New perspectives opened by the MAGNEX-EDEN facility at the LNS

Francesco Cappuzzello

Università di Catania e INFN-Laboratori Nazionali del Sud (Italy)

LEA-COLLIGA Meeting, Legnaro, November 18th - 19th 2010

The MAGNEX team

- F.C., Carbone, M.Cavallaro, A.Cunsolo, A.Foti, M.Bondì, G.Santagati, G.Taranto

INFN-LNS and Sez.CT

University of Catania

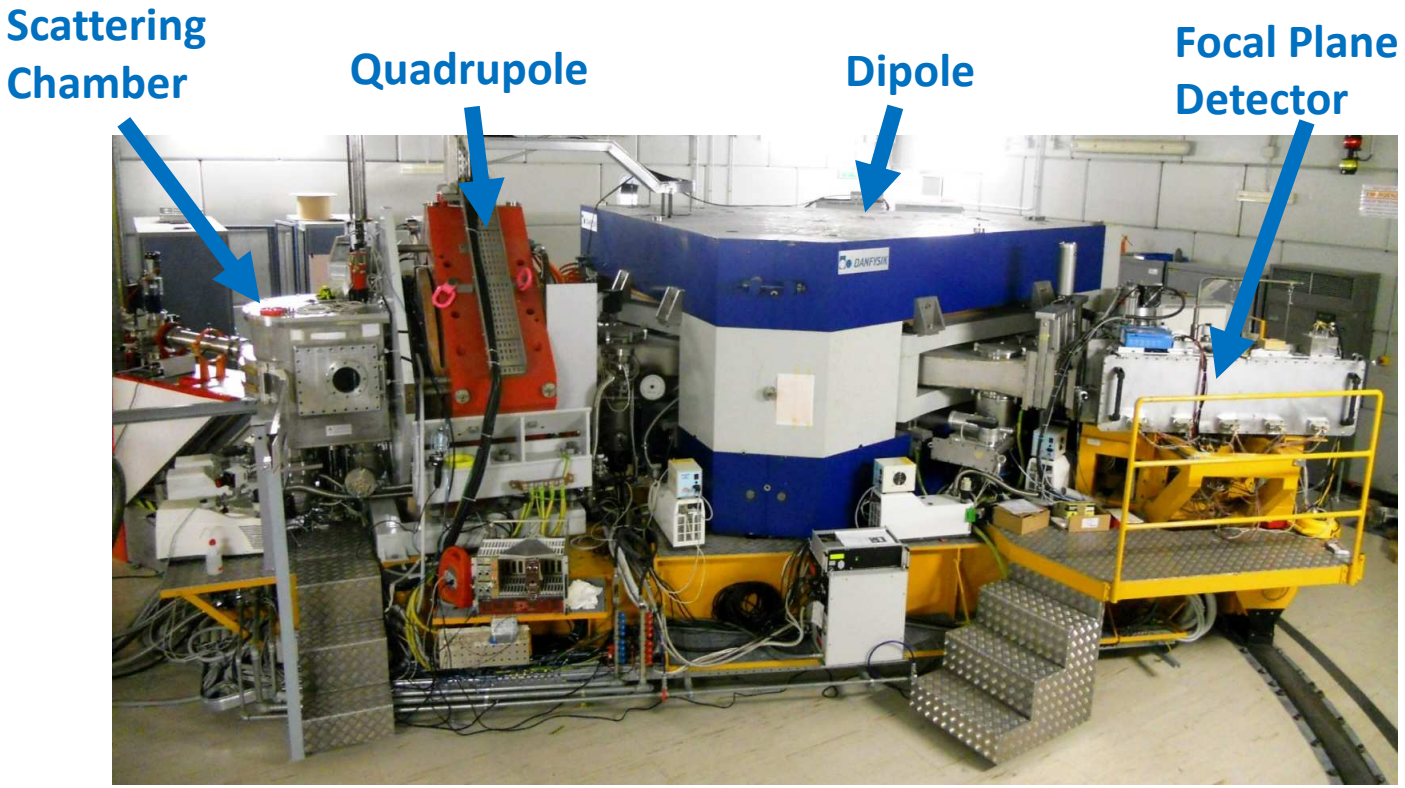
MAGNEX

Algebraic trajectory-reconstruction

Main features	Values
Maximum magnetic rigidity	1.8 T m
Solid angle	50 msr
Momentum acceptance	± 13%
Momentum dispersion for k = -0.104 (cm/%)	3.68
First order momentum resolution $R_p = \frac{D}{M_x \Delta x}$	5400

Measured resolution

Energy ΔE/E ~ 1/1000
Angle Δθ ~ 0.3°
Mass Δm/m ~ 1/160



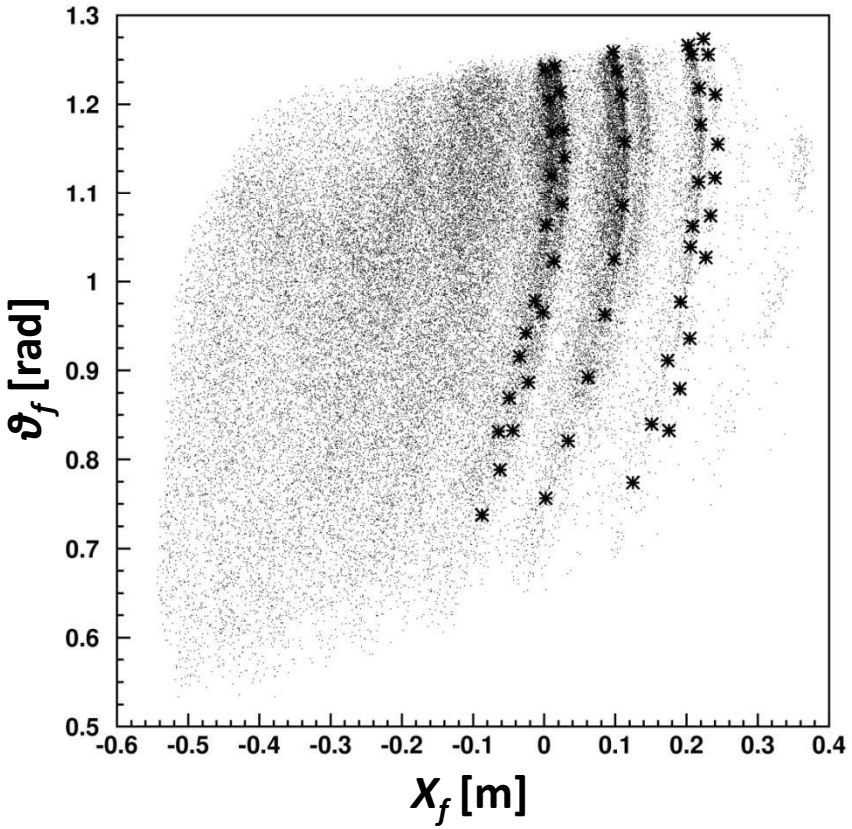
Last news on MAGNEX

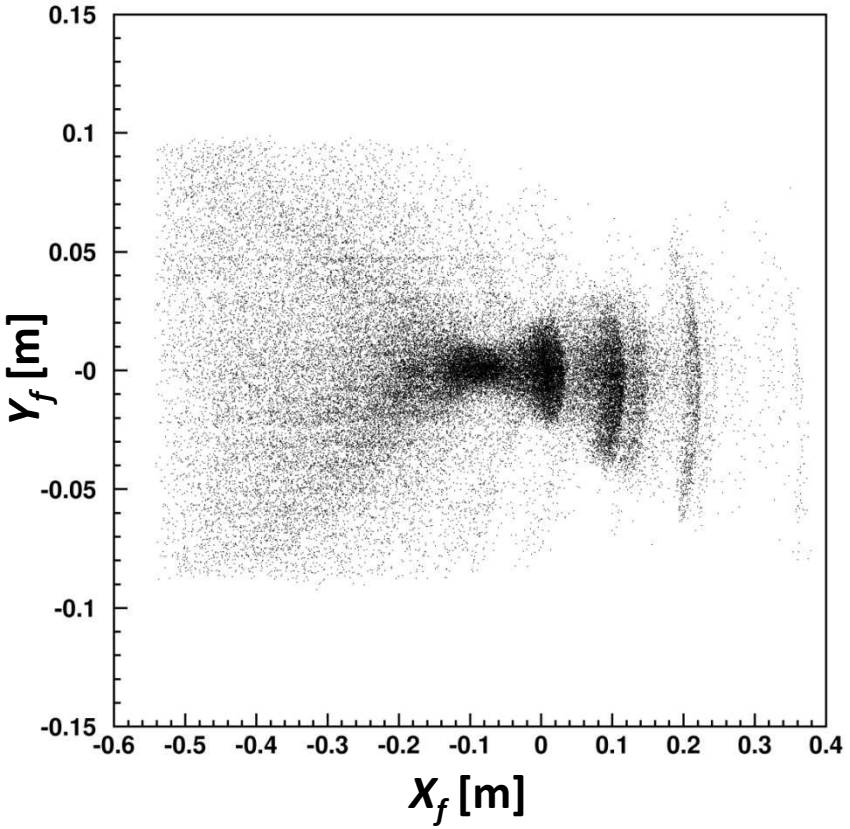
✓The new sliding seal installed and tested

Accuracy of the ray-reconstruction

Experimental data for the $^{13}C(^{18}O,^{16}O)^{15}C$ at 84 MeV

Some asterisks have been superimposed to the events corresponding to the ground and the states at 0.74 MeV, 4.22 MeV, 8.84 MeV, 7.35 MeV and are used to guide the eyes.



