Time request for E744s experiment with Vamos + Mugast setup

1) Introduction

The purpose of the measurement is to study the properties of the low lying negative parity states in the unbound nucleus ^{15}F. This project is a continuation of the study by the same team of the nuclei ^{15}F & ^{16}F published in references [1] & [2].

2) The scope of the measurement

The unbound nucleus ^{15}F was populated using the Spiral 1 radioactive beam of ^{14}O interacting with the hydrogen present in a CH2 target. The reactions induced on the Carbon present in the CH2 target represent the main background of the experiment. A measurement performed on a carbon target was performed in the same conditions as with the CH2 target and the result used to obtain the reactions of interest.
The stated aims of the measurement taken from the proposal:
a) Detail the resonant elastic scattering excitation function as seen in the 2018 measurement. Search for new states at high energy (>4.5 MeV) in the CM system. *A new state was clearly seen in the 2018 measurement (3/2- state@6.3 MeV preliminary assignment). The 5/2- is still to be found*
b) Two-proton decay from the new states. *In the 2018 2 protons decays have been seen in 2018 measurement but more statistics is required. Main background is produced by fusion-evaporation reactions on the carbon present in the CH2 target;*
c) Gamma decay from the already known 1/2- state. *Nothing can be said about this from the 2018 measurement due to the statistics*

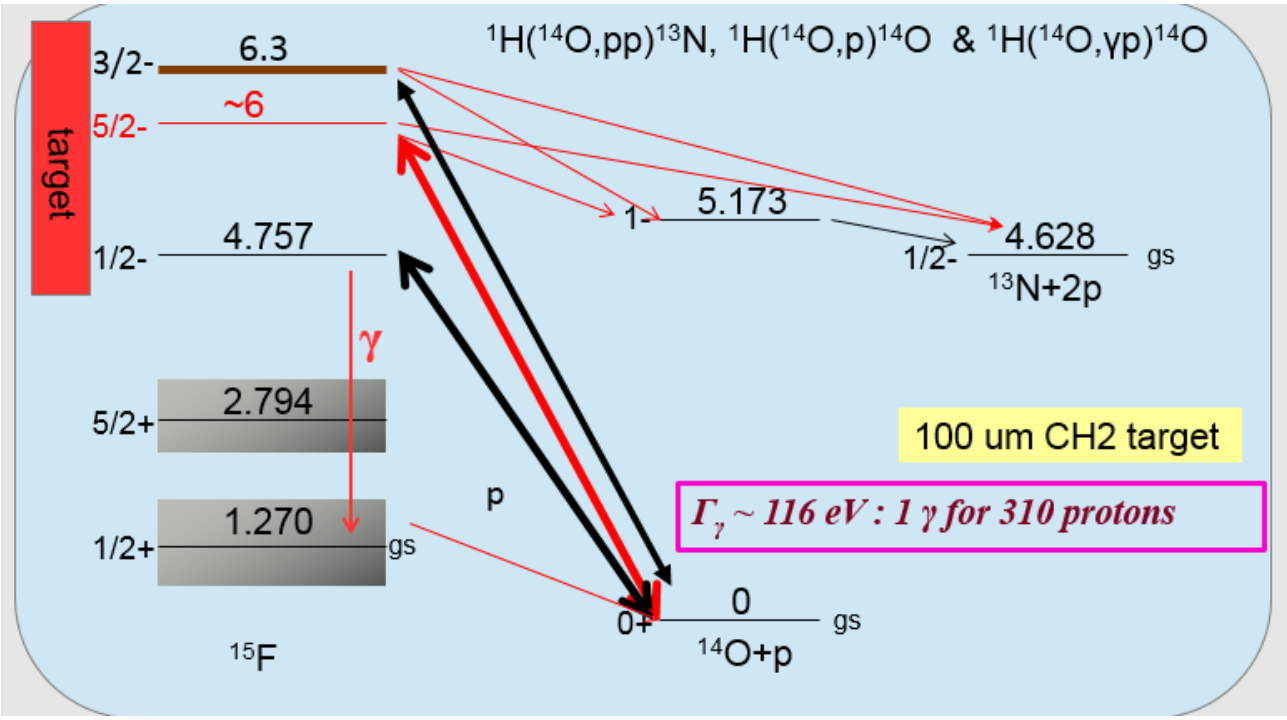

Figure 1 Schematic view of the points of interests for the measurement. Red lines shows what we intend to detect in the new measurement.

