

EB report 2019

Conference	Where	when	what	who	Sez
Bormio 2019	Bormio	1/19	talk	Franchini	Bo
15 th Vienna Conf Instr (VCI)	Vienna	2/19	" "	Aafke Kraan	Pi
15 th Vienna Conf Instr (VCI)	Vienna	2/19	" "	Cerello	To
Detector school	Padova	4/19	Poster	Silvestre	Pg
IFAE	Napoli	4/19	Poster	Silvestre	Pg
1 st Biophysics Coll Meeting	Darmstadt	5/19	talk	Patera	Roma1
FAIRness 2019	Genova	5/19	" "	Ridolfi	Bo
CRETE19 Int Conf Appl Nucl Tech	Crete	6/19	" "	Mengarelli	Bo
PTCOG58	Manchester	6/19	" "	Finck	Str
RAD 2019	Montenegro	6/19	" "	Bartosik	To
Young Research Meeting	Rome	4/19		Franciosini	Roma1
Nucleus 2019	Dubna	7/19	" "	Scavarda	To
African Nuclear Phys Conf ANPC	Kruger Park S. Africa	7/19	" "	Cerello	To
INPC 2019 Int Nucl Phys Conf	Glasgow	7/19	" "	Traini	Roma1
36 th Masurian Lakes Conf on Phys	Poland	9/19	" "	P. Carra	Pi
SIF	Aquila	9/19	" "	Spiriti	Lnf
SIF	Aquila	9/19	" "	Ubezio	Bo
SIF	Aquila	9/19	" "	Scavarda	To
DGMP (Germ Conf Med Phys)	Norimberga	9/19	" "	Weber	GSI
NSS/MIC-IEEE Nucl Sci & Med Imag	Manchester	10/19	" "	Morrocchi	Pi
Rad Research Society (RRS)	Helsinki	11/19	" "	Marafini	Roma1
NUSPRASEN Nucl Scien Appl	Helsinki	11/19	" "	Colombi	Trento

