Lecture 2: targets

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Targets for low energy measurements:

- Deterioration

- Composition

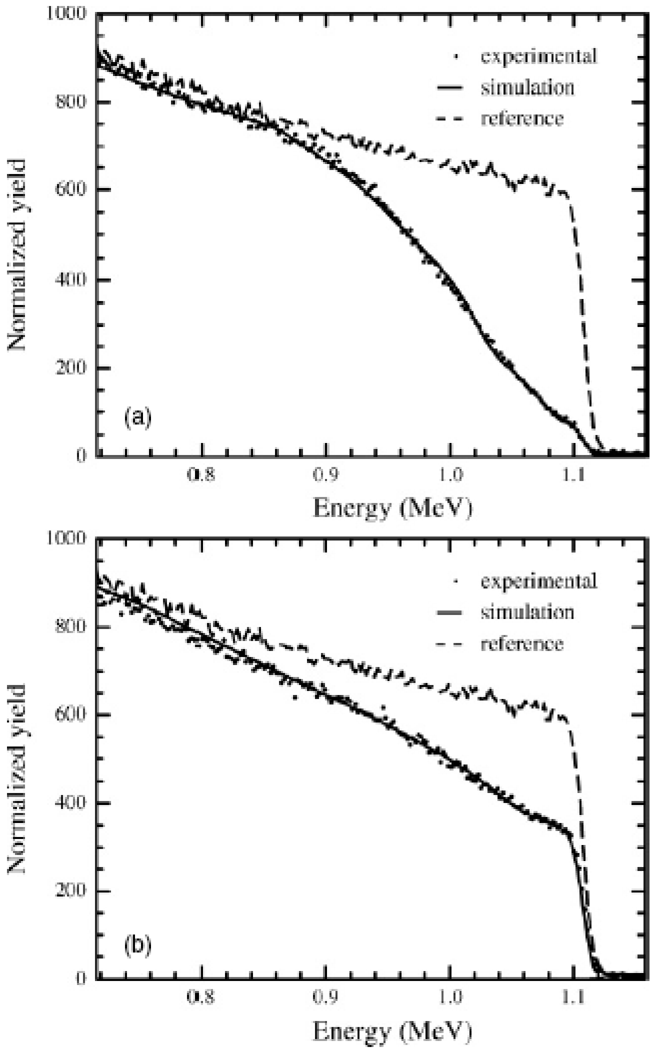
- Thickness

2 possible solutions. solid targets and gas targets

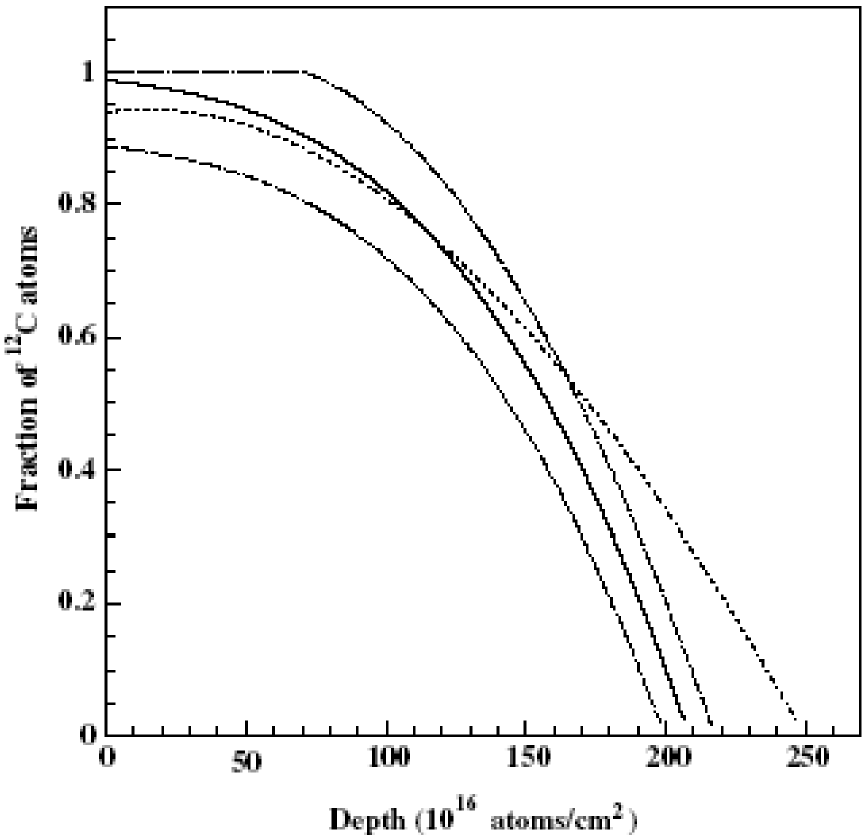
Isotopic enrichment by ion implantation: ^{12}C in Au

Reaction of interest: $^{12}C(\alpha,\gamma)^{16}O$

background reaction: $^{13}C(\alpha,n)^{16}O$



RBS



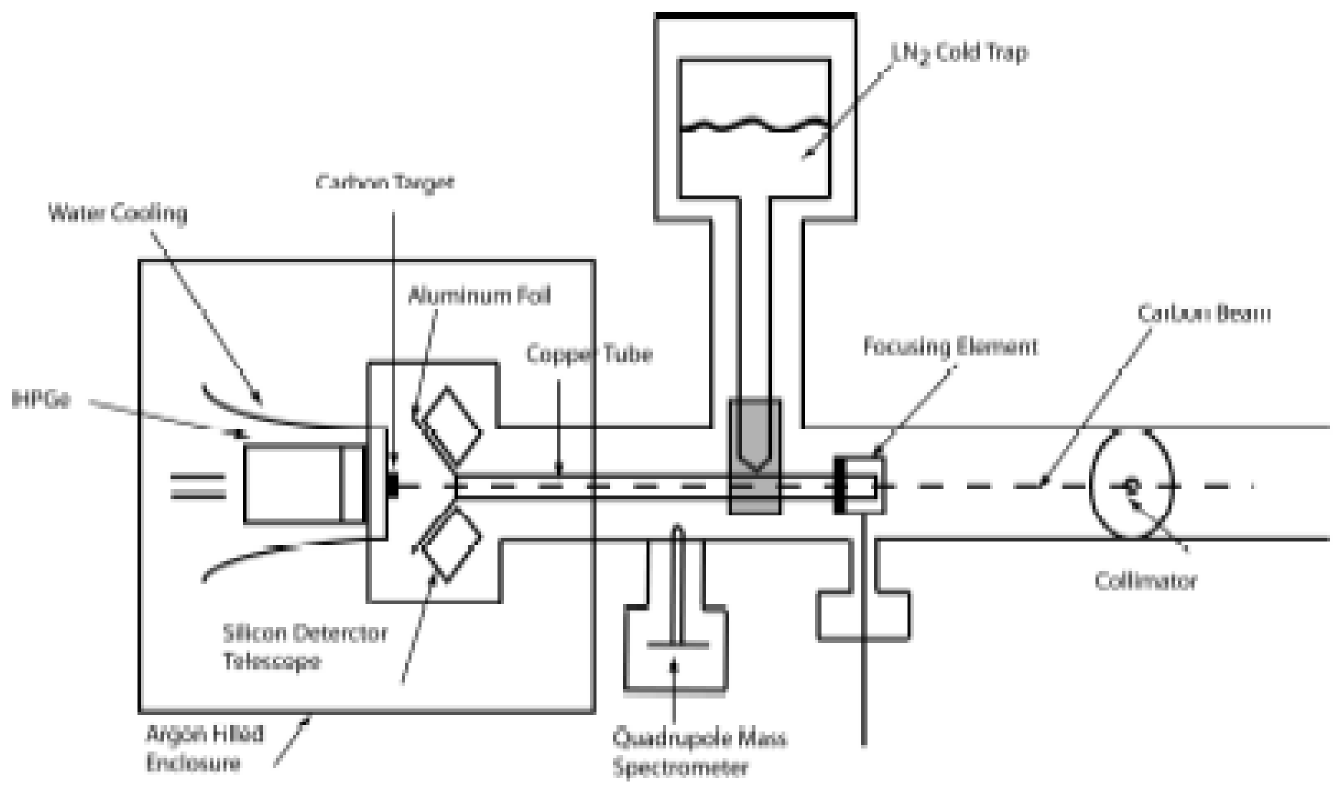
Note: target stoichiometry and structure change the stopping power and influence the effective energy and the yield.

