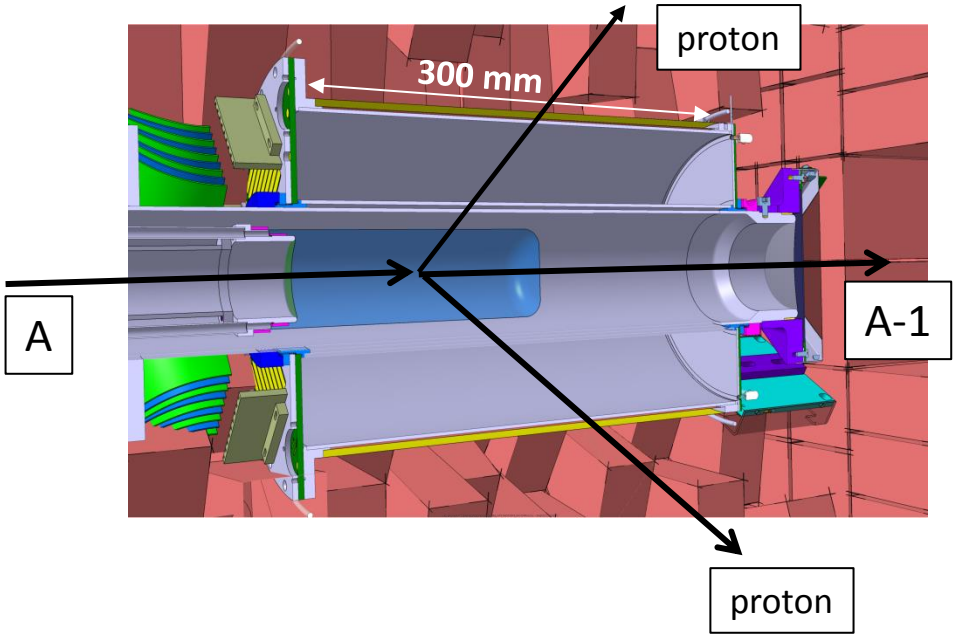
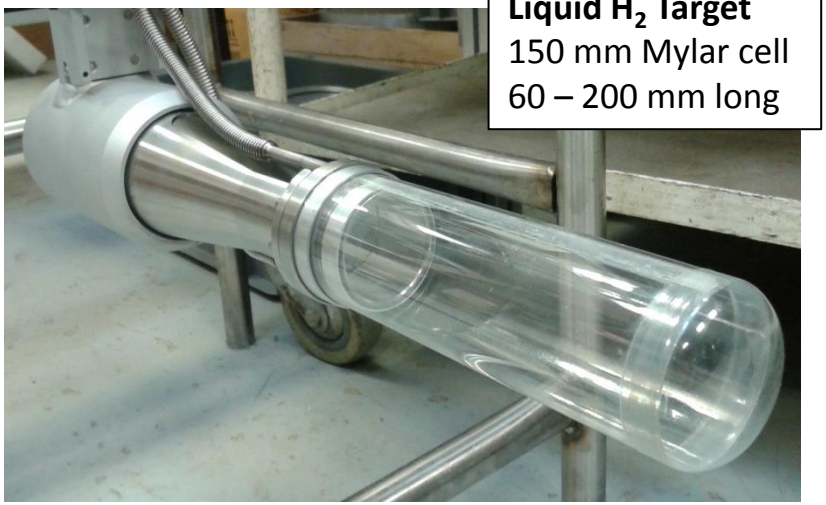
Physics program with MINOS at the RIBF

MINOS @ RIBF : what and why

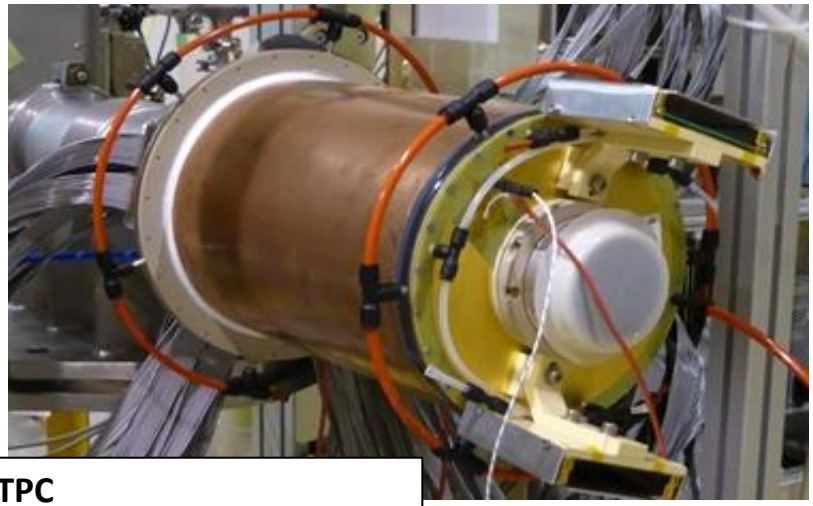
- liquid hydrogen target and vertex tracker
- ready to use from 2014

- Dedicated to **Exotic Nuclei** Studies
  at the RIKEN Radioactive Isotope Beam Facility
  at energies of ~250 MeV/nucleon





