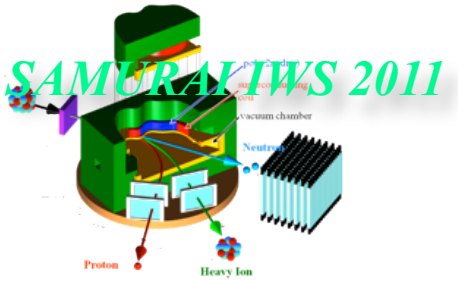
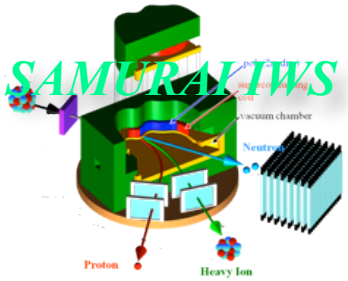


Survey of α cluster resonance in the Ne isotopes

SAMURAI International Workshop
2011/3/9-10

Hideaki Otsu
RI Physics lab., RIKEN Nishina Center



Survey of α cluster resonance in the Ne isotopes

1) α cluster resonance on ^{28}Ne

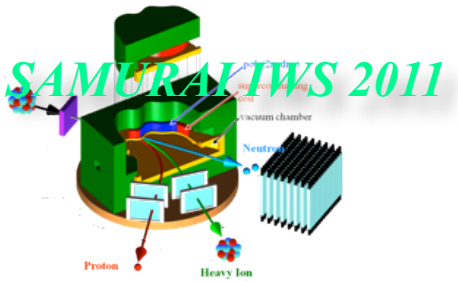
search for the resonance just above the α emission threshold energy of 10.1 MeV

for further description of cluster degree of freedom arise on n-rich nuclei

2) invariant mass measurement by detecting ^{24}O + α

Using SAMURAI spectrometer
which enable us to measure 2 or more particles in coincidence

