The MUST2 Array

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- Main features of MUST2
- First experiments at GANIL
- Physics program and outlooks

Terra incognita

DREB International Workshop, May 30th - June 2nd, 2007
**Direct reactions studies**

- **MISSING MASS method**
- **INVERSE MASS method** (proton-rich nuclei)

**The MUST array**
(IPNO–Saclay–Bruyères)

- **8 Telescopes**
  - Surface: 6x6 cm²
- **DS Strip 60X+60Y (300 µm)**
- **Si(Li) 3 mm**
- **CsI**

**MUST2: a major upgrade of MUST**

- **Increase angular coverage**
  - Better efficiency
  - Several reactions in one shot
- **More compact**
- **Higher granularity (multiparticle)**
- **New electronics**
Collaboration: IPNO/SPhN-Saclay/GANIL

DSSD
10x10cm²
128X+128Y
300µm

Si(Li) 5mm

CsI 4cm
MUST2 electronics

MUST2 ASIC  SACLAY (+IPNO)
- 16 channels  28 mW/ch
- Energy & Time
- Si, Si(Li) and CsI
- Multiplexer
- I2C interface

- High linear. pulser
- T sensor

MOTHER BOARDS (IPNO)

VXI board (GANIL)
16 ADC14 bits
2.3K parameters
2MHz
Slow Control I2C
Pedestal substraction
DNL correction

4 analog bus
Control signals
I2C bus
SOFTWARE features:
✓ Interface (Java) for setting and monitoring parameters of the system
✓ Automatic calibration using internal pulser
✓ Automatic alignment of pedestals for zero substraction

Resolutions
40 keV FWHM (α source)
~500 psec FWHM
Magicity loss at $Z=8$ using the $^{14}O(p,t)$ at GANIL

Spokesperson: H. Iwasaki, IPNO
(thesis work of D. Suzuki)

Magicity loss at $N=8$ e.g. $^{12}$Be

- Intruder configuration in ground states (knockout reaction at GANIL and MSU)

- Low-lying intruder $1^{-}$ and $0^{+}$ states (inelastic scattering at RIKEN)
  
  H. Iwasaki et al. PLB481(00)7
  H. Iwasaki et al. PLB491(00)8,
  S. Shimoura et al. PLB560(03)31

Magicity loss at $Z=8$ ??

- Low-lying $2s_{1/2}$ orbital ?

- Monopole interaction ?
  ($p\,1p_{1/2} - n\,1p_{3/2}$)

$\Rightarrow$ Spectroscopy on low-lying excited states in $^{12}$O
`Calculated angular distributions`

DWBA calc. $^{14}\text{O}(p,\text{t})^{12}\text{O}$

![Graph](image)

- Pure configurations are assumed:
  - $(1p_{3/2})^2$ for $0^+$, $2^+$
  - $(1p_{3/2})(1s_{1/2})$ for $1^-$
  - $(1p_{1/2})^2$ for $0_2^+$

Characteristic curves depending on the transfer L value

$\Rightarrow$ Spin assignment

- $\sim 75\%$ efficiency with MUST2
$^{16}$O beam

triton
Result (preliminary) at GANIL April 2007

collaboration between IPN-Orsay, Ganil, CEA-Saclay (France) and Univ. of Tokyo, RIKEN, RCNP (Japan)

$p^{(16O, 14O)}t$ at 40 AMeV

\[ E_{\text{ex}} = 6.6 \text{ MeV}, \quad 0.0 \text{ MeV} \]

g.s.

FWHM = 1 MeV

\[ 2^+ \]
Result (preliminary)

\[ p^{(16}\text{O},^{15}\text{O})d \text{ at } 40 \text{ AMeV} \]

Ex[MeV]

- FWHM 1.5MeV
- 6.17MeV(3/2^-)
- gs(1/2^-)
Test experiment @ GANIL: $^{22}\text{Ne} + \alpha$ at 30 MeV/u

$^{22}\text{Ne}(\alpha,^6\text{He})^{20}\text{O}$  30 MeV/u

$^{22}\text{Ne}(\alpha,^6\text{Be})^{20}\text{O}$  30 MeV/u

Using cryogenic He target made for missing mass measurements
$^{22}\text{Ne} + \alpha\,$ at 30 MeV/u
$^{22}\text{Ne} + \alpha$ at 30 MeV/u

Recoil PID

Ejectile PID
Physics program

- Shell evolution (S.O. interaction, tensor force,..)
  - (d,p) : localize and identify neutron shells
  - (d,$^3$He) (d,t) : SF of occupied proton (neutron) shells
- p-n isoscalar pairing
- Deuteron transfer on N=Z nuclei
- Astrophysics: simulation of (n,γ) using (d,p)
In view of SPIRAL2: the GASPARD collaboration
Gamma SPectroscopy and PARticle Detection

- Fully integrated $4\pi$ gamma (scintillators) + $4\pi$ particles high granularity
- PID for light particles using PSA in silicon