Liquid H_2 Target
150 mm Mylar cell
60 – 200 mm long



TPC
85% efficiency
5 mm FWHM resolution

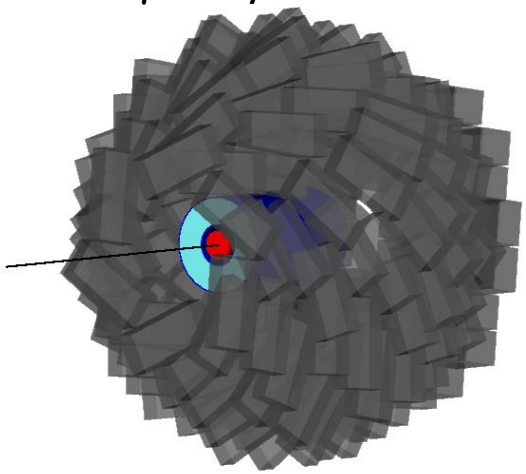
A. Obertelli *et al.,* Eur. Phys. J. A **8**, 50 (2014)
http://minos.cea.fr

MINOS : improves luminosity AND resolution

- Higher luminosity (factor > 5)
- better energy resolution (in-beam γ: limitation is γ detector)
- (semi) exclusive *(p,2p)* or *(p,pn):* "cleaner" probe

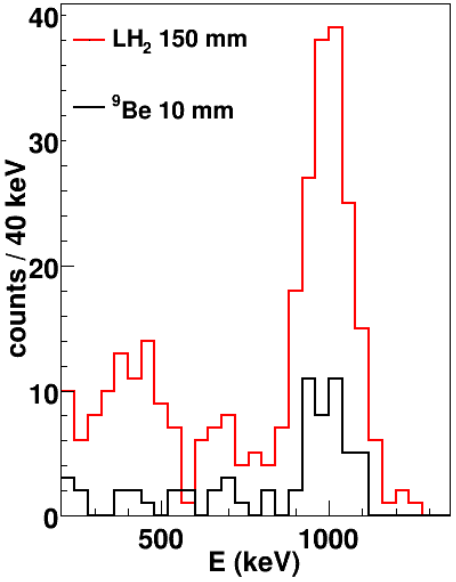
Doppler correction $$E = E_\gamma \frac{(1 - \beta \cos\theta)}{\sqrt{1 - \beta^2}}$$