2016

☐ Talk: 1

2017

☐ Talk: 4

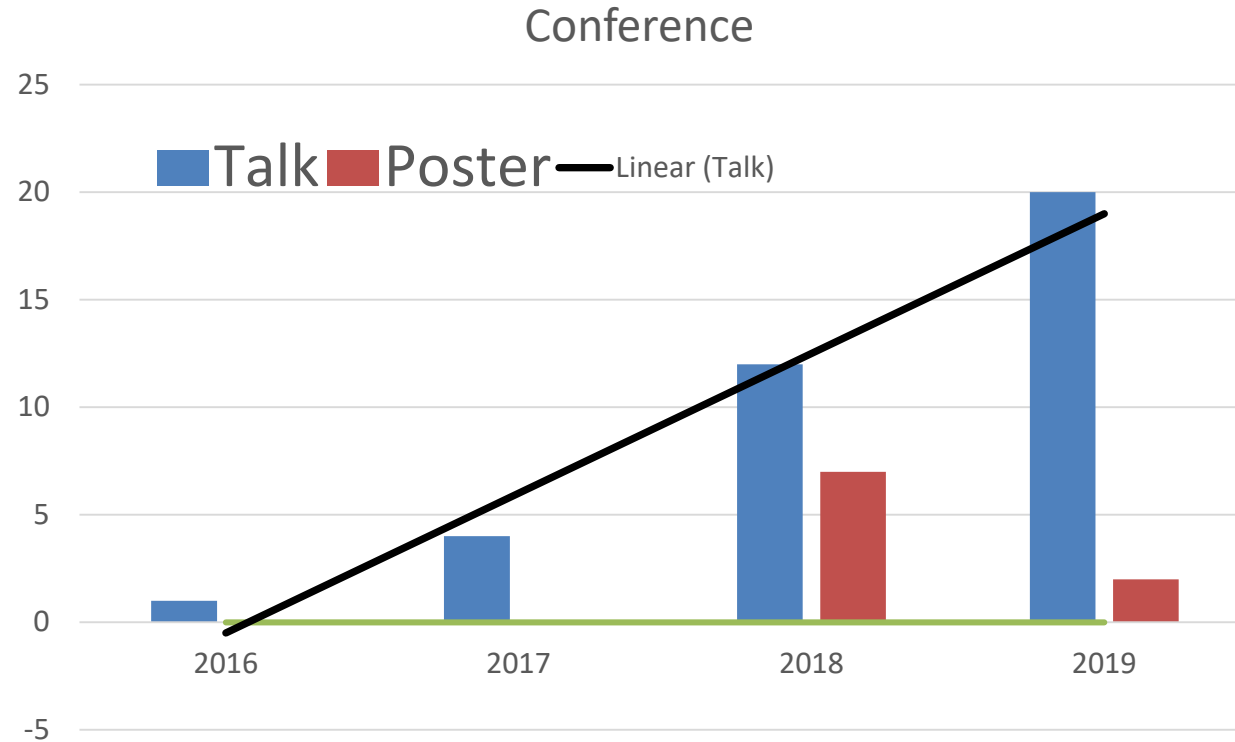
2018

☐ Talk: 12
 ☐ Poster: 7
 ☐ Seminar: 1

2019

☐ Talks: 20
 ☐ Posters: 2

Previous situation and 2020



Name	Abstract dead line	where	when	Person
AccApp'20	2/12/2019	Vien	5-9 / 4	Servoli
PTCOG59	2/12/2019	Taipei Taiwan	9-14 / 5	Traini
Anpc 2020 Applied Nucl Physics	12/4/2020	Prague	13-19/9	Montesi
55th Zakopane Conf on Nuclear Physics		Zakopane, Poland	30/8-6/9	

❑ **Published: 2019**

- ❑ NIMA 916 (2019) 116-124 “ *Development and characterization of a ΔE -TOF detector prototype for the FOOT experiment*”
- ❑ Open Phys. 2019; 17:233–240 “*Ion charge separation with new generation of nuclear emulsion films*”
- ❑ NIMA accepted in press: “*Fragment charge identification technique with a plastic scintillator detector using clinical carbon*” (signed by Pisa Group, citable)

❑ **Submitted:**

- ❑ special issue on Particle Therapy on IEEE Transactions on Radiations & Plasma Medical Science (TRPMS): “*Measurements of ^{12}C fragmentation cross section on C, O and H in the energy range of interest for Particle Therapy Application*” update by Michela-Ilaria
- ❑ Proceedings of many conferences

❑ **Preparation**

- ❑ Technical paper on MSD: test beam at Trento in July 2017
- ❑ General FOOT paper

Proceedings (not a complete list)

- ❑ “*The FOOT (FragmentatiOn Of Target) Experiment*”, Proceedings of Science, INPC 2016, 128, Adelaide 2016, Patera
- ❑ “*The FOOT (FragmentatiOn Of Target) Experiment*”, Proceedings of Science, vol. 32, 2017, Bormio, Battistoni
- ❑ “*The ΔE -TOF detector of the FOOT experiment: Experimental tests and MC simulations*”, NIMA 936 (2019) 78–79, Pisa meeting 2018, Ciarrocchi (Pisa group)
- ❑ “*THE FOOT EXPERIMENT: FRAGMENTATION MEASUREMENTS IN PARTICLE THERAPY*”, ISSN 2466-4294 (online) | rad-journal.org Vol. 3 | Issue 3 | pp. 190–196, 2018 doi: 10.21175/RadJ.2018.03.032, RAD2018 Ohrid, Montesi
- ❑ “*The FOOT (FragmentatiOn Of Target) experiment*”, IL NUOVO CIMENTO **41 C** (2018) 169, DOI 10.1393/ncc/i2018-18169-5, IWM-EC 2018 Valle
- ❑ “*Study of the performance of the FOOT experiment*”, ALKU Journal of Science 2019, Special Issue (NSP 2018): 86-92, Dong
- ❑ “*Evaluation of double-sided silicon microstrip sensor for the FOOT experiment*”, NIMA 936 (2019) 36–38, Pisa meeting, Silvestre
- ❑ “*The FOOT (FragmentatiON Of Target) Experiment*”, *Perspectives in Science* 2019 <https://doi.org/10.1016/j.pisc.2019.100415>, Strasbourg, Valle
- ❑ “*The FOOT FragmentatiOn Of Target Experiment*”, DOI: <http://dx.doi.org/10.23727/CERN-Proceedings-219-001>, Proceedings of the 15th International Conference on Nuclear Reaction Mechanisms, Varenna, Marafini
- ❑ “*The track reconstruction of nuclear fragments in hadrontherapy with the FOOT experiment*”, Il Nuovo Cimento, Bologna, Franchini
- ❑ “*FOOT: FragmentatiOn Of Target Experiment*”, Il Nuovo Cimento **42 C** (2019) 134, DOI 10.1393/ncc/i2019-19134-6, EUNPC, Bologna, Spighi
- ❑ “*Particle Therapy and Radioprotection in Space with the FOOT Experiment*”, International Journal of Modern Physics: Conference Series, Crete 2019, Mengarelli
- ❑ “*The FOOT experiment*”, Fairness 2019, Ridolfi
- ❑ “*Expected Performance of the FOOT experiment*”, IFAE; to be published on Il Nuovo Cimento, Silvestre

