ERINDA Progress Meeting, Prague, January 16, 2011

Nuclear Physics Institute (NPI) of ASCR, Řež, Czech Republic

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about 200 employees (70 scientists)

More institutes in Řež area
the biggest is Nuclear Research Institute plc. (NRI)

Main device of NPI ASCR
Main device of NRI
Accelerator – Cyclotron U-120M

**Beam:** protons with energy from 10 up to 24 MeV (3μA)  
deuterons with energy from 10 up to 20 MeV (3μA)  
$^3$He with energy from 17 up to 57 MeV (2μA)  
alpha with energy from 20 up to 40 MeV (2μA)

High intensive $10^{11}$ cm$^{-2}$s$^{-1}$ negative ion beam:

protons with energy from 20 up to 37 MeV (20μA)  
deuterons with energy from 10 up to 20 MeV (10μA)

**Different tasks:**

1) Radiopharmaceutical research and production  
2) Astrophysical reaction research (mainly with $^3$He beam)  
3) Neutron research using two different neutron generators
Fast neutron generators

NG 1 – white neutron source based on heavy water, beryllium and lithium targets

NG 2 – white source on H- beam (heavy water target) with very high neutron flux $10^{11}$ cm$^{-2}$s$^{-1}$
  spectrum range from 2 up to 34 MeV
  neutron irradiation of small samples, integral benchmark tests of fusion (IFMIF) relevant
  neutron activation cross sections

NG 2 - quasi monoenergetic p – $^7$Li source with neutron flux $10^9$ cm$^{-2}$s$^{-1}$, energy 18 – 35 MeV

Negative ions high intensity for activation and irradiation experiments

NG - 1

Lower intensive beam for spectroscopic measurement

NG - 2
Neutron background studies

Description of background:

Usage of Uwamino – CYRIC measurements

Simulation by means of MCNPX (La150h)
Proton recoil measurements:
Proton energy – 27.6 MeV

Comparison:

<table>
<thead>
<tr>
<th></th>
<th>MCNPX</th>
<th>CYRIC</th>
<th>Recoil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total 10-29 MeV</td>
<td>4.60</td>
<td>5.24</td>
<td>5.05</td>
</tr>
<tr>
<td>Peak 23-29 MeV</td>
<td>3.31</td>
<td>3.35</td>
<td>3.18</td>
</tr>
<tr>
<td>Continuum</td>
<td>1.29</td>
<td>1.89</td>
<td>1.87</td>
</tr>
</tbody>
</table>

Crystal diamond measurements:
Presentation of Mario Pillon

Measured proton recoil spectrum – line
MCNPX simulation - squares

Line – CYRIC TOF spectra
Empty square – MCNPX simulation
Full square – deconvolution of proton recoil spectra
Tests to prepare Yttrium measurements

Proposal to ERINDA – Polish colleagues
Marcin Szuta, Stanislav Kilim

Cross-sections of neutron threshold reactions

Test methodical measurement:
neutron energy 32.5 MeV (only reactions (n,2n) and (n,3n))

French and Austria students analyzed data:

Bachelar thesis of Barbara Geier:

More about cross-section measurements of neutron threshold reactions – Ondřej Svoboda
Accuracy of gamma spectroscopy measurement

Source detector distance – 23 mm

Yttrium – thicker sample (~ mm) → if different side facing to the detector → small difference:

\begin{align*}
N(\text{side a}) &= 1.990(10) \times 10^{10} \\
N(\text{side b}) &= 2.017(13) \times 10^{10} \\
N(\text{all}) &= 2.000(7) \times 10^{10}
\end{align*}

Phenomena is quickly decreasing with bigger source detector distances

Gold - very thin foil → no difference which side is nearer to detector
Different measurements in the same source detector distance → more or less only statistical differences (differences smaller than ~ 1 %)

Different source detector distance → influence of systematic uncertainties:

1) Efficiency determination uncertainties
2) Coincidence corrections, the biggest for position near to detector
3) Influence of sample size

The differences reach values about a few percents, possibility to improve situation by improving of efficiency accuracy
Reactor LVR-15

It is not a device of NPI of ASCR

It is a device of NRI plc

Power up to 10 MW<sub>th</sub>

usually used about 8 MW

flux in the core: 10<sup>14</sup> cm<sup>-2</sup>s<sup>-1</sup>

number of horizontal channels

rent by NPI

thermal neutron flux in the channels: 10<sup>7</sup> cm<sup>-2</sup>s<sup>-1</sup>
Neutron guide installed at reactor channels
(NPI ASCR devices)

Beam cross-section: $4 \times 60 \, \text{mm}^2$

Beam intensity through cross section: $(1.5\pm0.2) \cdot 10^7 \, \text{n cm}^{-2} \, \text{s}^{-1}$

Angular deviations of beam below 0.5 °

Gamma-gamma coincidence spectrometric set-up