DALI2 γ array



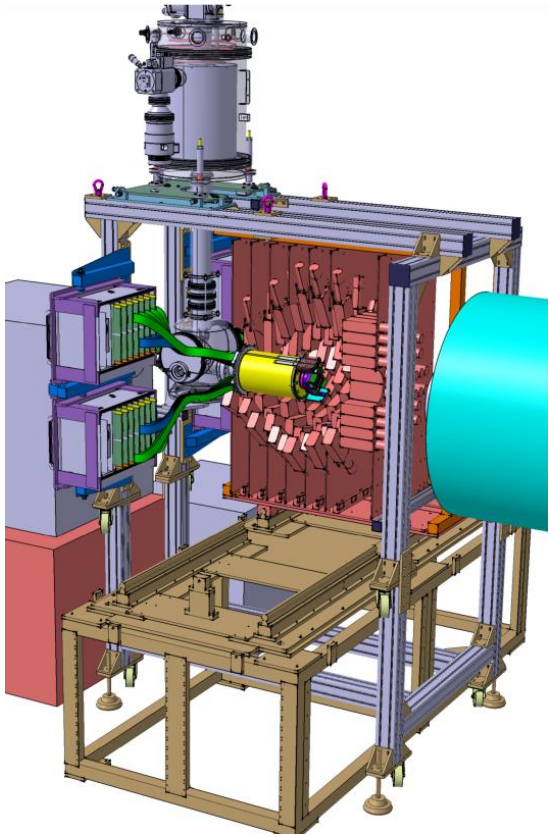
Geant4 simulation

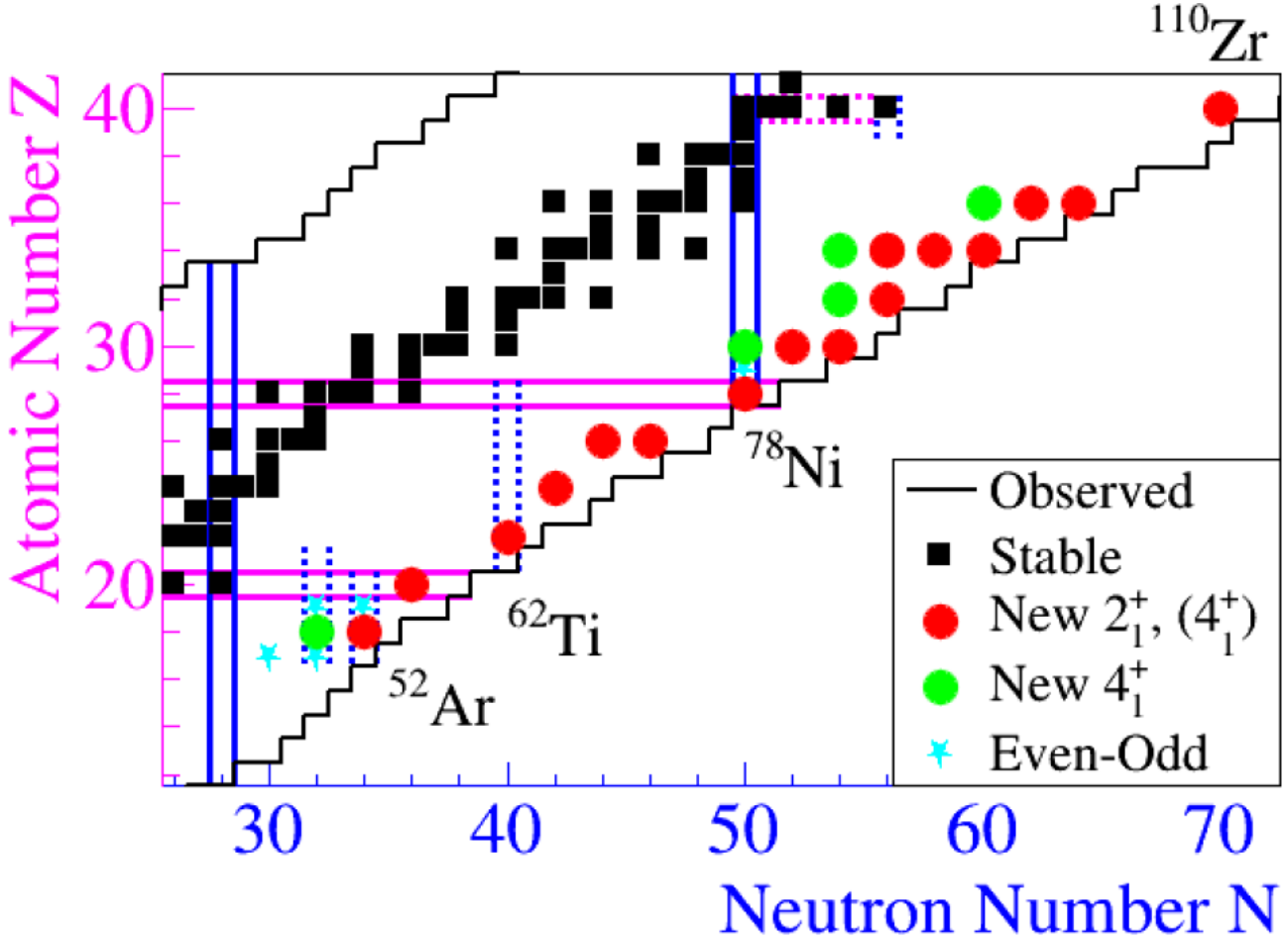
^{53}K(p,2p)^{52}Ar @ 250 MeV/nucleon



Shell Evolution and Search for Two-plus Energies At the RIBF (SEASTAR)

Spokesperson: P. Doornenbal (RIKEN), A. Obertelli (CEA)





http://www.nishina.riken.jp/collaboration/SUNFLOWER/experiment/seastar/index.html

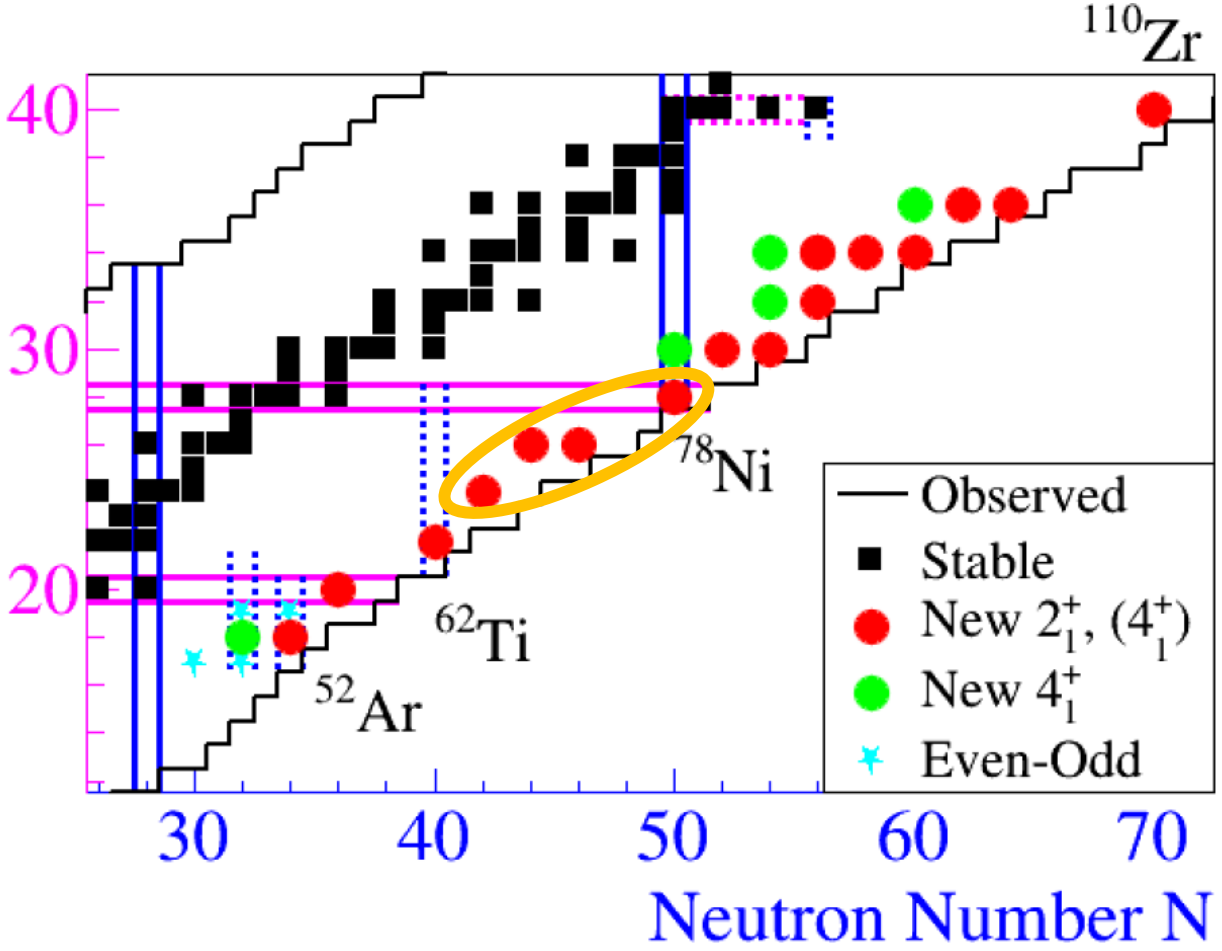
Shell Evolution and Search for Two-plus Energies At the RIBF (SEASTAR)

