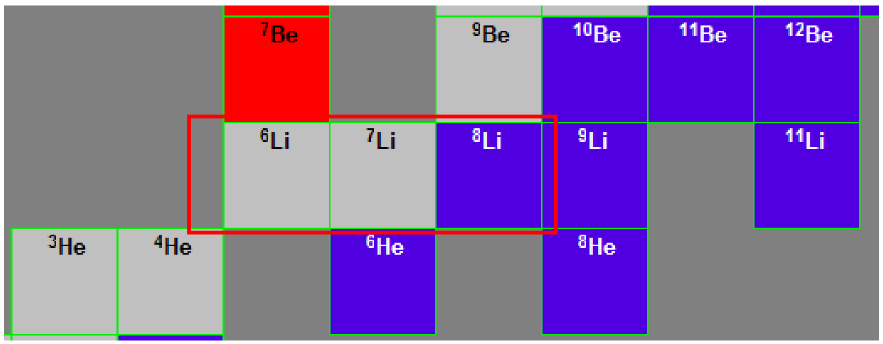
DMFCI University of Catania and LNS-INFN

A. Musumarra

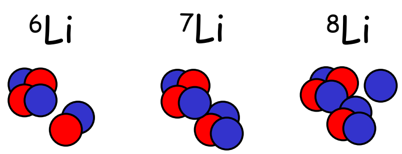
Measuring total reaction cross-sections at energies near the coulomb barrier by the active target method

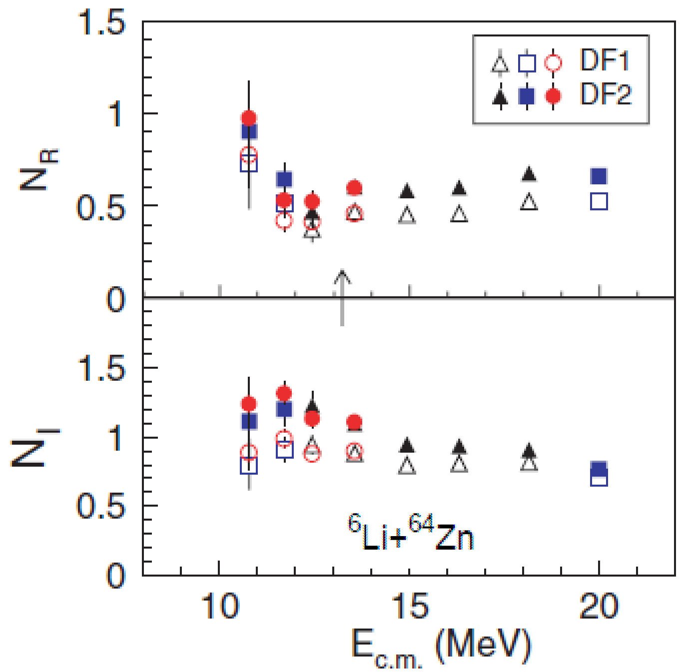
DREB09

Why to measure σ_R around the Coulomb barrier ?



i) Following the trend of σ_R along the Li (^{6,7,8,9}Li) isotopic chain at low energy we can reveal changes in structures (e.g. $^{6-9}$Li isotopes).