3) The beam

Beam to be used -> pure ^{14}O Spiral1 beam ~7.65 MeV/A with the intensity between 1-3 e+5 pps.

4) The setup

To achieve the aims of the experiment Cats + Mugast + Vamos + Agata should be used

The protons will be detected & identified by Mugast setup (4x Must detectors at forward angles)

The heavy partners will be identified in Vamos. This will be very selective as will remove most of the fusion evaporation background. For the kinematic reconstruction of the reaction, the protons detected with Mugast are sufficient in the cases where they are detected. We expect ~99% Vamos efficiency for the ^{14}O produced (Brho between 0.46 to 0.53 Tm) from ^{1}H(^{14}O,gamma p)^{14}O (see fig 2) and 45% efficiency for the ^{13}N obtained in ^{1}H(^{14}O,2p)^{13}N reaction (see figure 3). The simulations shown below use the 2010 Vamos config. Compared with the simulation, the Brho of reference for Vamos should be settled at slightly lower value to accommodate Vamos + Mugast final acceptance map with the idea of reducing the direct beam counting.

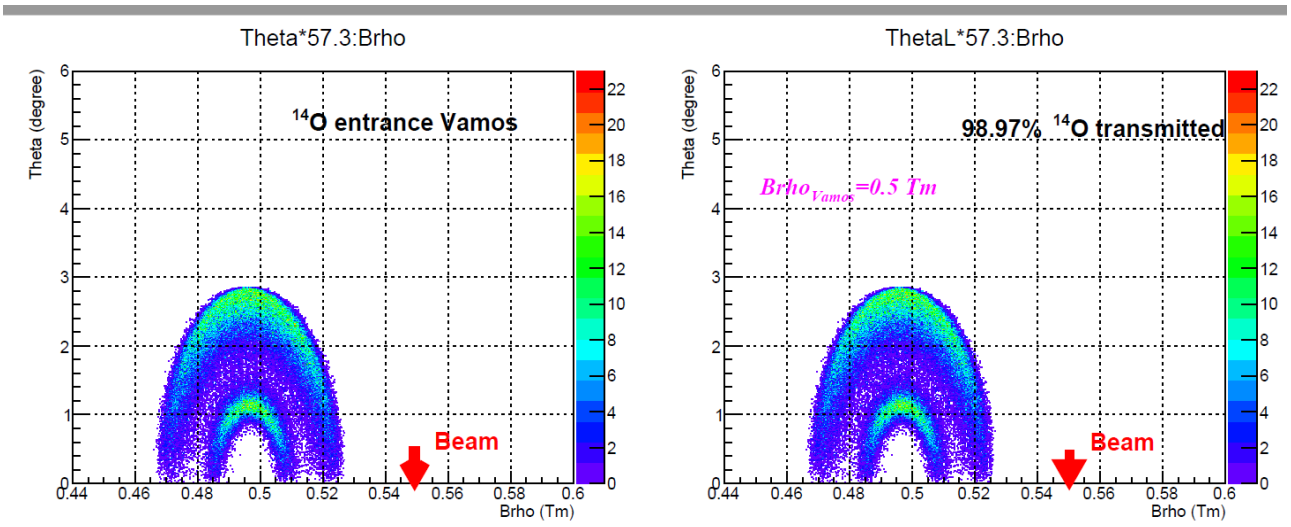

Figure 2 Transmission of the ^{14}O trough Vamos. Brho for the ^{14}O beam is 0.55 Tm and the ^{14}O of interest is found between (0.46 to 0.53 Tm). Brho of reference for Vamos used in the simulation ~ 0.5 Tm

