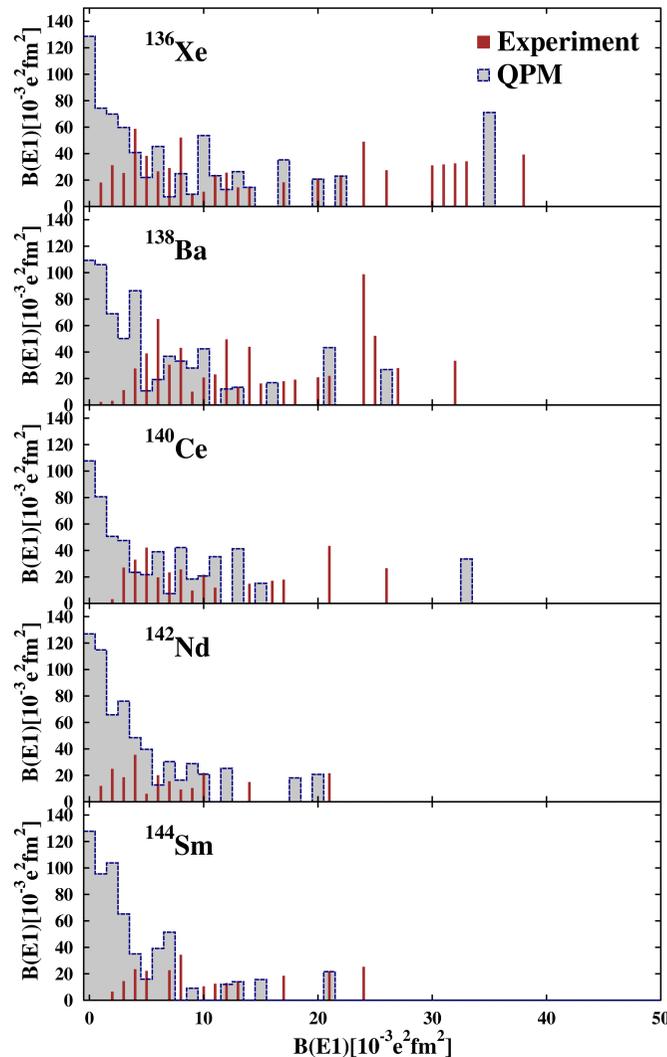
V. Yu. Ponomarev

Fragmentation: Experiment vs. QPM



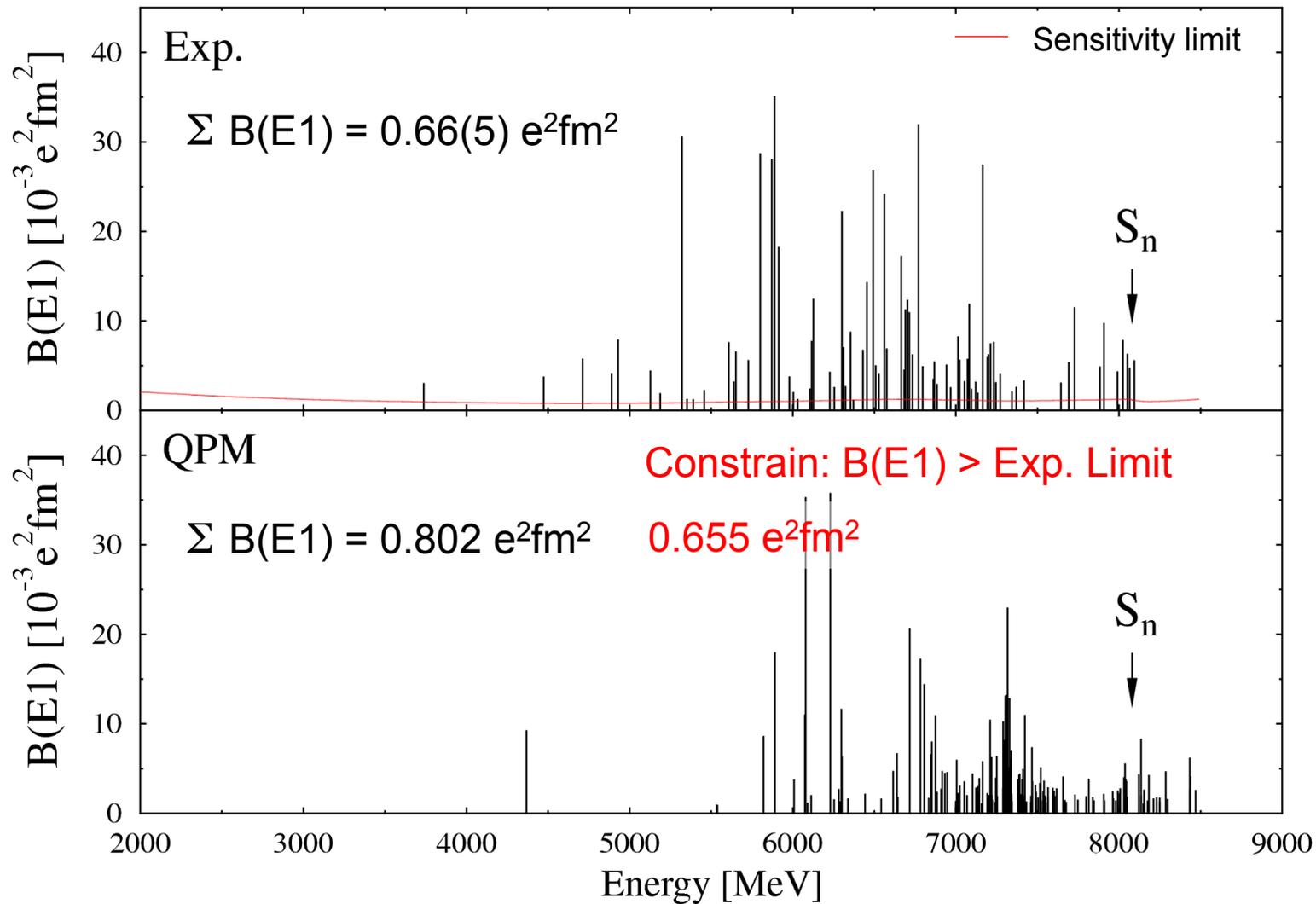
D. Savran et al., PRL **100** (2008) 232501

