Test of a new ^{3}He target to be used for transfer reactions in inverse kinematics

Gabriele Carozzi

University of Padova, INFN-LNL

Outline

- Motivation
- ^{3}He target
- Test experiment
- Results

Motivation

Study exotic nuclei close to the proton dripline

Use RIBs to move far from the valley of stability.

One way to make use of these beams is via direct reactions

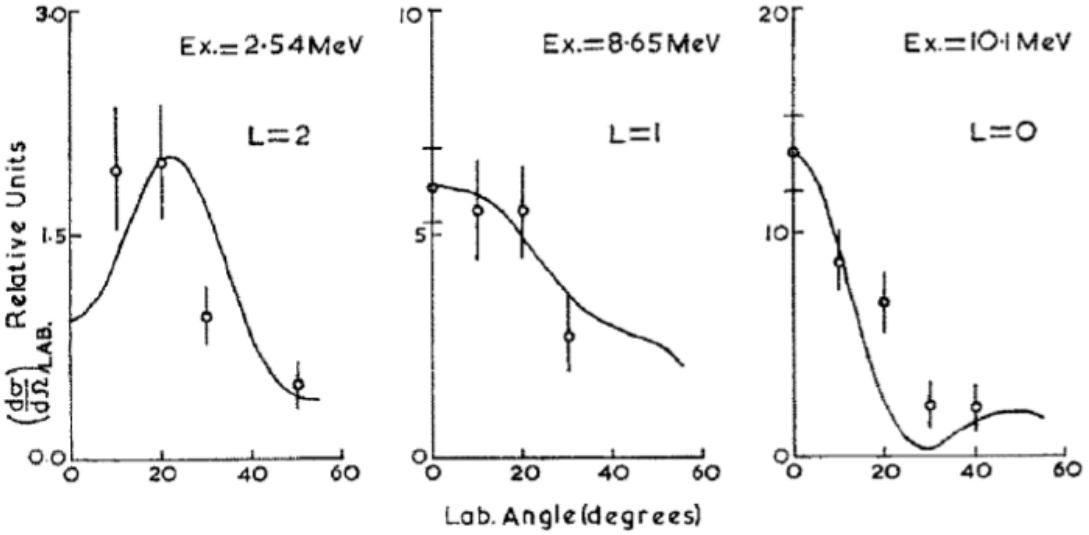
↓

Transfer reactions to study spectroscopy and lifetimes of **low lying states** in exotic nuclei

Transfer reactions

High selectivity in the angular momentum of the populated states in the final nucleus: states of interest populated **directly,** no need to worry about feeding from upper states!

Angular distribution of emitted particles gives information about the the populated state in the final nucleus.



$^{54}Fe(^{3}He,n)^{56}Ni$

R. P. J. Winsborrow, B. E. F. Macefield, Nuclear Physics A 182 (1972) 591-594.

^{3}He

^{3}He chosen to study neutron-deficient nuclei via the (^{3}He,n) **two proton transfer reaction**:

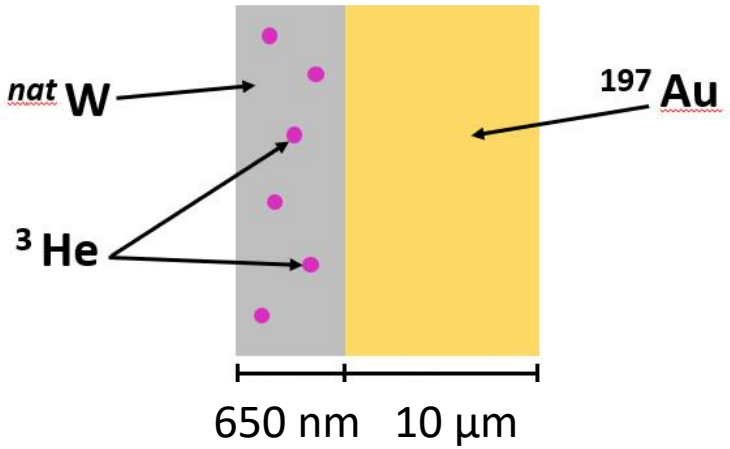
- 2p transfer populates nuclei near the proton dripline
- tagged by detecting the emitted neutron
- neutron distribution can be measured to know the angular momentum of the populated states