Large momentum acceptance : $R_{max}/R_{min} = 3$



Physics motivation of α cluster resonance

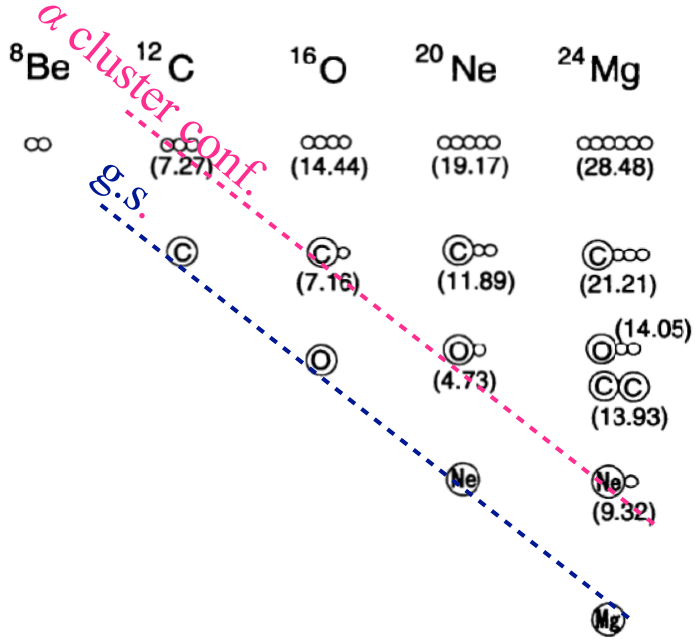
1) α cluster resonance

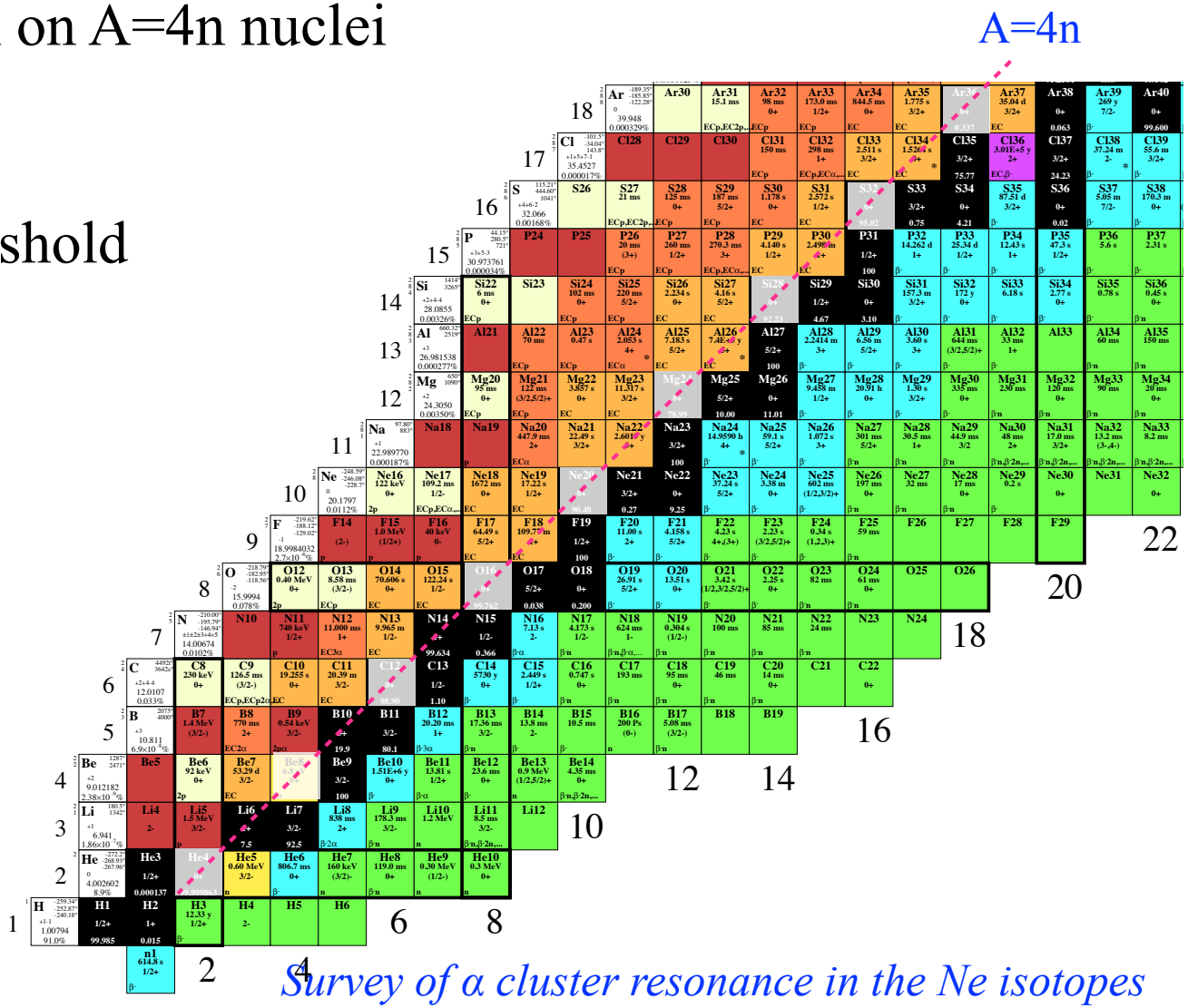
Ikeda Diagram

Successful description on A=4n nuclei (~ 1970)