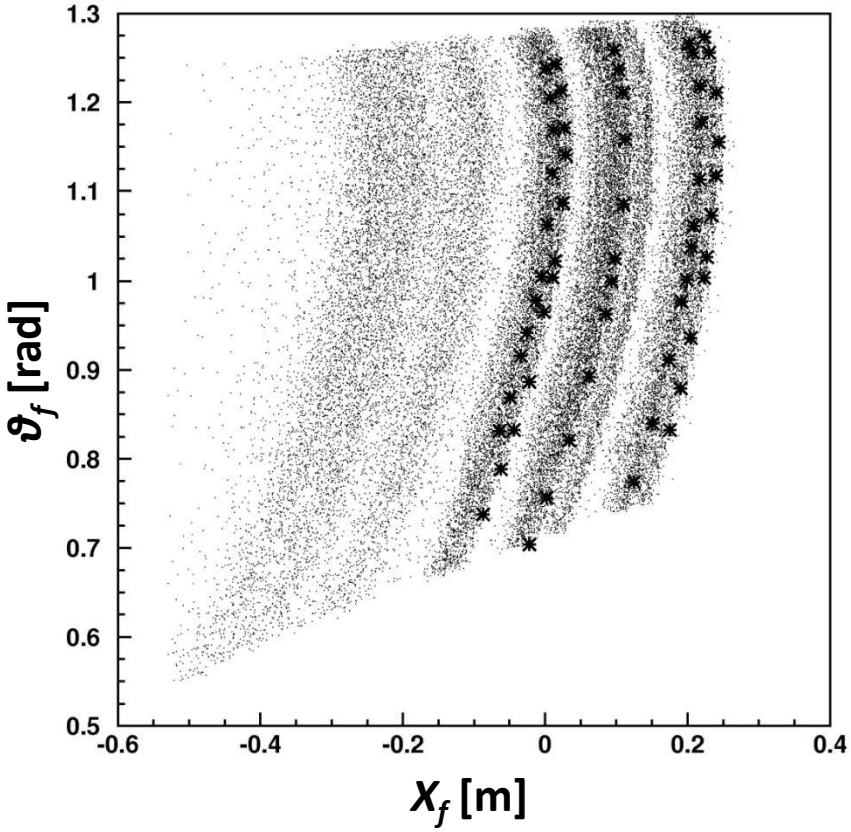


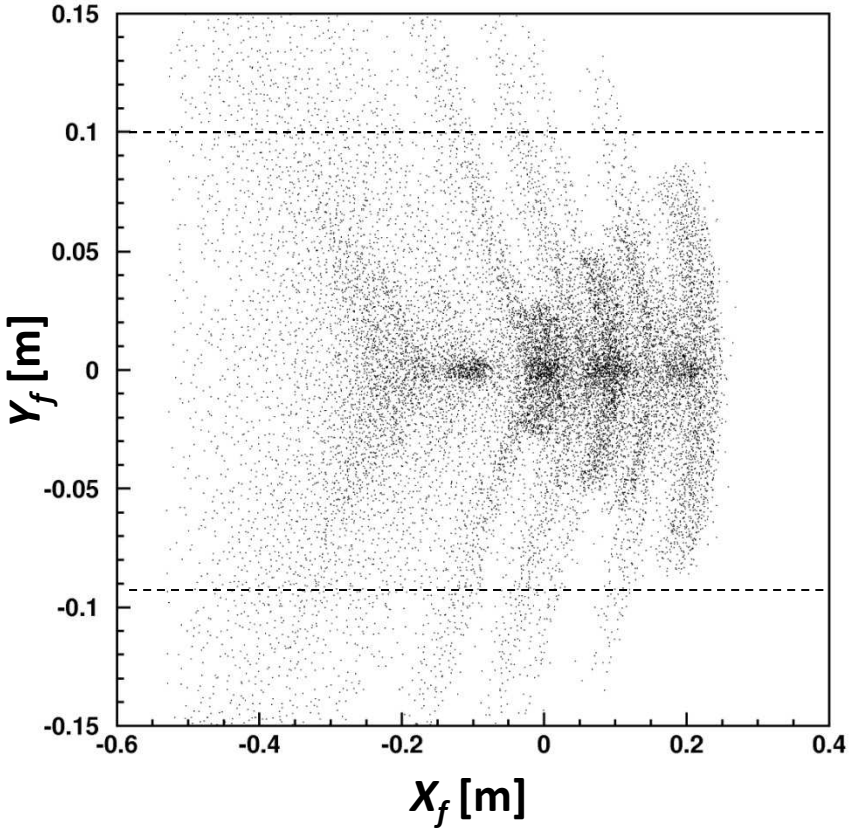
Accuracy of the ray-reconstruction

Simulations for the $^{13}C(^{18}O,^{16}O)^{15}C$ at 84 MeV

The asterisks are drawn at the same coordinates as for the experimental data

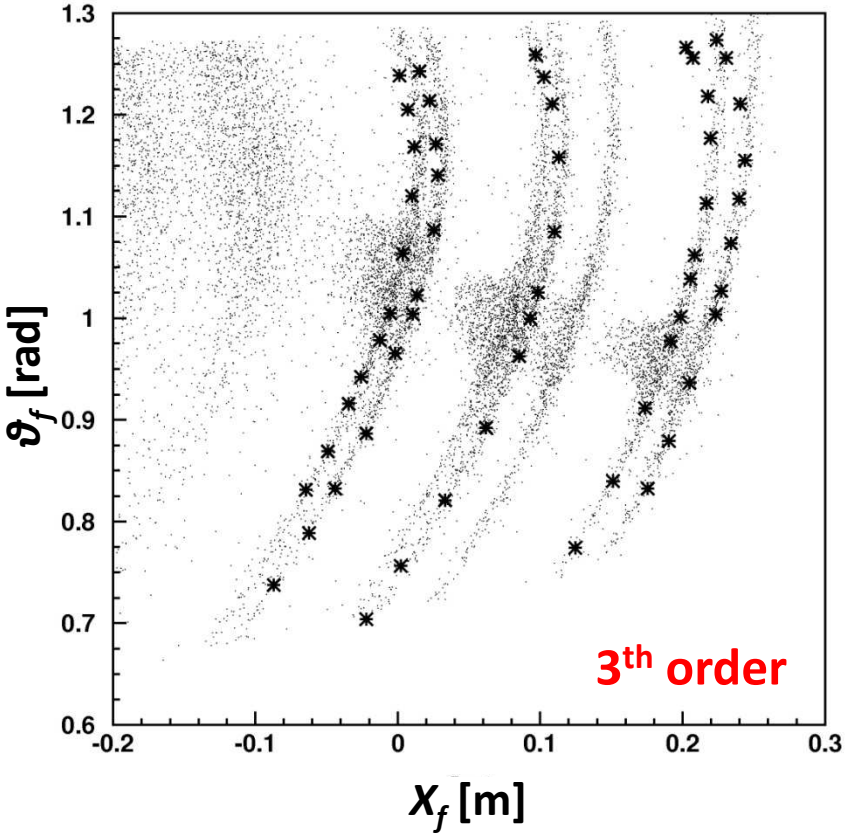
The dashed lines indicate the vertical cut-off due to the limited size of the FPD.