GENERAL PAPER

`\title{The FOOT experiment}`

`\section{Introduction}`

Vincenzo

`\section{Apparatus}`

`\subsection{Requirements}`

`\subsection{Electronic Setup}`

`\subsubsection{Upstream and Target region}`

`\paragraph{Start Counter}`

`\paragraph{Beam monitor}`

`\paragraph{Target}`

`\subsubsection{Tracking system}`

`\paragraph{Magnetic System}`

`\paragraph{Vertex}`

`\paragraph{Inner Tracker}`

`\paragraph{Micro Strip Detector}`

Perugia

`\subsubsection{Fragment Identification}`

`\paragraph{Scintillator}`

`\paragraph{Calorimeter}`

`\subsubsection{Trigger and Data Acquisition System}`

`\subsection{Emulsion Chamber Setup}`

Napoli

`\subsection{Global Tracking}`

`\section{Performances}`

`\subsection{Electronic Setup Performances}`

`\subsection{Emulsion Chamber Performances}`

`\section{Conclusions}`

`\thebibliography{}`

All files are in baltig

a lot of interesting measurements:

- ❑ Emulsion at GSI
- ❑ Electronic setup at GSI
- ❑ Test beam on STC, VTX, SCN, MSD, CAL

We have the possibility to write a beautiful paper!!!!

Measurement of Cross Sections for ^{12}C fragmentation at large angles

Milano+Roma Teams for FOOT

FLUKA Collaboration Meeting
Roma, 4-6 Dicembre 2017



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Measurement of ¹²C Fragmentation Cross Sections on C, O and H in the Energy Range of interest for Particle Therapy Applications.

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Abstract—In a carbon ion treatment the nuclear fragments of both target and beam projectiles impacts on the dose released on the tumour and on the surrounding healthy tissues. Carbon ion fragmentation occurring inside the patient body has to be studied in order to take into account this contribution. These data are also important for the development of the range monitoring techniques with charged particles. The production of charged fragments generated by carbon ion beams of 115-353 MeV/u kinetic energy impinging on Carbon (C), Oxygen (O) and Hydrogen (H) targets has been measured at the CNAO particle therapy center (Pavia, Italy). The use of thin targets of graphite (C), PMMA (C₅O₂H₈) and polyvinyl-toluene (plastic scintillator, C₉H₈) allowed to measure fragments production cross sections, exploiting a Time of Flight (ToF) technique. Plastic scintillator detectors have been used to perform the ToF measurements, while LYSO crystals have been used for the deposited energy measurement and to perform particle identification. Cross sections have been measured at 90 and 60 degrees with respect to the beam direction. The measured proton, deuteron and triton differential production cross sections on C, O and H, obtained exploiting the target subtraction strategy, are presented here as a function of the fragment kinetic energy.

Index Terms—Scintillators Radiation Detectors for medical applications Radiation Therapy Clinical/preclinical evaluation/application studies Therapy imaging Clinical/preclinical evaluation/application studies

INTRODUCTION

PARTICLE Therapy (PT) is a well established external radiotherapy technique that exploits light charged hadron beams (as protons and carbon ions) to treat solid tumours. PT is particularly suitable in case of tumours located close to organs at risk, as well as for deep-seated or radio resistant cancers [1]. The maximum dose deposition is concentrated in

❖ 1/03/2019: the paper on the cross section measurements at 90° and 60° was submitted on IEEE Transactions on Radiation and Plasma Medical Sciences

❖ 6/05/2019: the review of the manuscript has been received

We took the chance to improve the analysis:

- Improvements in the PID
- Introduction of the Tritons Analysis
- Improvement on the efficiency calculation
- Correction of the spectra at production energy (from measured spectra)

The paper has been re-edited!!

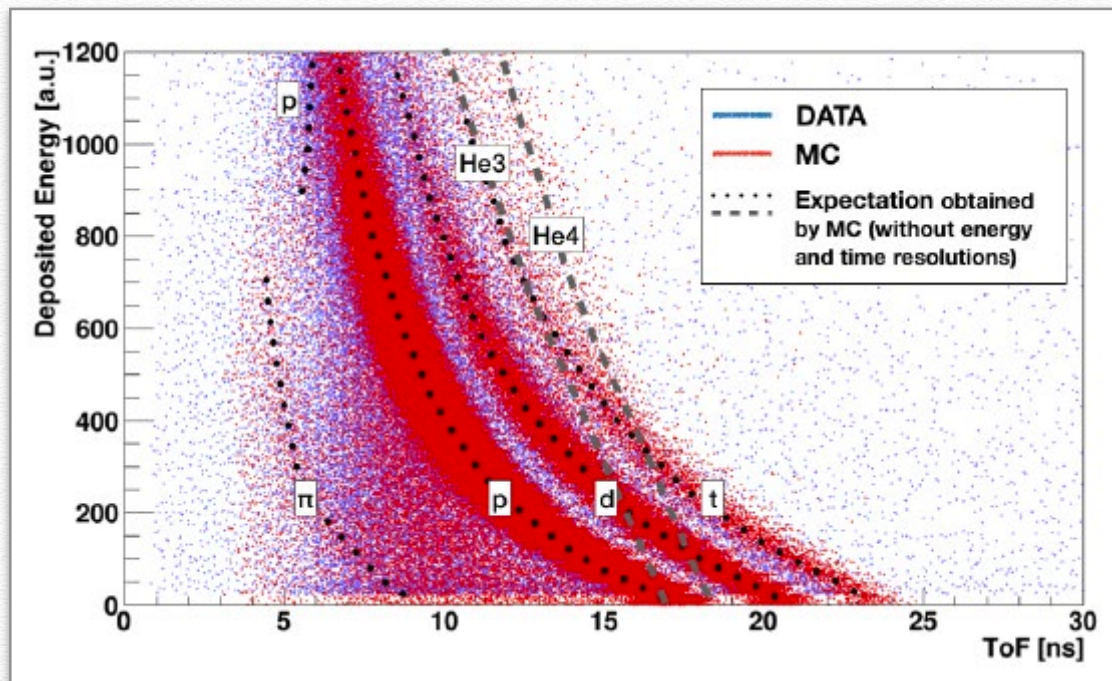
❖ 1/11/2019: we submitted!