Assuncao,et al PRC **73, 055801 (2006)**

Purity: pure C targets

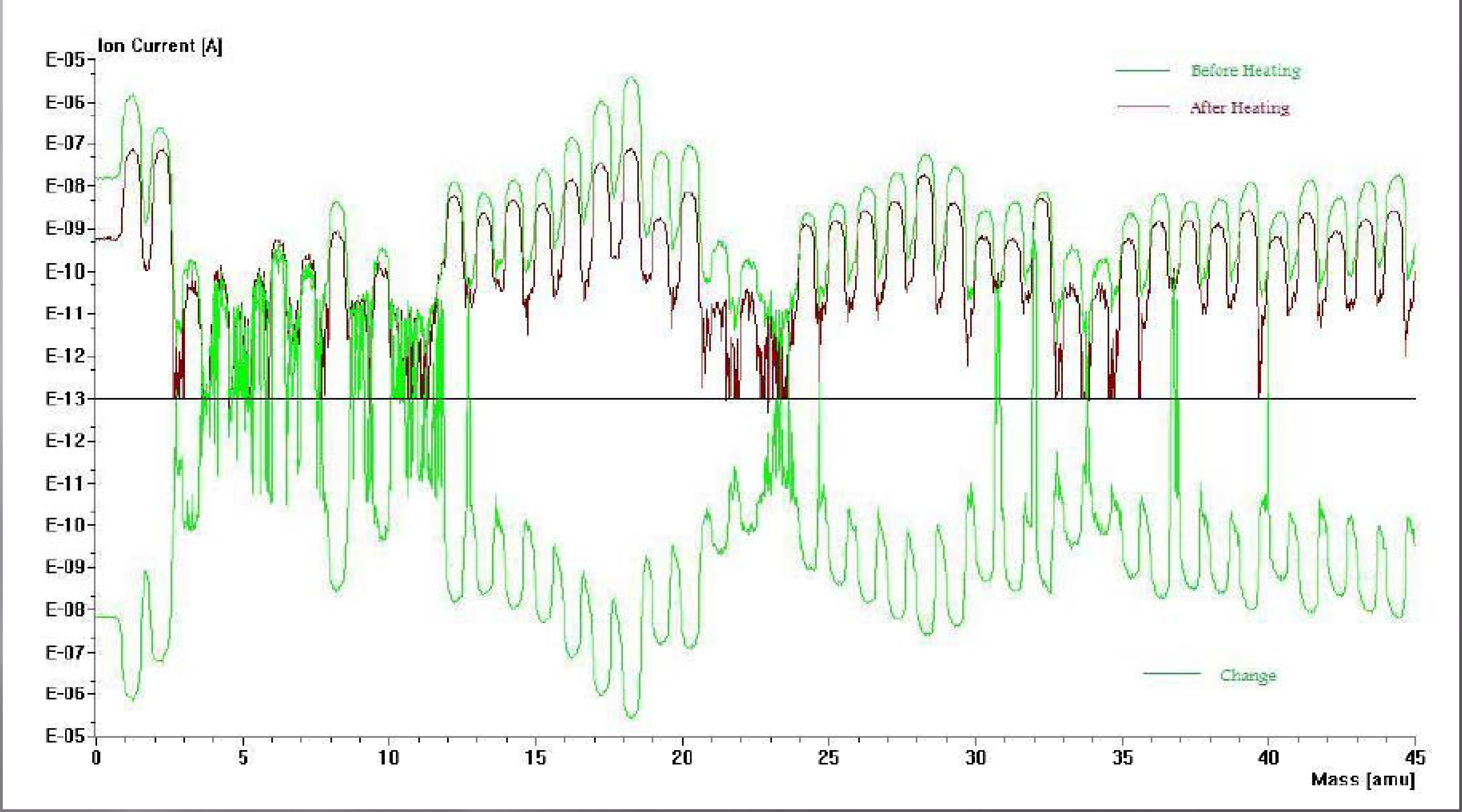
Reaction of interest: $^{12}C(^{12}C,p)^{23}Na$

background reaction: $d(^{12}C,p)^{13}C$



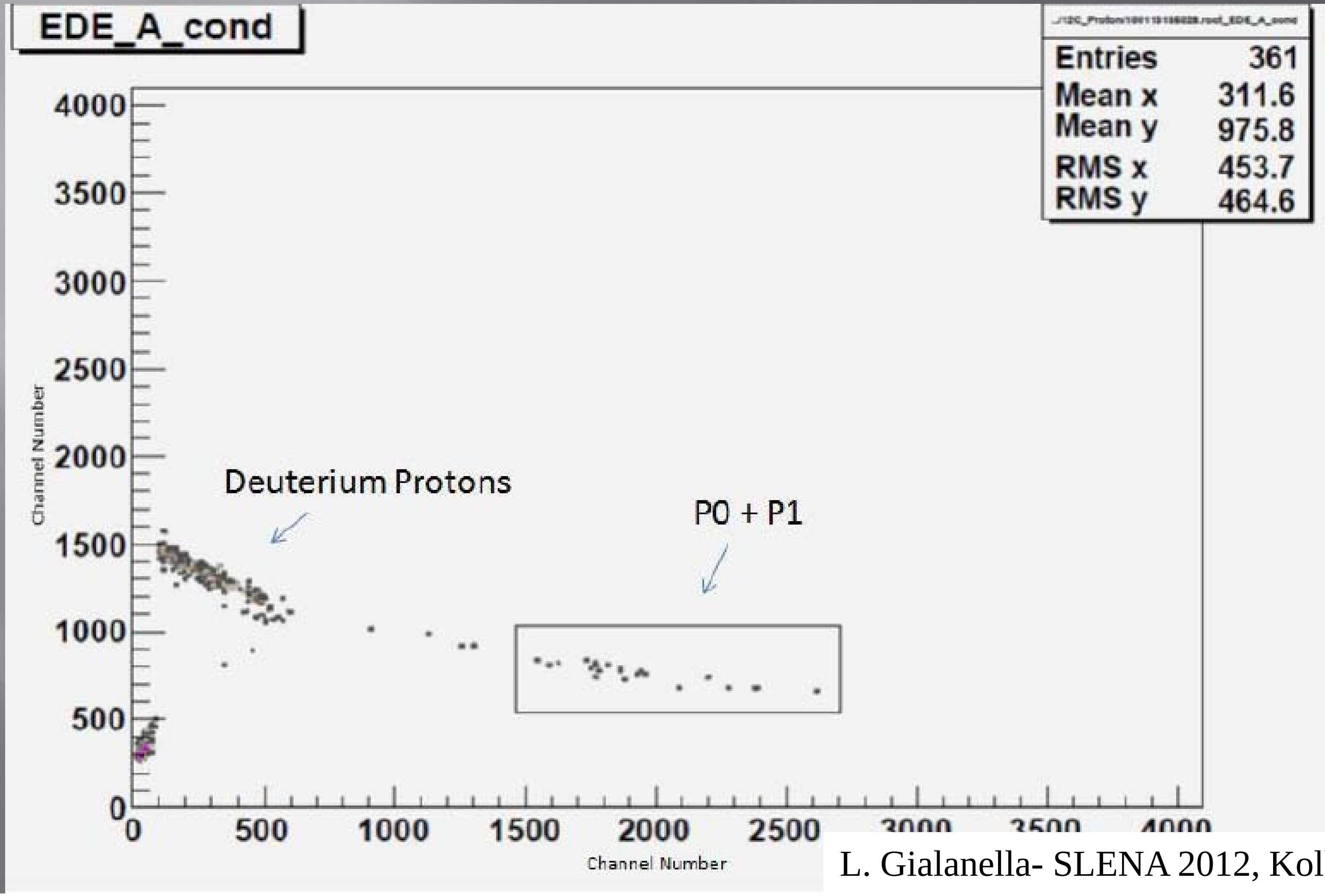
J. Zickefoose, PhD Thesis, University of Connecticut