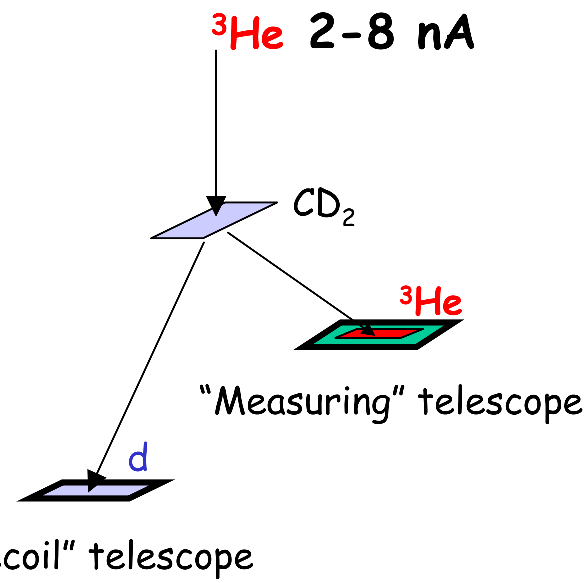
Zadro et al. PRC in press

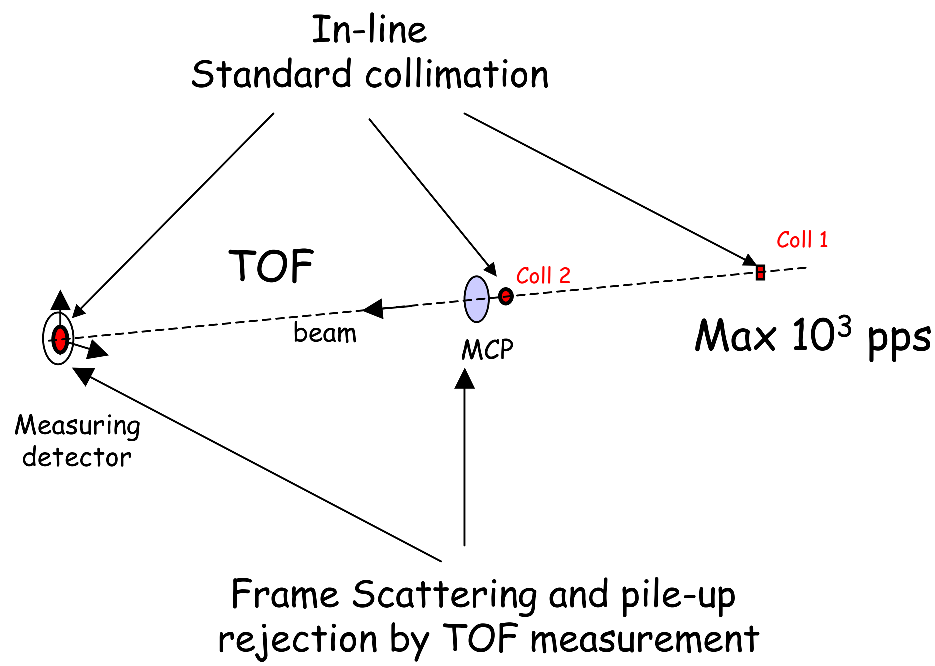
ii) At such energies we expect rapid variations of the real and imaginary part of the optical potential (Threshold Anomaly). Measuring σ_R we can put constraints on optical model parameters.

How to measure σ_R

Direct Technique
A silicon detector used as an active target

R.E. Warner





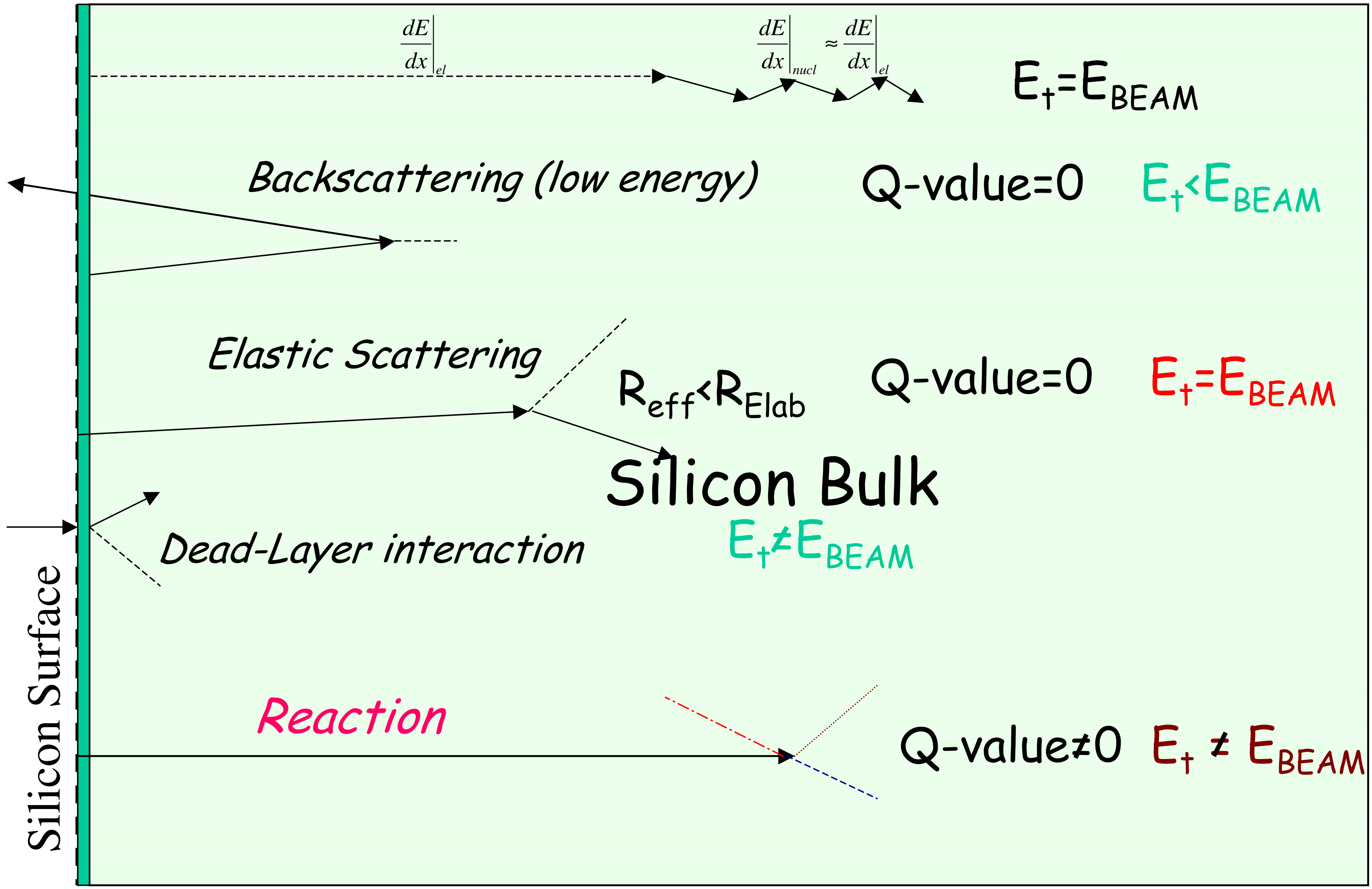
Kinematic coincidences (collimation)