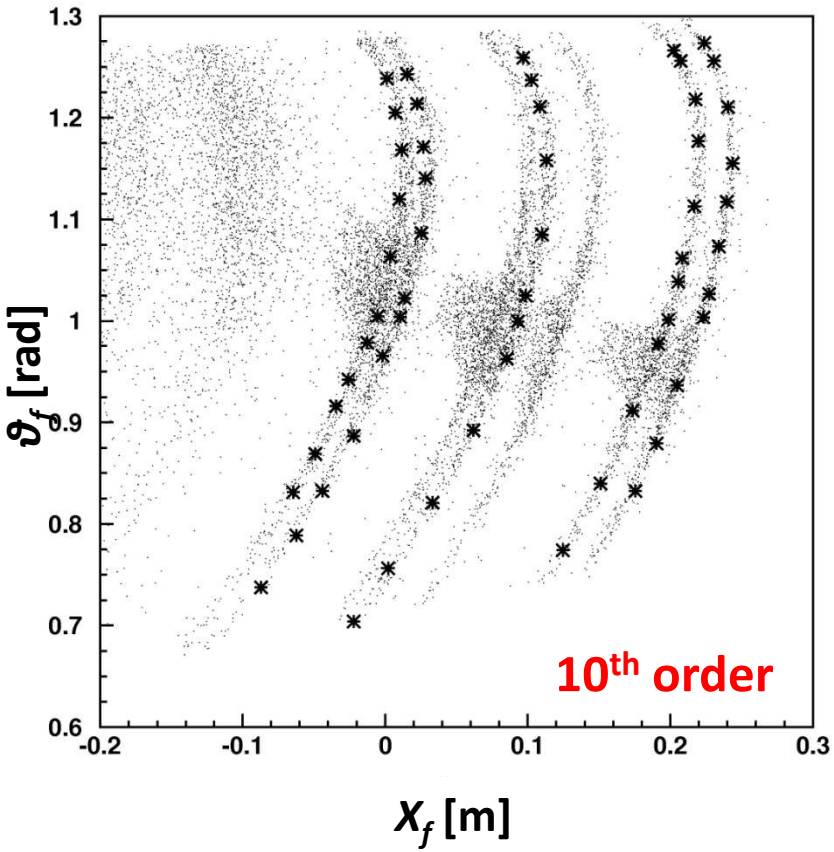




Accuracy of the ray-reconstruction

With condition:
-0.01 m < Y_f < 0.01 m



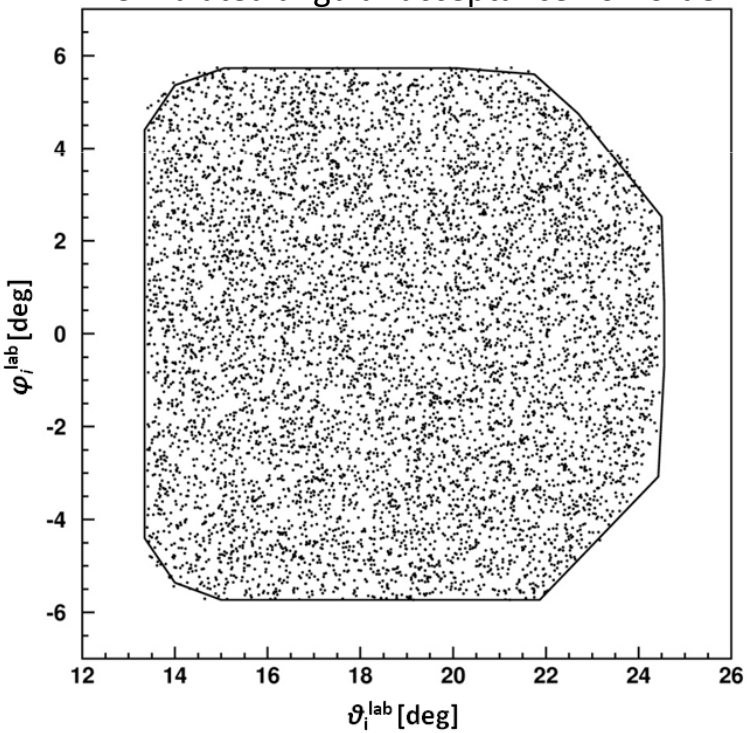


More about the transport efficiency

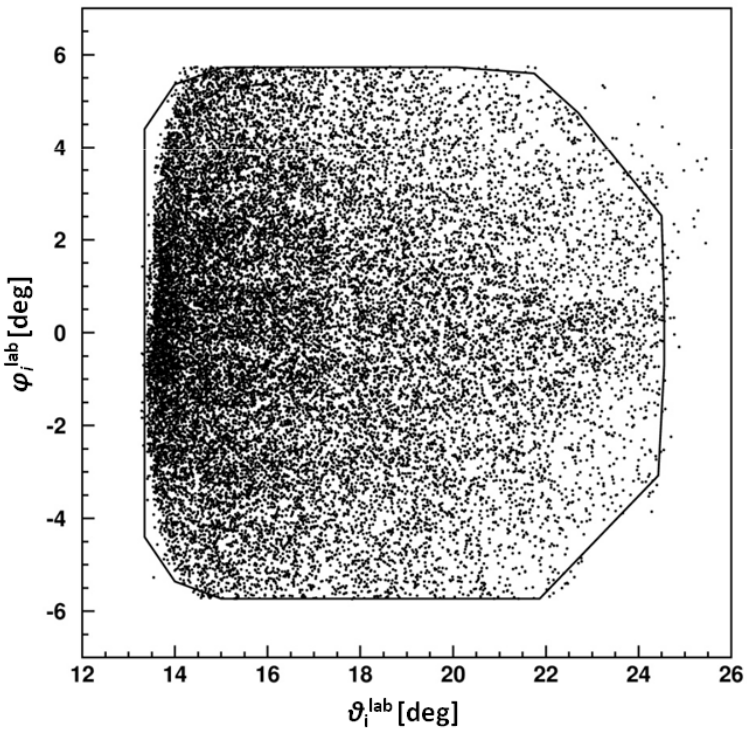
✓The transport efficiency accurately determined by trajectory reconstruction