Fragmentation

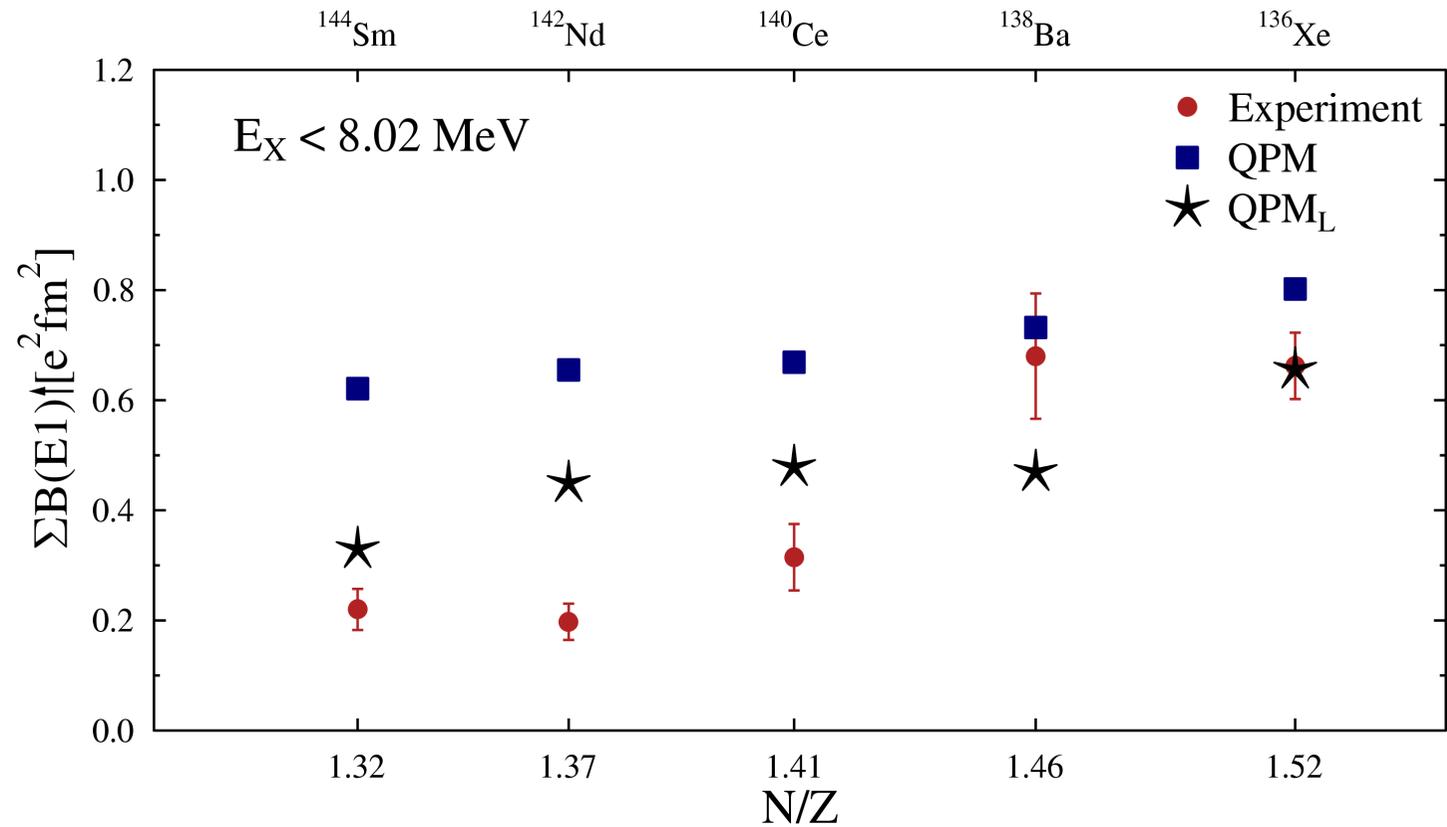
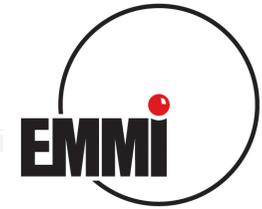