Suitable for low intensity
stable and radioactive beams

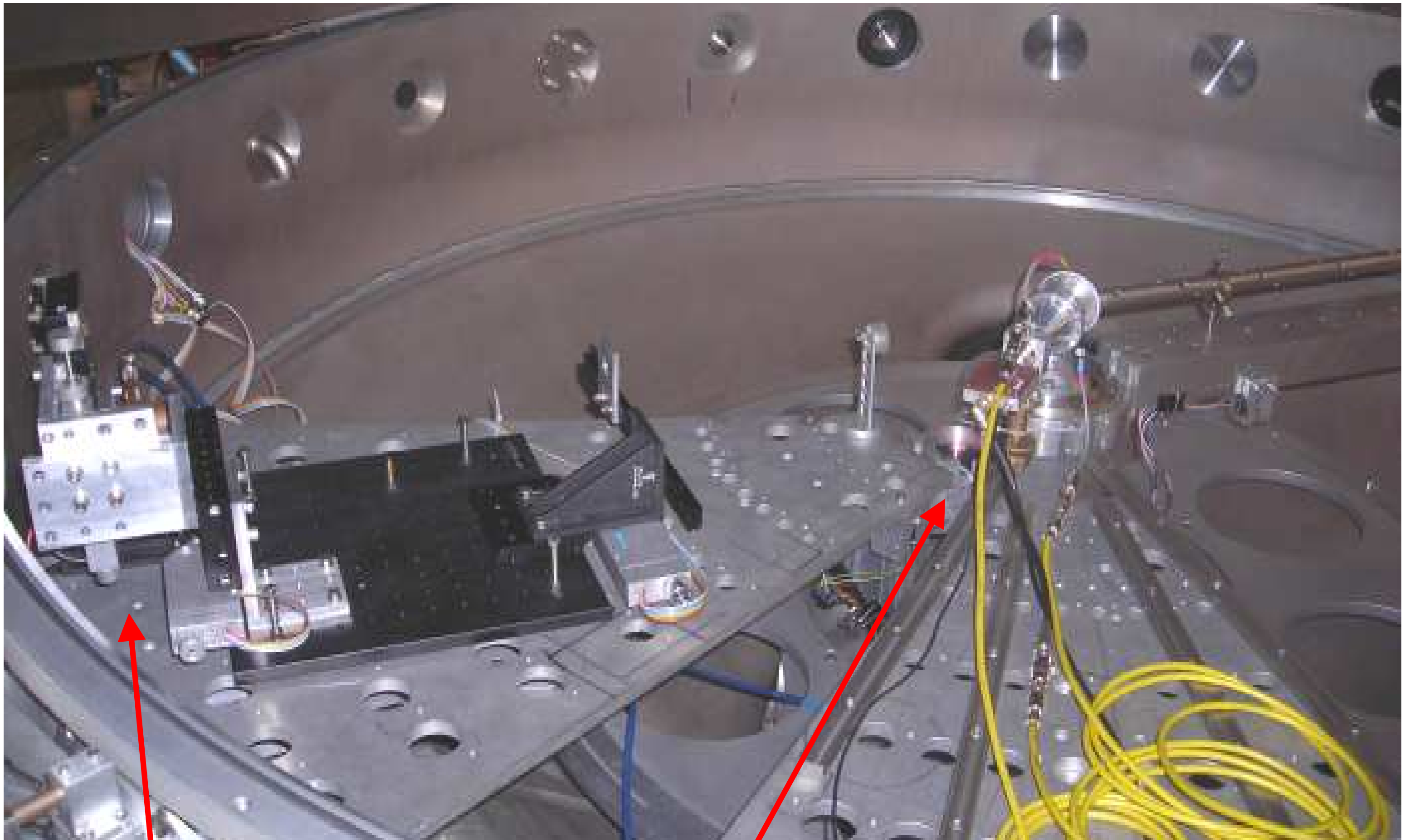
R.E. Warner, C.P. Browne and S.E. Darden et al.,
Phys. Rev. C 37 (1988), p. 1884.

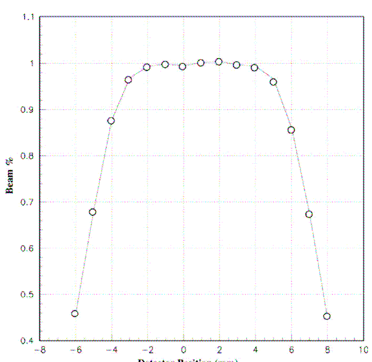
A. Musumarra , P. Figuera et al.
NIM A in press
doi:10.1016/j.nima.2009.11.039