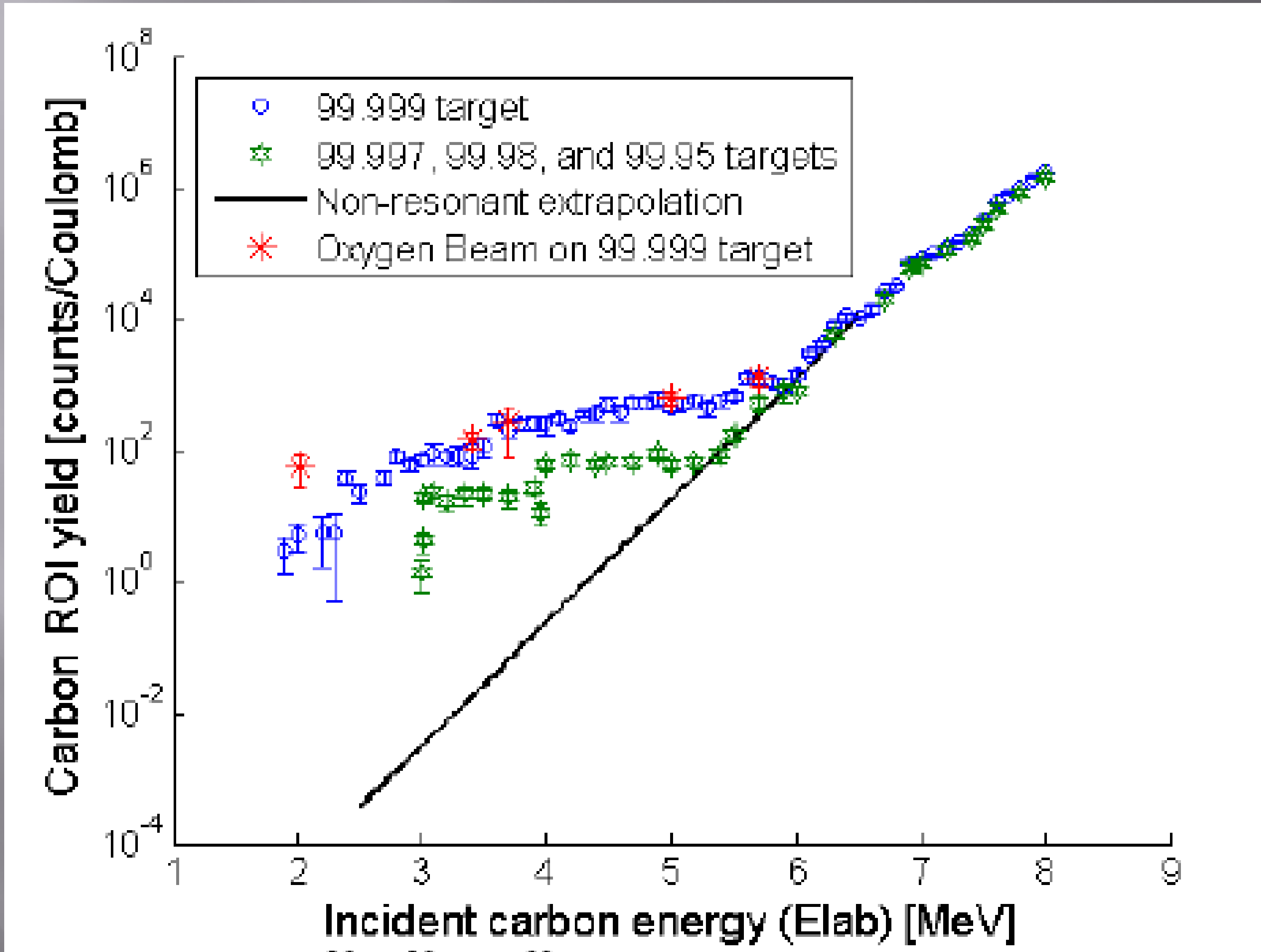
Heating in vacuum: rest gas composition



Particle identification

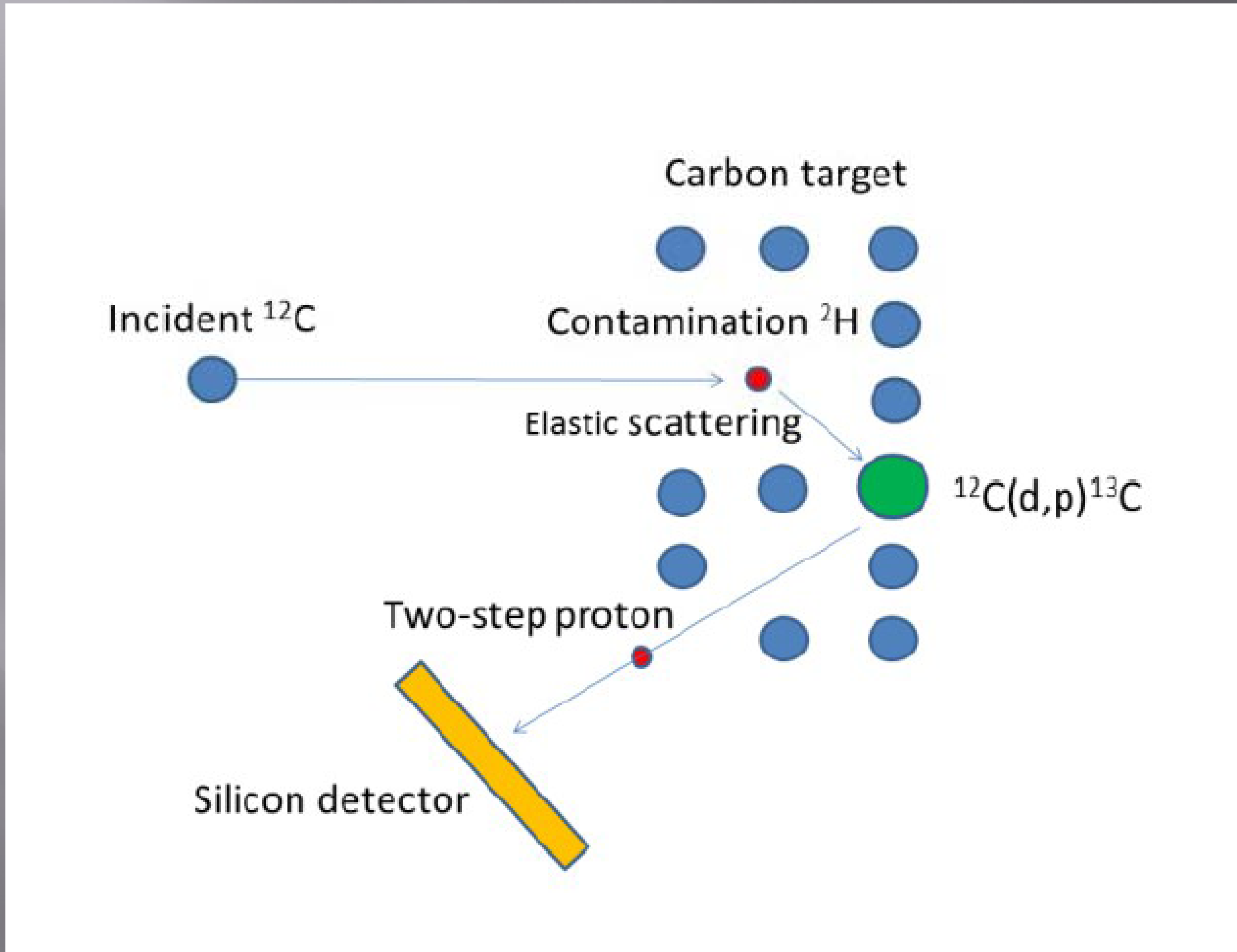
Bethe Block formula: $\Delta E \cdot E \propto MZ^2$





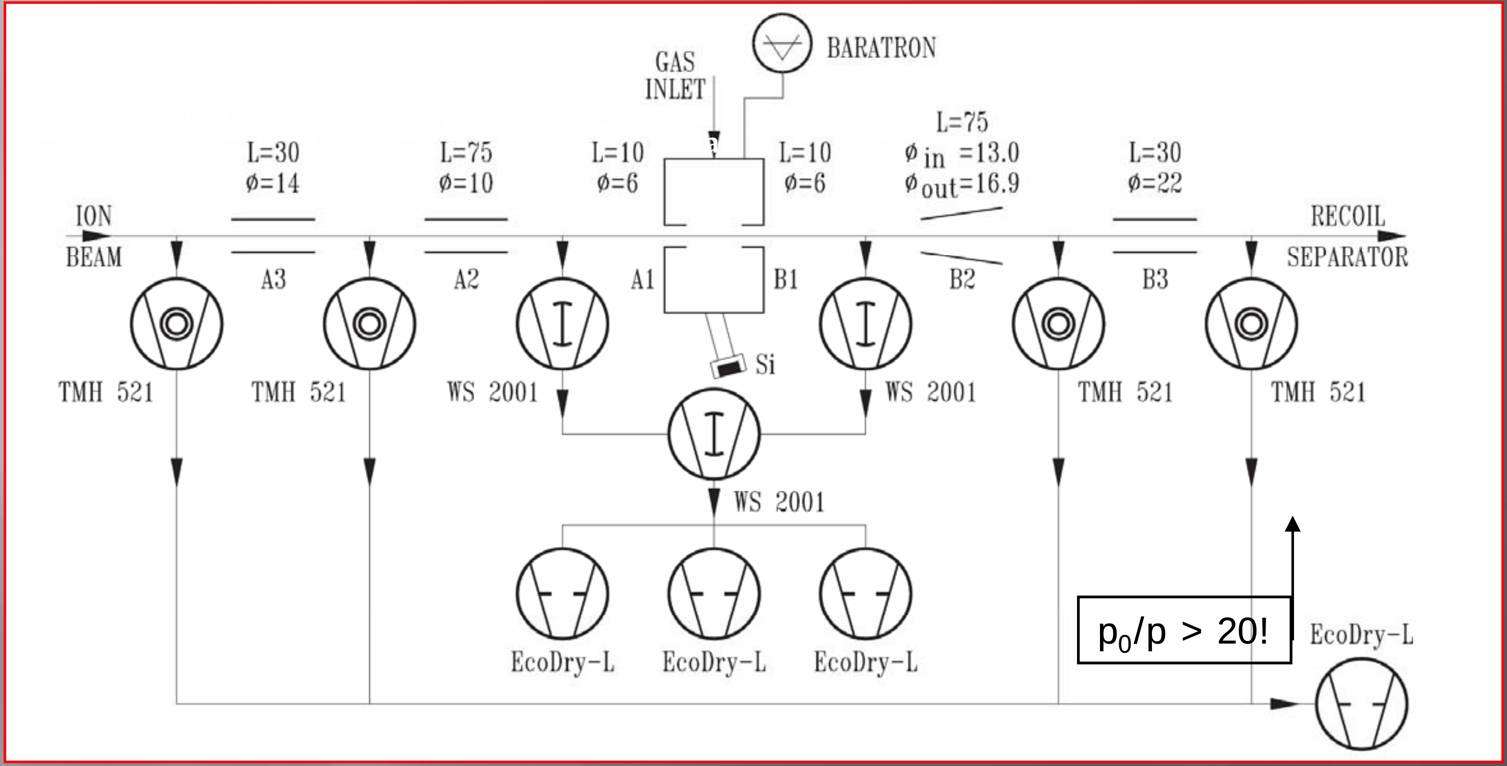
J. Zickefoose, *11th Symposium on Nuclei in the Cosmos - NIC XI* - POS 2010