$^{16}O + ^{197}Au$ elastic scattering at 100 MeV

Simulated angular acceptance 10th order



Experimental angular acceptance 10th order



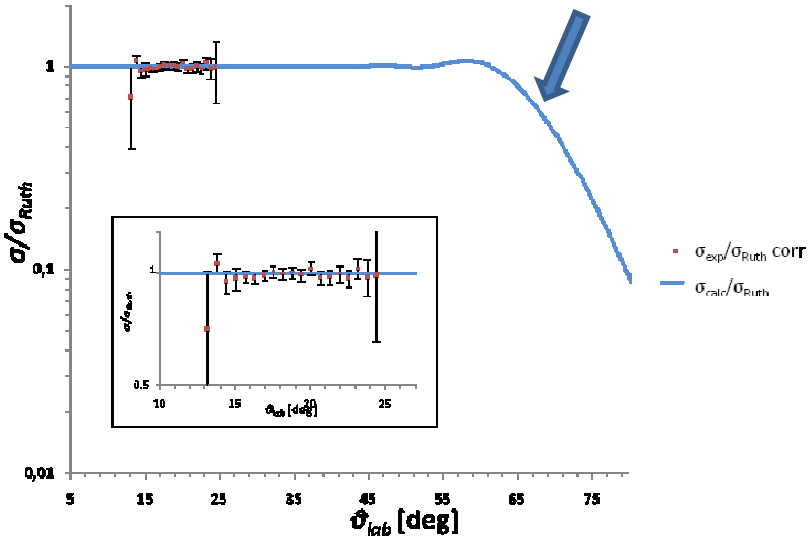
M.Cavallaro et al. Submitted to NIM A

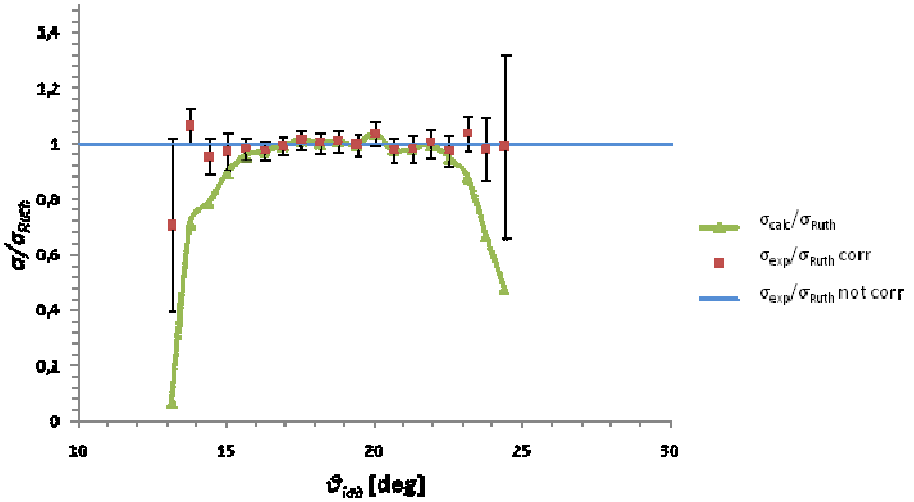
Last news on MAGNEX

✓The transport efficiency accurately determined by trajectory reconstruction

$^{16}O + ^{197}Au$ elastic scattering at 100 MeV

DWBA with San Paolo potential



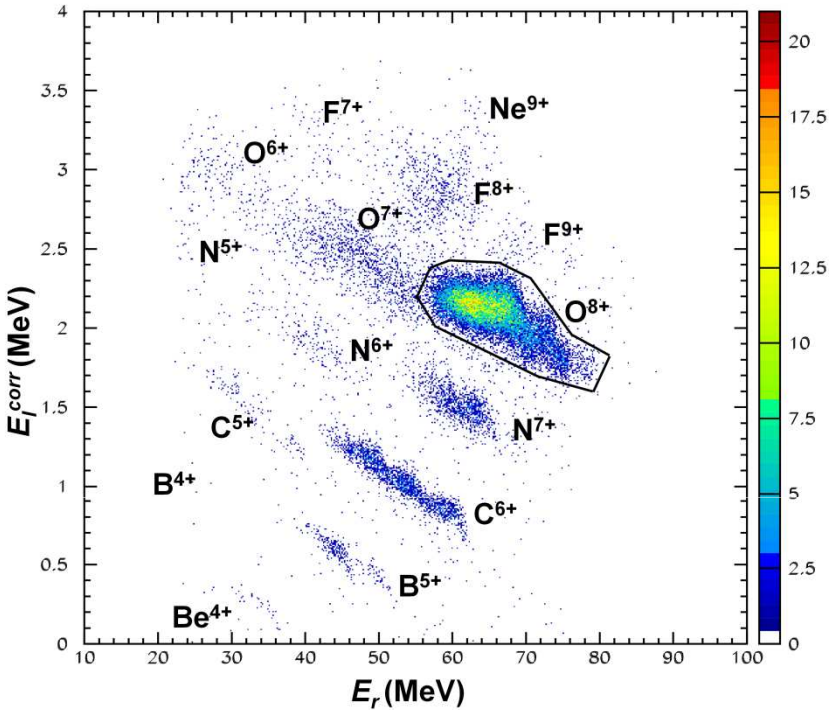


$\langle \sigma_{exp}/\sigma_{ruth} \rangle = 0.996 \pm 0.015$

$\Delta \sigma_{exp} / \sigma_{exp} = \pm 0.05$

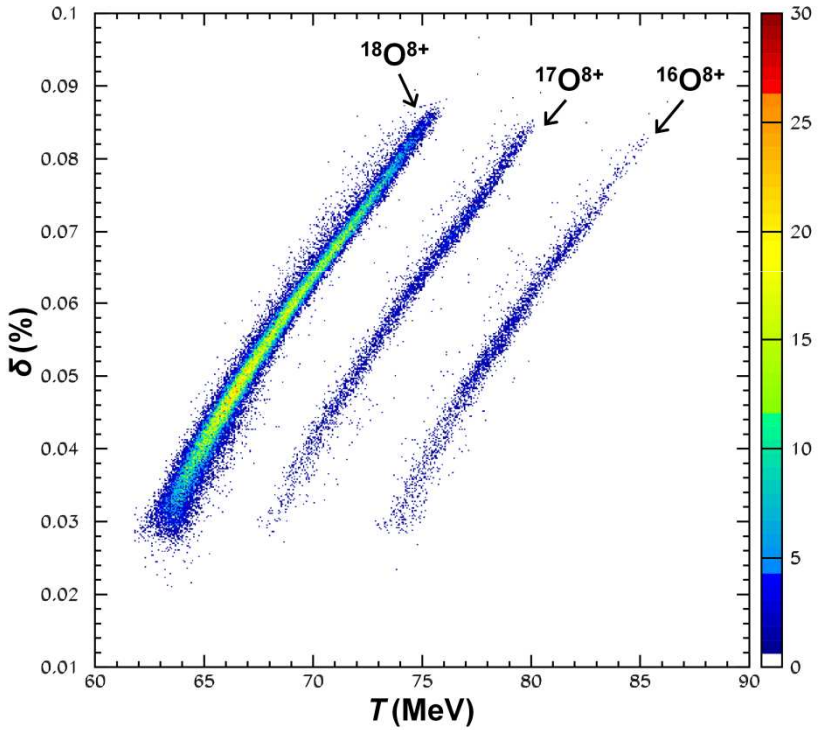
M.Cavallaro et al. Submitted to NIM A

Particle Identification



$$E_l^{corr} = E_l \frac{\cos\theta_{tilt}}{\cos\theta_{foc}}$$

$$B\rho = \frac{p}{q} \rightarrow \frac{\sqrt{m}}{q} = \frac{p_0(\delta+1)}{q\sqrt{2T}}$$



$$T = E_r + E_l + E_d$$

Mass resolution Δm/m ~ 1/160

F.Cappuzzello et al. NIMA 621 (2010) 419-423

Study of 2n transfer reactions (^{18}O,^{16}O) at 84 MeV

on ^{9}Be, ^{11}B, ^{12}C, ^{13}C, ^{28}Si, ^{56}Ni,^{64}Ni, ^{120}Sn e ^{208}Pb targets