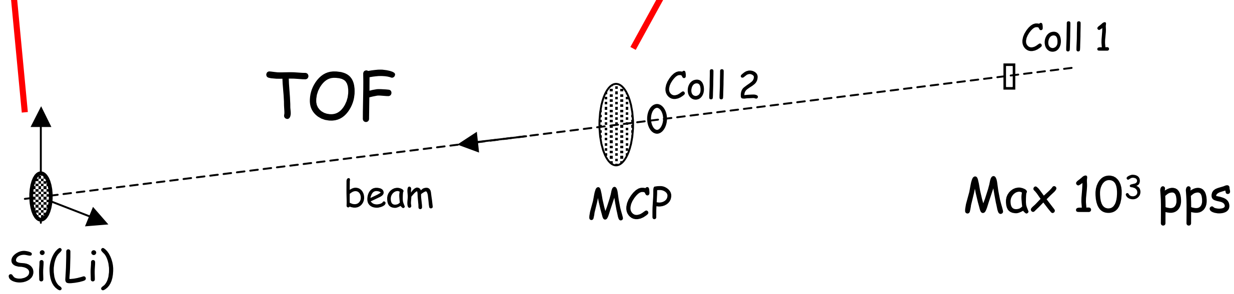
Charged Particle vs Silicon Detector

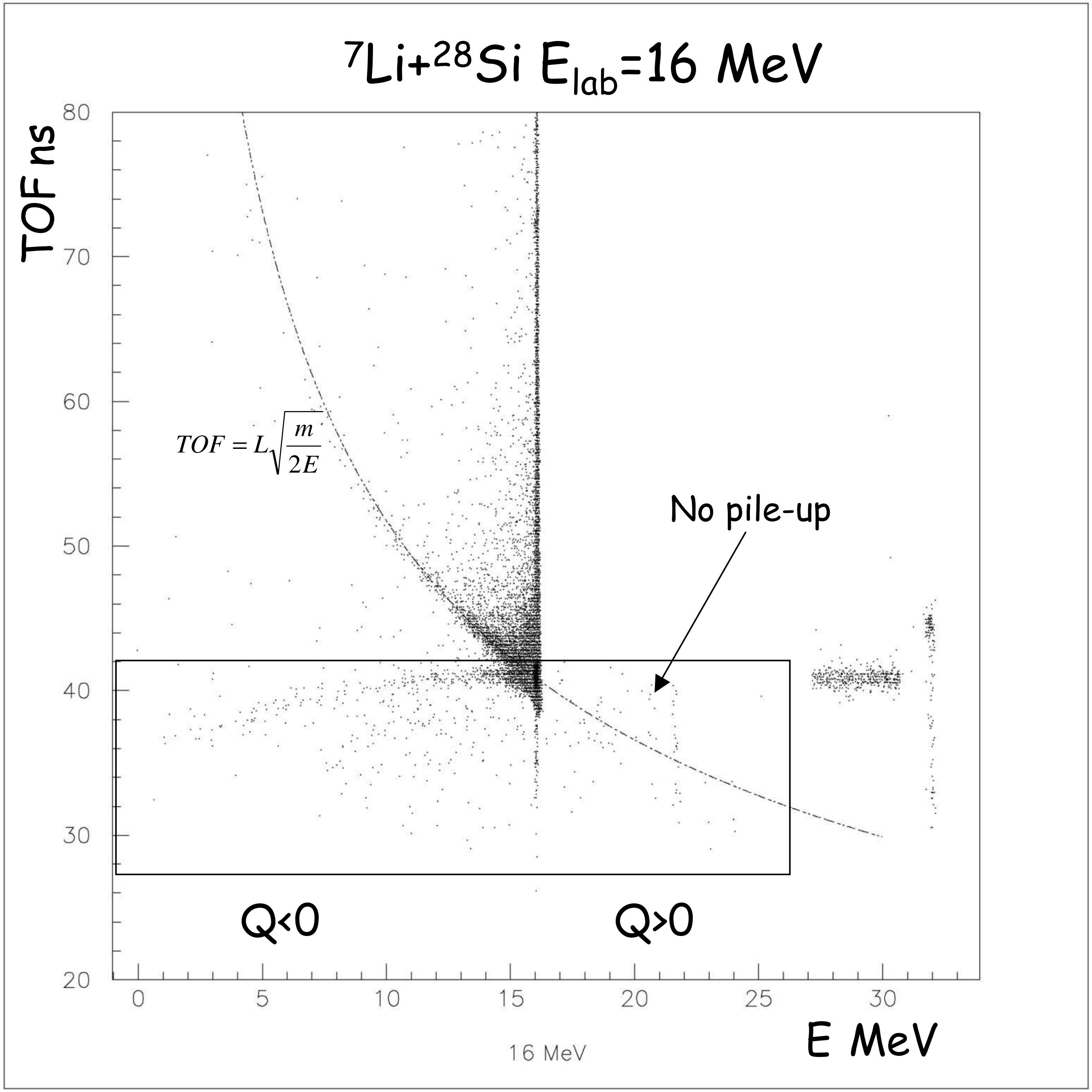


Experimental set-up 2000 scattering chamber at LNS-INFN