Two-step mechanism



Isotopic enrichment by using inverse kinematics: gas targets

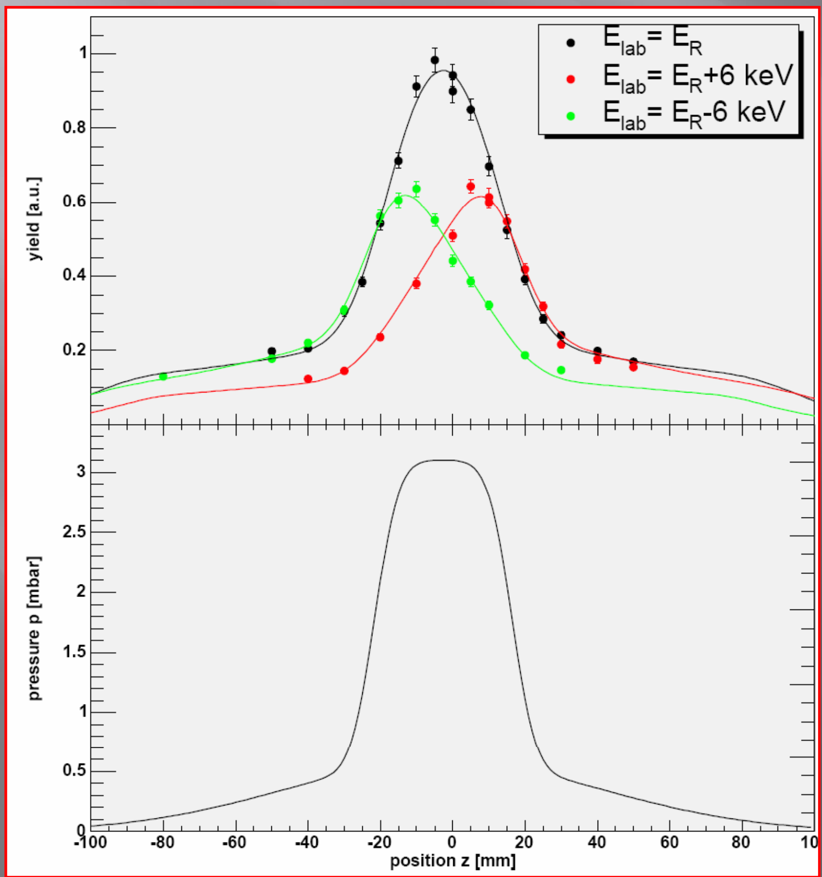
Reaction of interest: $^{12}C(\alpha,\gamma)^{16}O$