- Increasing fragmentation from ^{136}Xe to ^{144}Sm in experiment and QPM
- Total strength distributed on more weaker states
- Impact of experimental sensitivity limit more important with increasing proton number
- Good agreement of QPM and experiment

B(E1) in QPM und experiment



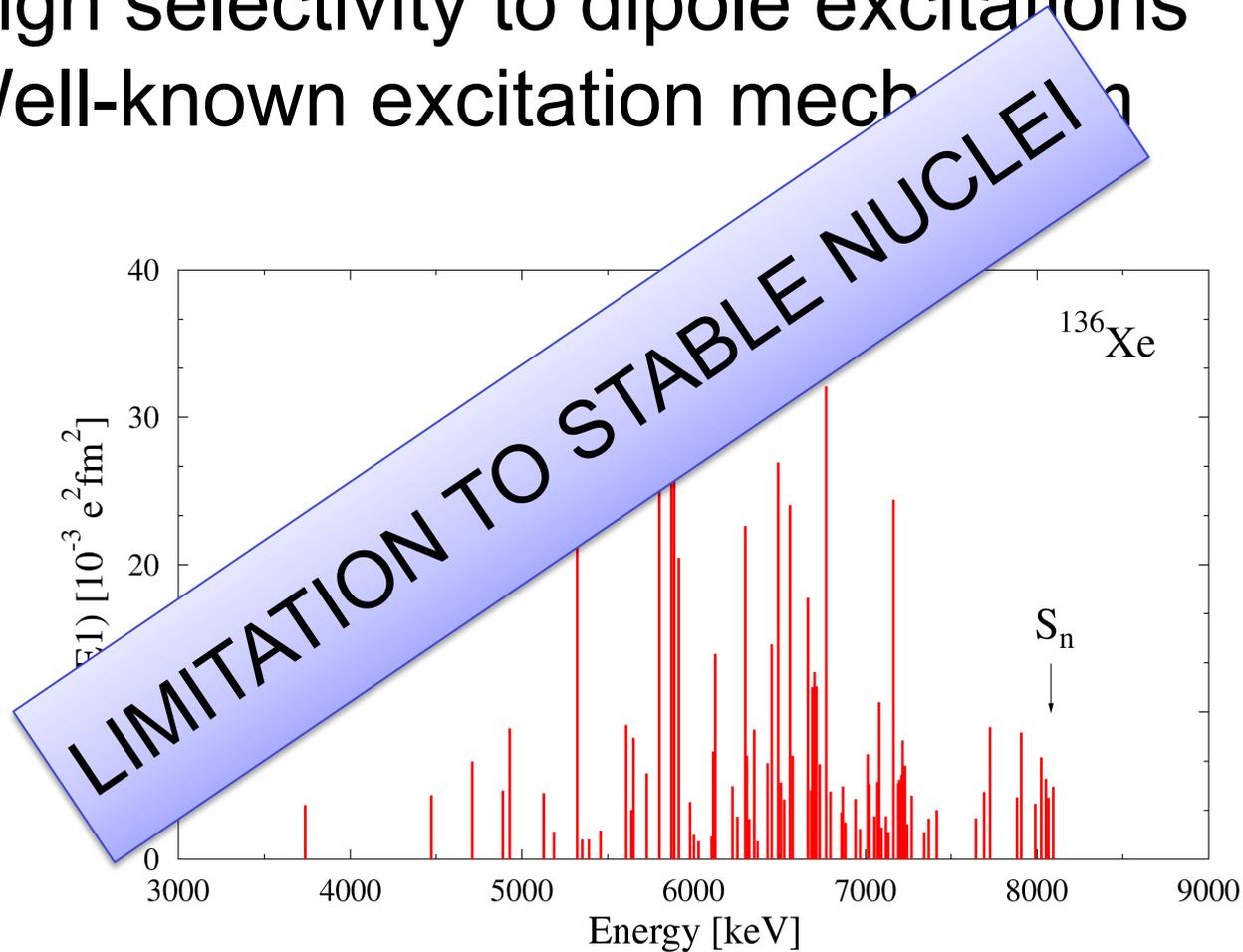
Integrated B(E1) strength



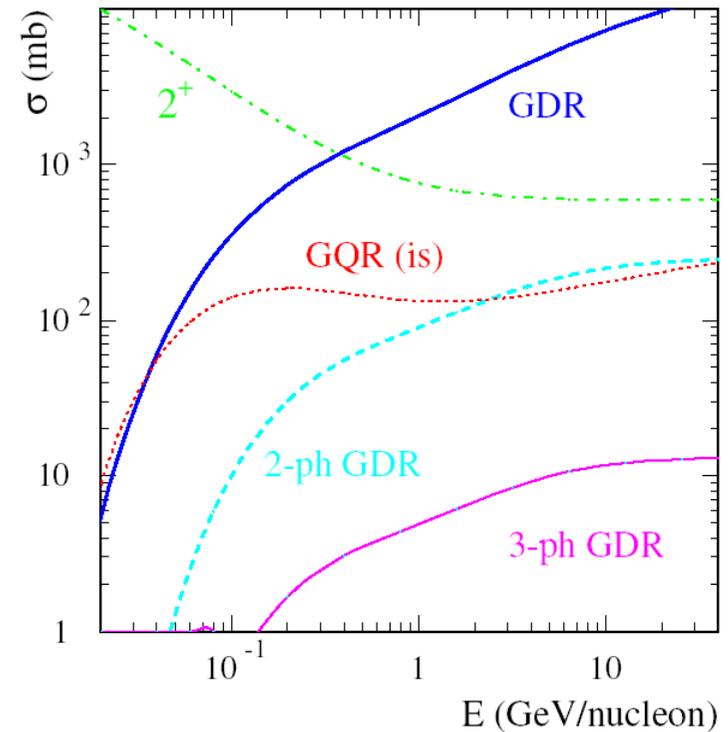
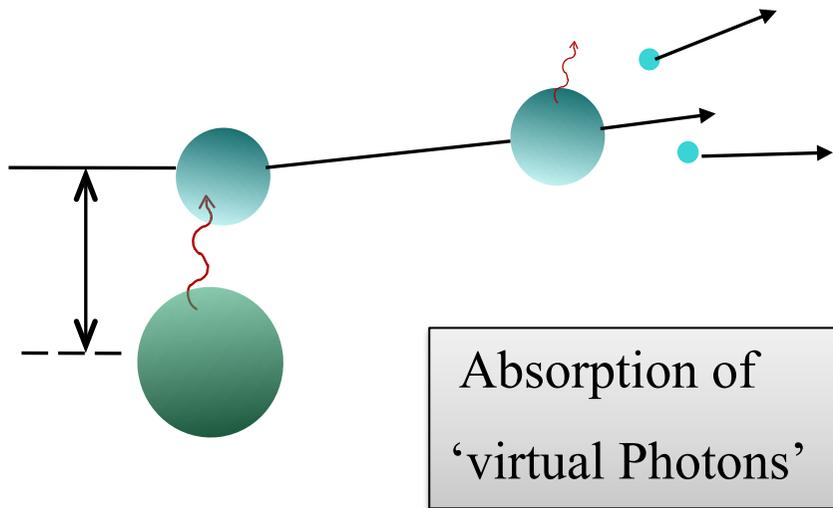
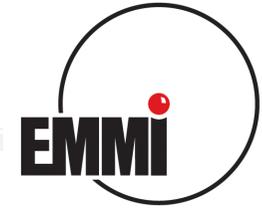
Experiments with ~~real~~ photons