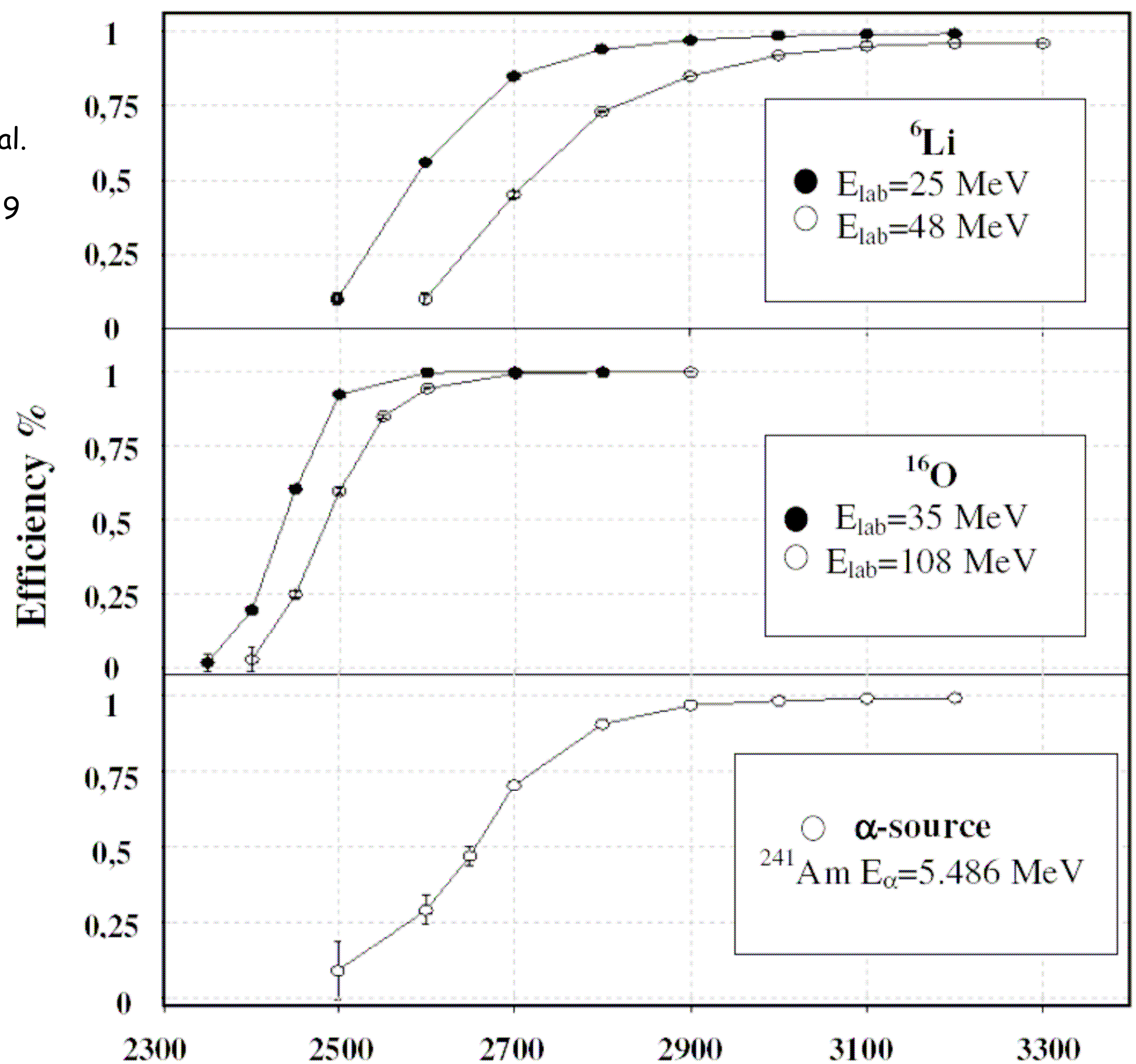




$^7Li+^{28}Si$ E_{lab}=16 MeV
TOF ns
$TOF = L\sqrt{\frac{m}{2E}}$
No pile-up
Q<0
Q>0
16 MeV
E MeV

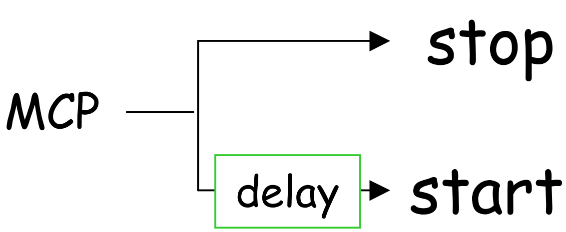
MCP efficiency - LiF coated emitter foil