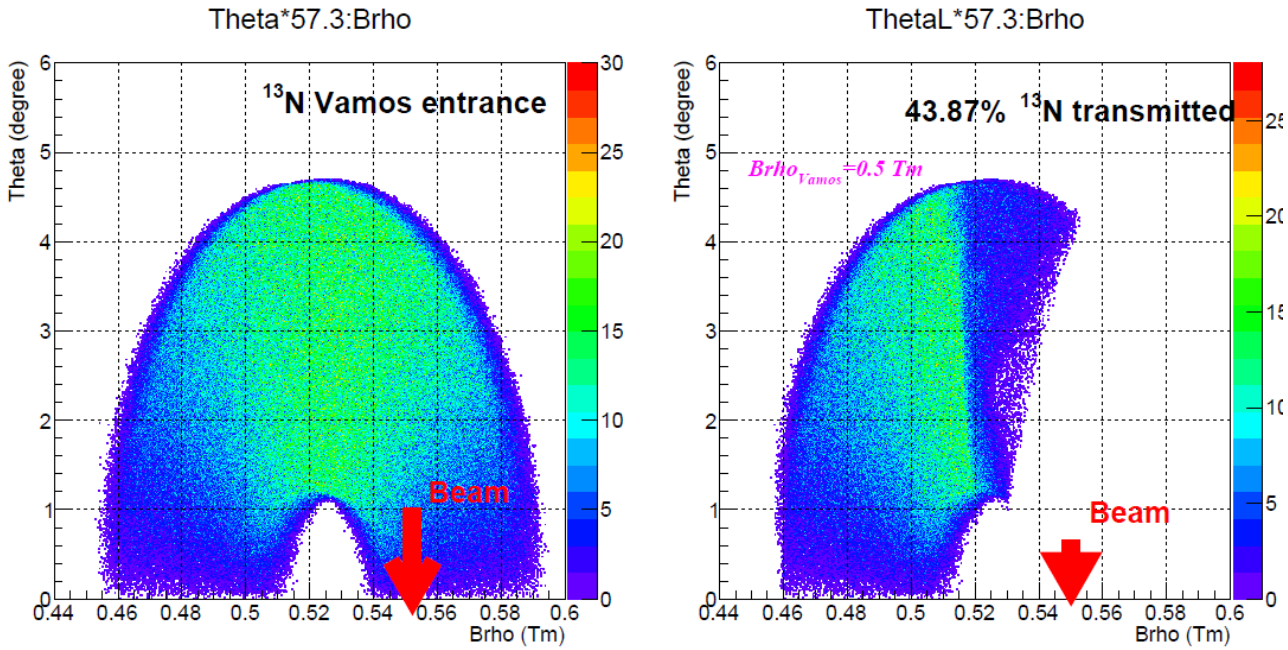

Figure 3 Transmission of ^{13}N trough Vamos. Brho for the ^{13}N of interest if between 0.45 to 0.58 Tm. Brho of reference for Vamos ~ 0.5 Tm

The gammas emitted from the ^{1}H(^{14}O,gamma p)^{14}O reaction will be detected by Agata