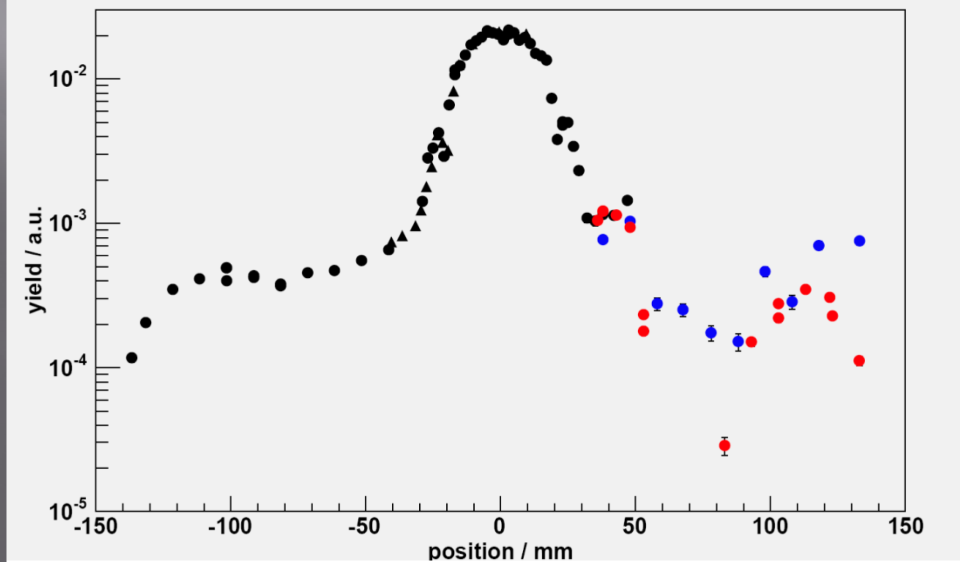


Isotopic enrichment by using inverse kinematics: gas targets

Reaction of interest: $^{12}C(\alpha,\gamma)^{16}O$

$^{7}Li(\alpha,\gamma)^{11}B$, E_{lab}=1.688 MeV Γ_{lab}= 7 keV

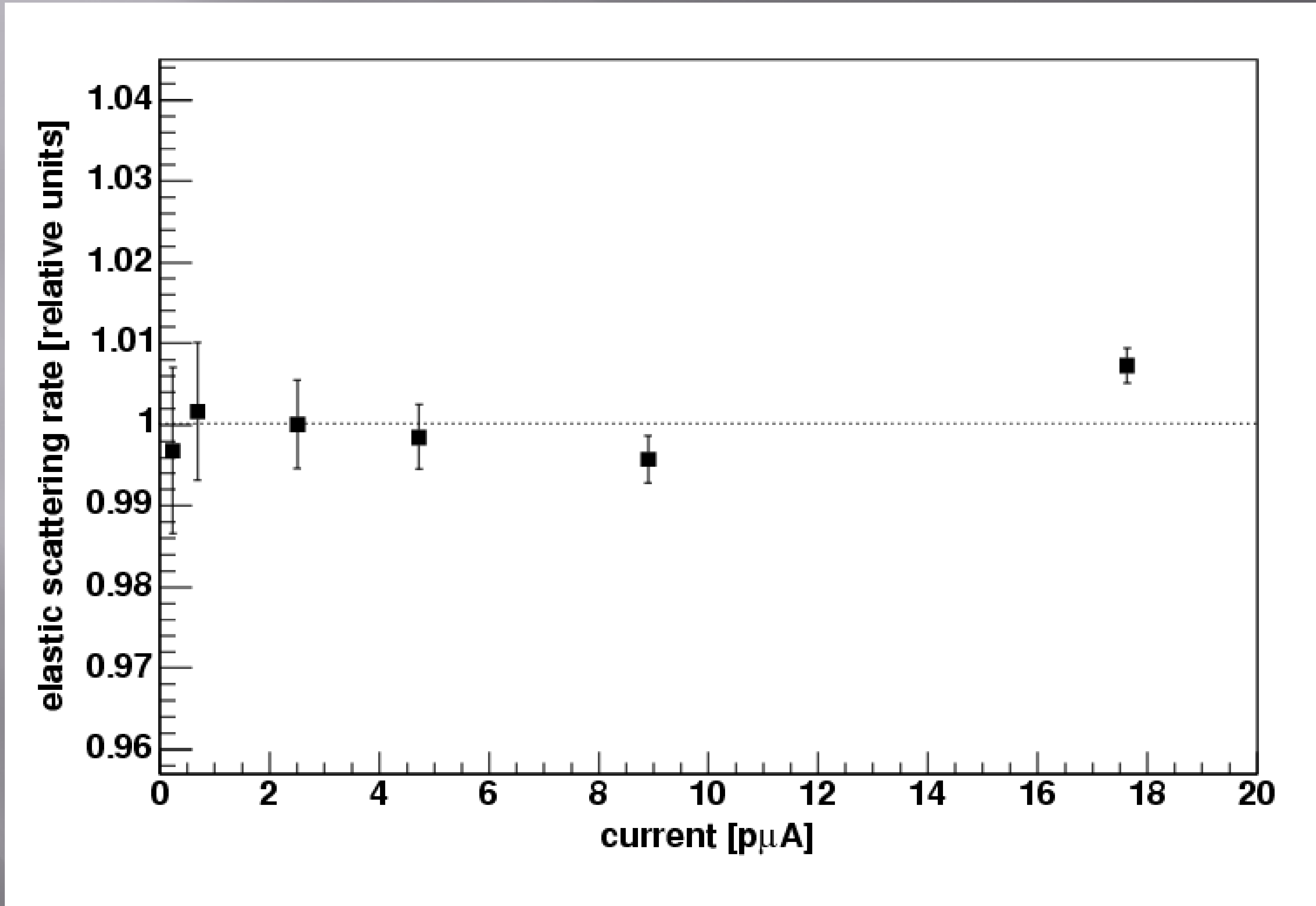




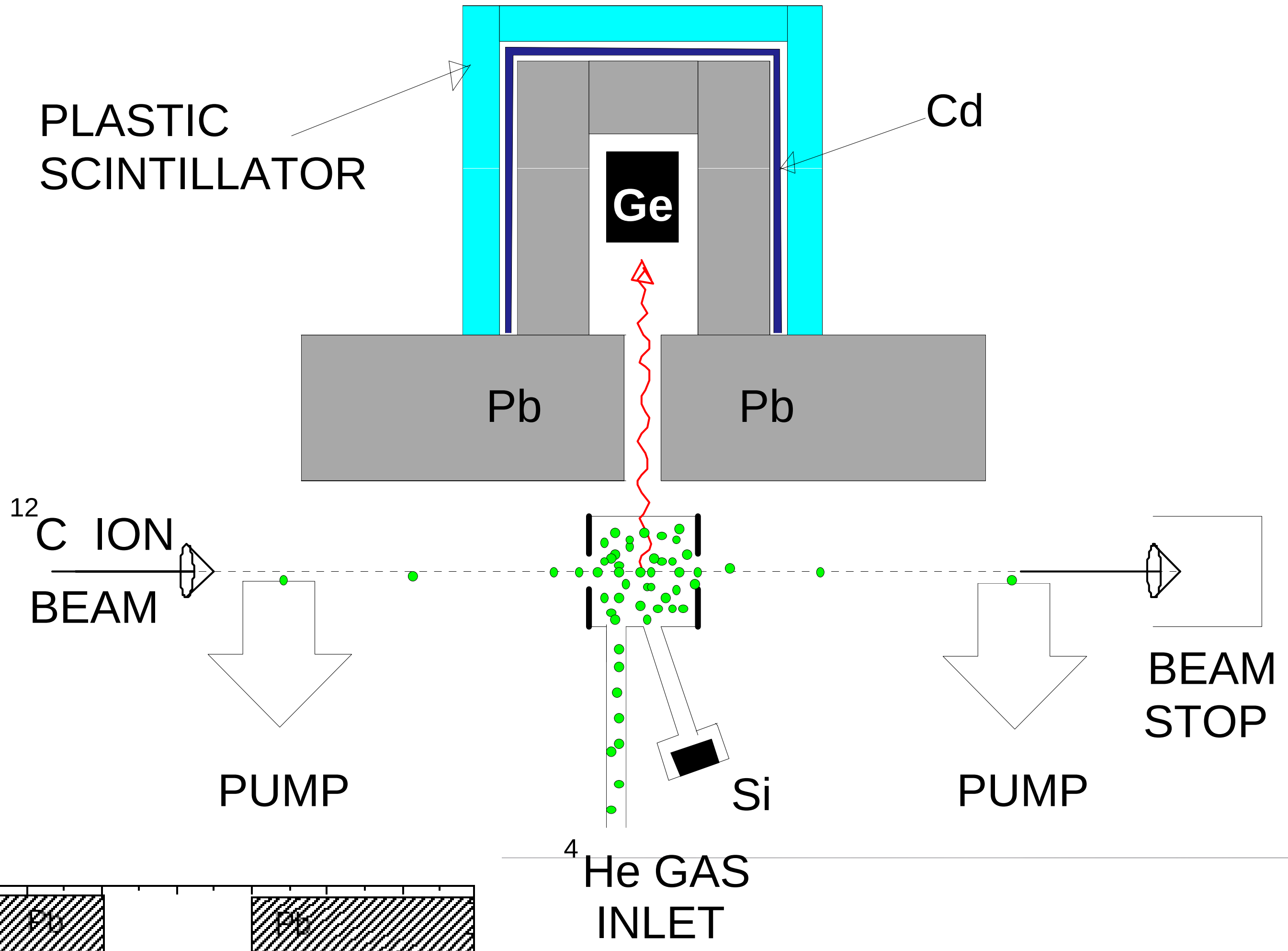
7Li(α,α') E_{lab}=3.325 MeV Γ_{lab}= 130 keV

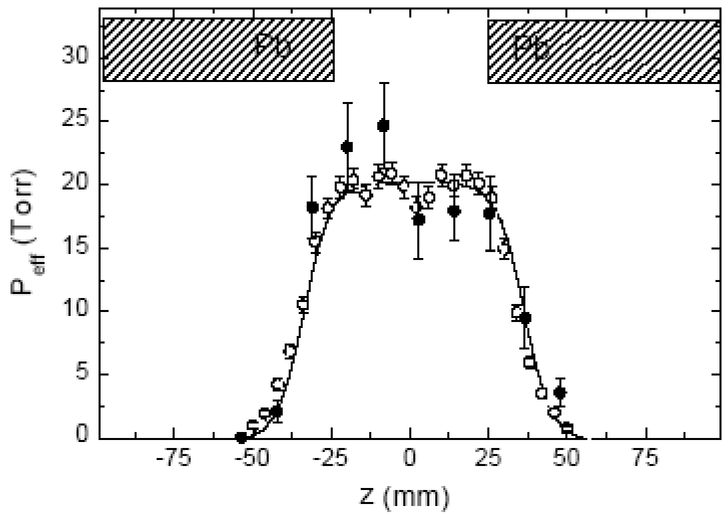
L. Gialanella- SLENA 2012, Kolkata, India

Normalization to $^{12}C(\alpha,\alpha)$: test for heating of the target



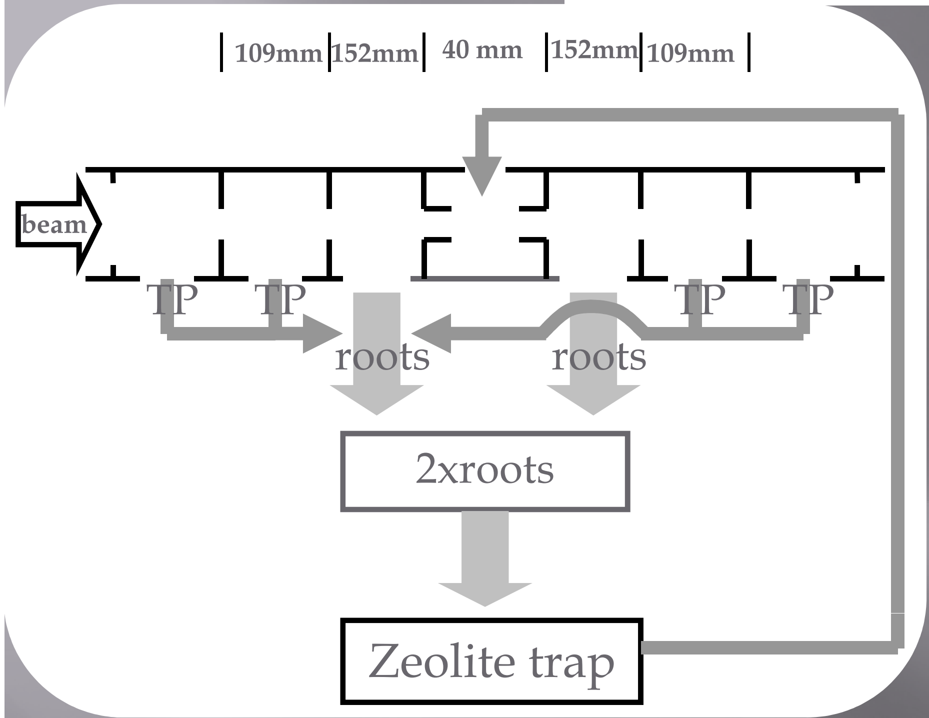
Schuermann et al, NIM A 531 (2004) 428–434