- High selectivity to dipole excitations
- Well-known excitation mechanism



Coulomb excitation in inverse kinematics

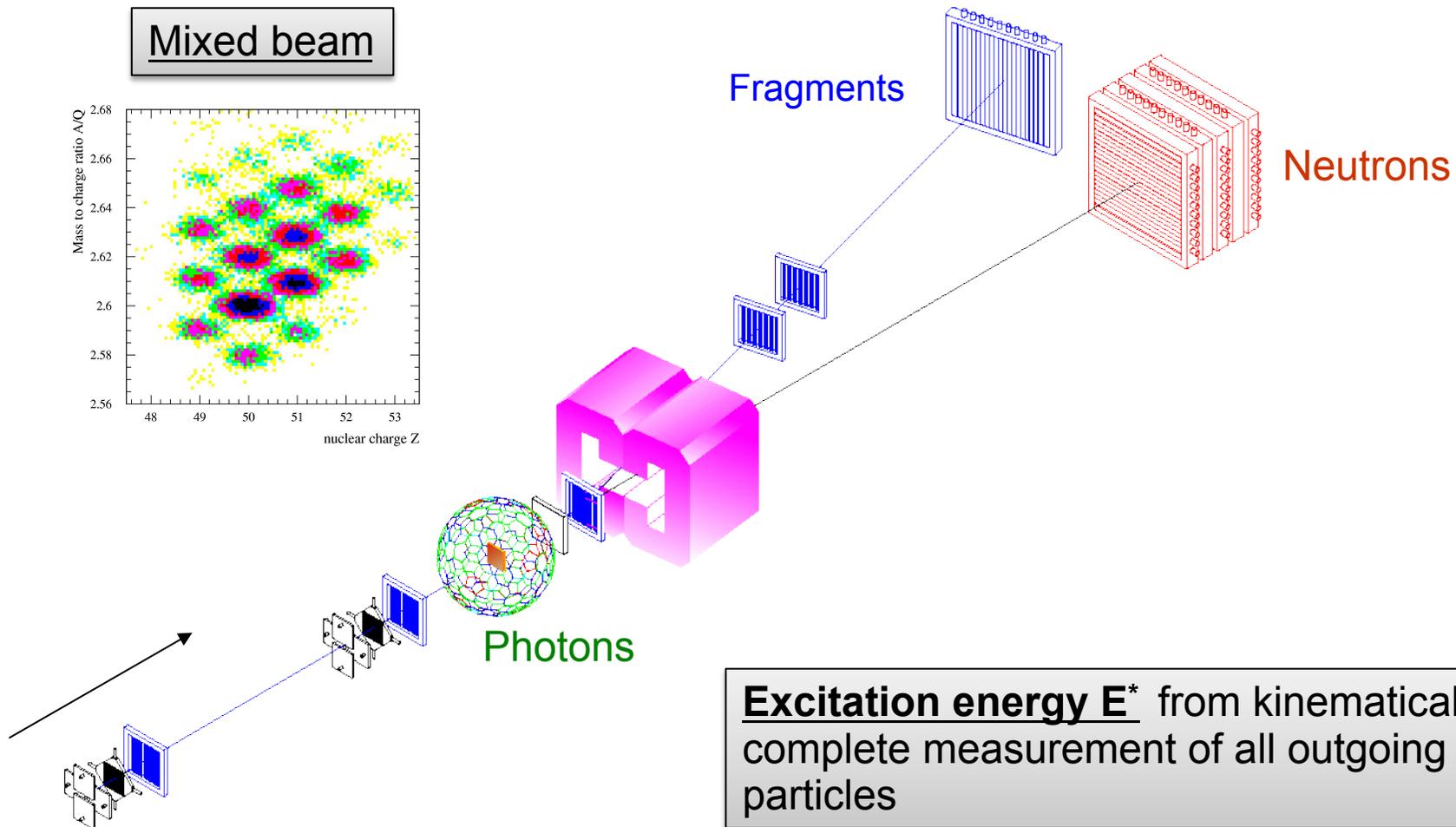
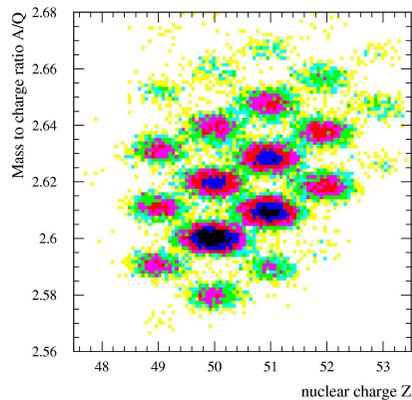