WHAT HAS BEEN

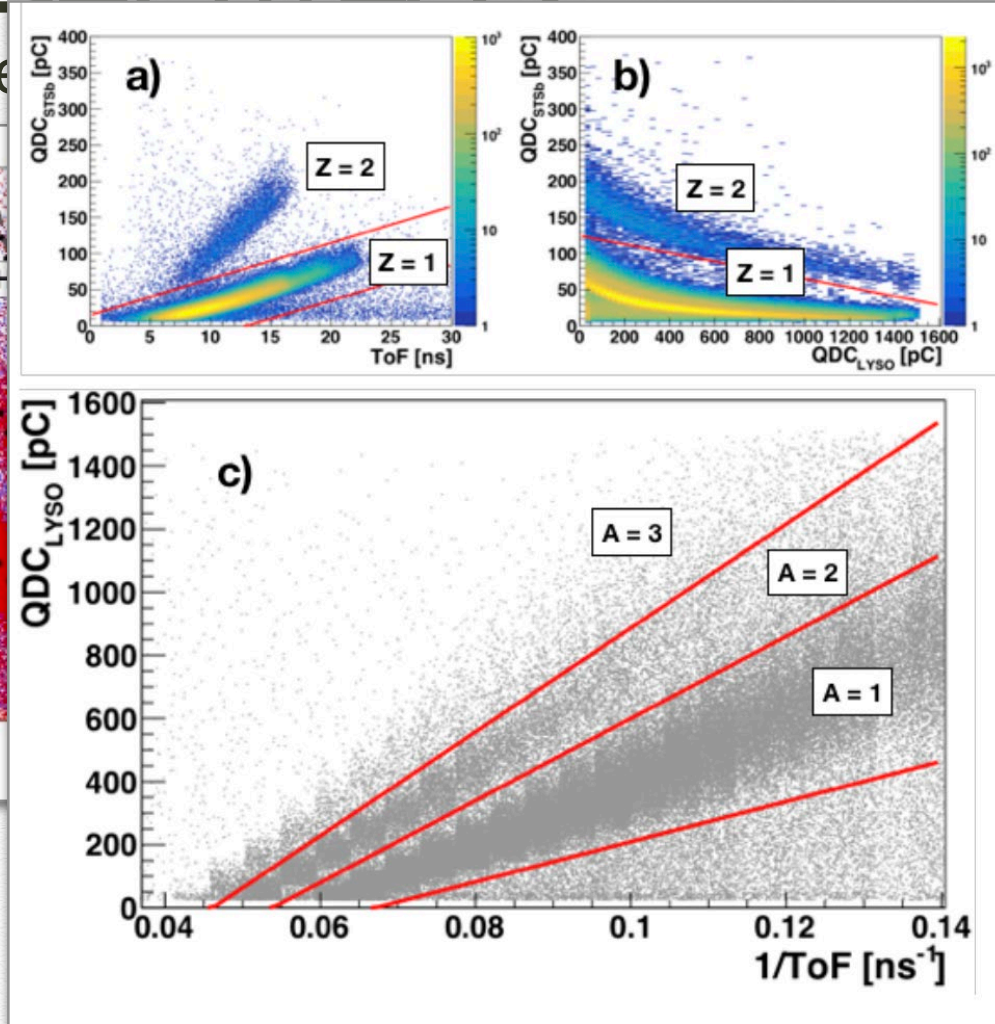
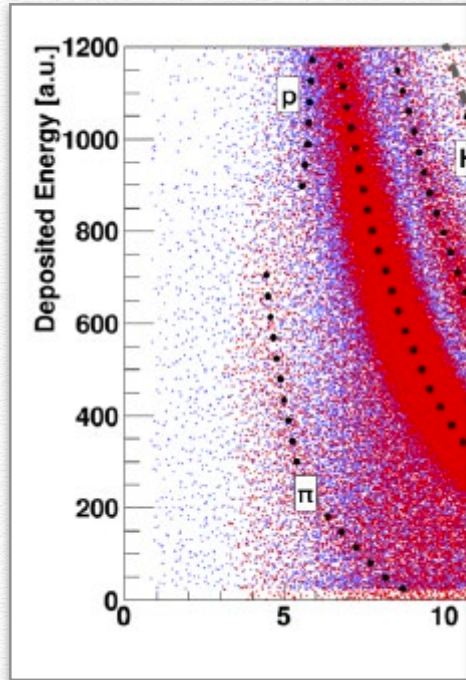
IMPROVED?