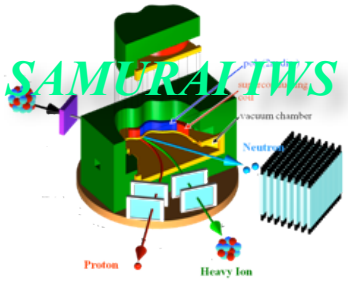
2) Threshold law

α cluster appears on threshold





Survey of α cluster resonance in the Ne isotopes



α cluster resonance outer than A=4n

1) Cluster state in A=4n±1

^{11}B

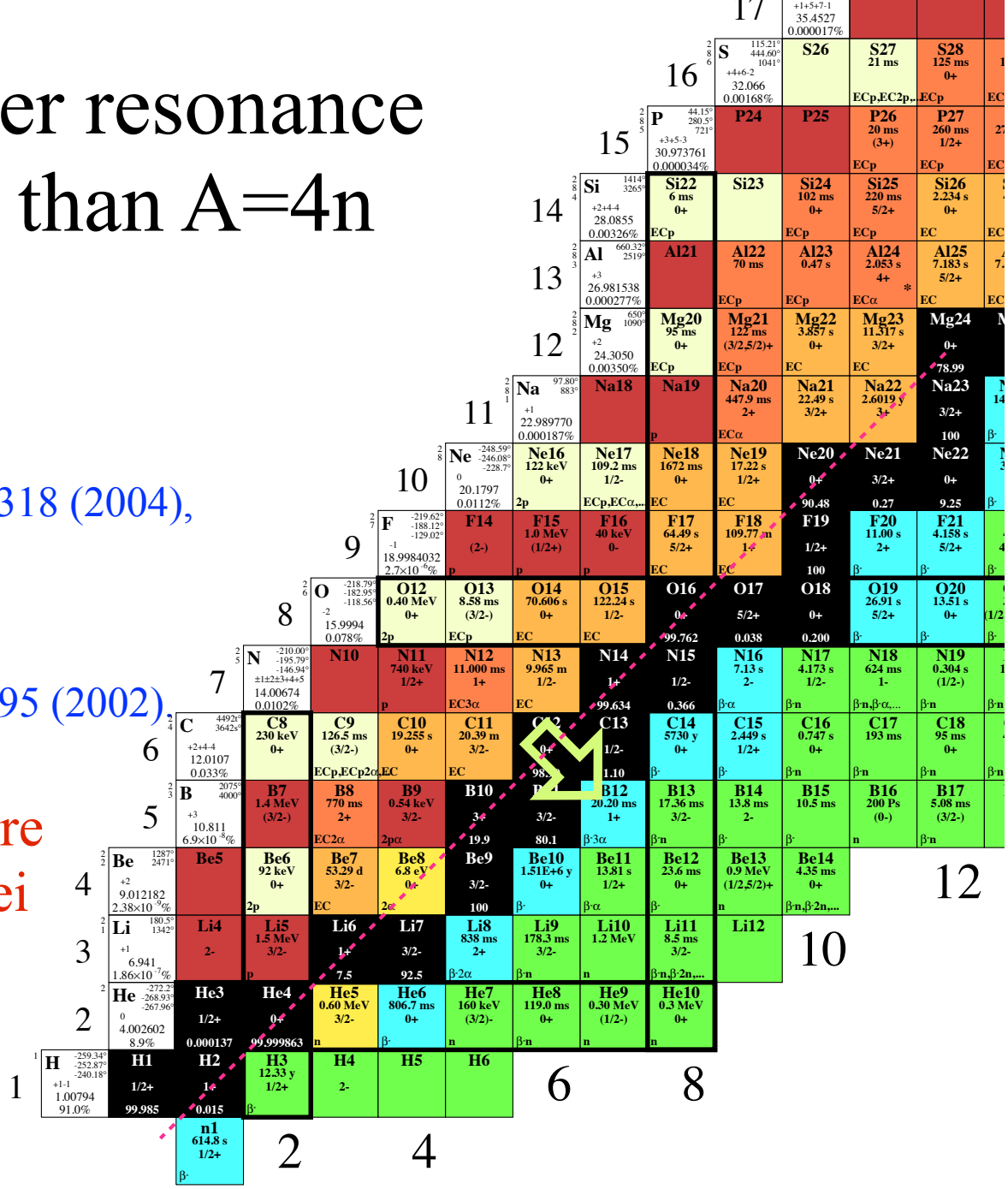
T. Kawabata et al. Phys. Rev. C 70, 034318 (2004), Phys. Lett. B 646, 6 (2007).

^{13}C

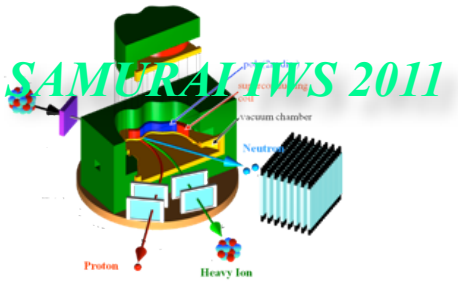
Milin and Oertzen, Eur. Phys. J. A 14, 295 (2002).