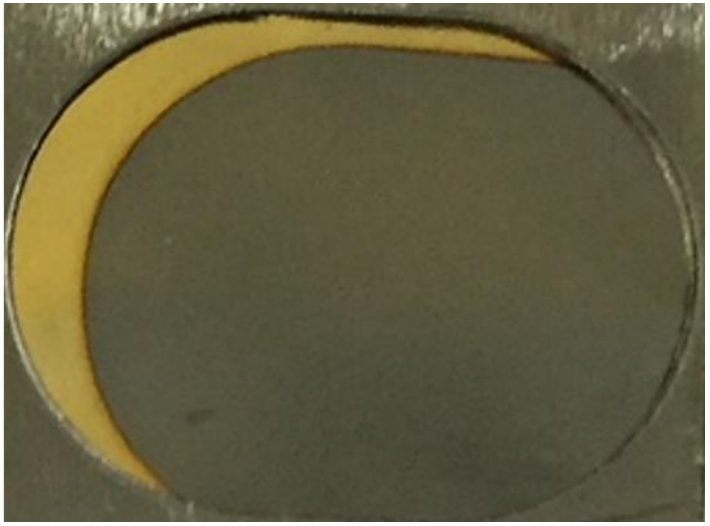
^{3}He target

Collaboration between the Materials Science Institute of Seville and the Legnaro National Laboratories (LNL)

Solid target produced with an innovative sputtering technique: ^{3}He trapped inside ^{nat}W

^{197}Au backing foil added as support + DSAM





Target composition

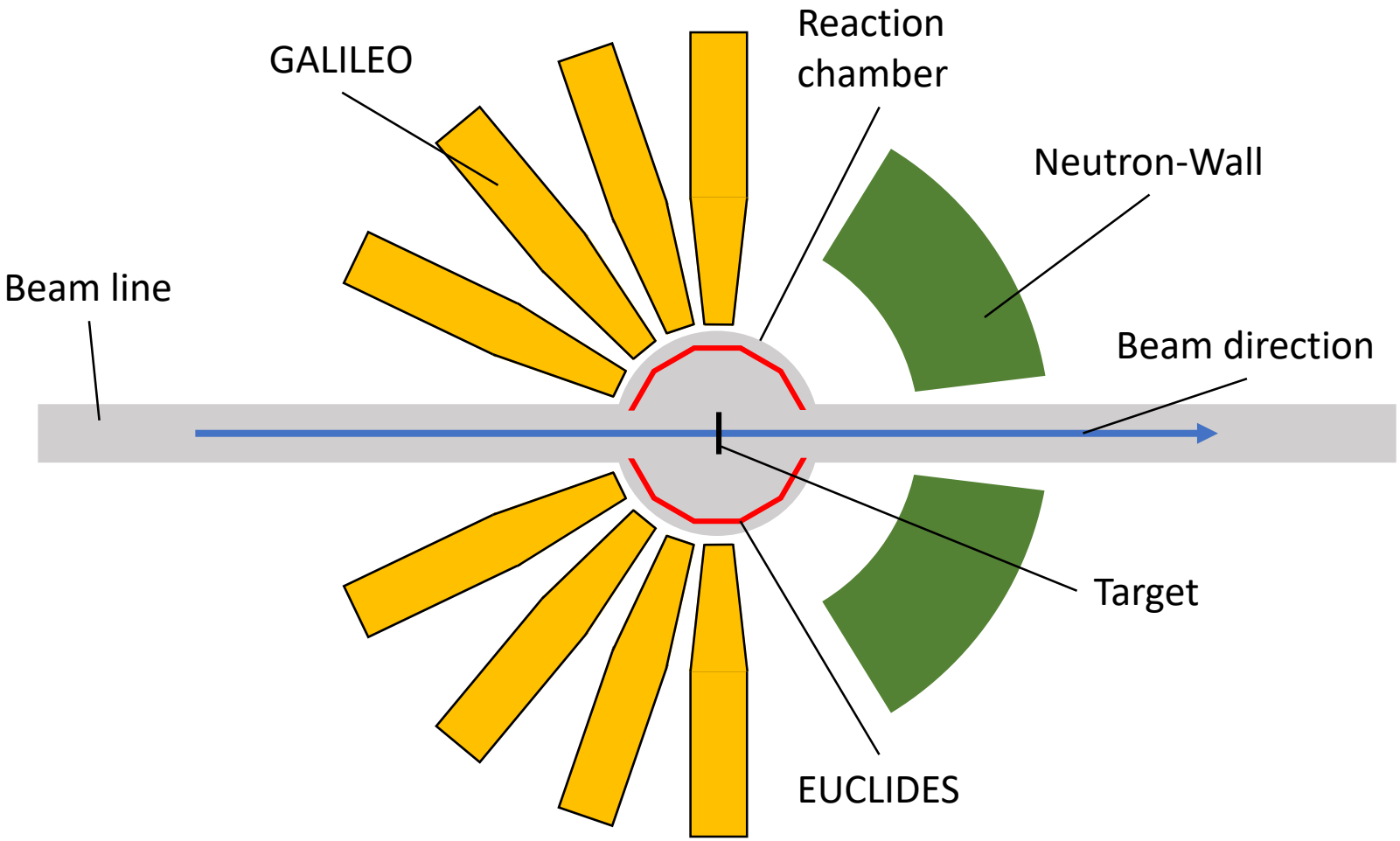
Nucleus	Surface density (10^{15} at/cm^2)	Composition %
^{nat}W	2475	64.64
^{3}He	286	7.47
^{16}O	403	10.53
^{12}C	131	3.42
^{1}H	430	11.23
^{28}Si	25	0.65
Other	78	2.06

