FOOT
FragmentatiOn Of Target

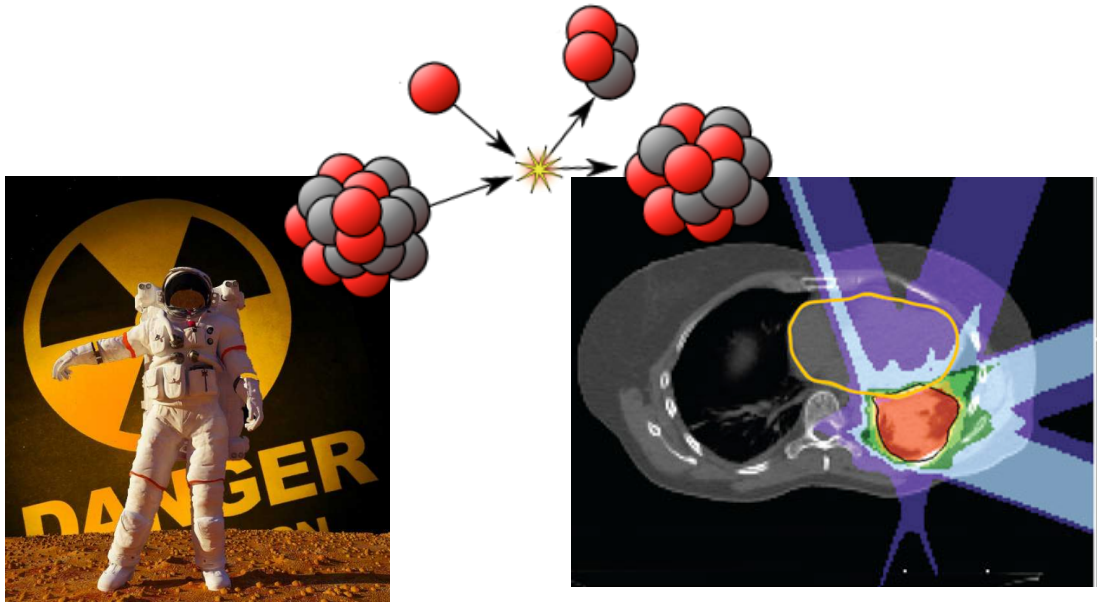
An experiment for the measurement of the nuclear fragmentation for Particle Therapy

FOOT in pills

Sections/Labs: Bologna, Frascati, Milano, Napoli, Perugia, (Pavia), Pisa, Roma1, Roma2, Torino, Trento