Experimentally, cluster states are successfully observed on nuclei outer than A=4n

2) n-rich region in RIBF



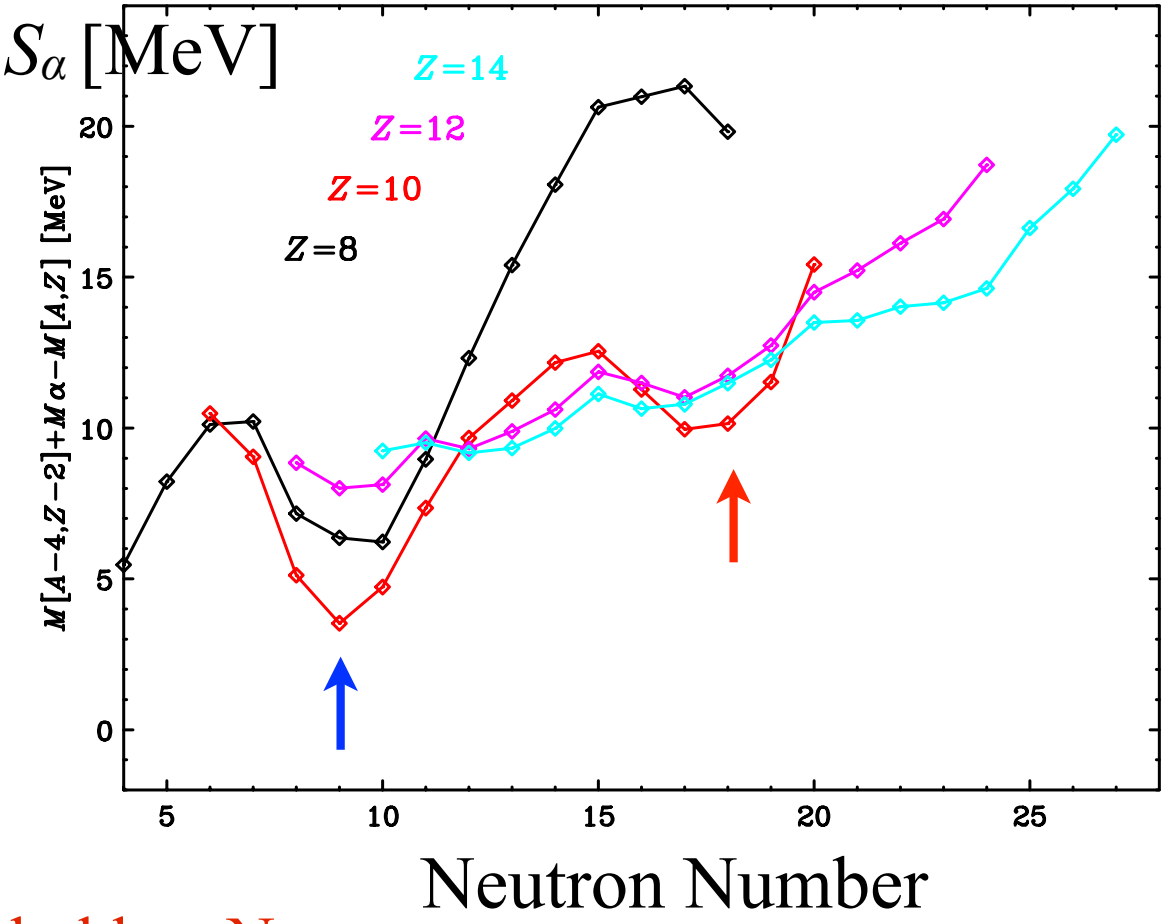
Survey of α cluster resonance in the Ne isotopes



S_α tendency at $Z = 8 \sim 14$

1) α separation energy S_α tendency at $Z = 8 \sim 14$

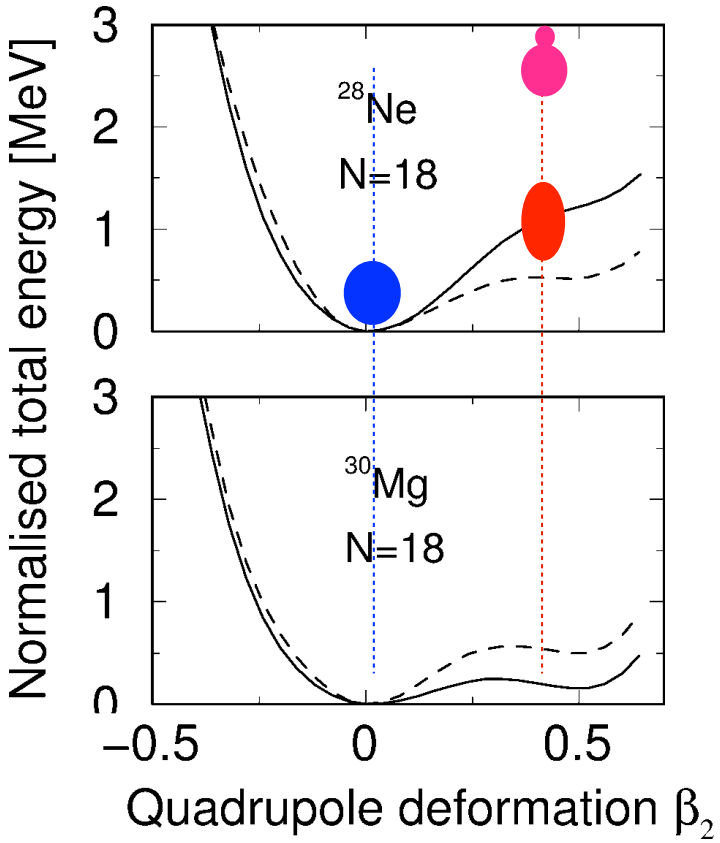
2) Z=10 2 dips
~ Double magicity of
Z=8, N=8 and N=16