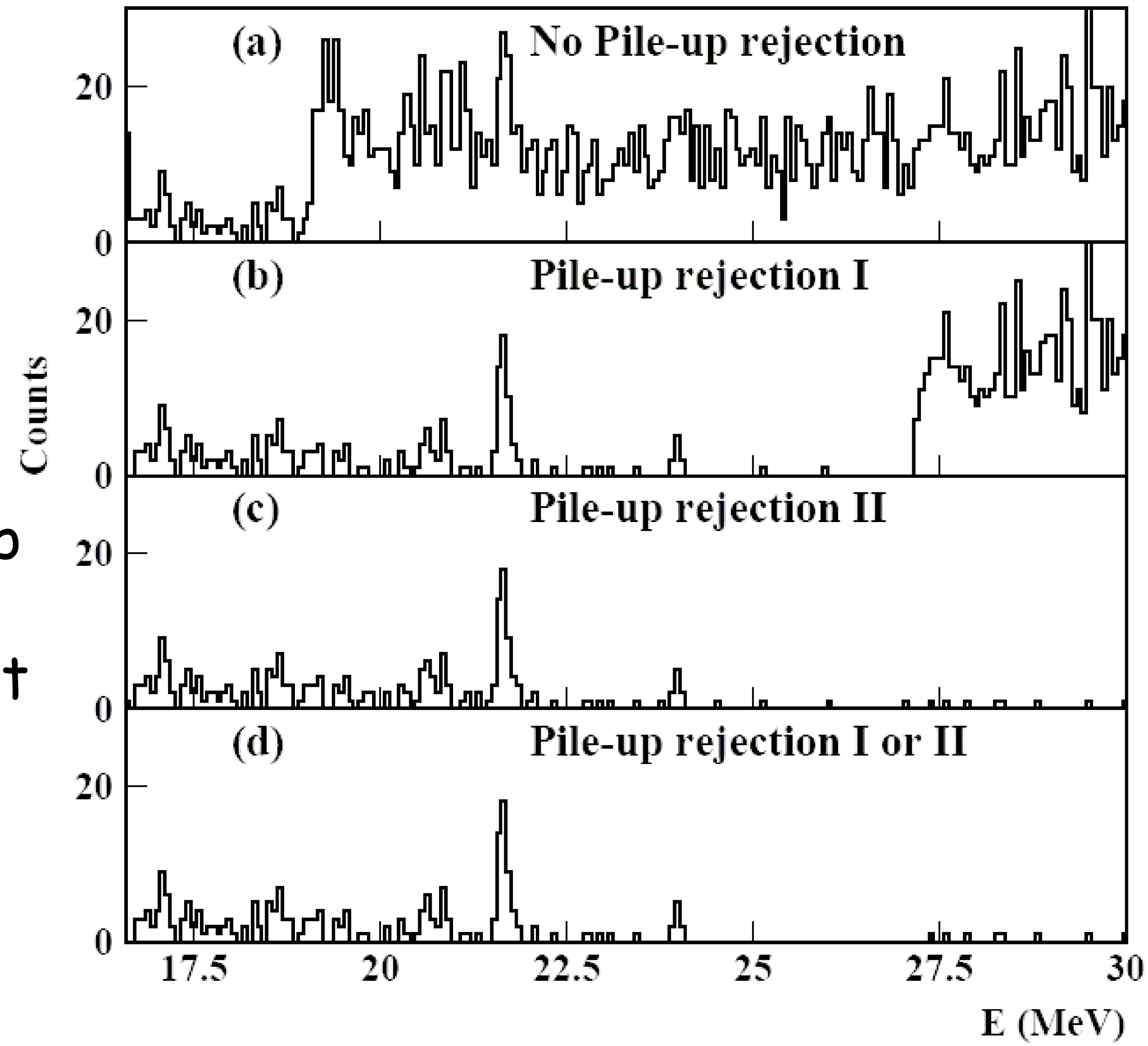
A. Musumarra , P. Figuera et al.
NIM A in press
doi:10.1016/j.nima.2009.11.039



Pile-up rejection - double rejection technique

PUR (672)





$^{7}Li+^{28}Si$ E_{lab}=16 MeV

A. Musumarra , P. Figuera et al.
NIM A in press
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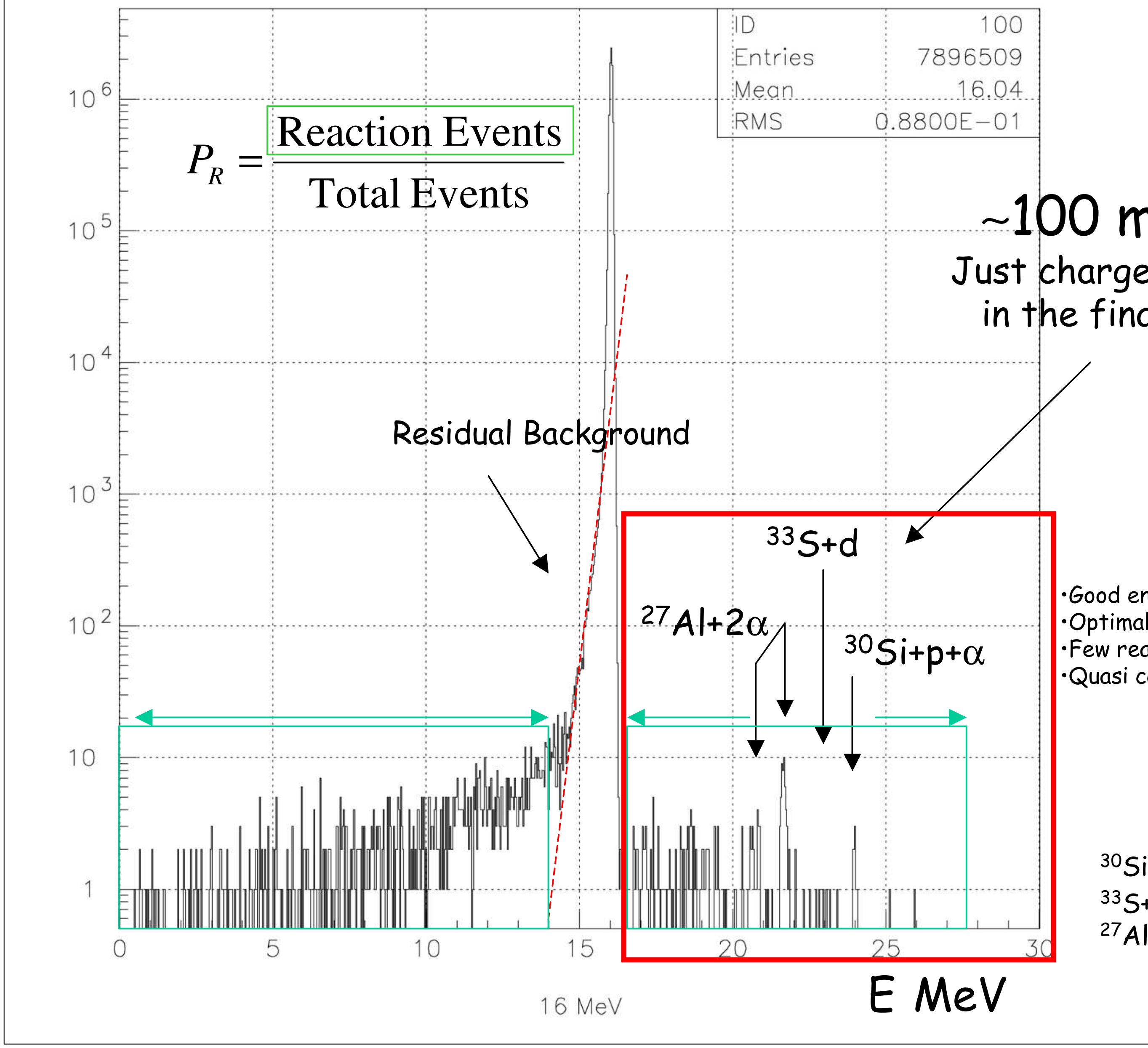
3-4 hours ^{7}Li @ 800 pps