- ❖ ToF resolution included in the Monte Carlo



WHAT HAS BEEN IMPROVED?

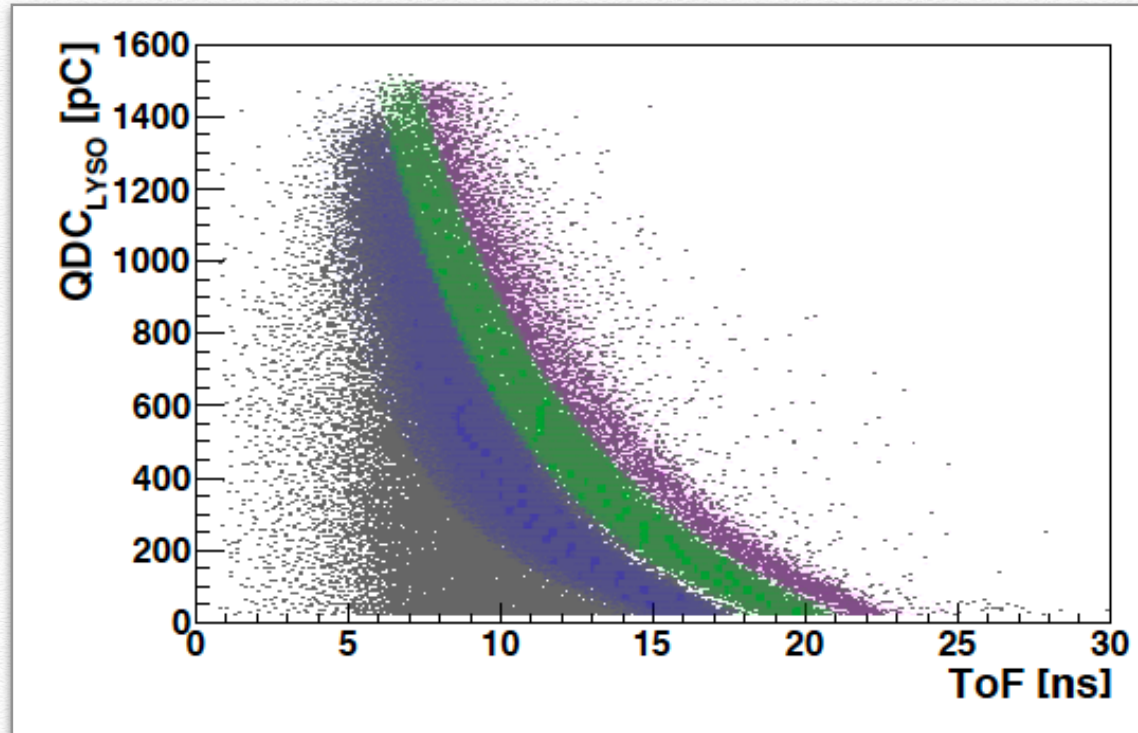
- ◆ ToF resolution includes



- ◆ New Particle Identification (PID) selection based on QDC vs 1/ToF

WHAT HAS BEEN IMPROVED?