In collaboration with

F.Azaiez, S.Franchoo, M.Niikura, J.A.Scarpaci …….
IN2P3-IPN-Orsay

A.Bonaccorso
INFN Sez.Pisa

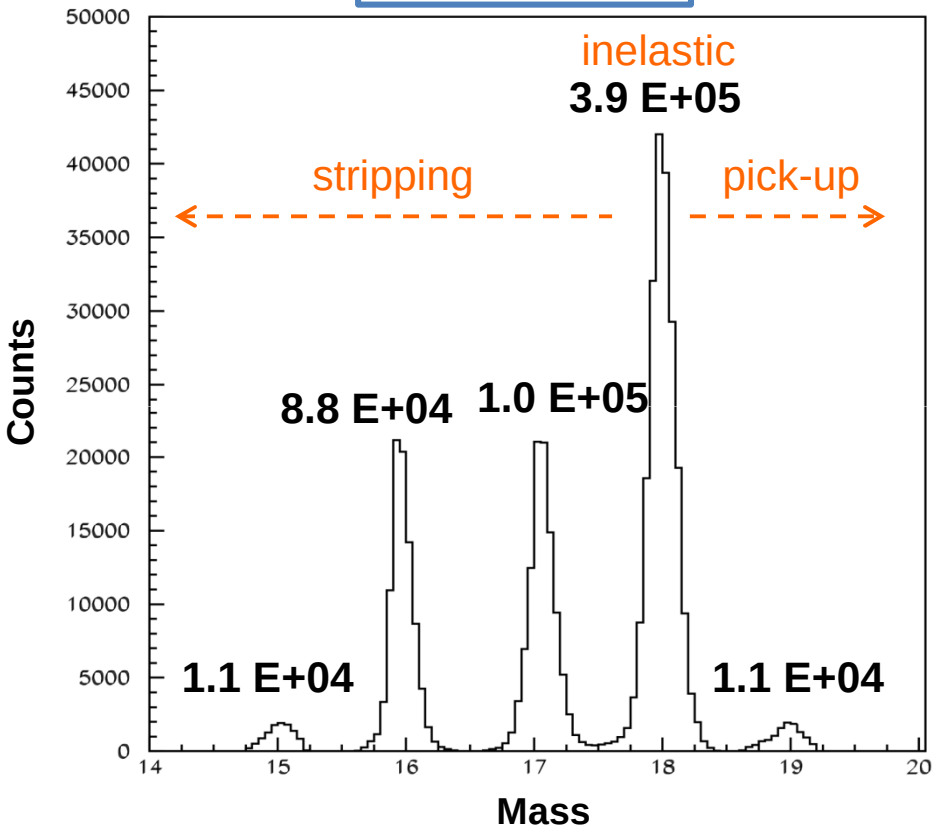
H.Lenske
University of Giessen

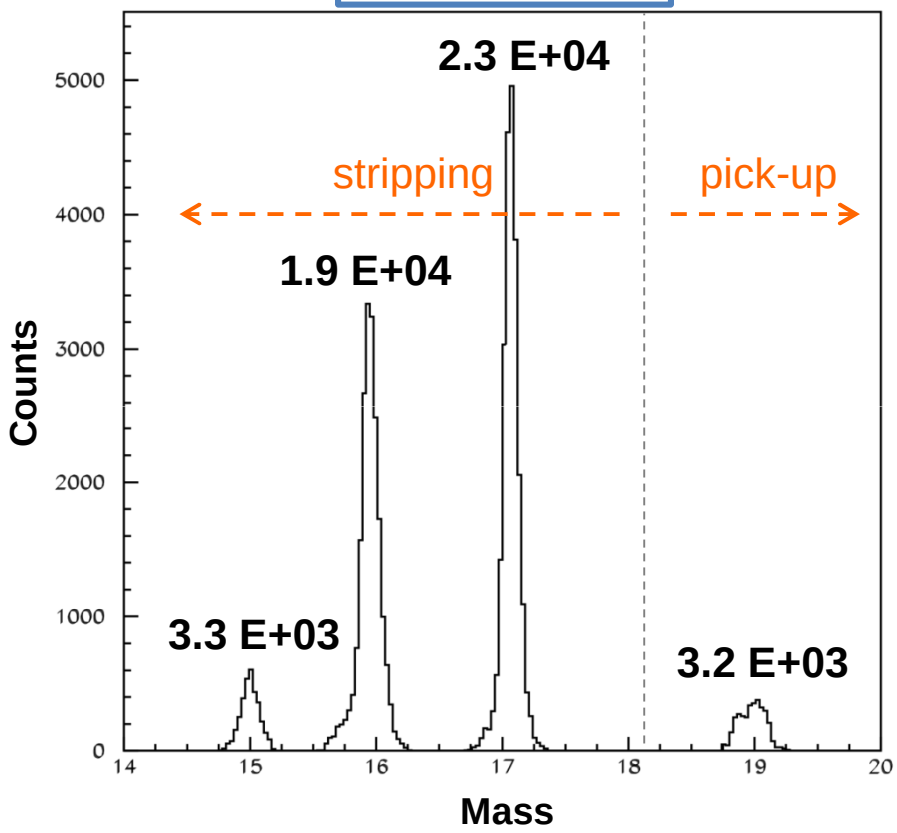
Experimental results

Target ^{13}C

$7° < \theta_{lab} < 13°$

Target ^{12}C





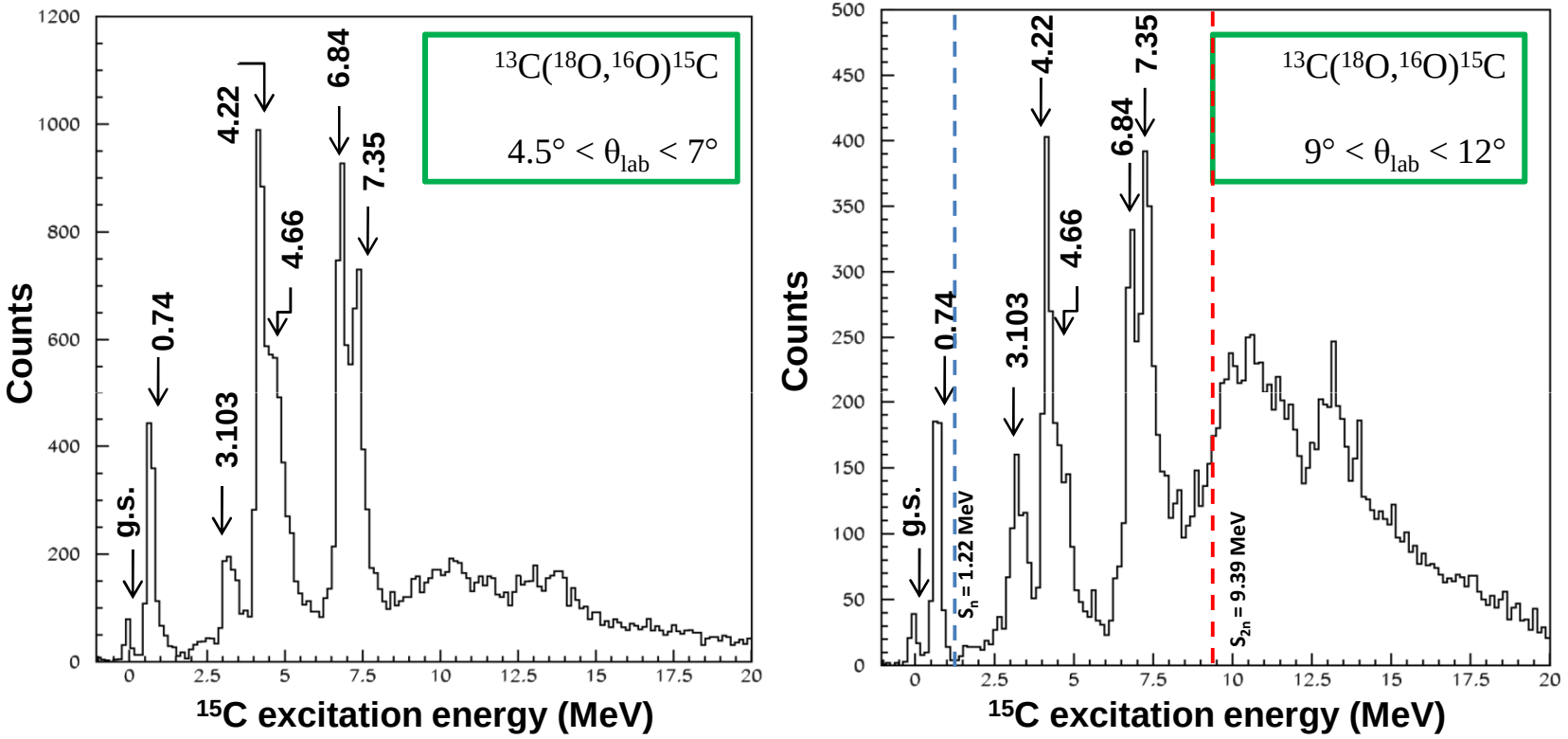
Arbitrary units

Efficiency for the production of different charge states estimated using the program INTENSITY

J.A.Winger et al., NIM B70(1992) 380-392

Experimental results

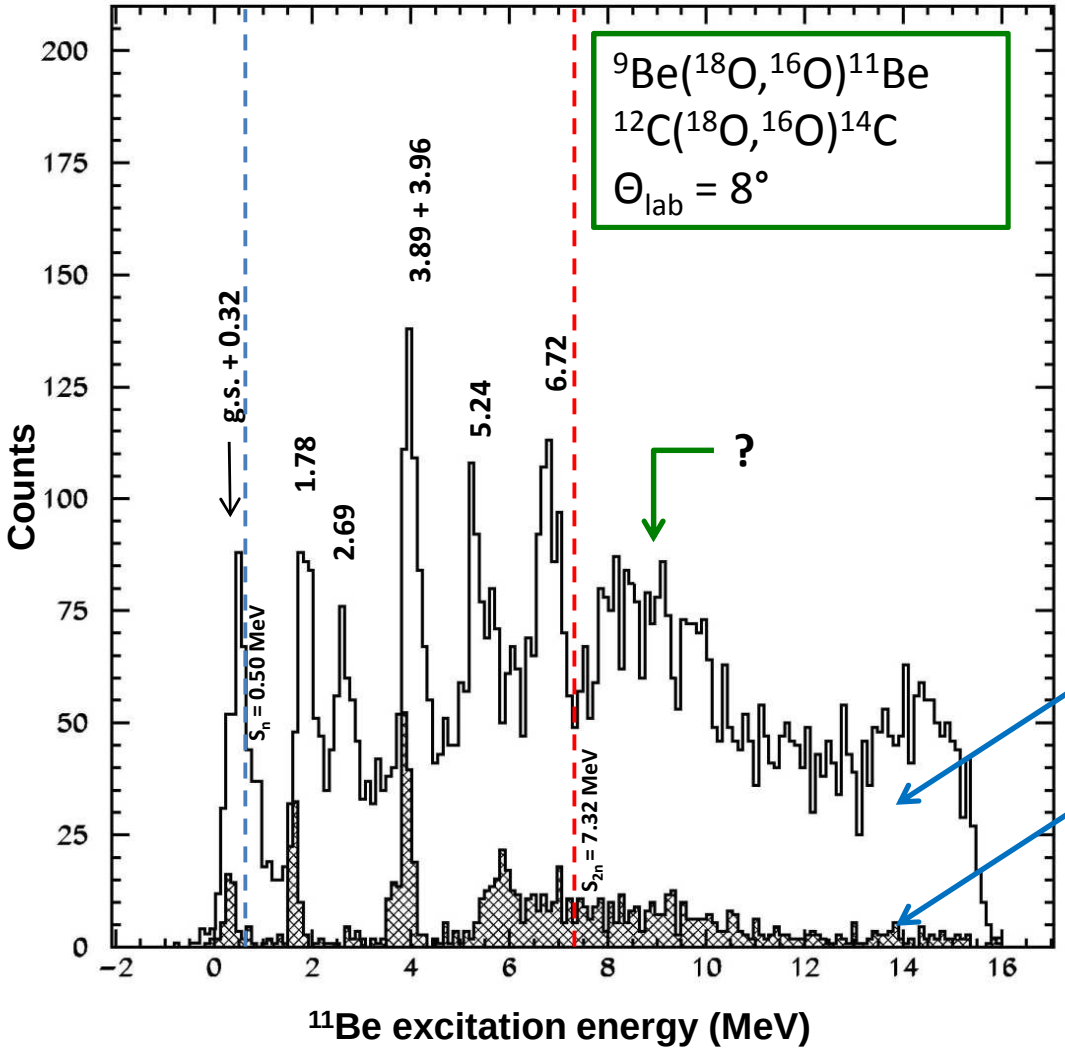
PRELIMINARY



$^{13}C_{g.s.}(1/2^-) \rightarrow {}^{15}C_{g.s.}(1/2^+)$	L = 1	$^{13}C_{g.s.}(1/2^-) \rightarrow {}^{15}C_{4.66}(3/2^-)$	L = 2
$^{13}C_{g.s.}(1/2^-) \rightarrow {}^{15}C_{0.74}(5/2^+)$	L = 3	$^{13}C_{g.s.}(1/2^-) \rightarrow {}^{15}C_{6.84}(7/2^-,9/2^-)$	L = 4
$^{13}C_{g.s.}(1/2^-) \rightarrow {}^{15}C_{3.103}(1/2^-)$	L = 0	$^{13}C_{g.s.}(1/2^-) \rightarrow {}^{15}C_{7.35}(7/2^-,9/2^-)$	L = 4
$^{13}C_{g.s.}(1/2^-) \rightarrow {}^{15}C_{4.22}(5/2^-)$	L = 2		

S.Truong and H.T.Fortune, Phys.Rev.C28,977(1983)