Spokesperson: P. Doornenbal (RIKEN), A. Obertelli (CEA, RIKEN)

Spring 2014:

- Spectroscopy of ^{66}Cr
- Spectroscopy of ^{70,72}Fe
- Spectroscopy of ^{78}Ni

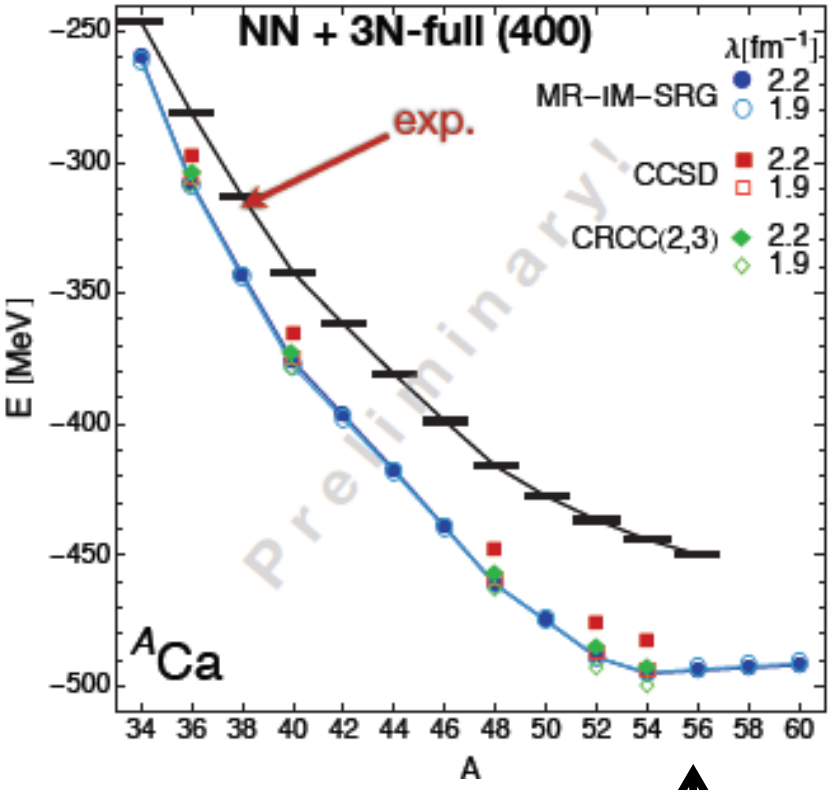
^{238}U primary beam at 10 pnA
10 days of beam time