Excitation energy E^* from kinematically complete measurement of all outgoing particles

LAND reaction setup @GSI



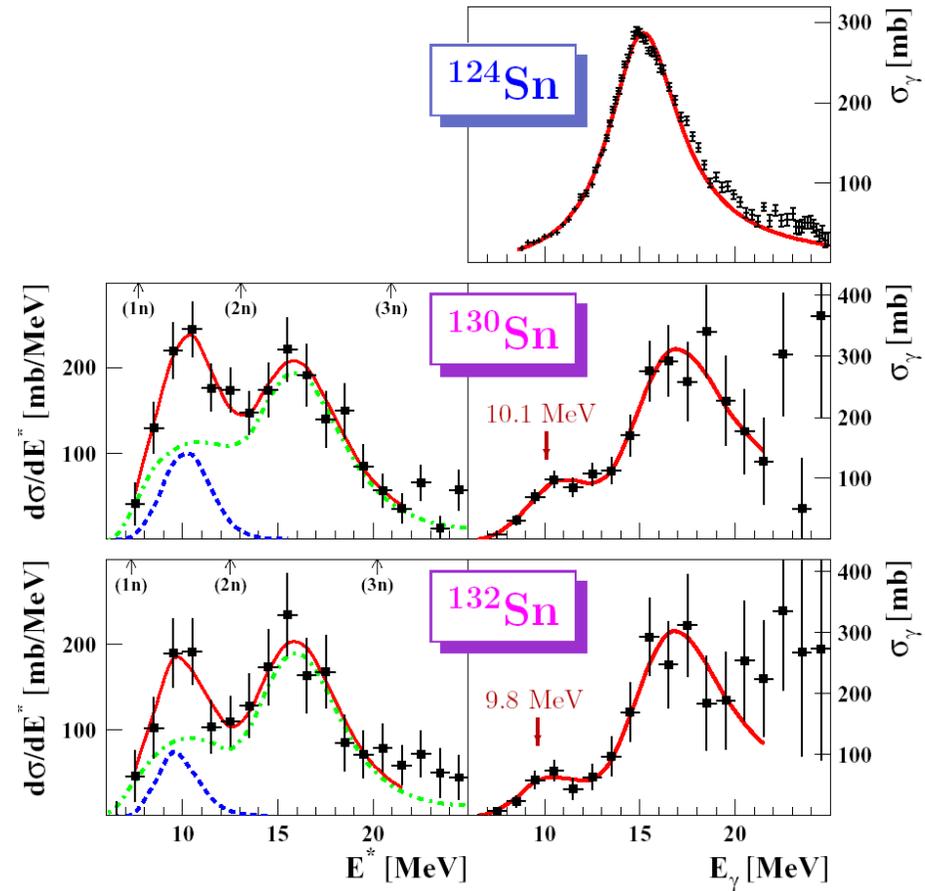
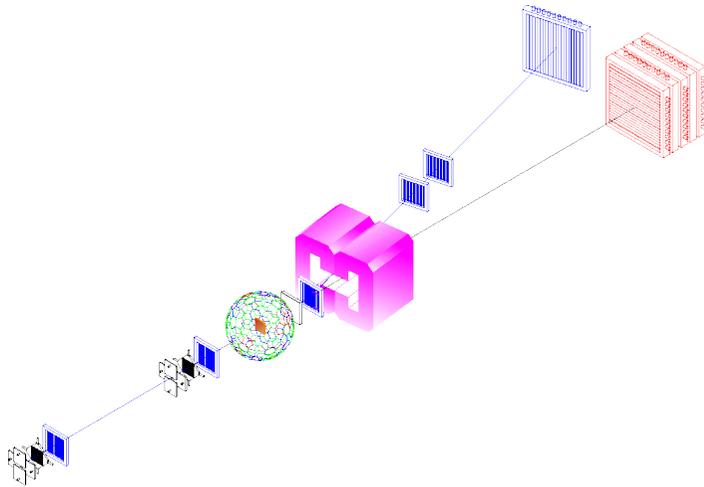
Mixed beam