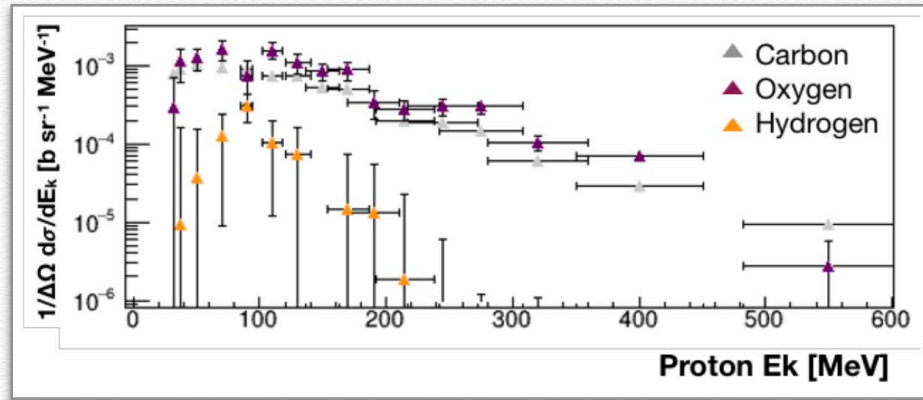
- ❖ Tritons analysis added



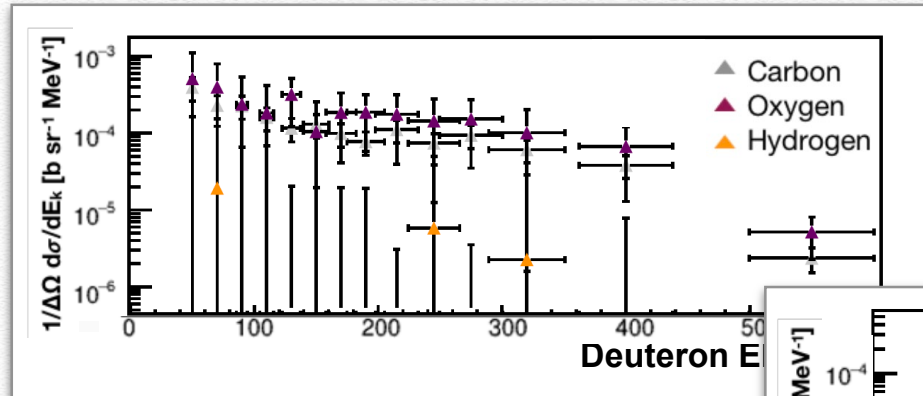
- ❖ The measured kinetic energy has been corrected up to the production exploiting the MC in order to calculate the energy loss of the fragments in the target and first time detector.

PUBLISHED RESULTS

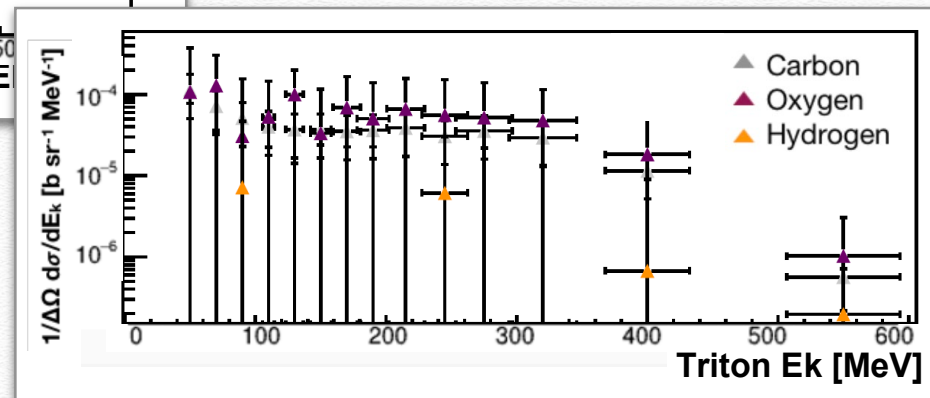
- ❖ Differential cross section vs Fragment Production E_{kin} @ 60°