Effective thickness 1.4 µg/cm²

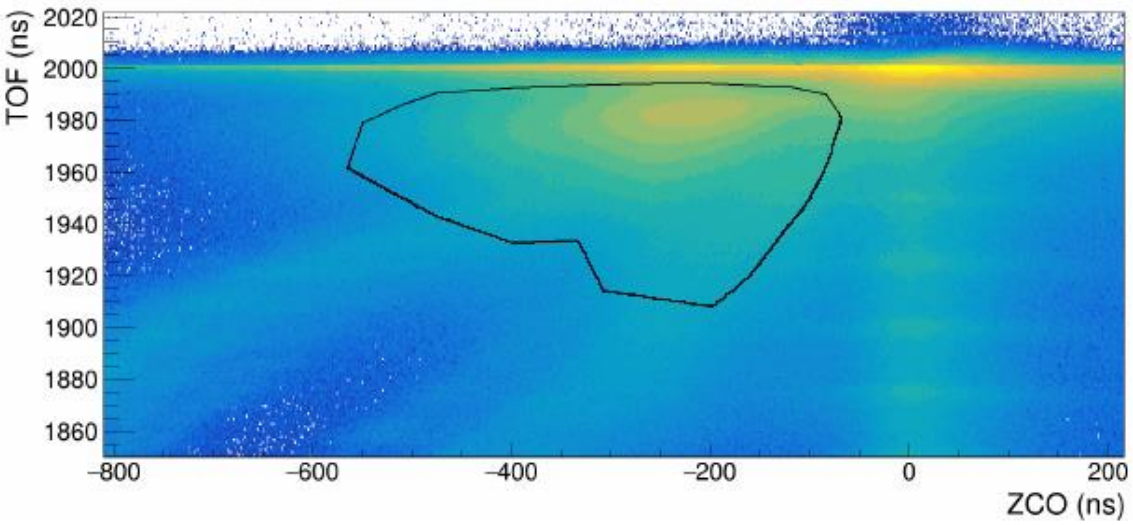
Contaminants! ~ 28 %

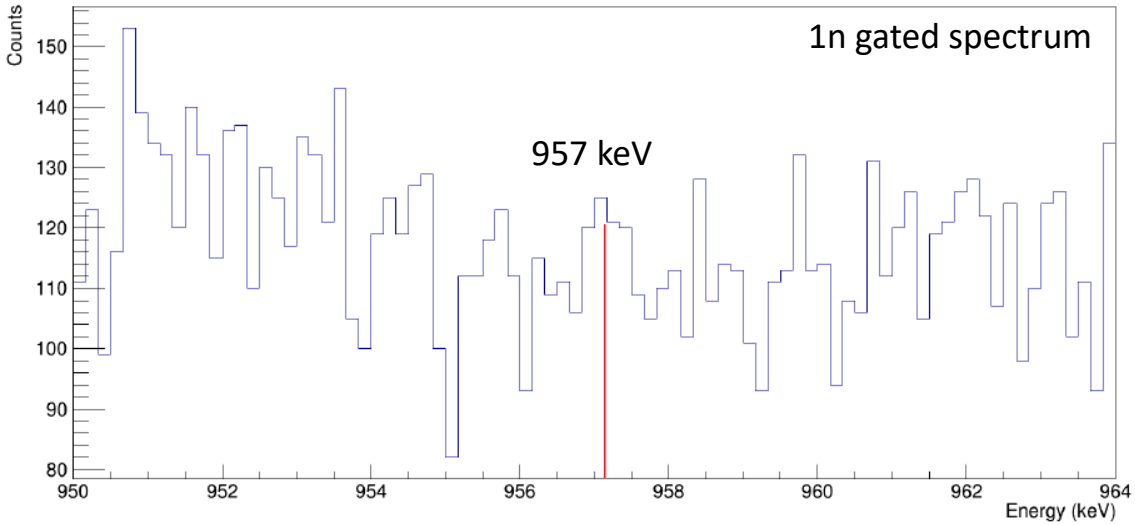
Test experiment of ^{3}He target

Beam: ^{64}Zn at 275 MeV, intensity 0.5÷5 pnA Duration: 22 hours



γ-ray spectrum analysis





Reaction of interest: $^{64}Zn(^{3}He,n)^{66}Ge$

Transition at 957 keV of ^{66}Ge observed in 1-neutron-gated γ-ray spectrum, 56 counts over background

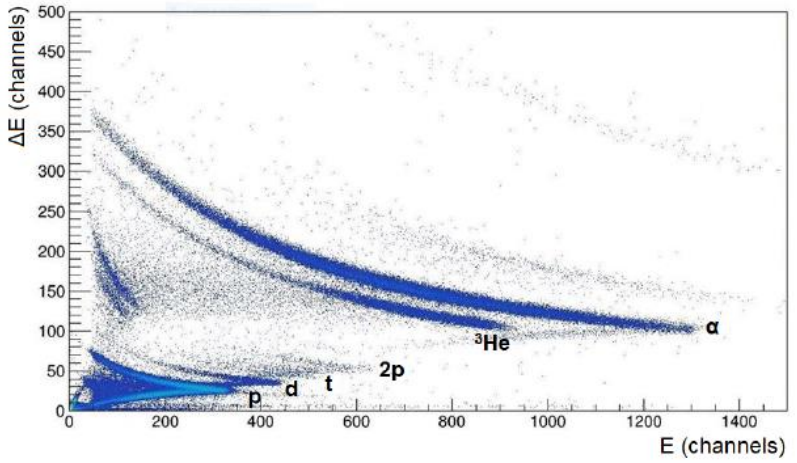
Expected cross section ~ 1 mb, evaluated ~ 0.3 mb