Preliminary spectrum of ^{11}Be



^{18}O beam 84 MeV

^{9}Be target 114µg/cm^2 +
collodion 6 µg/cm^2

^{9}Be target

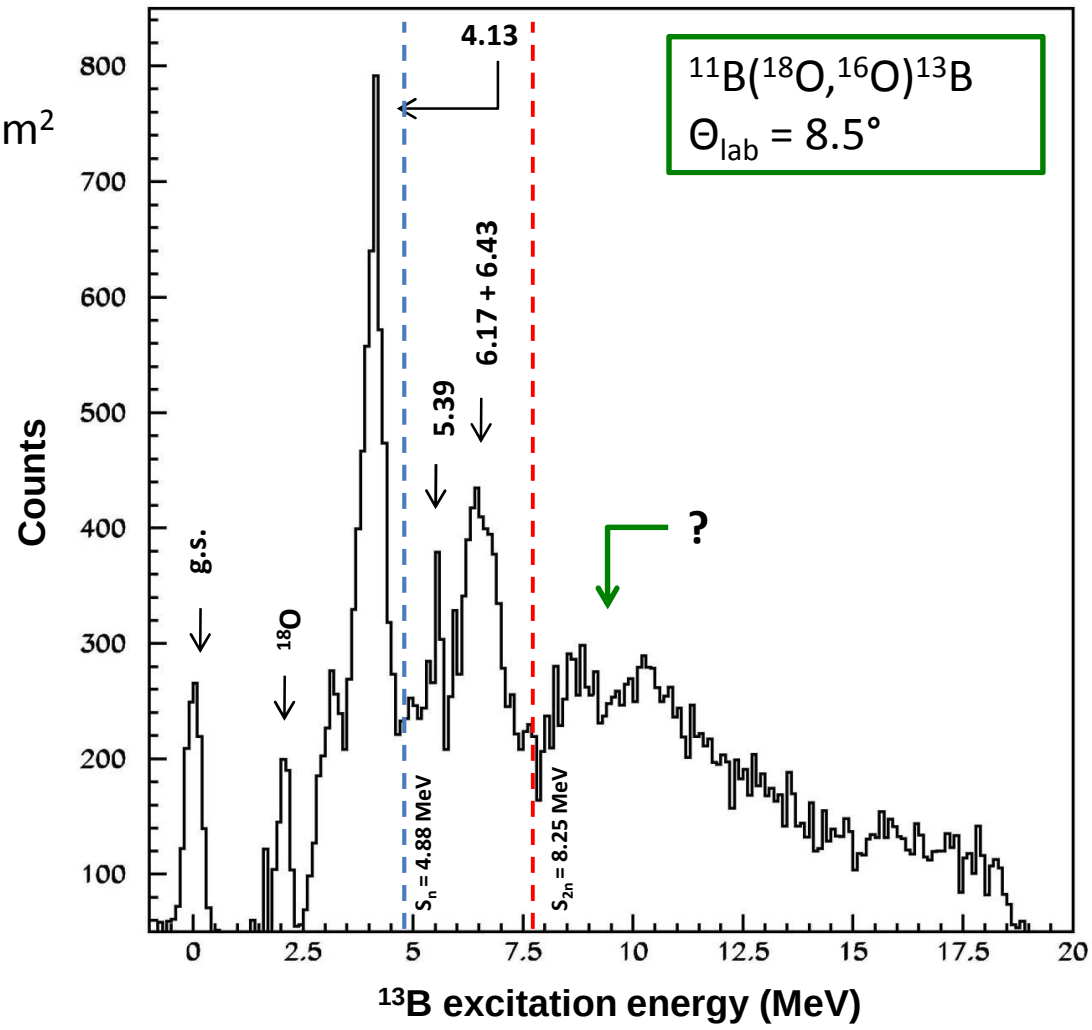
^{12}C target

Preliminary spectrum of ^{13}B

^{18}O beam 84 MeV

^{11}B target 33µg/cm^2 + Formvar 4 µg/cm^2
^{12}C target 50 µg/cm^2

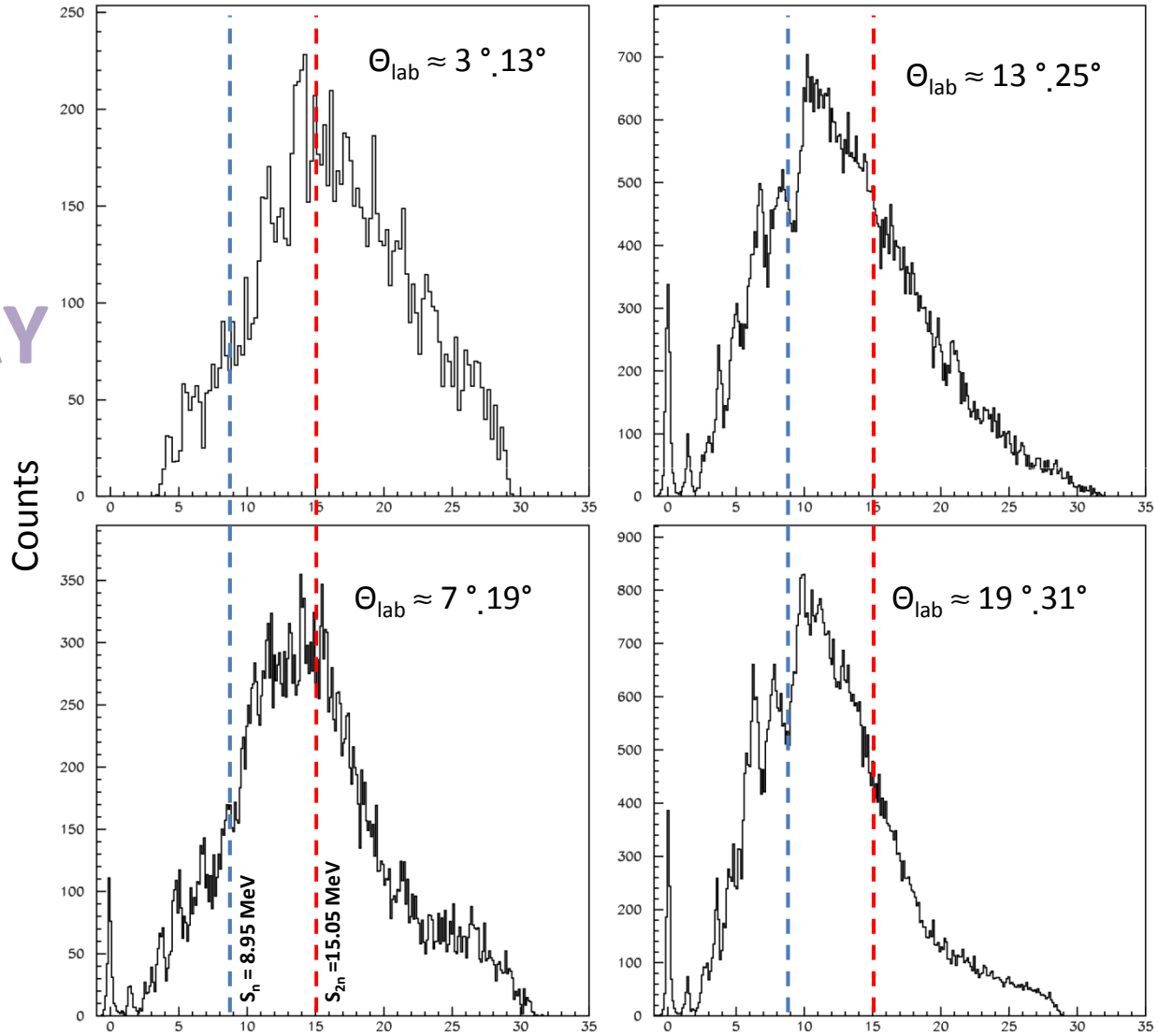
Contribution due to carbon impurities subtracted



$^{64}Ni(^{18}O,^{16}O)^{66}Ni$

$^{64}Ni(^{18}O,^{16}O)^{66}Ni$
E_{beam} = 84 MeV
Max E^* 28 MeV

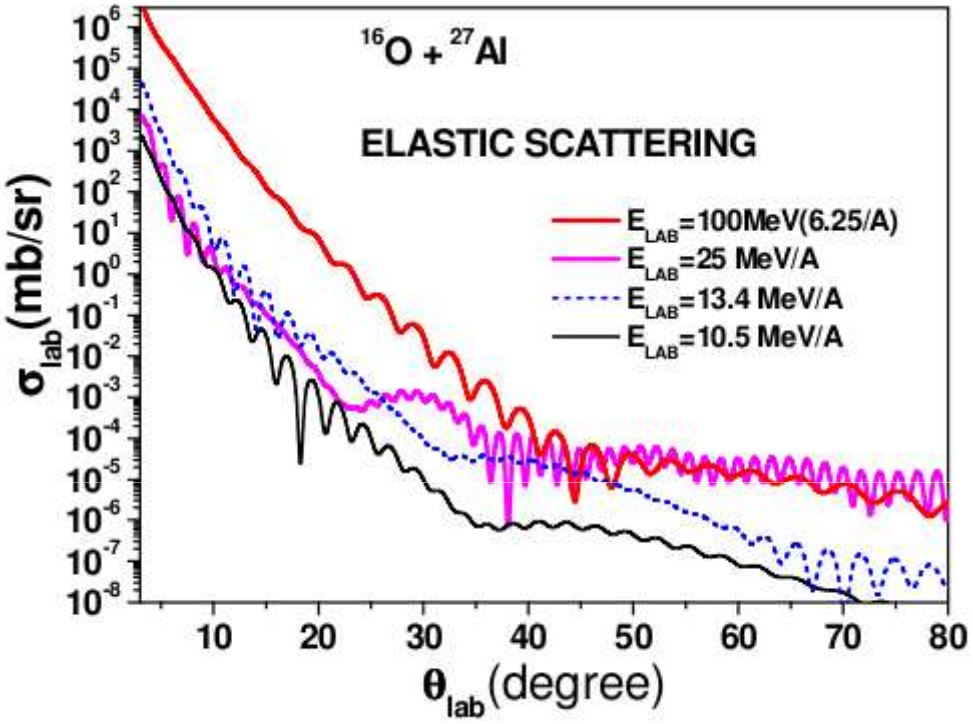
PRELIMINARY



Nuclear Rainbow
in the $^{16}O + ^{27}Al$ elastic scattering at 100 MeV

Feasibility Test (March 2010)