People: ~50 researcher, ~24 FTE

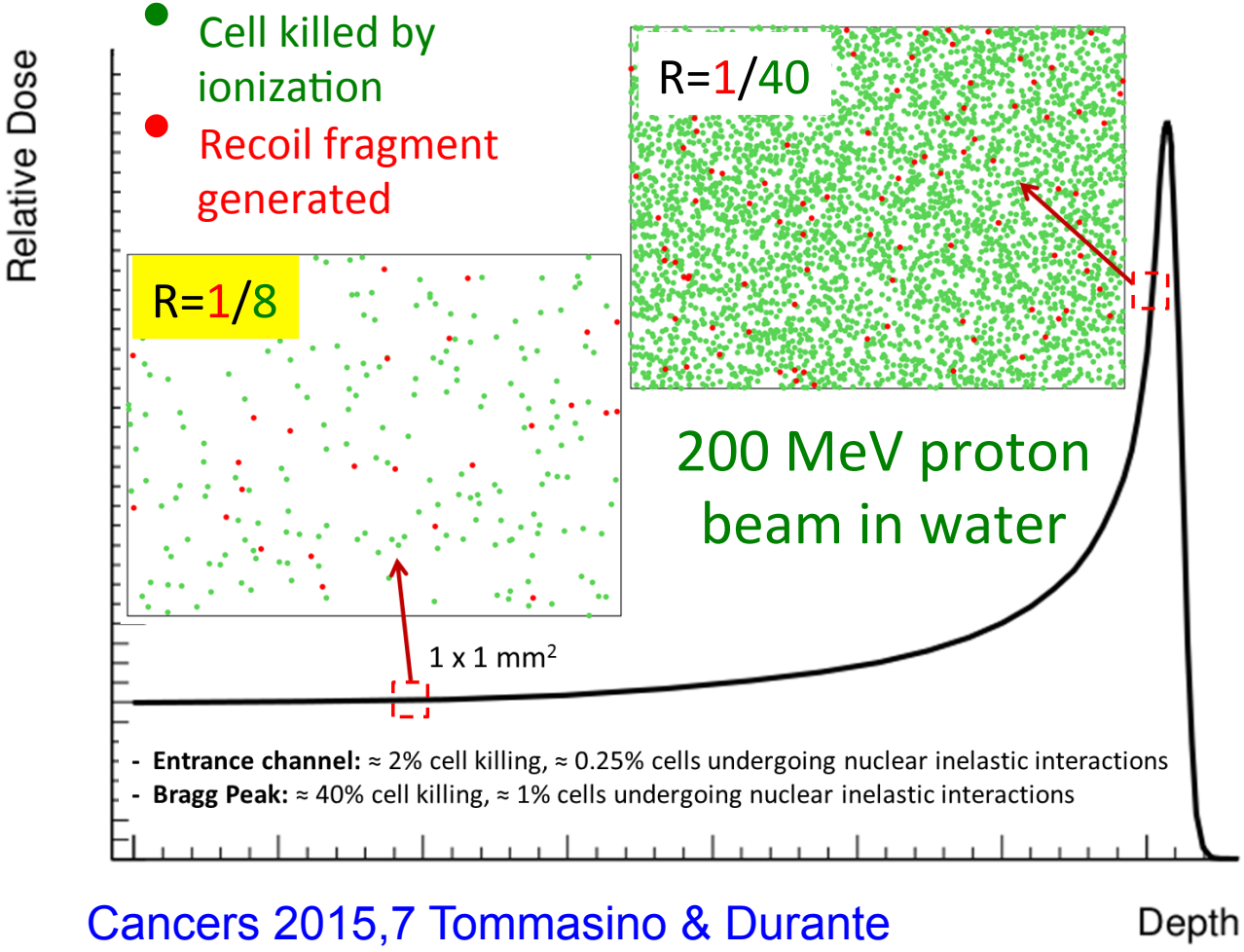
DATA taking foreseen @ CNAO, TIFPA, LNS, BTF



Experiment with translational approach: focus on nuclear physics, physics applied to medicine and radioprotection in space

Target (patient) fragmentation & PT

Target fragmentation in proton therapy: gives contribution also outside the tumor region!



Cancers 2015,7 Tommasino & Durante

About 10% of biological effect in the entrance channel due to secondary fragments (Grun 2013)

Largest contributions of recoil fragments expected from
He, C, Be, O, N
In particular on Normal Tissue Complication Probability
See also :
- Paganetti 2002 PMB
- Grassberger 2011 PMB