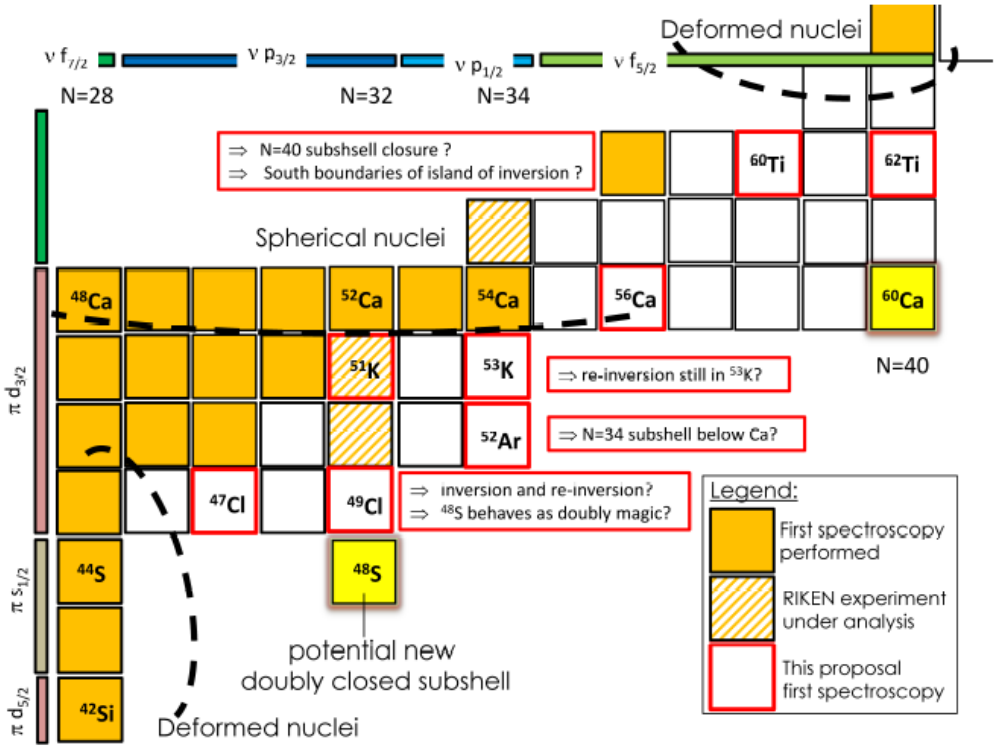


http://www.nishina.riken.jp/collaboration/SUNFLOWER/experiment/seastar/index.html

SEASTAR in 2015 (tentative)

Image from H. Hergert (ESNT, 2014)





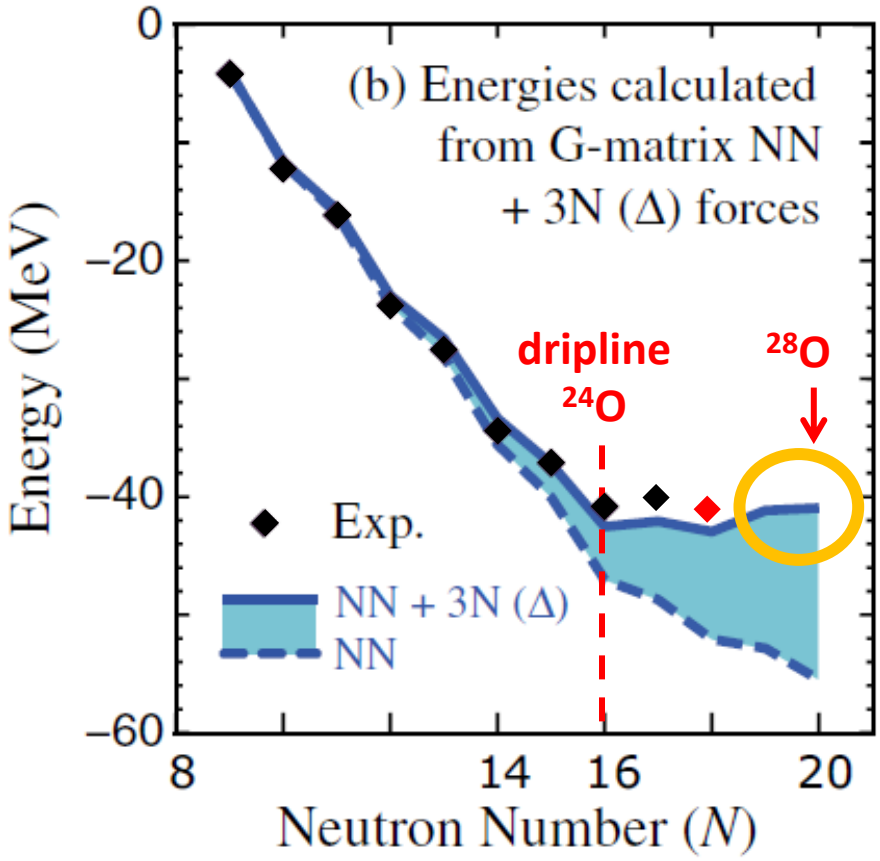
Spectroscopy of ^{55,56}**Ca**
Spectroscopy of ^{62}**Ti**

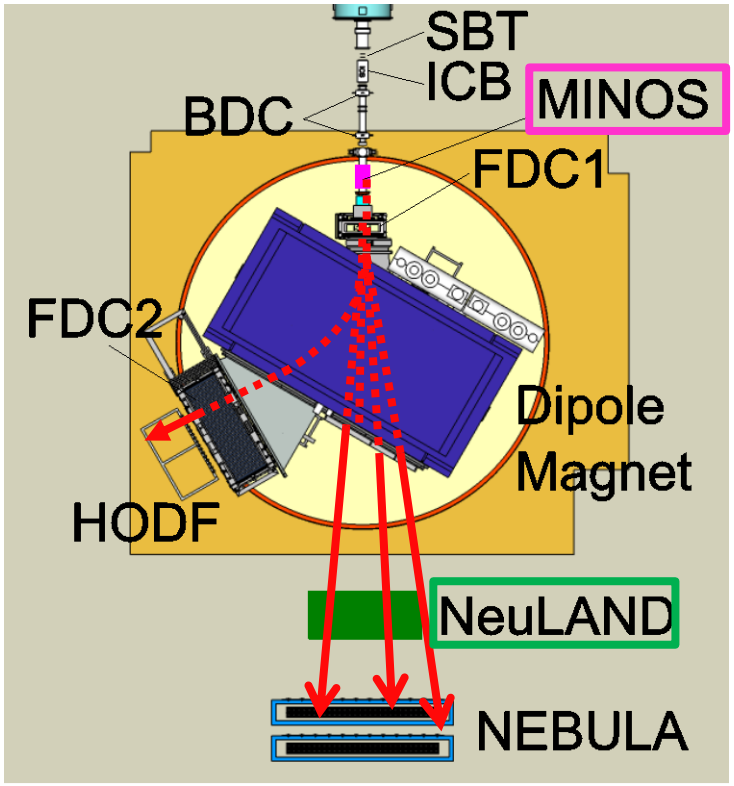
Spectroscopy of ^{52}**Ar**
and neutron-rich K, Cl isotopes