Sao Paulo potential prevision

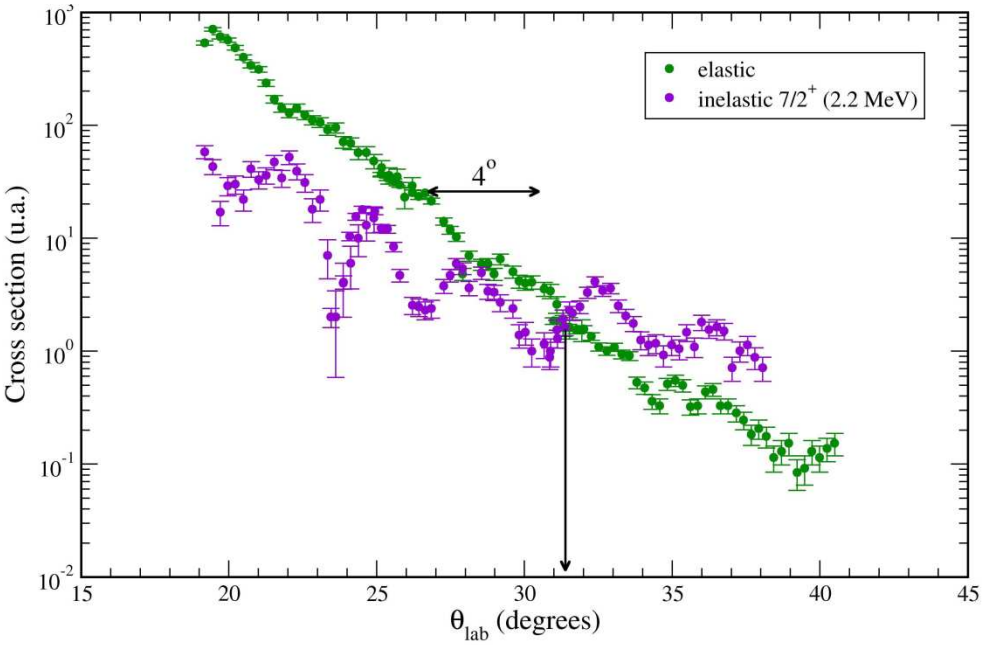


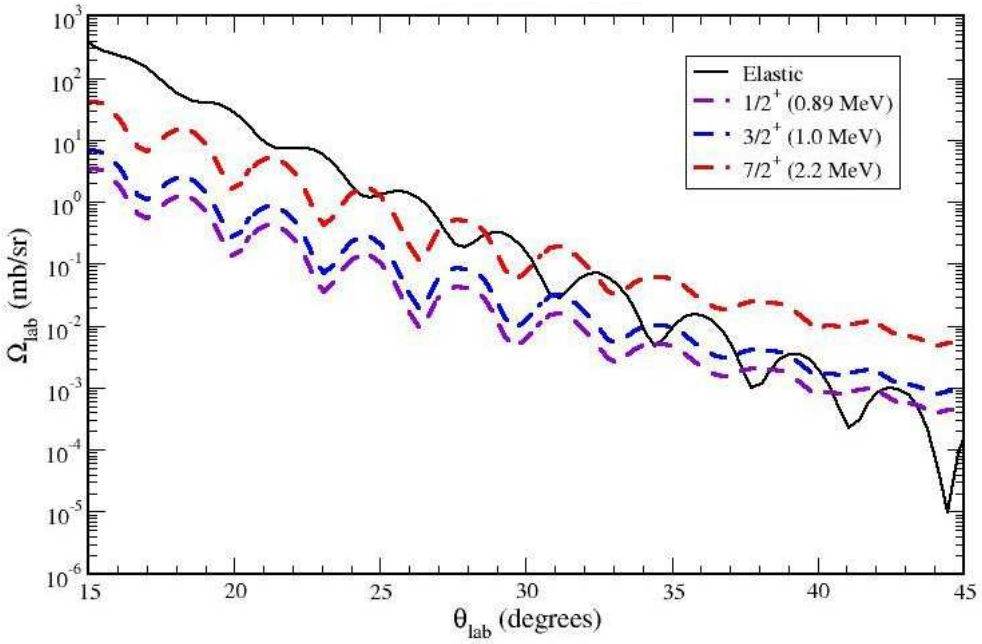
Coupled Channel formalism considering a new generation of parameter-free **Sao Paulo Potential** that takes into account surface dissipative processes (deep-inelastic/breakup), see refs. [24].

- M.A.Candido Ribeiro,et al PRL78 (1997) 3270.
- L.C..Chamon, D.Pereira, et al, PRL 79 (1997) 5218.

D. Pereira[a], A. Cunsolo[b,c], F. Cappuzzello[b,c], M. Cavallaro[b,c], J.R.B. Oliveira[a], R. Linares[d], J. Lubian[d], A.Foti[e], D.Carbone[b,c],M. Bondì[b,c], G. Santagati [b,c], G. Taranto [b,c], L.C. Chamon [a], P.R.S. Gomes[d], E.Crema[a], C.P. Silva[a], E.S. Rossi Jr[a], and L.R. Gasques[a].

a) Instituto de física da Universidade de São Paulo, São Paulo, Brazil.
b) Dipartimento di Fisica e Astronomia, Università di Catania, Catania, Italy
c) INFN - Laboratori Nazionali del Sud, Catania, Italy
d) Instituto de física da Universidade Federal Fluminense, Rio de Janeiro, Brazil
e) INFN - CT,Catania, Italy





Mai esplorata la sezione d'urto sotto 10^{-2} σ_{ruth} ad alta risoluzione

Obiettivo 10^{-5} σ_{ruth} !

^{16}O beam at 100MeV

^{27}Al target

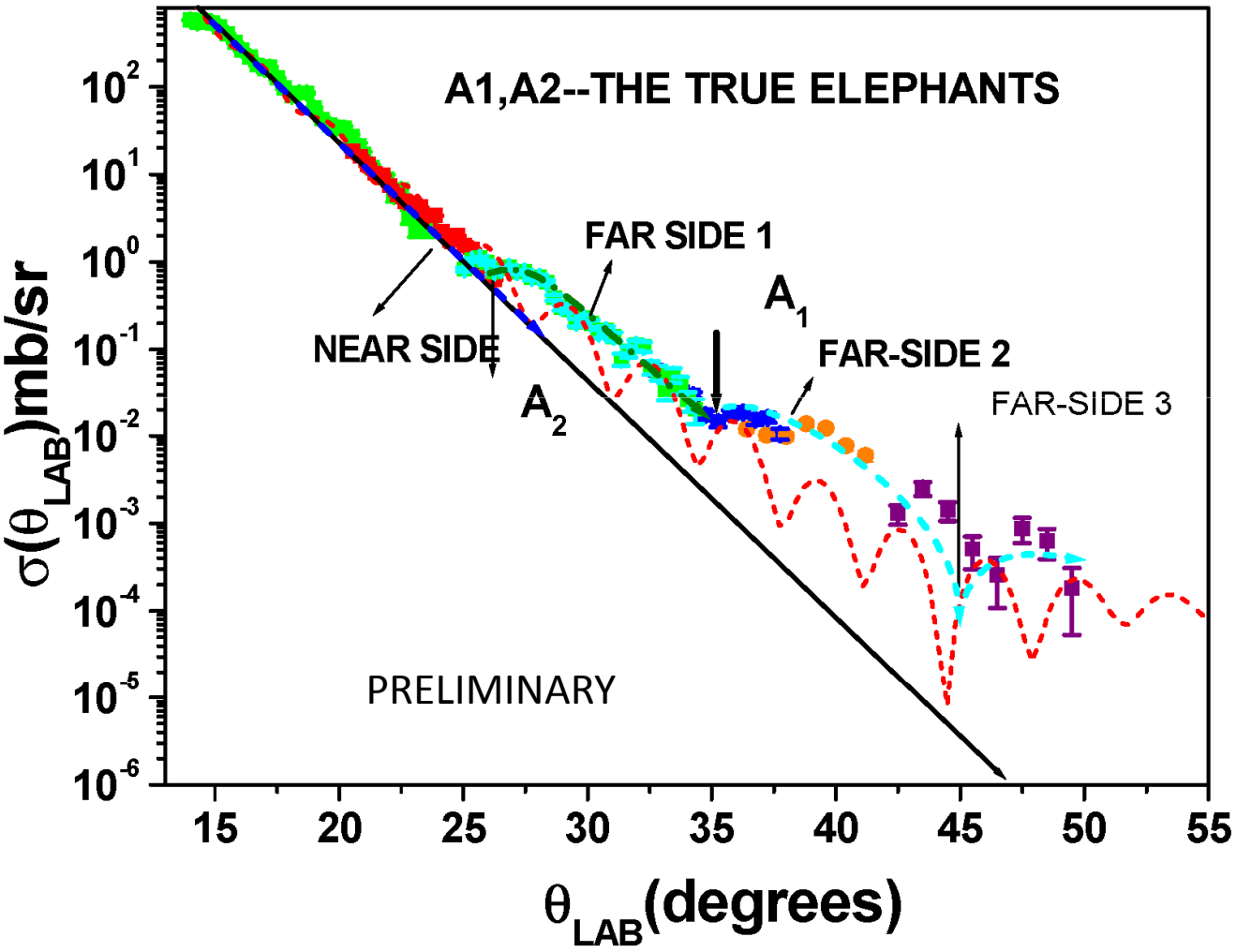
Angular range 13°< θ_{lab} < 52°

Angular resolution ~ 0.5°

Analysis in progress

PRELIMINARY RESULTS

Cross section measured over 7 orders of magnitude



The MAGNEX-EDEN collaboration

MAGNEX + EDEN 2011-2013

MOU signed

INFN -LNS

Francesco Cappuzzello
Angelo Cunsolo
Manuela Cavallaro
Diana Carbone
Salvatore Tudisco
Antonino Foti
Pierpaolo Figuera
Luciano Calabretta
Silvio Cherubini
Stefano Romano
Francesca Rizzo
Clementina Agodi