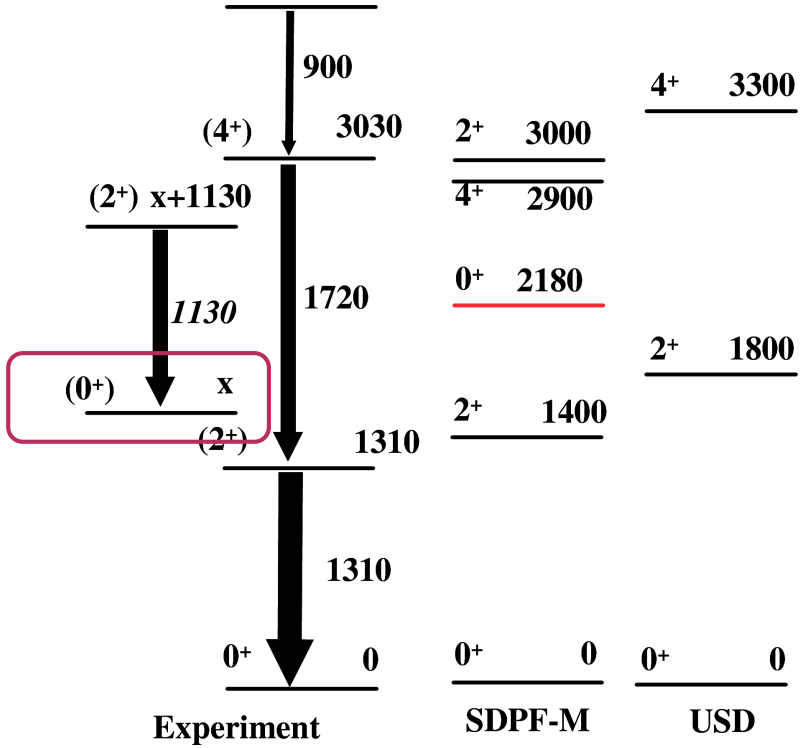
Resonance states above α threshold on Ne isotope are expected in n-rich region, especially on ^{28}Ne

^{28}Ne

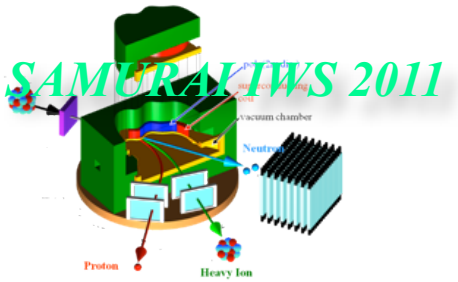
Possible 0^+_2 is expected but not fixed yet.



P.D. Stevenson, et. al.,
Phys. Lett. B545 (2002) 291.