Spectroscopy of unbound Oxygen isotopes

Spokesperson: Y. Kondo, Tokyo Institute of Technology
graded S by the 13th RIBF NP-PAC

$^{29}F(p,2p)^{28}O \rightarrow {}^{24}O + 4n$

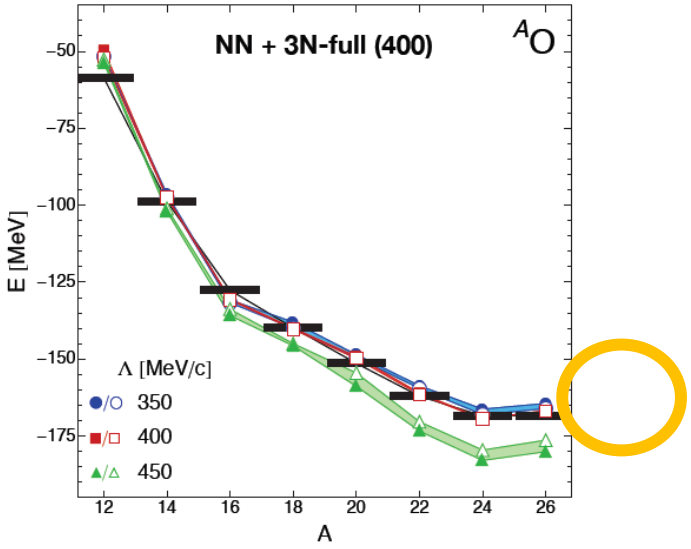




Invariant mass measurement

Spectroscopy of unbound Oxygen isotopes

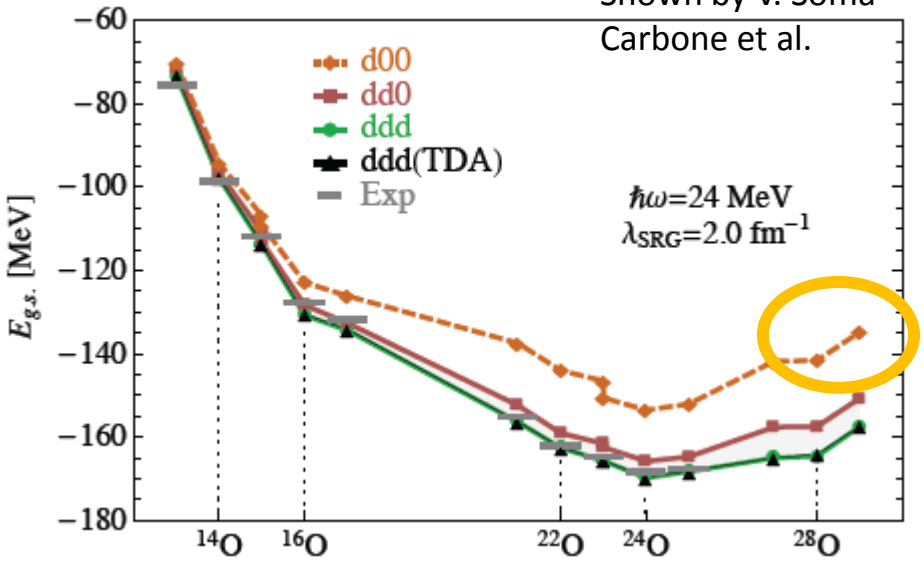
H. Hergert et al.

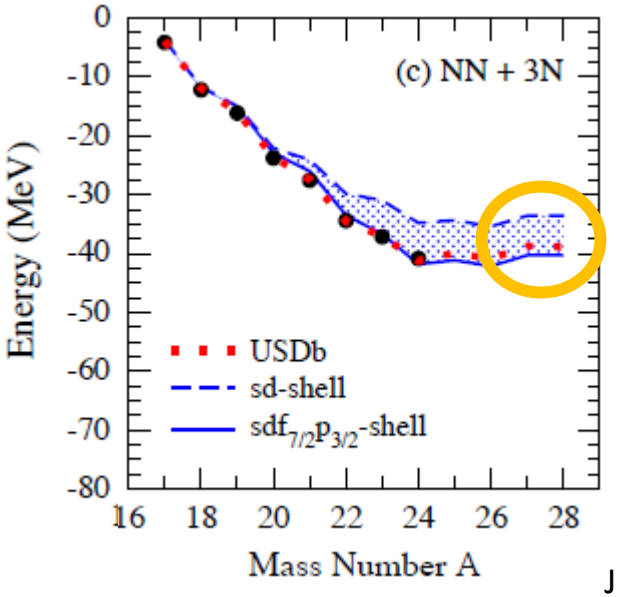


Phys. Rev. Lett. **110**, 242501 (2013)