Excitation energy E^* from kinematically complete measurement of all outgoing particles

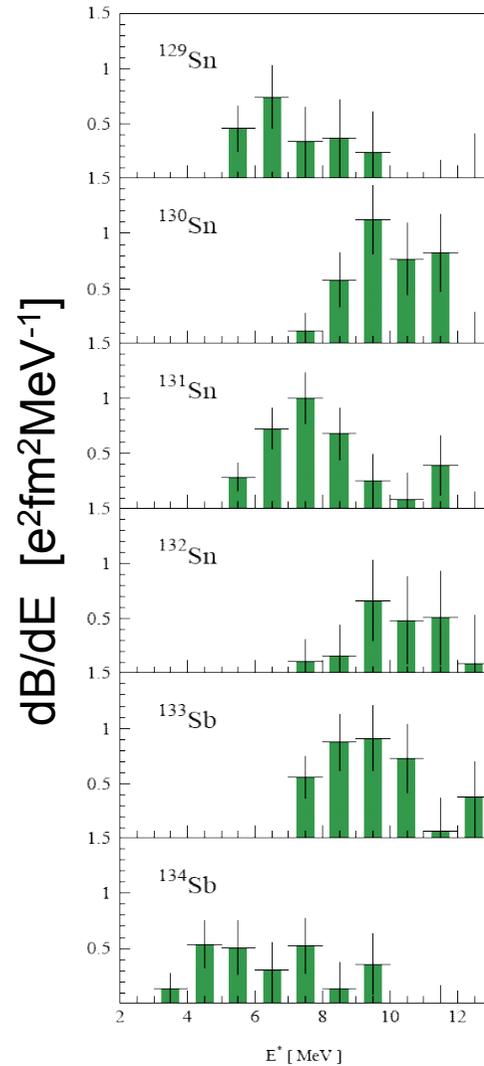
T. Aumann, Eur. Phys. Journal A **26** (2005) 441