Protons



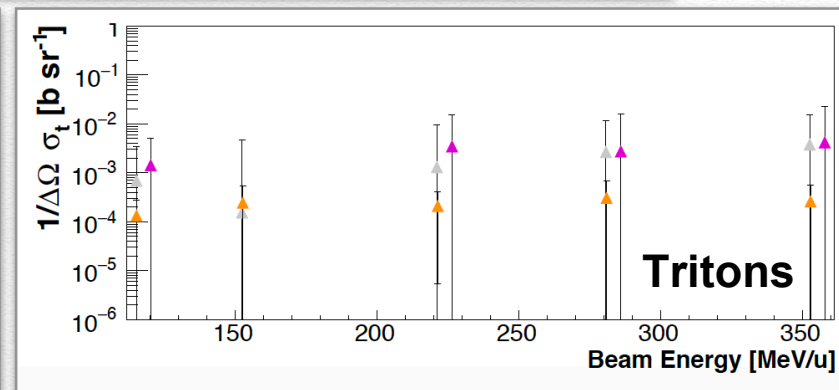
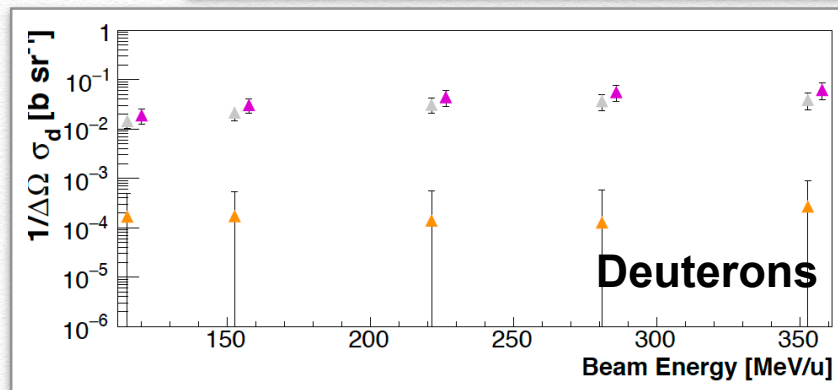
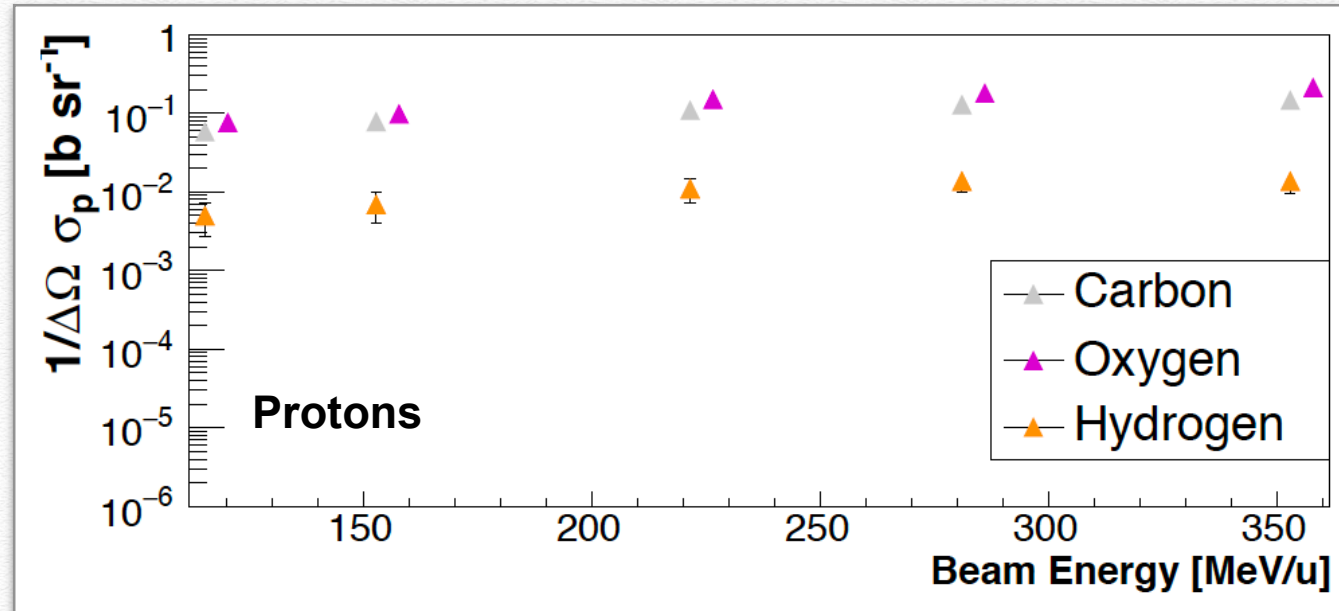
Deuterons