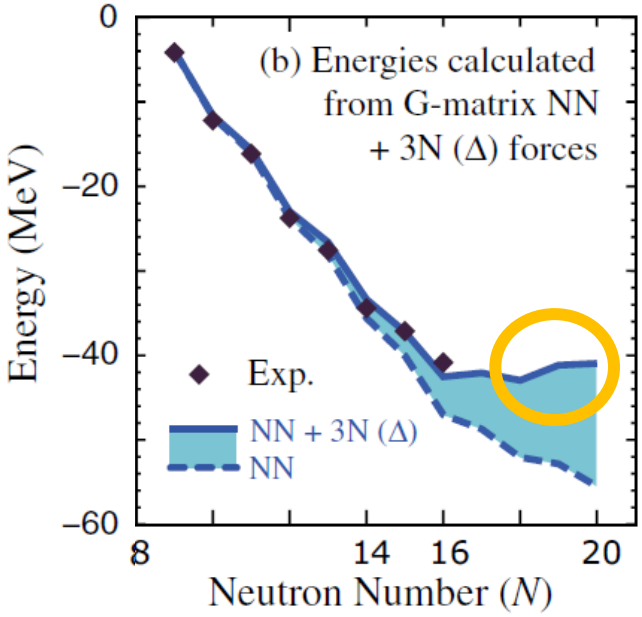
Shown by V. Soma

Carbone et al.





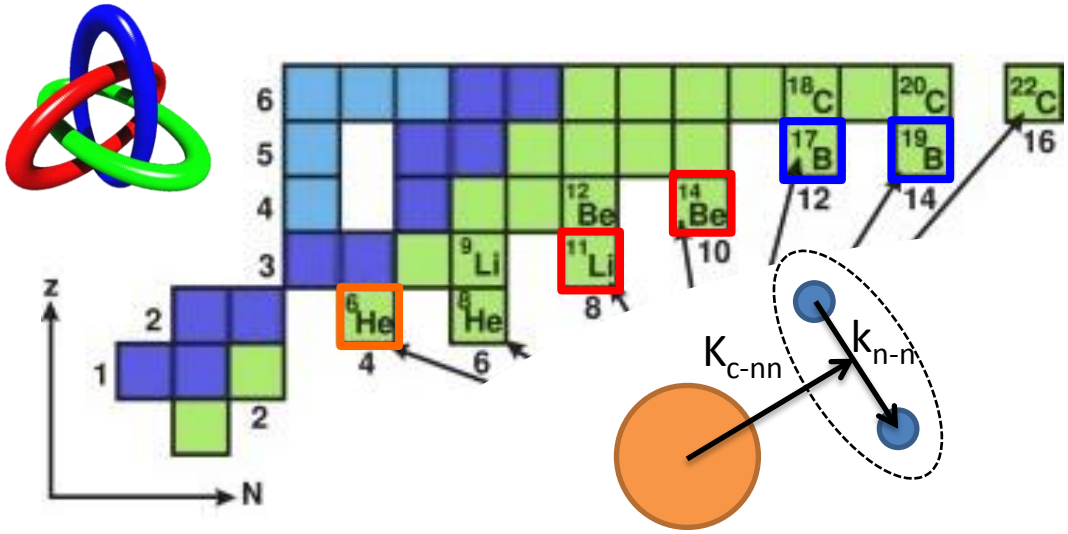
J.D. Holt et al.

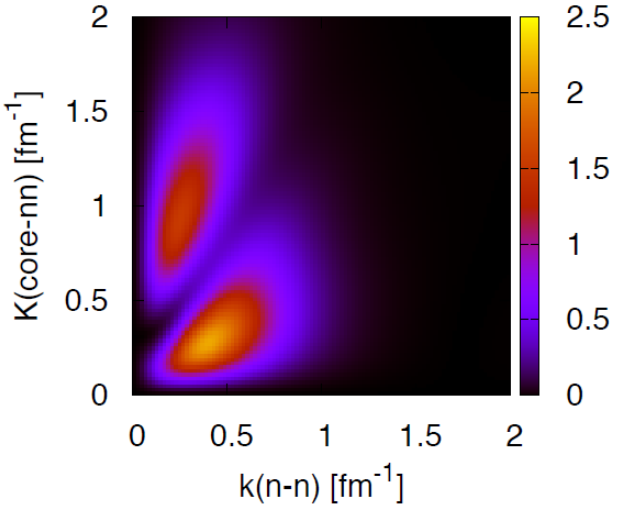


Otsuka et al.