- Good energy resolution
- Optimal pile-up suppression
- Few reaction channels opened
- Quasi calorimeter

^{30}Si+p+α	8134 keV
^{33}S+d	6865 keV
^{27}Al+2α	5762 keV

(dE/dx)$^{-1}$

measured

$$\overline{\sigma}_R = \frac{\int_0^{E\max} \sigma_R(E)\left(dR(E) / dE \right) dE}{\int_0^{R\max} dR} = -\frac{m \cdot \log(1-P_r)}{\rho \cdot N_A R_{\max}}$$

10^{-4}

m=mol-weight (28)
N_A=Avogadro number
R_{max}=Range of the projectile (in silicon)
ρ=target density

From P_r —Unfolding→ σ_r

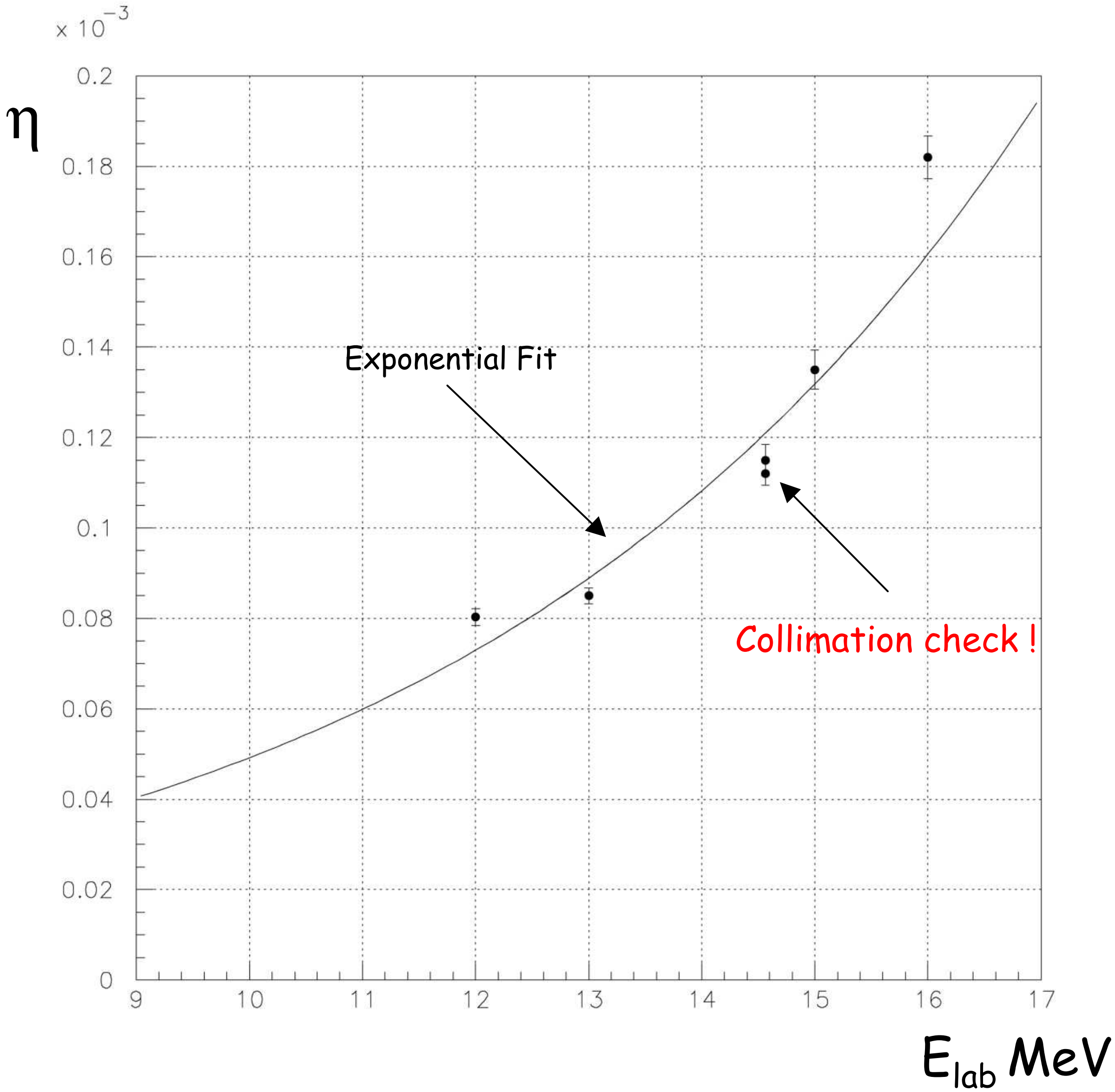
How to unfold ?