Adopted level scheme
in ENDSF for ^{28}Ne
by P. Fallon



Experimental procedure

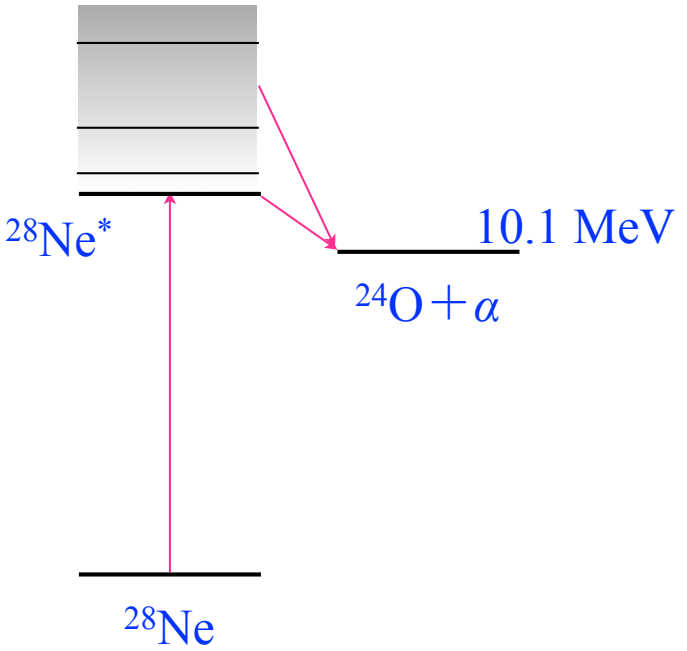
1) Invariant mass measurement
induced by nuclear break up by C target

$^{28}\mathrm{Ne} + \mathrm{C} \rightarrow {}^{24}\mathrm{O} + \alpha + \mathrm{X}$

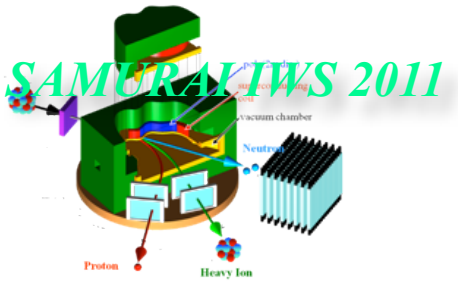
$M_{INV}^2 = (\Sigma E_i)^2 - (\Sigma \vec{p}_i)^2$

$E_x = M_{INV} - m_0 \ ; E_{rel} = M_{INV} - \Sigma m_i$

2) $E_x > 10$ MeV :
nuclear excitation (by C target) selected



c.f. $S_n = 3.7$ MeV



Experimental procedure

1)Invariant mass measurement

$^{28}Ne \rightarrow {}^{24}O + \alpha$

(FDC2) (FDC2)

$^{29}Ne \rightarrow {}^{24}O + \alpha + n$

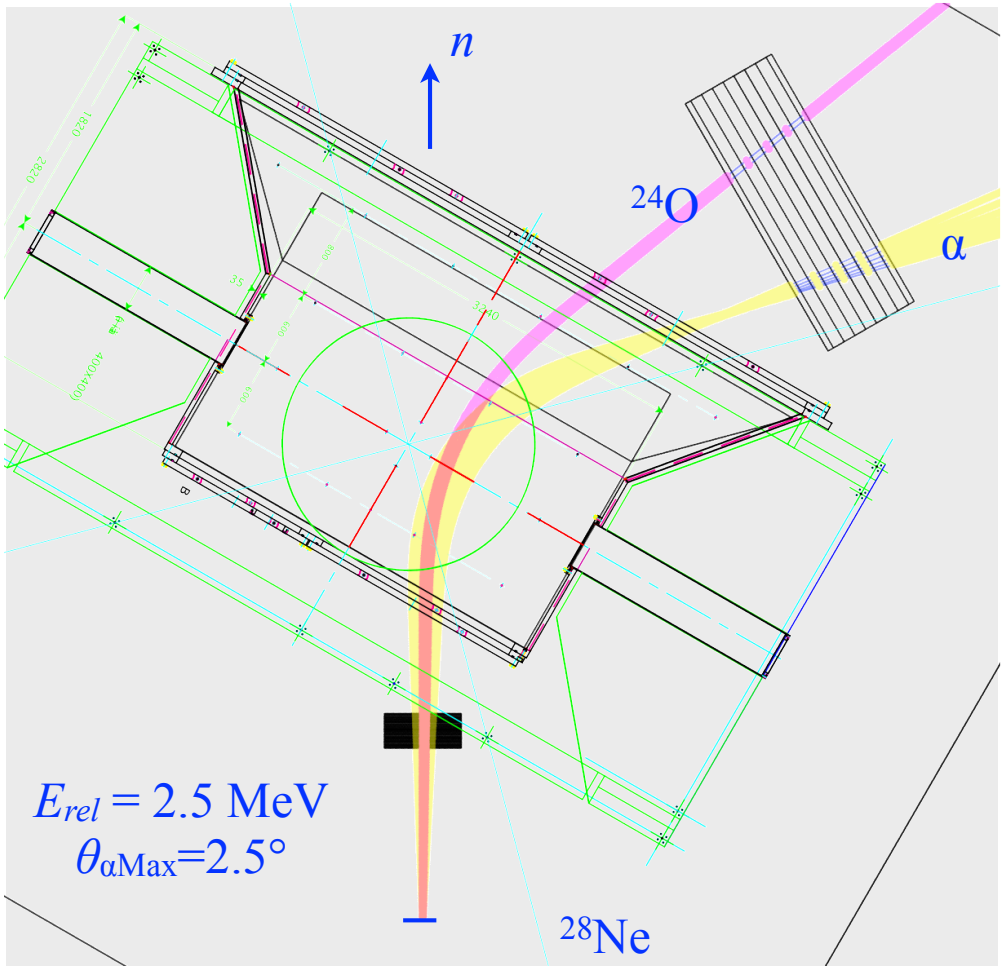
(FDC2²) (NEBULA)