Tritons

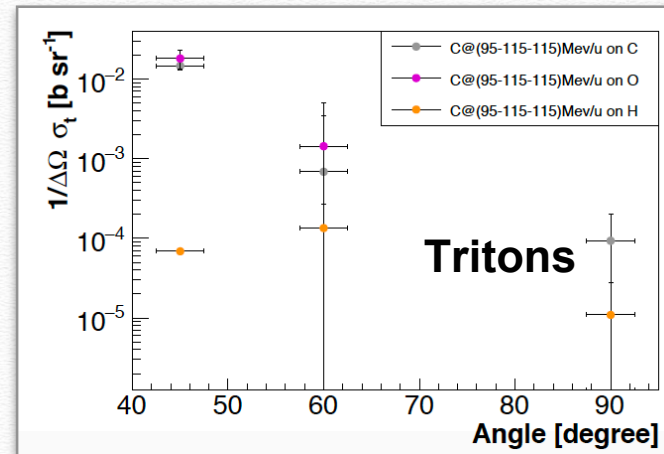
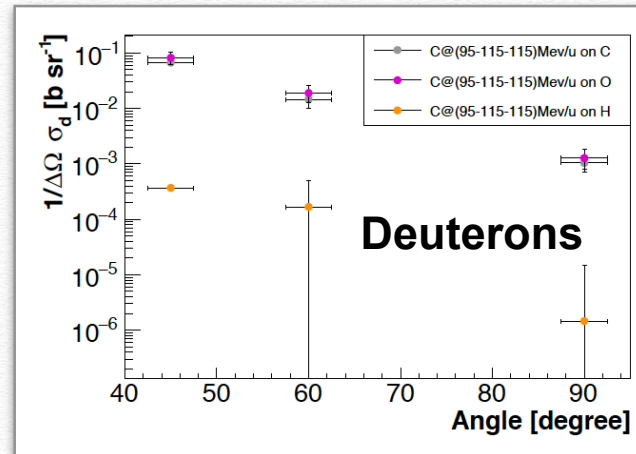
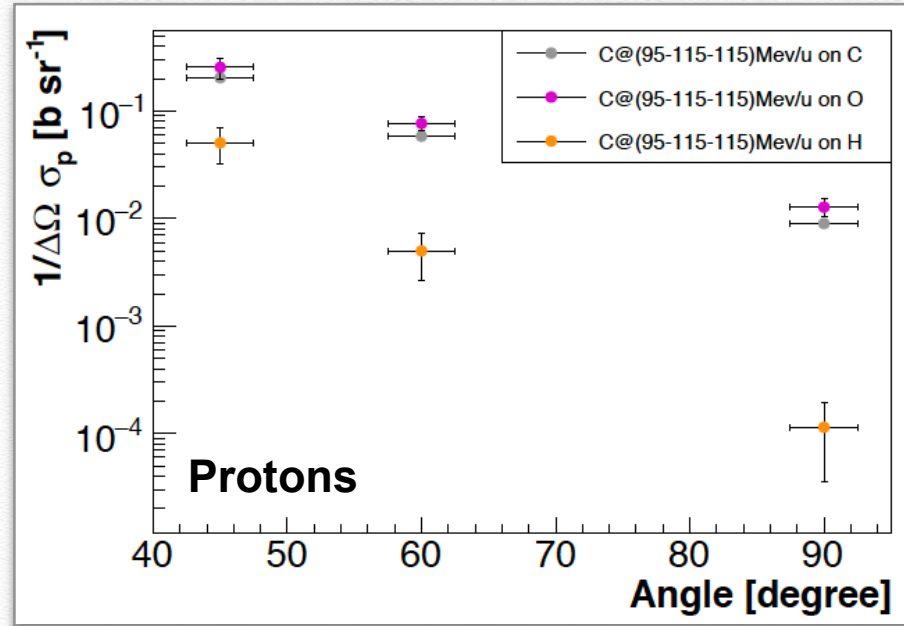
PUBLISHED RESULTS

- ◆ Integrated cross section vs Beam Energy @ 60°



PUBLISHED RESULTS

- ❖ Integrated cross section vs Angle



PUBLISHED RESULTS

While no comparison with MC can be shown and we have no other data at 90 and 60 degrees in literature we introduce an more qualitative comparison with Ganil data (<http://hadrontherapy-data.in2p3.fr>).

❖ Measurement vs Empirical equation

$$\sigma_{tot} = \pi r_0^2 \cdot (A_P^{1/3} + A_T^{1/3} - b_0)^2$$

where $r_0 = 1.31 \text{ fm}$, $b_0 = 1.0$, A_P and A_T are the projectile and target mass numbers, respectively.

EXPECTED

$$\frac{\sigma_O}{\sigma_C} \sim 1.1$$

PROTONS

$$[45^\circ] = 1.3 \pm 0.3$$

$$[60^\circ] = 1.3 \pm 0.2$$

$$[90^\circ] = 1.4 \pm 0.3$$

DEUTERONS

$$[45^\circ] = 1.2 \pm 0.3$$

$$[60^\circ] = 1.3 \pm 0.6$$

$$[90^\circ] = 1.2 \pm 0.6$$

TRITONS

$$[45^\circ] = 1.2 \pm 0.4$$

$$[60^\circ] = 2.1 \pm 10.0$$

$$[90^\circ] = -0.2 \pm 1.4$$

Measured ratios are compatible with the expectation

WHAT'S NEXT

- ❖ The analysis at small angles (30° - 40°) is still ongoing. The data have been analysed but some MC study for the efficiency evaluation was missing.



NEW EDITORIAL BOARD

Editorial board Staff:

- ❑ Ronja Hetzel
- ❑ Giovanni de Lellis
- ❑ Roberto Spighi

Editorial board tasks:

- ❑ Look for all the opportunities to present FOOT (conferences, workshop, school, ...)
- ❑ Keep the collaboration informed on the Conferences
- ❑ Read/Referee/help for paper and conference proceeding publications
- ❑ Push up for publications
- ❑ Keep the statistics of conferences/papers/FOOT members

The staff of the Editorial board starts its operation 2 years ago (December 2017)

The obtained results are (we hope) positive

In our opinion it is appropriate to change the offices every 2 years

THANK YOU ALL

We will look for 3 volunteers