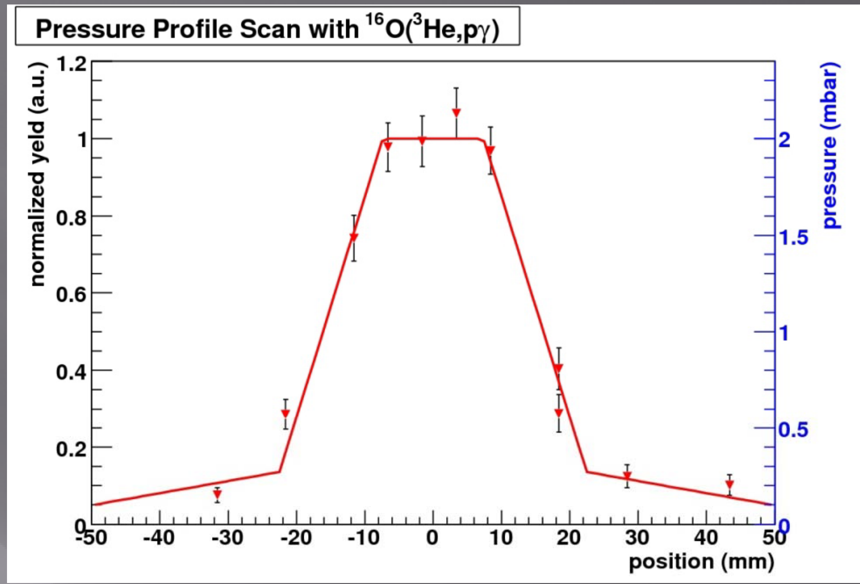




Gialanella et al Eur. Phys. J. A **11, 357–370 (2001)**

Recirculating gas target

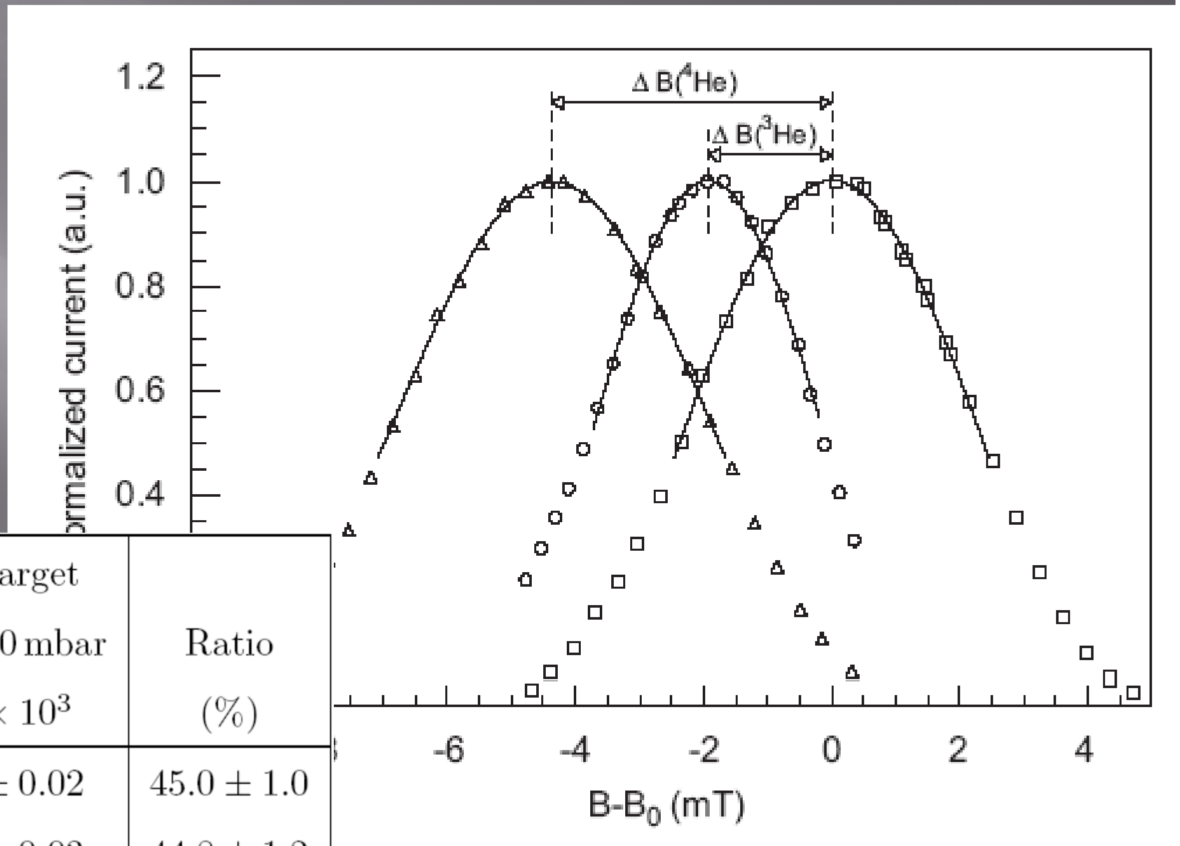




Thickness: $2.00 \pm 0.08 \times 10^{17}$ atoms/cm^2

A. Di Leva et al. NIMA 595 (2008) 381–390

Energy loss measurements



ion	E(MeV)	^{3}He target $p = 2.00\,\mathrm{mbar}$ $\frac{\Delta B}{B} \times 10^3$	^{4}He target $p = 4.00\,\mathrm{mbar}$ $\frac{\Delta B}{B} \times 10^3$	Ratio (%)
$^7Li^+$	1.68	1.71 ± 0.02	3.97 ± 0.02	45.0 ± 1.0
$^{12}C^{2+}$	2.00	3.21 ± 0.03	7.17 ± 0.03	44.8 ± 1.2
$^{12}C^{2+}$	4.50	1.46 ± 0.02	3.17 ± 0.03	45.8 ± 1.9
$^{14}N^{2+}$	2.00	3.49 ± 0.02	7.50 ± 0.02	46.5 ± 0.6
$^{16}O^{3+}$	4.50	2.10 ± 0.02	4.54 ± 0.02	46 ± 2
weighted average				45.9 ± 0.5

Di Leva et al. NIMA 595 (2008) 381–390

Basic concepts in gas target design: continuity equation and gas flow conductivity

$$Q = p_A \cdot S_{eff} = pv \cdot S_V$$

$$q_{pV} = C(p_1 - p_2) = \Delta p \cdot C$$

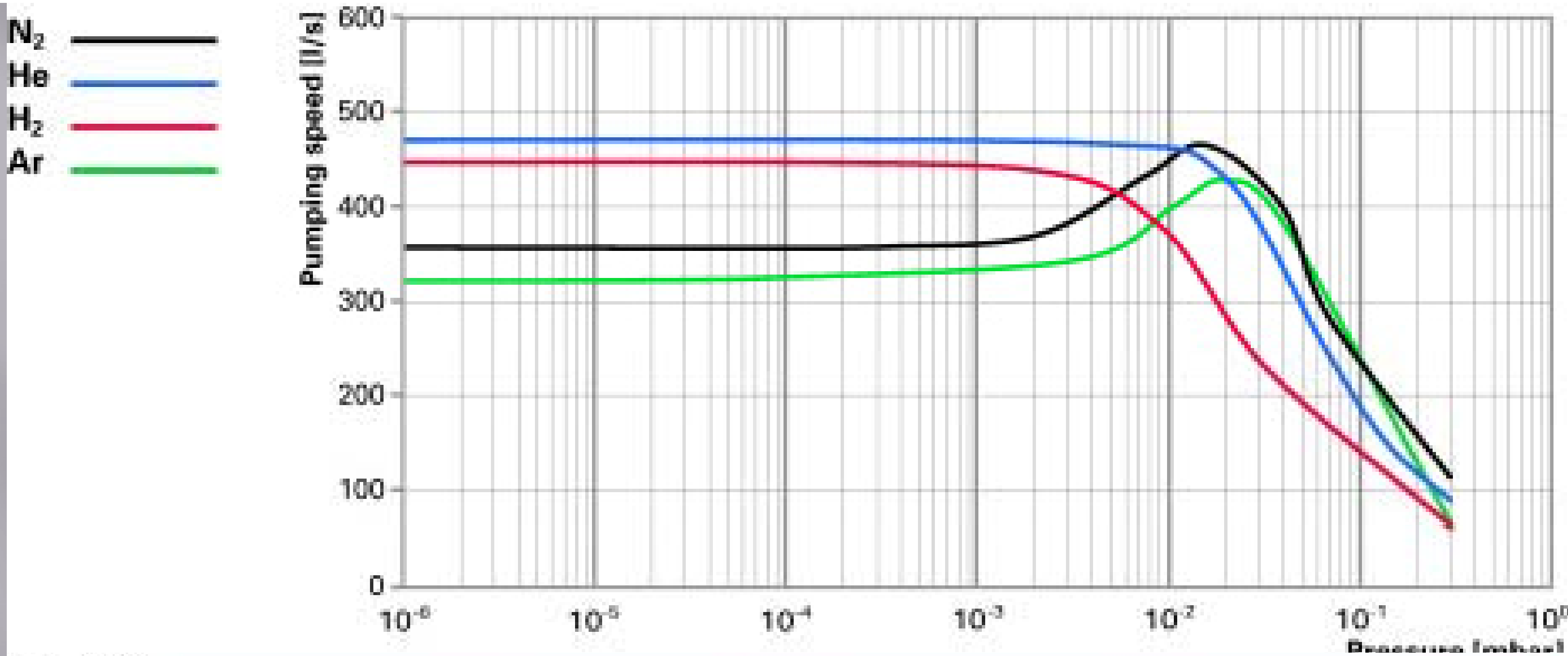
$$C = 135 \frac{d^4}{l} \bar{p} + 12.1 \frac{d^3}{l} \cdot \frac{1 + 192 \cdot d \cdot \bar{p}}{1 + 237 \cdot d \cdot \bar{p}} \; \ell/s \qquad (1.26)$$