$(^{30}Ne \rightarrow {}^{24}O + \alpha + n + n)$

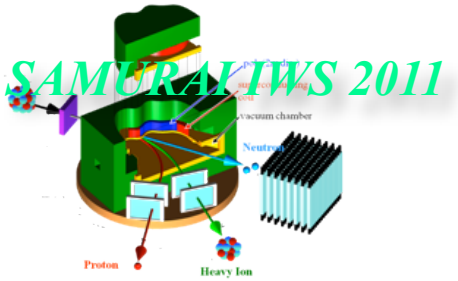
(FDC2²) (NEBULA²)

$M_{INV}^2 = \Sigma(E_i)^2 - \Sigma(p_i)^2$

$E_{rel} = M_{INV} - \Sigma m_i$



2) Every particle ^{24}O, α, *n*: no bound excited states



Feasibility : Yield Estimation

Yield estimation (preliminary)

Assumption : $\sigma = 0.05$ mb

Target : 200 mg/cm^2 C : $N_T = 1.0 \times 10^{22}$

Secondary beam intensity ^{28}Ne: $N_I = 1 \times 10^4$ from ^{48}Ca 200 pnA

Angular coverage ?= 100 % for ^{24}O + α

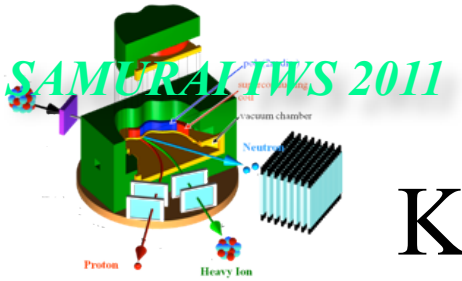
Expected total yield : Y(1days) ~= 400 for ^{24}O + α

c.f.)

Secondary beam intensity ^{29}Ne: $N_I = 5 \times 10^2$

Expected total yield : Y(1days) ~= 6 for ^{24}O + α + n

(ε_{1n} =30% assumed)



Readiness / Known difficulties to be solved

1) Readiness :

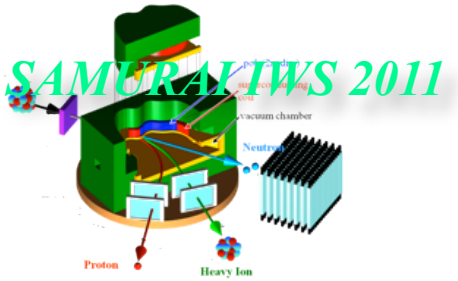
To be confirmed for feasibility
including theoretical point of view

2) FDC1/2 response

Z=2 particle detection on the circumstance of *Z*=10 particles

25 times larger pulses w/ beam intensity

FDC2 : spatially separated
2 set of HV ?
FDC1 : not separated
give up determining α trajectory here ?



Summary
Future perspective

1) α cluster resonance on ^{28}Ne

search for the resonance at α threshold energy at E_x = 10.1 MeV

for further description of cluster degree of freedom arise on n-rich nuclei

2) invariant mass measurement by detecting ^{24}O + α

Using SAMURAI spectrometer

which enable us to measure 2 or more particles in coincidence

3) Several experimental parameters should be tuned

4) $^{29\text{-}30}$Ne isotopes are also under consideration

neutrons can be also detected in coincidence with ^{24}O+α