FOOT ➔ Inverse kinematic strategy

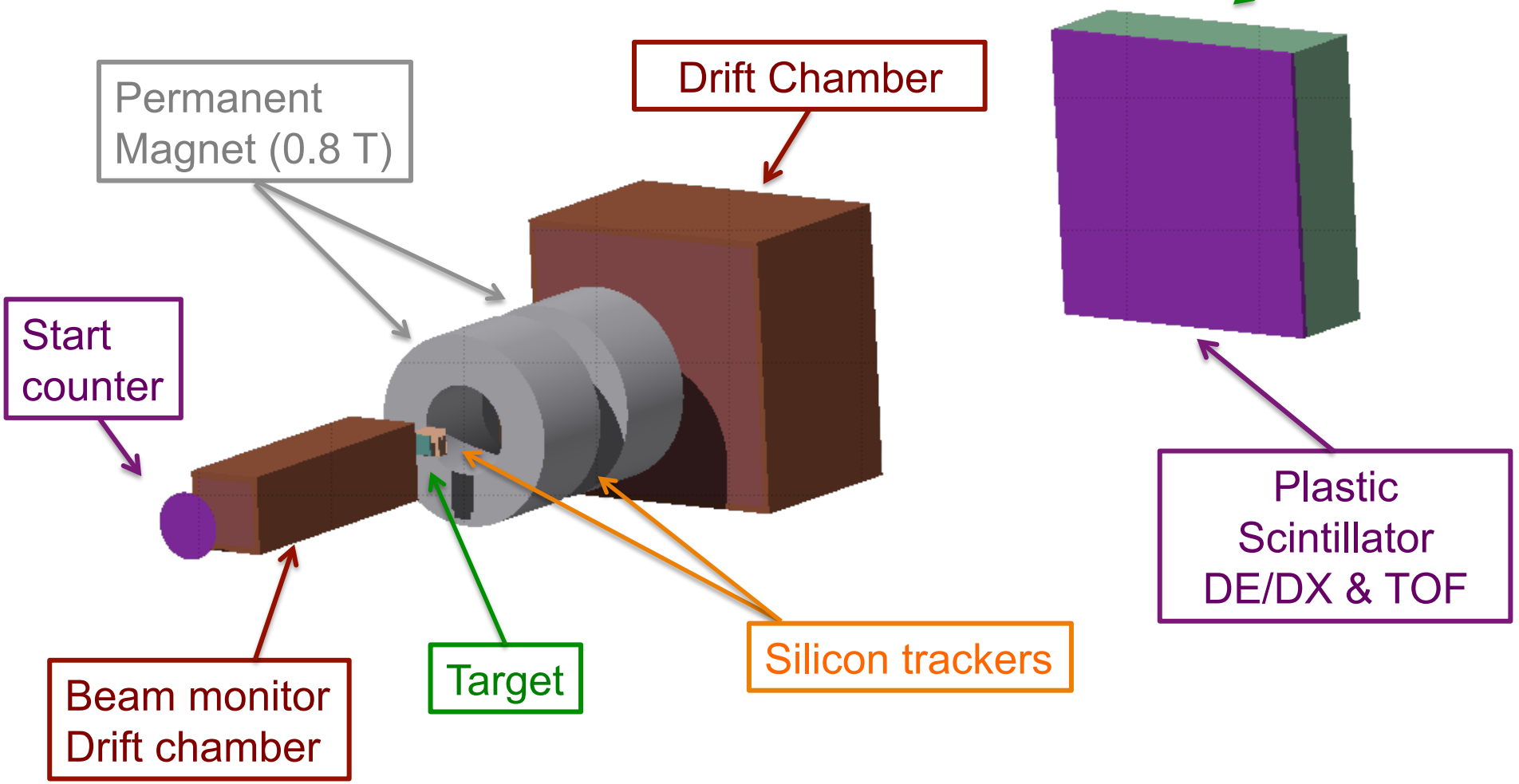
Since shooting a proton with a given β (for instance Ekin=200 MeV ➔ β=0.6) on a patient (i.e. at 98% a H,C,O nucleus) at rest gives little detection opportunity… let's shoot a β=0.6 patient (i.e. O,C beam) on a proton at rest and measure how it fragments..

A possible procedure would be:

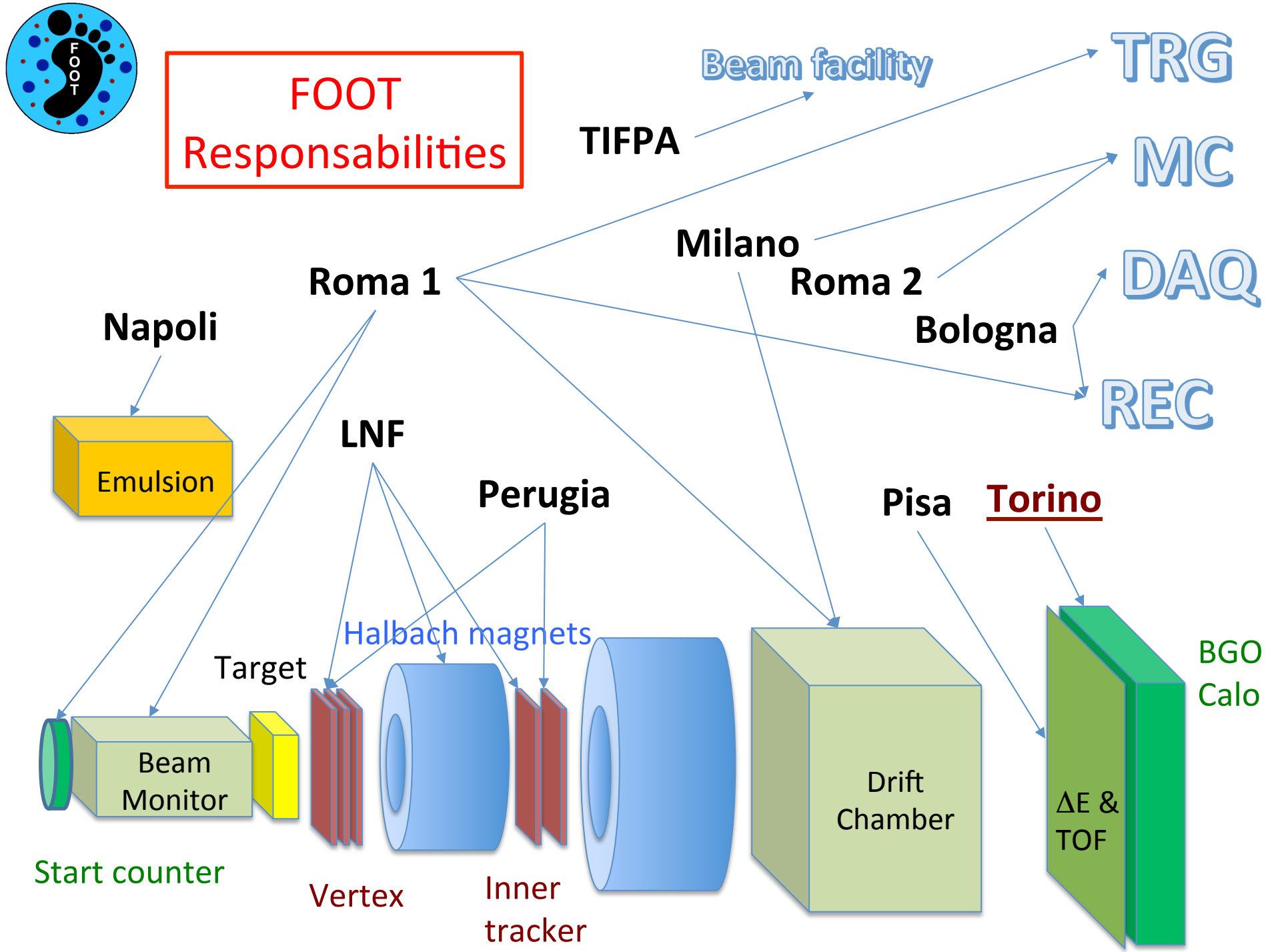
- Use as beams the ions that are the constituents of the patient (mainly ^{16}O, ^{12}C) with Ekin/nucl in the 100-200 MeV/A.
- Use twin targets made of C and polyethylene $(C_2H_4)_n$ and obtain the H target result from difference
- Apply the reverse boost with the well known β of the beam

CAVEAT!: The fragment direction must be well measured in the Lab frame to obtain the correct energy in the Patient frame