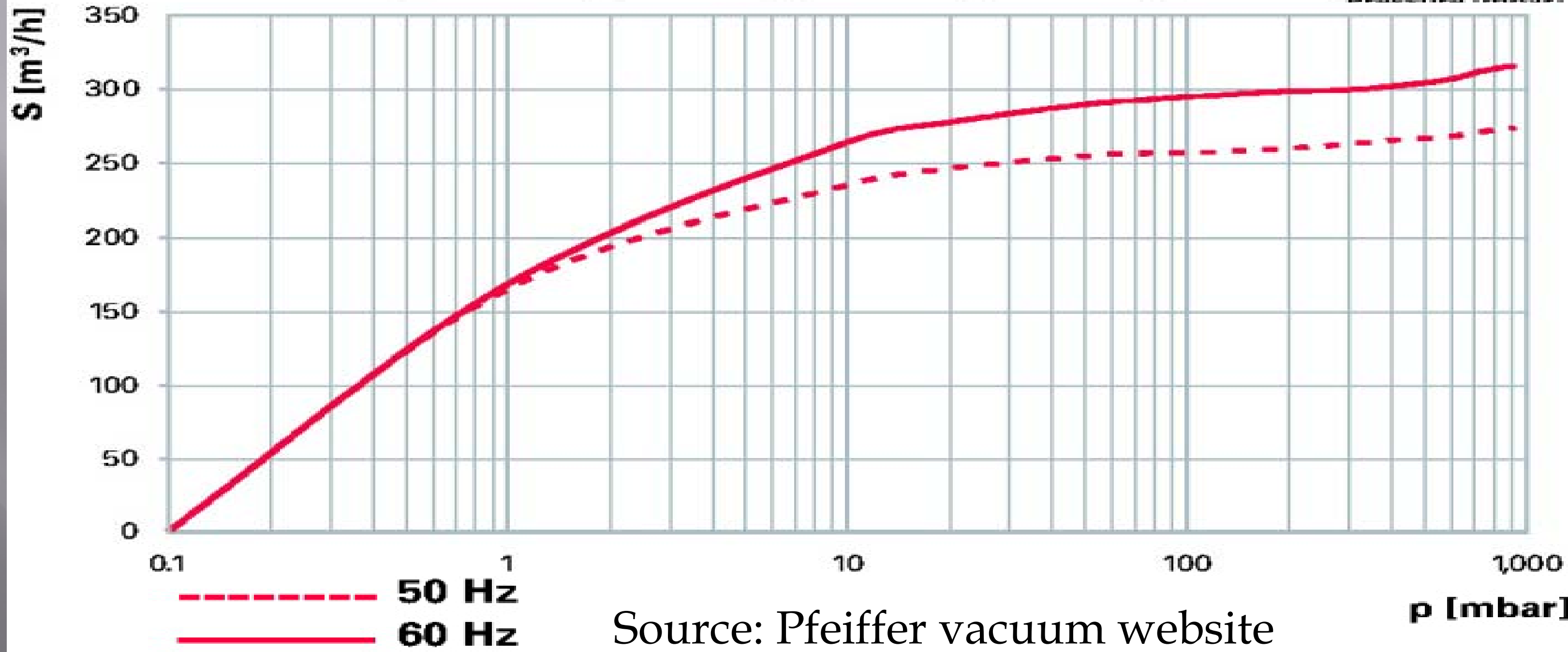
where

$$\bar{p} = \frac{p_1 + p_2}{2}$$

d = Pipe inside diameter in cm
l = Pipe length in cm ($l \geq 10$ d)
p_1 = Pressure at start of pipe (along the direction of flow) in mbar
p_2 = Pressure at end of pipe (along the direction of flow) in mbar