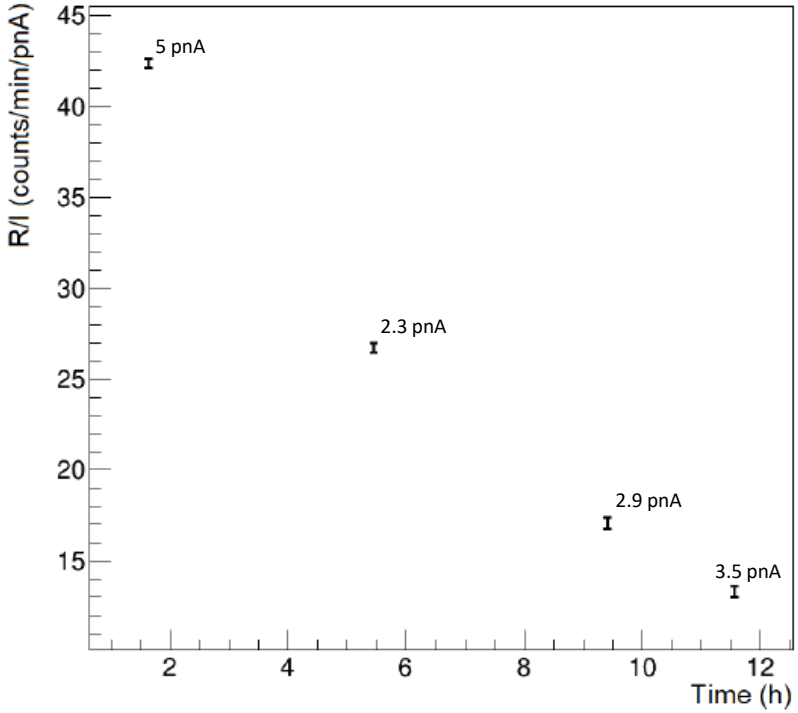
^{3}He evaporation from the target

Concerns about ^{3}He evaporating from the target due to heating caused by the beam

Counting rate decreased by a factor of ~ 3 in 11 hours

Lower beam intensities for RIBs (<1 pnA): minimal impact expected during experiments