The FOOT Detector

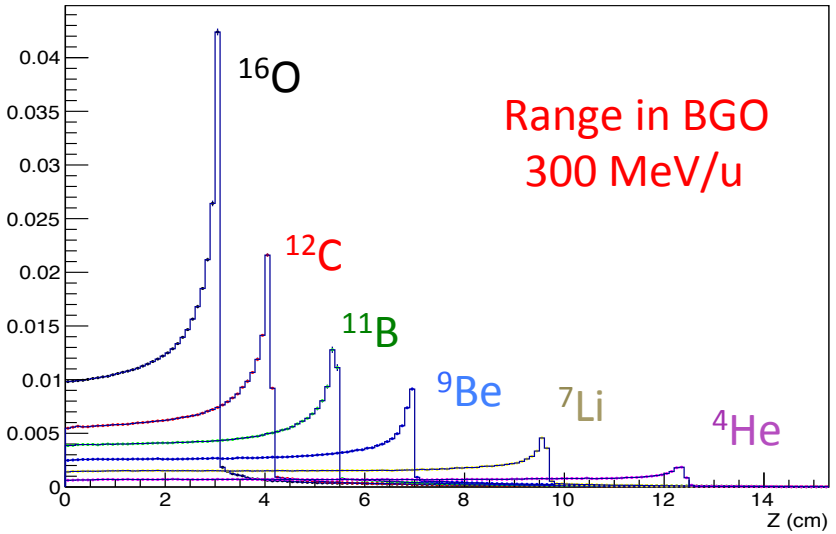


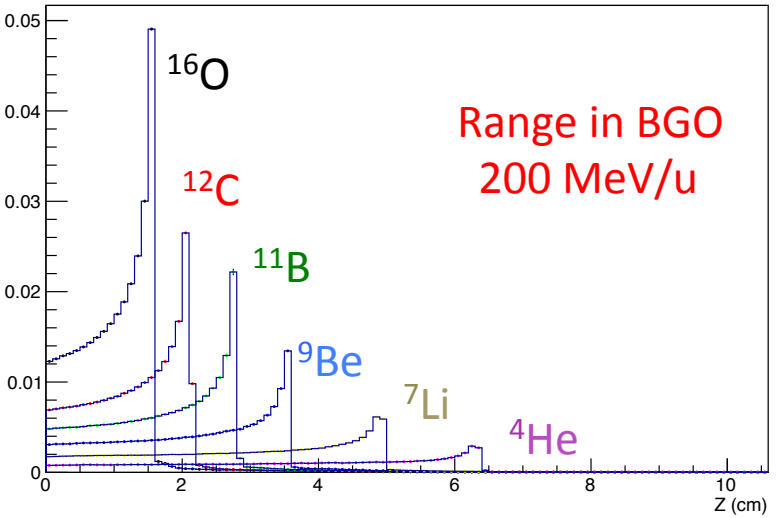
Combines magnetic, TOF and calorimetric measurements


FOOT
Responsabilities
Beam facility
TIFPA
TRG
MC
DAQ
REC
Milano
Roma 1
Roma 2
Bologna
Napoli
Emulsion
LNF
Perugia
Pisa
Torino
Halbach magnets
Target
Beam
Monitor
Start counter
Vertex
Inner
tracker
Drift
Chamber
ΔE &
TOF
BGO
Calo

FOOT Calorimeter

- No TOF, high density and good energy resolution -> BGO
- TOF asks for 1.2 m lever arm -> R = 20 cm with 10^0 angular aperture of the fragments
- A 2x2 cm2 granularity is due to the minimum track separation (1deg)
- Thickness must contain the heavier fragment @ 200 MeV/u -> 7 cm
- 2x2x7 cm^3 BGO units -> ~ 300 channels





Read-out: not critical due to the high light yield, low rate (PMT, APD, SiPM)

Profilo di spesa 2017-2020

	FTE		missioni	consumo	inventario	costr app	Totale	2017
Bologna	1,2		6	4	15		25	
Milano	2,9		7	5			12	
Napoli	3,0		15	5	21		41	
LNF	1,5		10	15	5	50	80	
Perugia	1,3							
Pisa	4,7		7	15			22	
Roma1	3,8		7	8			15	
Roma2	0,7		3				3	
TIFPA	1,8		5	10			15	
Torino	3,0		7	40			47	
FOOT	24,0		67	102	41	50	260	2017
			60	55	50	290	410	2018
			100	55	40	90	210	2019
			55	20	0	0	20	2020
Missioni : 282								
Apparato : 793			282	232	131	430	1075	2017-2020

Richieste Servizi 2017

- I partecipanti
  - S. Argiro'
  - P. Cerello
  - V. Ferrero
  - G. Giraudo
  - N. Pastrone
  - C. Peroni
  - L. Ramello
  - M. Sitta

- Costruzione di un prototipo di 3x3 cristalli di BGO
- Test (CNAO?, LNS?)

- 4 mesi tecnologo/tecnico meccanico
- 2 mesi tecnologo elettronico (readout: PM? SiPM?)