PDR in ^{130}Sn and ^{132}Sn

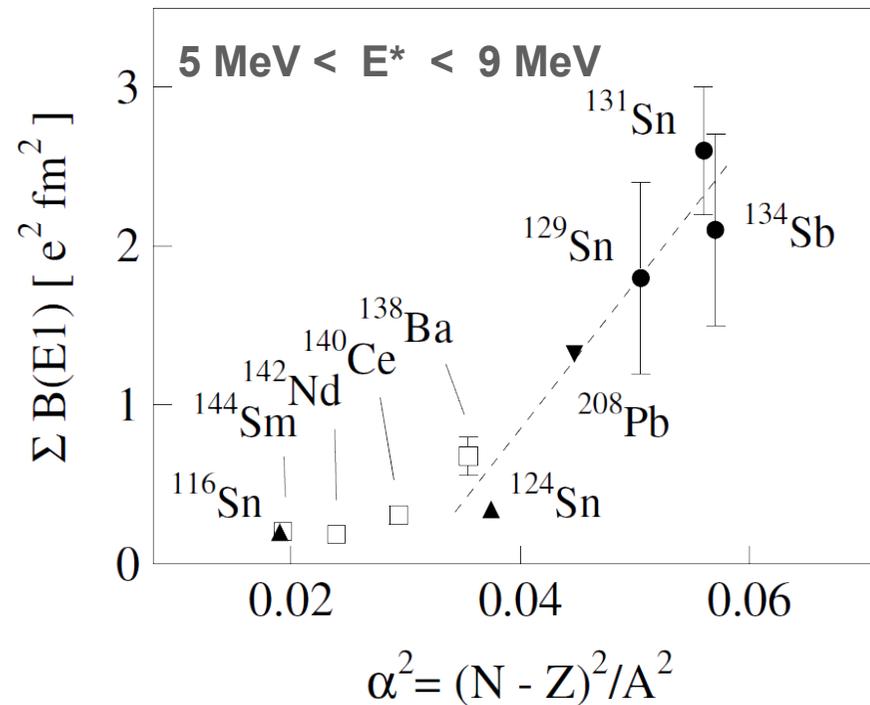


P. Adrich et al., PRL 95 (2005) 132501

Systematics of the PDR



A. Klimkiewicz et al., PRC 76 (2007) 051603(R)

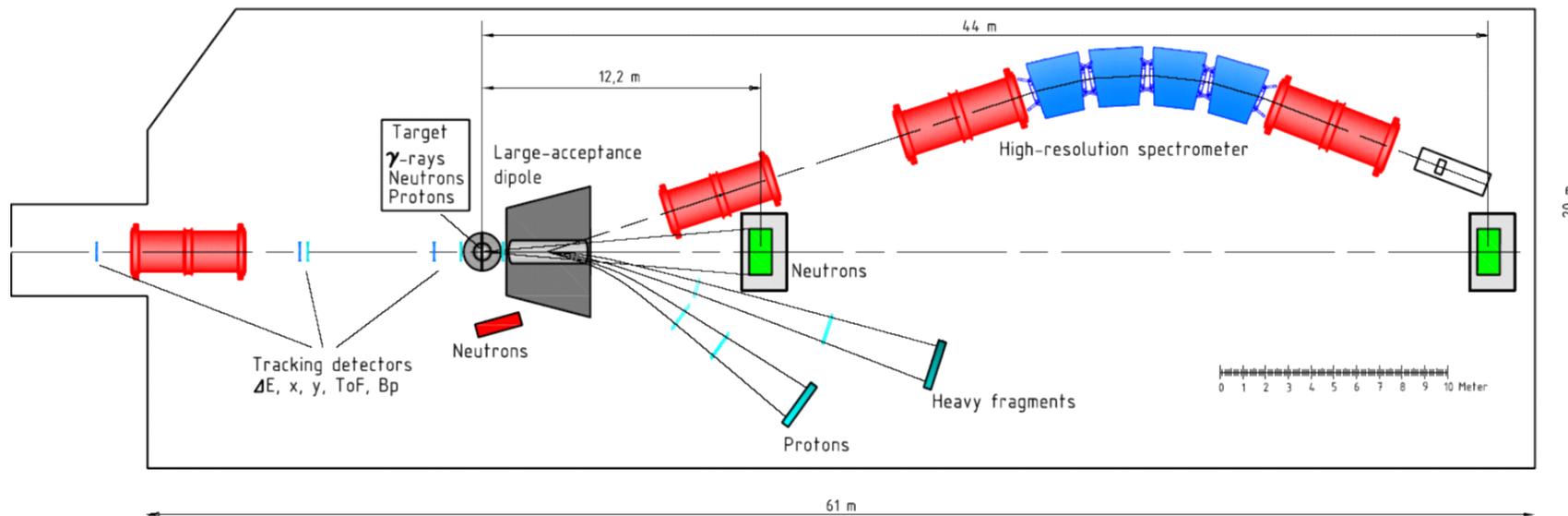


Different experimental limitations
⇒ consistent sets of data important

R³B setup at GSI/FAIR

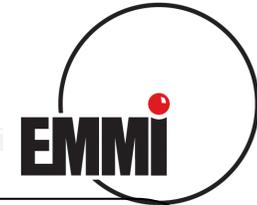


(Reactions with Relativistic Radioactive Beams)

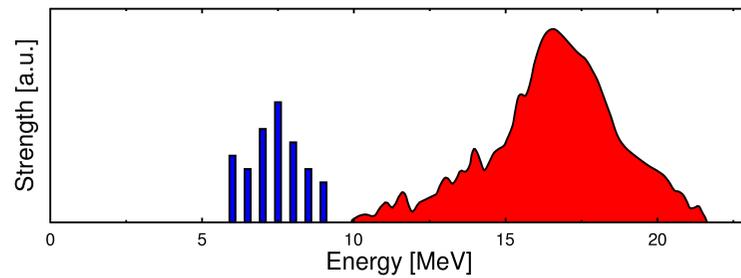


- Kinematically complete measurements of reactions with high-energetic secondary beams
- Detection of all decay channels