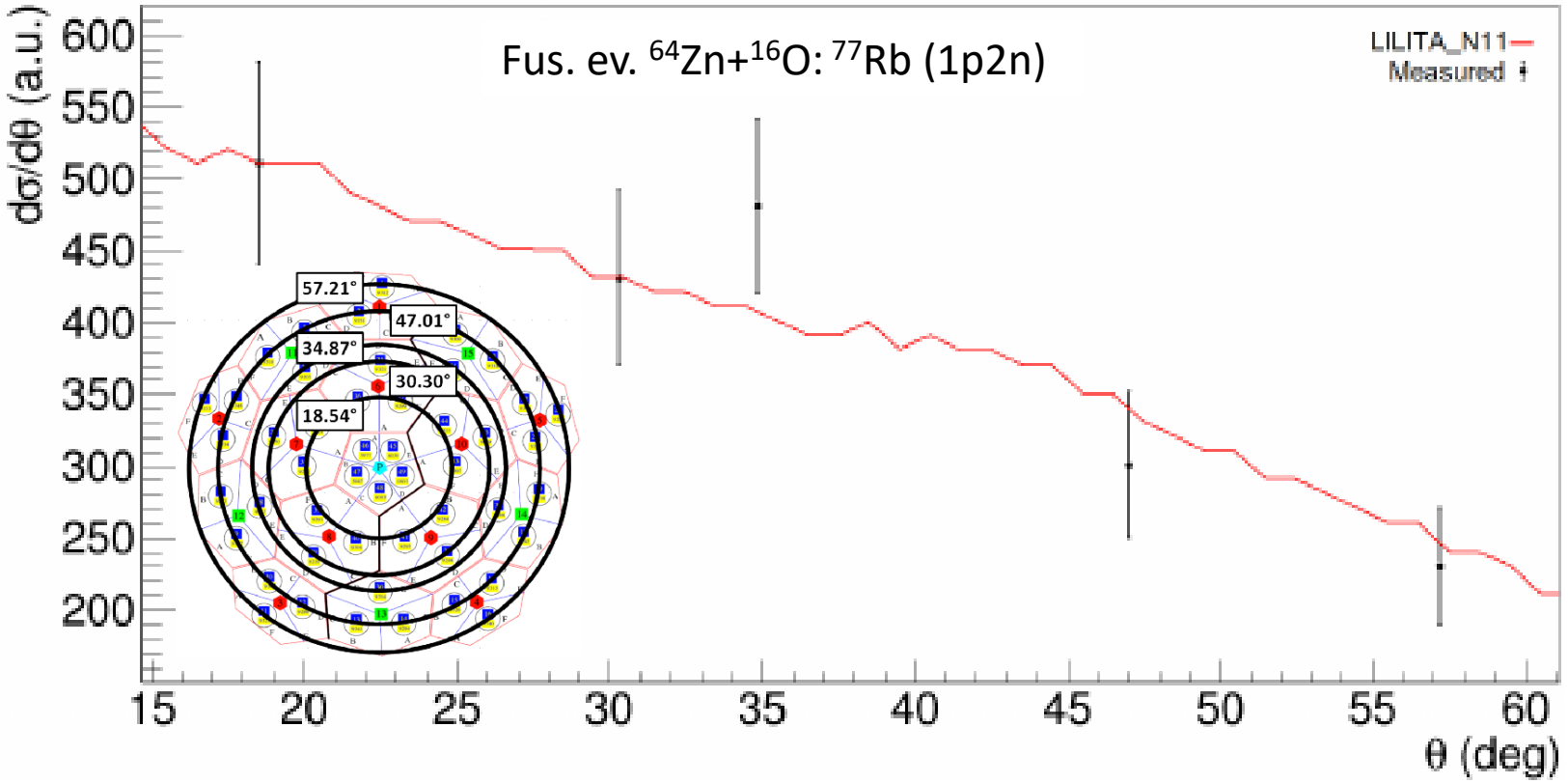




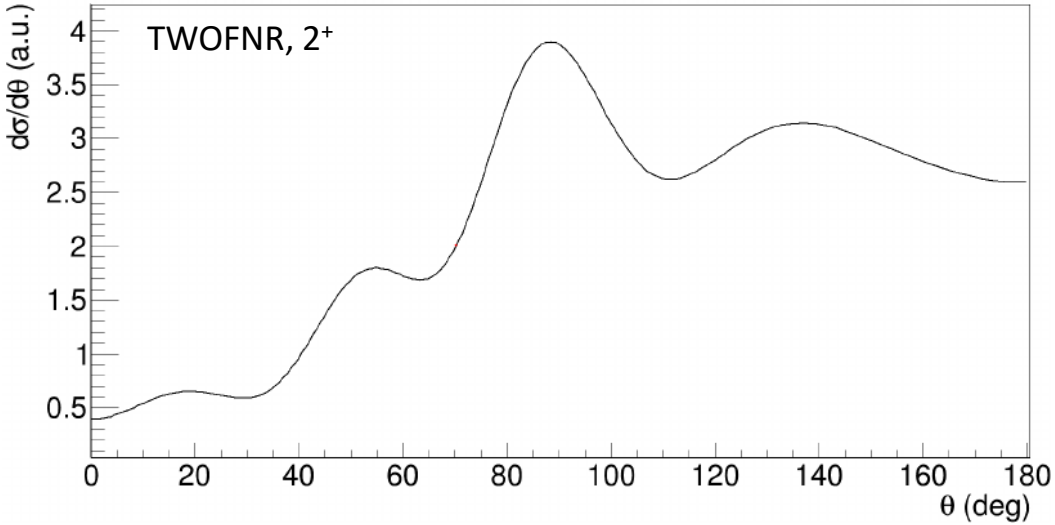
Neutron-Wall angular distributions

Neutrons detected in coincidence with γ rays detected in GALILEO

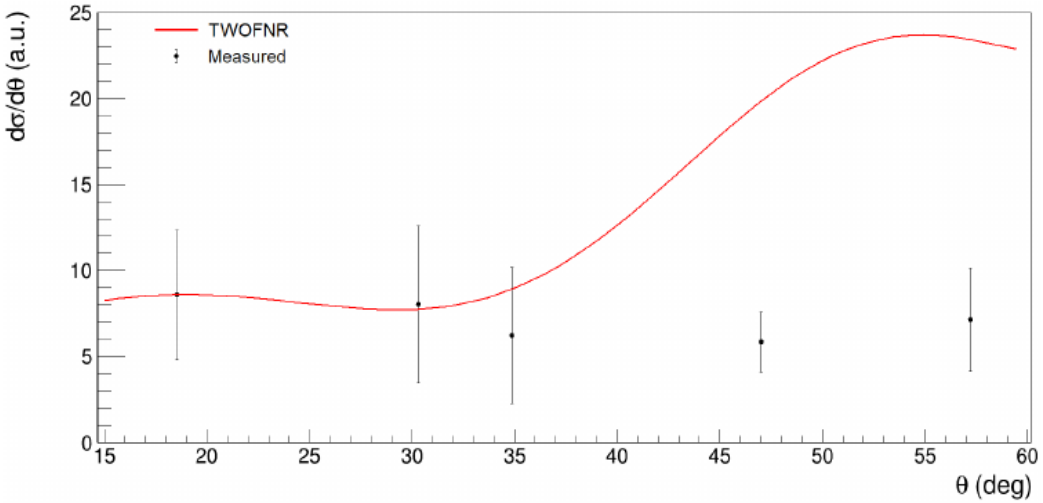
Concerns: angular resolution (~11°) and neutrons scattering between detectors ⟶ Feasibility test (first measurement)



Neutrons from $^{64}Zn(^{3}He,n)^{66}Ge$



Only single neutrons in coincidence with γ rays at 957 keV were considered



Counts too low, 13 over 45 detectors not counting over background

Conclusions and future perspectives

^{3}He evaporation from the target is limited; should be minimal when working with RIBs due to lower beam intensities.