Origin of di-neutron correlations in Halo nuclei

Spokesperson: Y. Kubota (CNS, RIKEN) and A. Corsi (CEA)
graded A by the 13th RIBF NP-PAC





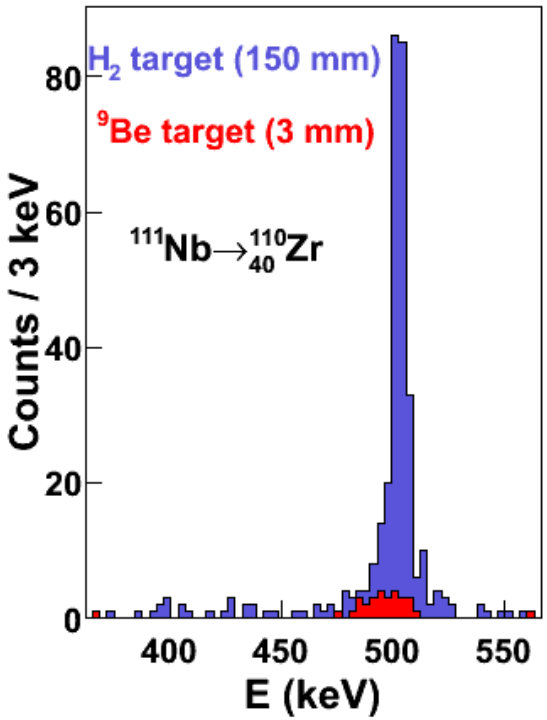
A program to understand **Neutron Halos** in Borromean nuclei

- **Exclusive** measurement
- Quasi-free scattering *(p,pn)* as a probe / **minimize Final State Interactions**

⇒ Requires high luminosity: MINOS

- **core excitations** (γ detection)

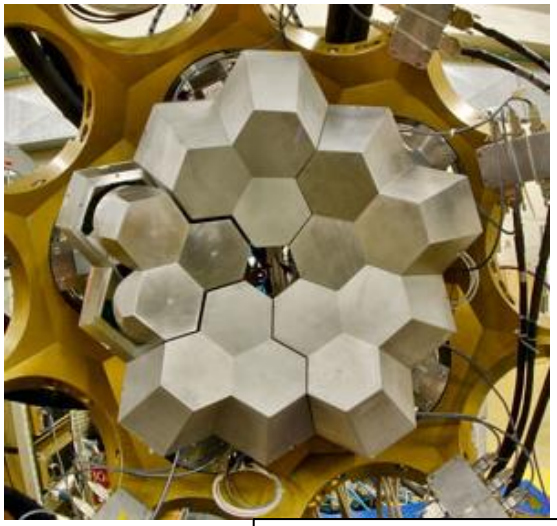
AGATA at the RIBF: a possible program with MINOS



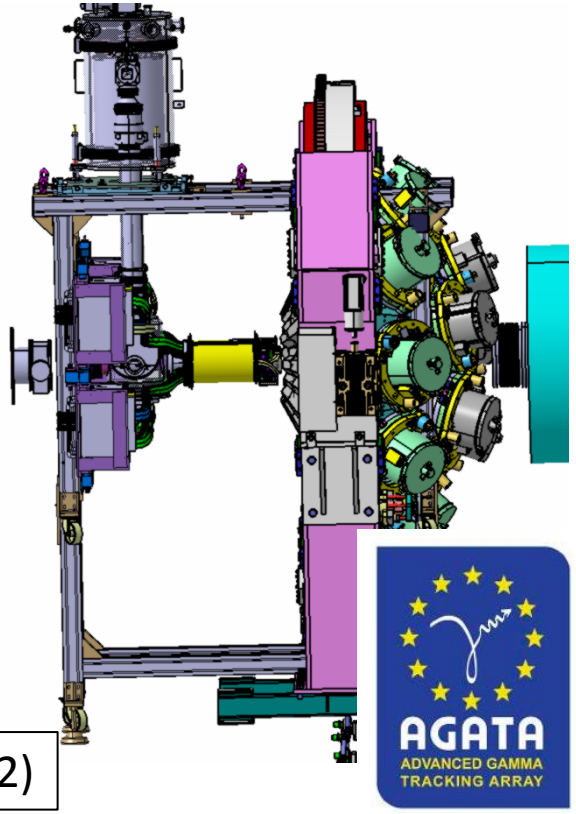
- AGATA: new generation high resolution Ge tracking array
- 2 keV FWHM at E=1.3 MeV, 5 mm FWHM resolution
- about 34 crystals in **2017**

- Ultimate combination with MINOS:

1) High resolution (<20 keV)
2) High luminosity
3) High efficiency



15 crystals (in 2012)



Possibility of **high resolution spectroscopy of heavy or deformed exotic nuclei**

Naive (already asked?) questions related to 3N:

1) Apart from extra repulsion, is there any intuition on the mass dependence, asymmetry dependence of the 3N force effect?

2) Is there any saturation – upper limit with mass of the 3N effect (at saturation density)?

3) Would/Does comparison with QCD (very preliminary) studies on 3N forces bring valuable information?

4) Have we reached a stage where the interpretation of nuclear spectroscopy should be more and more left to theorists? Are experimentalists usually pertinent in their approach?

5) Would/does the spectroscopy of hypernuclei give more insight on the 3N forces?
[first excited state of Lambda much lower than of Nucleons]
Is it on your research line?