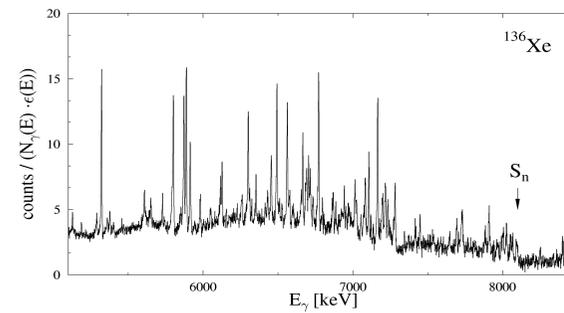
Summary



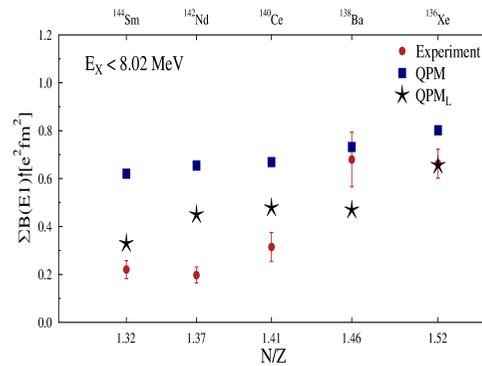
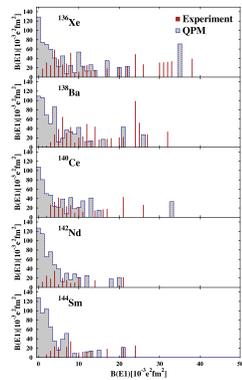
Photon induced reactions as experimental approach



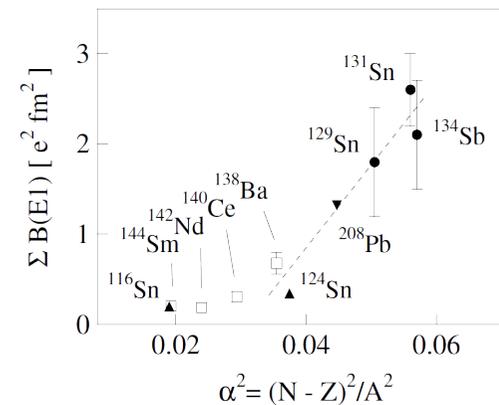
High resolution NRF experiments



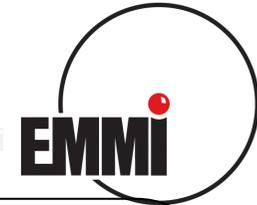
Fragmentation of E1 strength



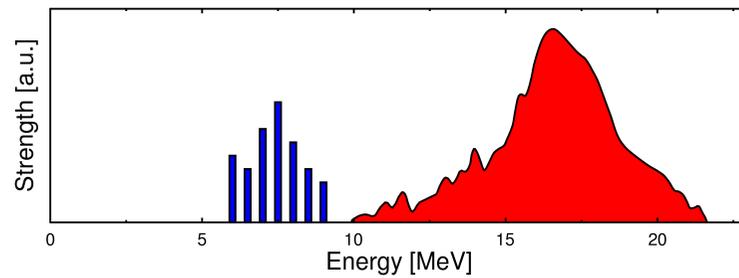
Systematics of E1 strength



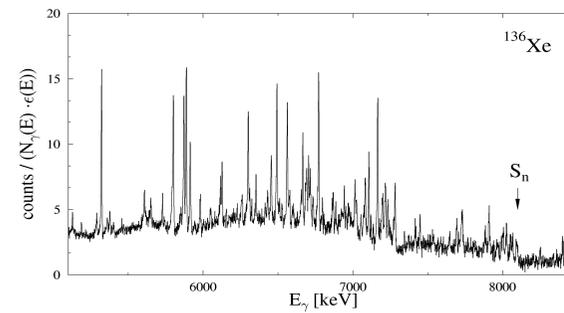
Summary



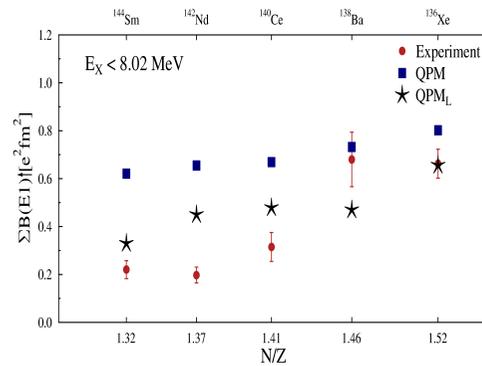
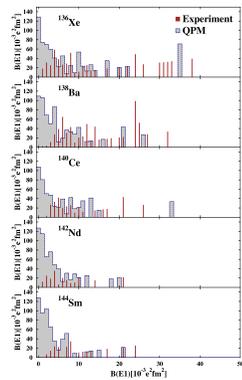
Photon induced reactions as experimental approach



High resolution NRF experiments



Fragmentation of E1 strength



Systematics of E1 strength