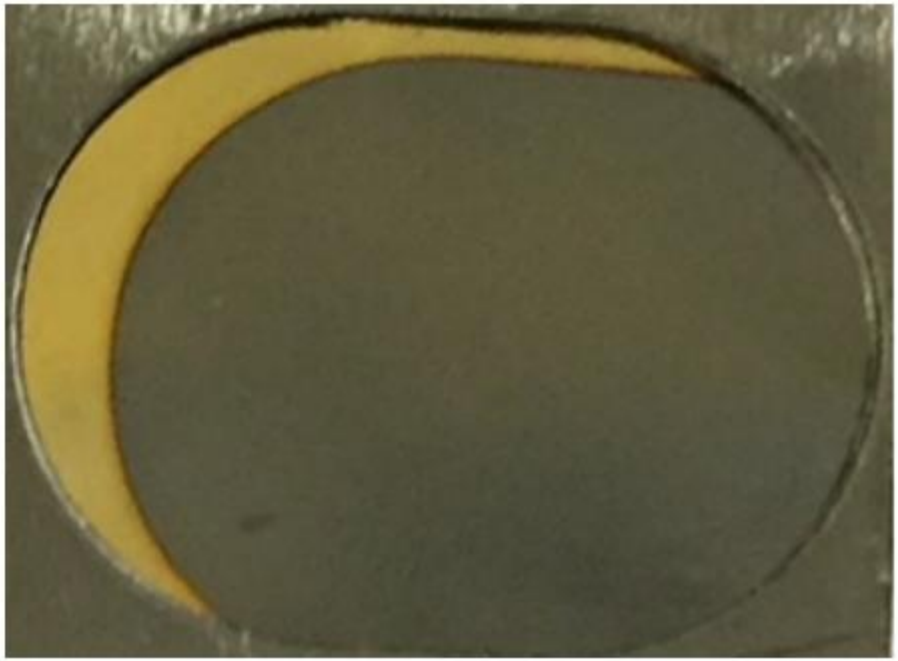
Neutron angular distributions measured with Neutron-Wall agree with calculations for the fusion evaporation reaction: scattering between detectors, if present, is minimal.

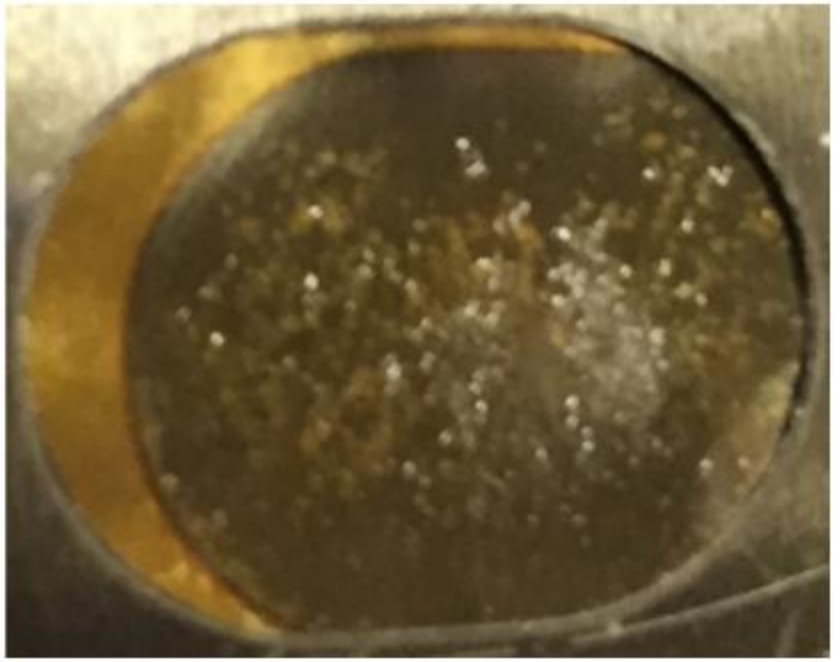
The Materials Science Institute of Seville is working to increase the concentration of ^{3}He up to 10^{18} at/cm^{2}, while reducing the concentration of contaminants below 5%.