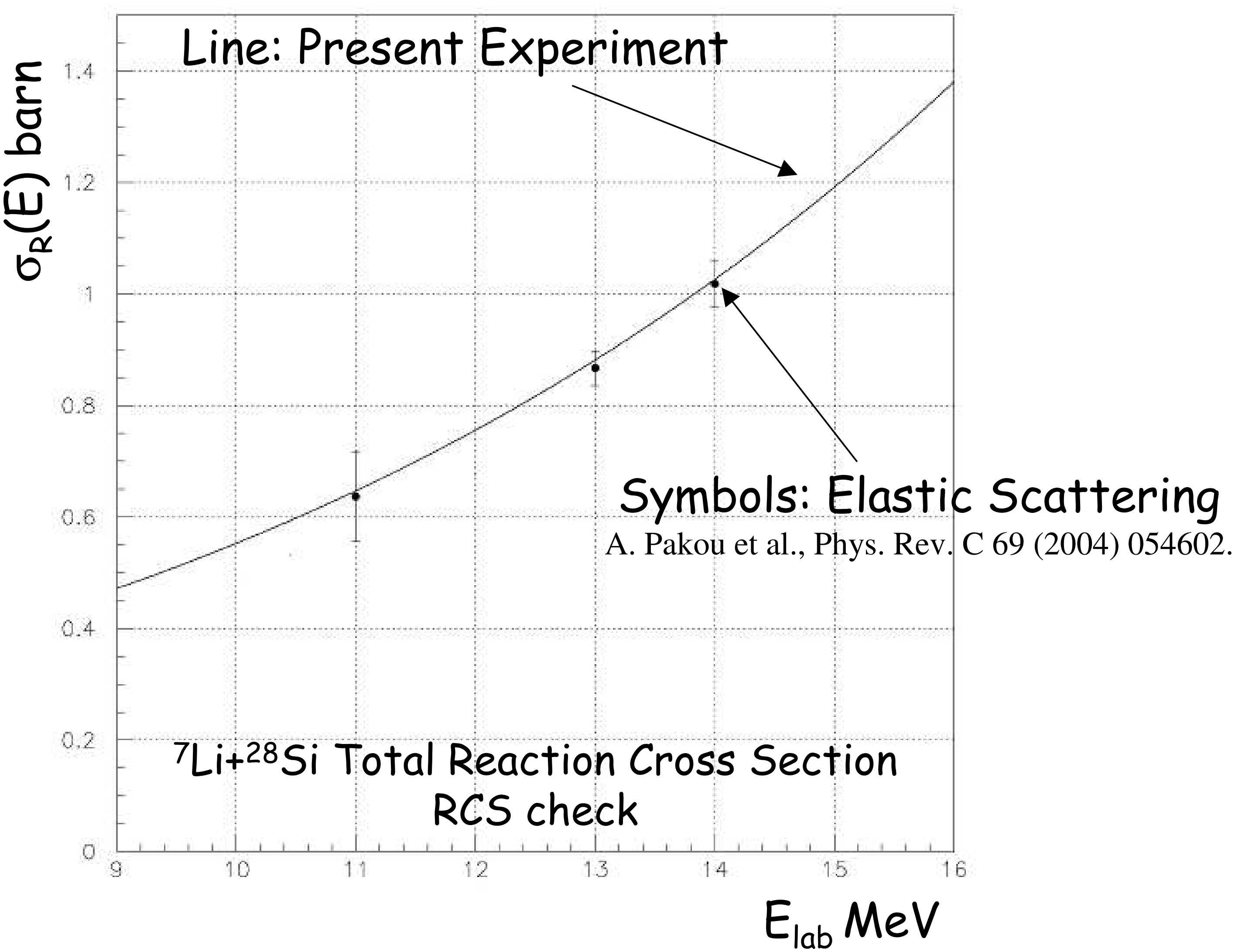
$$A_n(E_n) = -\frac{m \cdot \log(1-P_R(E_n))}{\rho \cdot N_A}$$

Stopping power

$$\sigma_R(E_n) = \frac{dA}{dE} \cdot \frac{dE}{dx}$$

$^{7}Li+^{28}Si$ Reaction Probability Ex. Fun.





Line: Present Experiment
Symbols: Elastic Scattering
A. Pakou et al., Phys. Rev. C 69 (2004) 054602.
^{7}Li+^{28}Si Total Reaction Cross Section
RCS check
σ_R(E) barn
E_{lab} MeV
0
0.2
0.4
0.6
0.8
1
1.2
1.4
9
10
11
12
13
14
15
16

Conclusions

- Warner technique very effective in σ_R determination near the Coulomb barrier
- Specific reaction channels can be disentangled (Fusion – Transfer) by very low intensity beam (10^3 pps)
- Technique sperimentally checked for the $^{7}Li+^{28}Si$ system @ E(^{7}Li) 12-16 MeV
- Work in progress for the $^{8}Li+^{28}Si$ system

Thank you

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