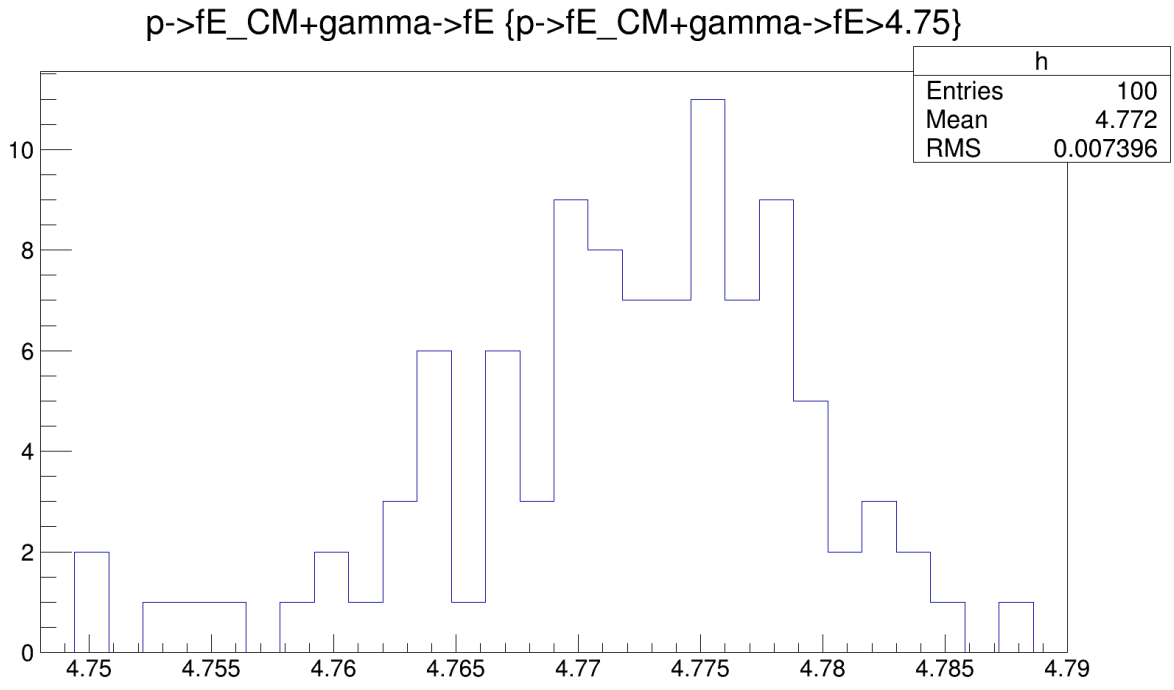

Figure 4 Reconstruction of the ^{15}F energy in the CM E_{CM}=Egamma+ Eproton, where Egamma is the energy detected in Agata and Ep energy of the proton detected in Mugast, while the ^{14}O is detected in Vamos.

5) Counting

(I) Other 2p states in ^{15}F

^{1}H(^{14}O,p)^{14}O resonant scattering → cross-section (>10 mb) 0.8 count/s Mugast

(II) 2p decay from states above 1/2-

^{1}H(^{14}O,pp)^{13}N 0.1 – 350 counts/h in Mugast depending on the state characteristics. 0.04-150 counts/h if we look at the coincidences between protons in Mugast ***and*** ^{13}N in Vamos

(III) Gamma branching ratio of the 1/2- state

^{1}H(^{14}O,γp)^{14}O 40 – 150 /UT (γp) decays from the 1/2- state

10 – 70 /UT p-^{14}O measured protons from the $^{15}F_{gs}$ after γ decay in Mugast and ^{14}O in Vamos

1 - 10 /UT p-γ-^{14}O measured coincidences in Mugast –Vamos – Agata

For 6 UT for the measurement on the CH2 target of 100 um -> 360–900 p-^{14}O measured in Mugast – Vamos and 6-60 p-γ-^{14}O measured coincidences in Mugast –Vamos –Agata

4 UT are required for off resonance measurement -> CH2 target of 70 um

3 UT for background measurement (C target of the same thickness as 100 um CH2)

3 UT for tuning, beam purification and ^{1}H(^{14}N,p)^{14}N calibration measurement

Total 6+4+3+3 = 16 UTs (for comparison 18 UTs allocated for 2018 measurement)

[1] F. de Grancey et al. Phys. Lett. B 758, 26 (2016)

[2] I. Stefan et al. Phys. Rev. C 90, 014307 (2014)