Two experiments that make use of the target have been proposed to study the low-lying structure of ^{56}Ni (at LNL) and ^{36}Ca (at GANIL).

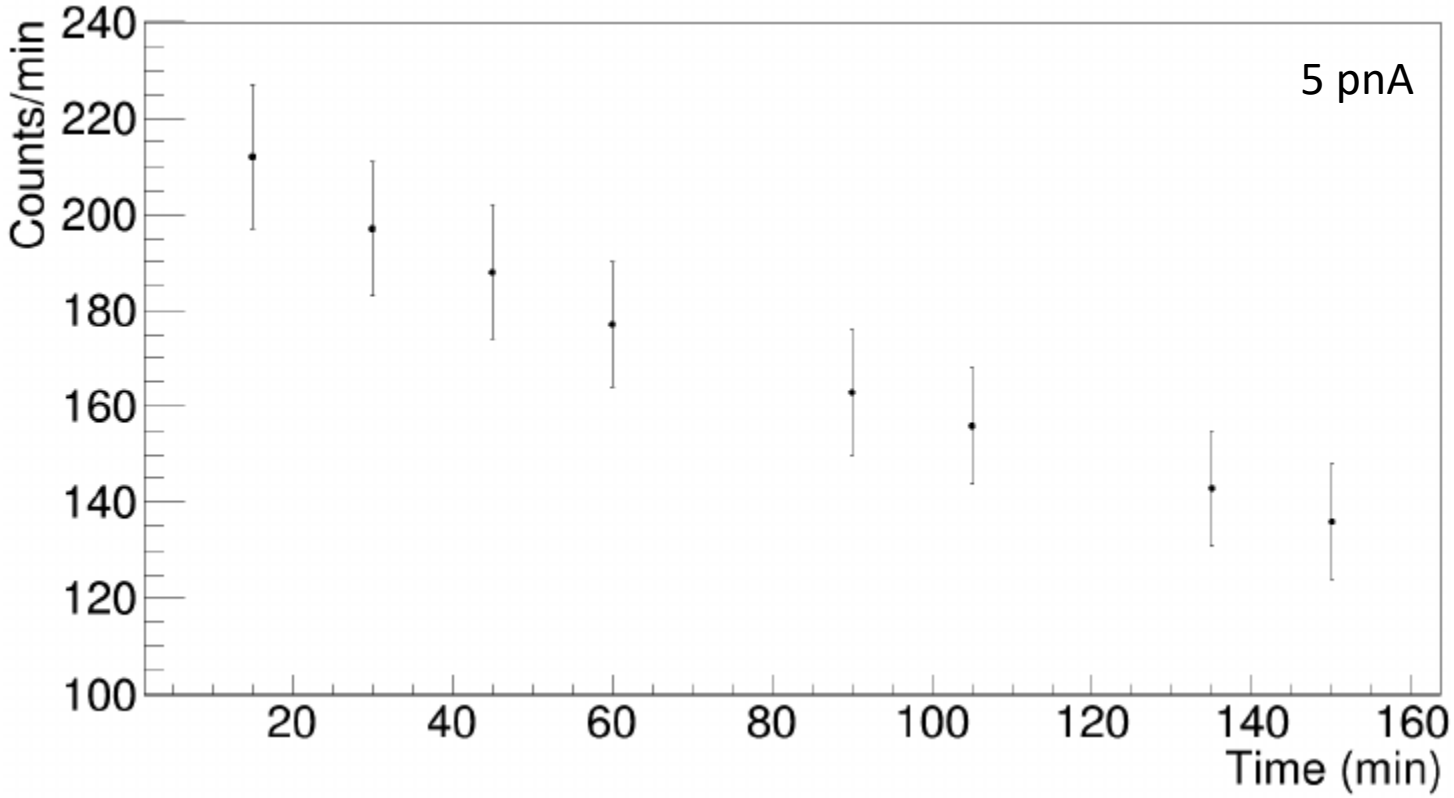
BACKUP SLIDES

Target before/after the experient





^{3}He evaporation, constant beam intensity



Neutron-Wall relative efficiency