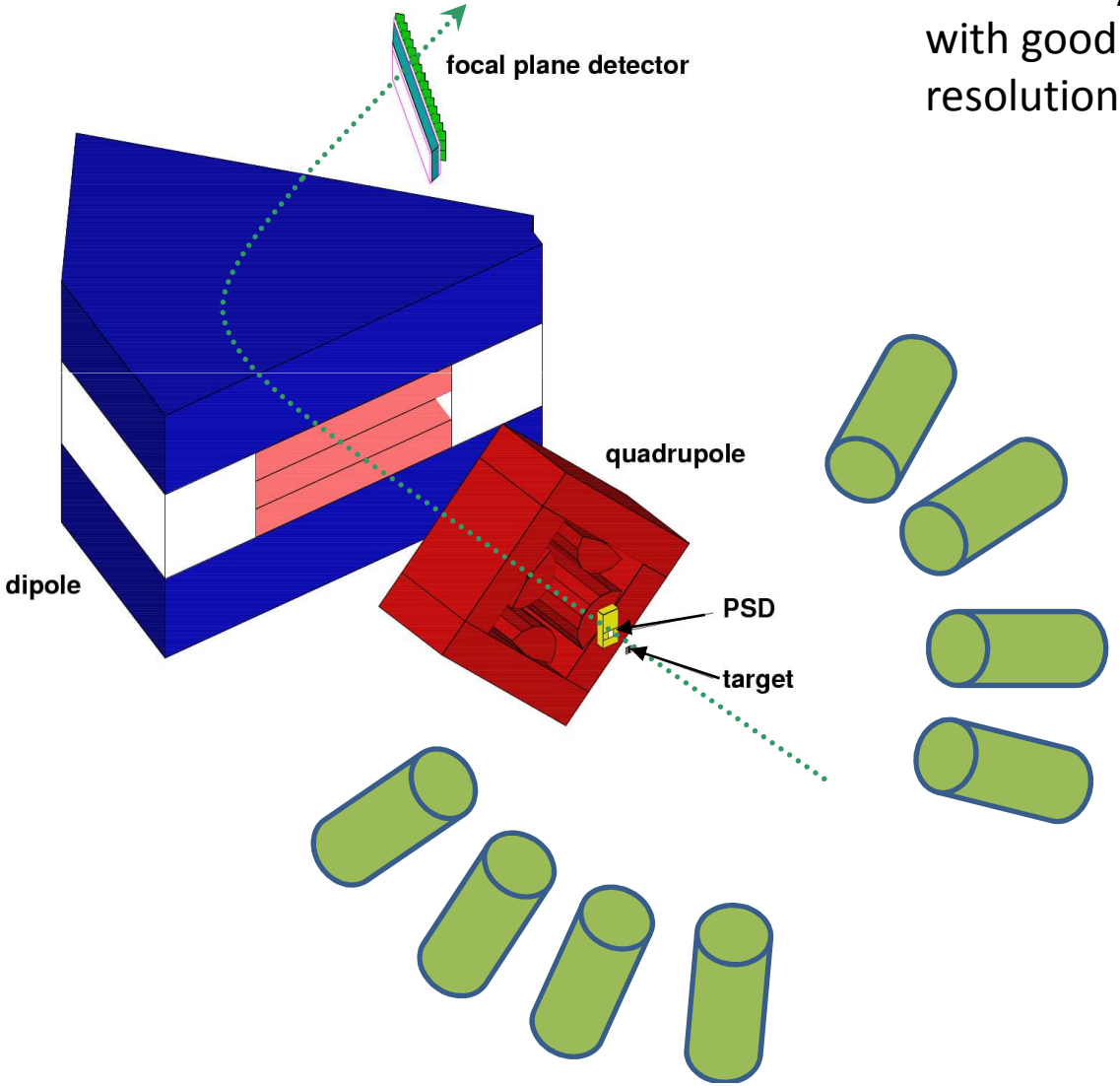
IN2P3 – IPN Orsay

Jean-Antoine Scarpaci
Faical Azaiez
Nicolas de Séréville
Iulian Stefan
Serge Franchoo
Iolanda Matea
Elias Khan
Didier Beaumel
Jacques Guillot
Fairouz Hamache
David Verney
Fadi Ibrahim
Marlene Assié
Francois Leblanc
Brigitte Roussiere

MAGNEX + EDEN

MAGNEX to measure high resolution energy spectra for well identified reaction products

EDEN to study the decaying neutrons emitted by the observed resonances with good efficiency and energy resolution



Unique facility to study the resonant states of neutron rich nuclei (low separation energy)

The EDEN Time Of Flight multidetector

H. Laurent et al., NIM A326 (1993) 417-525

Main features

✓40 NE213 liquid scintillators from the IPN-Orsay

✓Possibility of n - γ discrimination by pulse shape analysis

✓Time resolution of 0.9 ns for TOF measurements

✓Typical energy resolution at a 1.7 m distance from the target: 60 keV/850 keV and 350 keV/3.6 MeV

✓Intrinsic efficiency ~ 50% for 1 MeV and 30% for 6 MeV neutrons

✓Mechanic assembly easily configurable for different experimental requirements

Just one problem

✓Obsolete and unreliable CAMAC electronics for the signal treatment

EDEN Electronics Upgrading

Present pulse shape based on

GANELEC Costant Fraction Discriminators 8 channels NIM(model FCC8)

Gate and Delay Generators 8input/16output NIM (model RDV 8/16)

Charge to Digital Converters 16 channels CAMAC (model QDC 1612F)

New project based on

BaF-PRO processor 16 inputs / 32 analog outputs NIM (developed at the INFN-MI)

32 channels peak sensing ADC VME(model Caen V785)

EDEN Electronics Upgrading

TOF measurement based on

16 channels Time to Digital Converters CAMAC (model GANELEC TDC 812F)

New project based on

32 channel TDC VME (model Caen V775)

32 channels high stability ECL delay line NIM(developed at the INFN-MI)

Time schedule

✓October 2010: arrival of the first four EDEN modules at the LNS

✓October-December 2010: Test of the modules with the new electronics

✓February-March 2011: arrival of the complete EDEN array at the LNS

✓March-April 2011: installation of EDEN on the MAGNEX experimental area

✓May-July 2011: in beam-test of MAGNEX-EDEN

✓September 2011: start the experimental activity

Proposal at the LNS PAC for the commissioning

Requested 15 BTU at the Tandem LNS facility for studying the

$^{12}C(^{18}O,^{17}O)^{13}C$ at 84 MeV	To setup electronics and study efficiency and resolution
$^{16}O(^{18}O,^{17}O)^{17}O$ at 84 MeV	

and the

$^{13}C(^{18}O,^{16}O)^{15}C$ at 84 MeV	2 neutron coincidences

Request fully approved by the LNS Scientific Committee

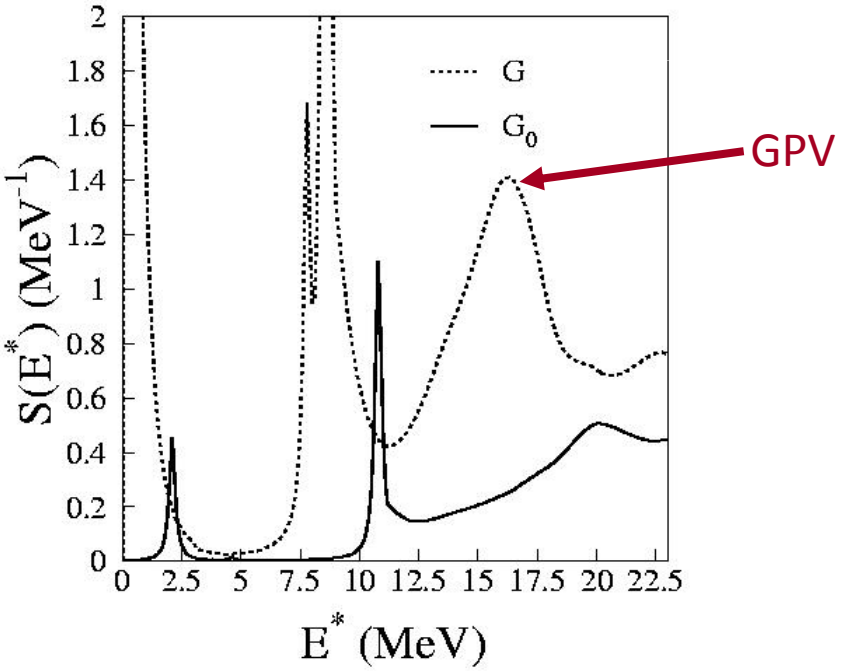
Proposal for beam time approved by the LNS PAC

Discovering Giant Pairing Vibrations with the (p,t) reaction at zero degree

J.A.Scarpaci, E.Khan, M.Assié , F.Azaiez, D.Beaumel, S.Franchoo,
B.Mouginot, I.Stefan, R.Neveling, F.D.Smit

F.Cappuzzello, D.Carbone, M.Cavallaro, A.Cunsolo, A.Foti,
M.Bondì,G.Santagati, G.Taranto,

Predicted using QRPA approach.



E. Khan et al., Phys. Rev. C 69 (2004) 014314

(p,t) on ^{120}Sn and ^{208}Pb target
E_p = 35 MeV

The GPV area is expected between 10 and 16 MeV excitation energy

Four magnetic settings (MAGNEXenergy acceptance ±25%)

Conclusions

- The MAGNEX – EDEN system is going to be installed in 1 year at the LNS

- It will be a unique instrument worldwide opening a very wide range of possibilities in the field of experimental nuclear physics

- A strong collaboration has been established between the LNS and the IPN-Orsay within the LEA framework