Source: Leybold vacuum handbook



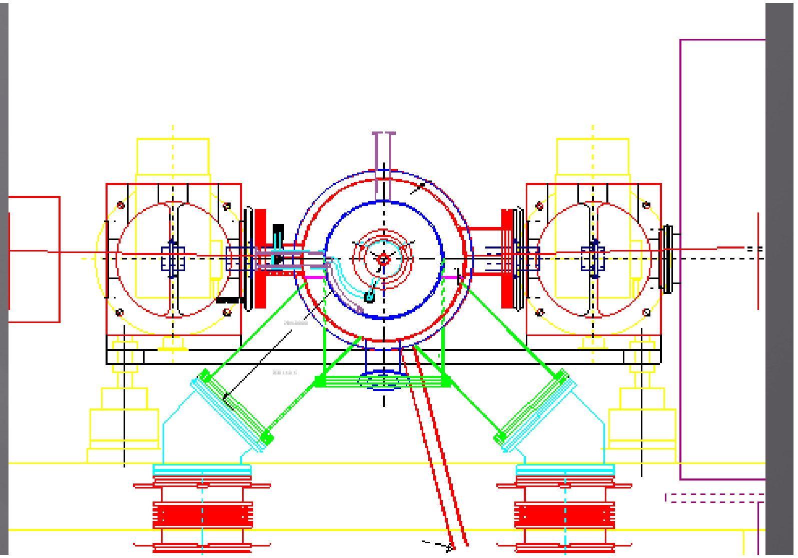


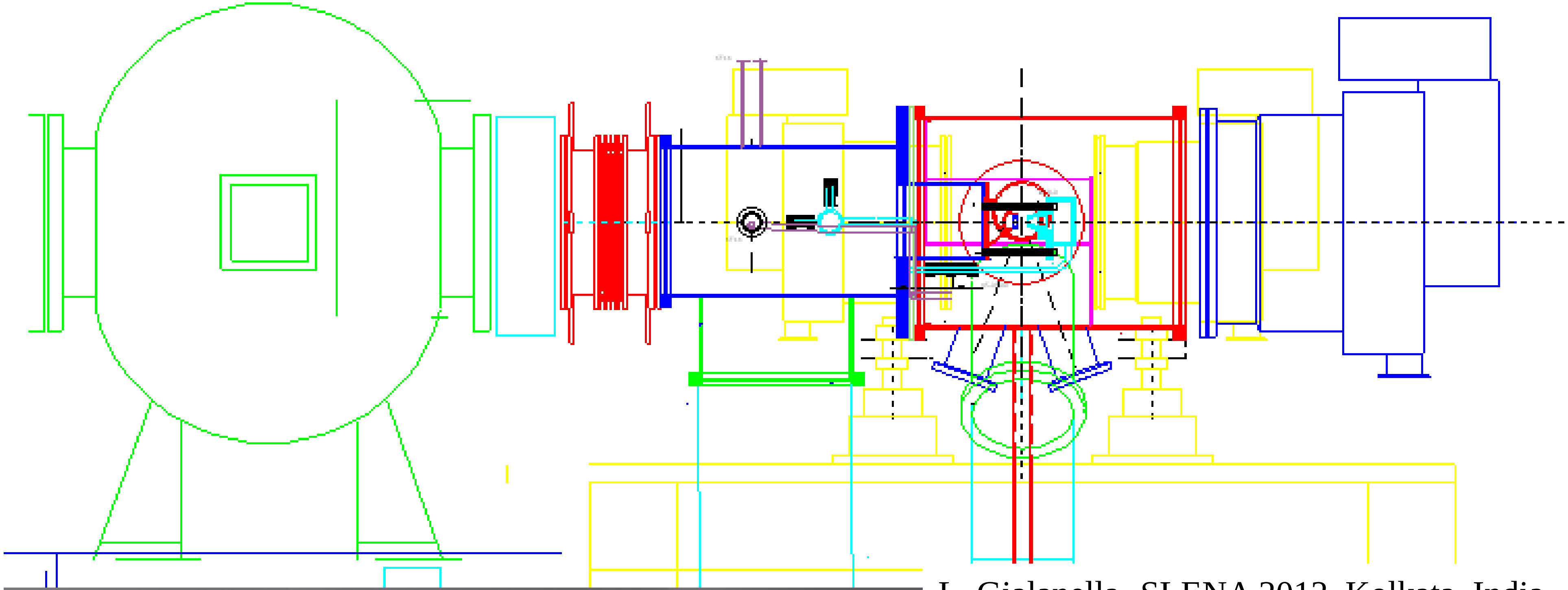
Source: Pfeiffer vacuum website

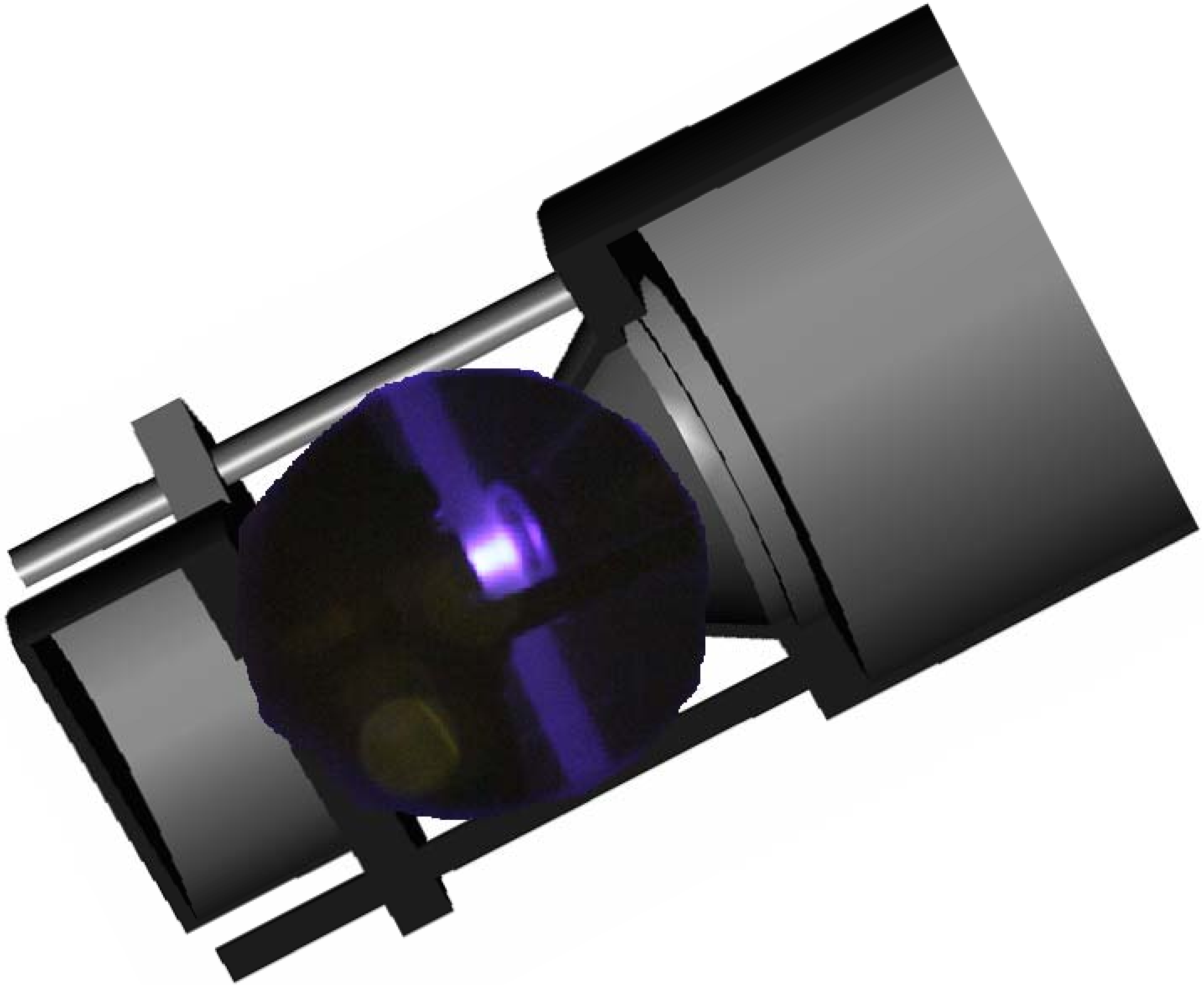
Attention: see 2008 J. Phys.: Conf. Ser. 114 012018

2. Target

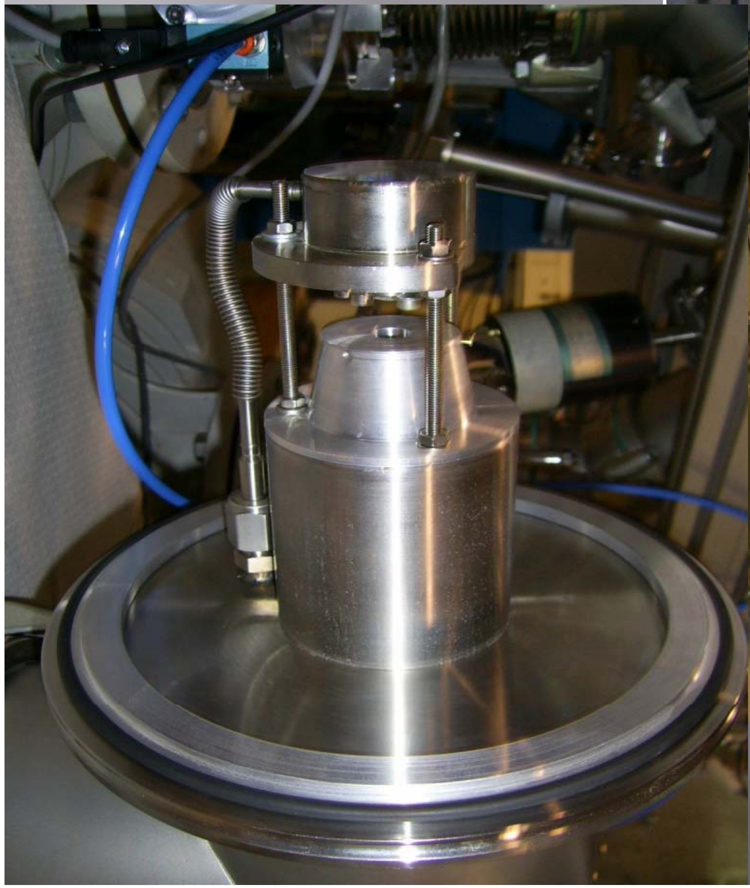
1. Thin jet gas target (4 10^{17} at/cm^2)
2. Compact
3. 1-2 π for gamma detectors (NaI, HPGe)

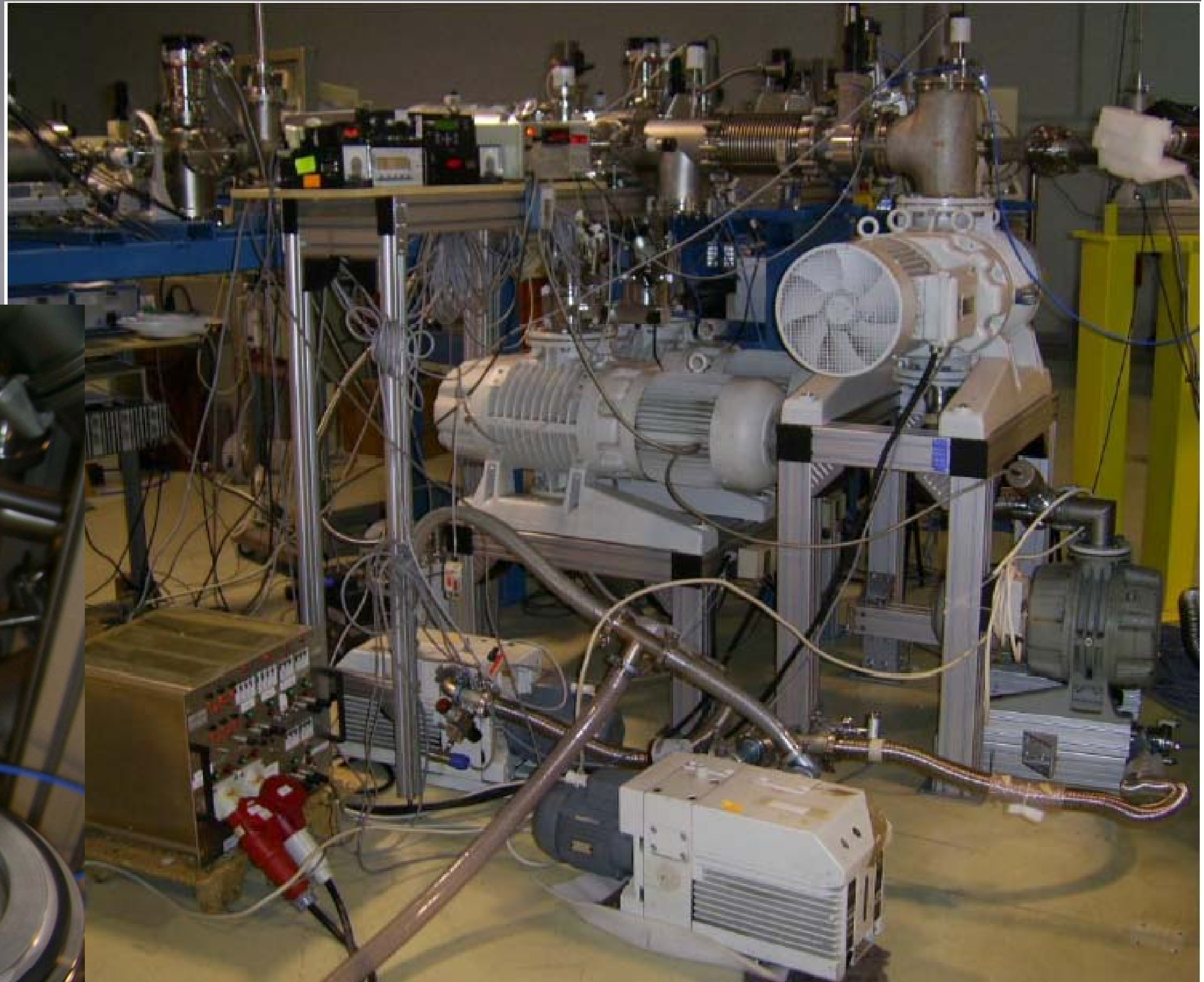






ERNA test gas target





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Test version – preliminary results