S395

Determination of proton radii and neutron skin thickness of p,sd shell nuclei by Charge-Changing Cross Section Measurement

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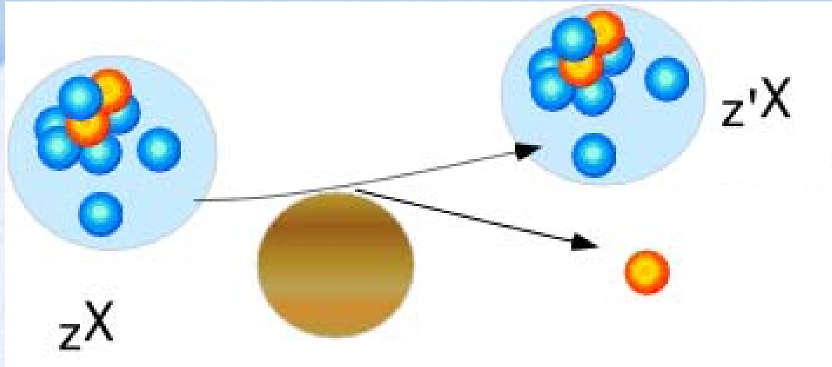
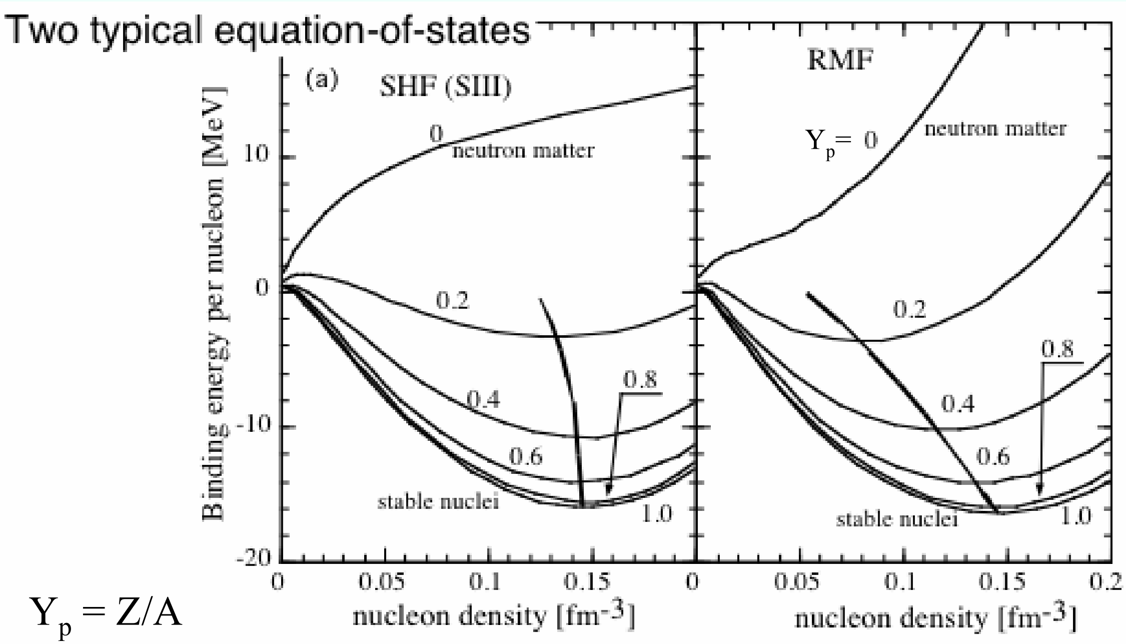
H. J. Ong, S. Pietri, A. Prochazka, C. Scheidenberger, B. Sitar, P. Strmen, T. Suzuki, I. Szarka, A. Tamii, M. Uchida, H. Weick, M. Winkler

Charge-changing cross section : *a measure of charge radius*



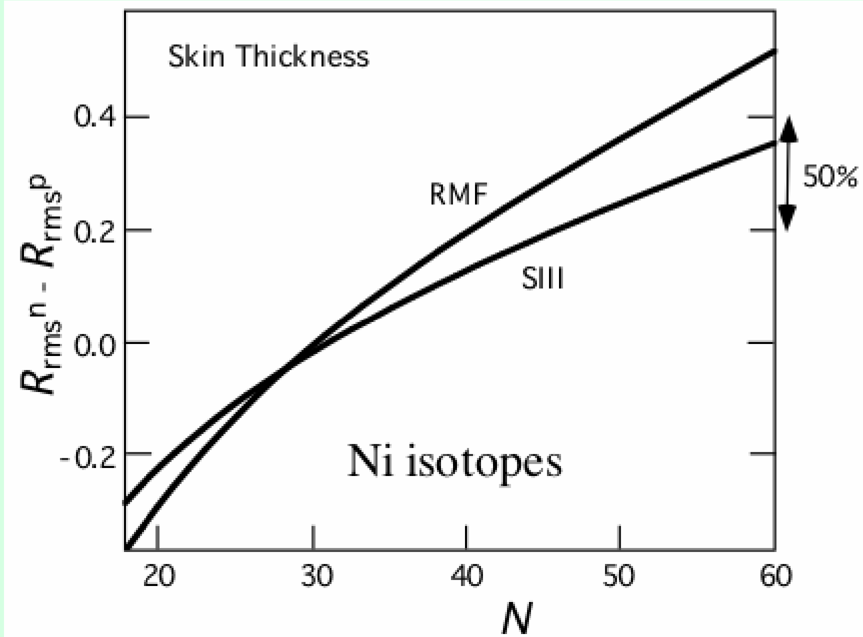
- Neutron skin thickness :
  Equation of state of asymmetric nuclear matter
- Structure models :
  Evolution of deformation and cluster structure
- Nucleon correlation :
  Center of mass motion effect

Neutron Skin



$Y_p = Z/A$

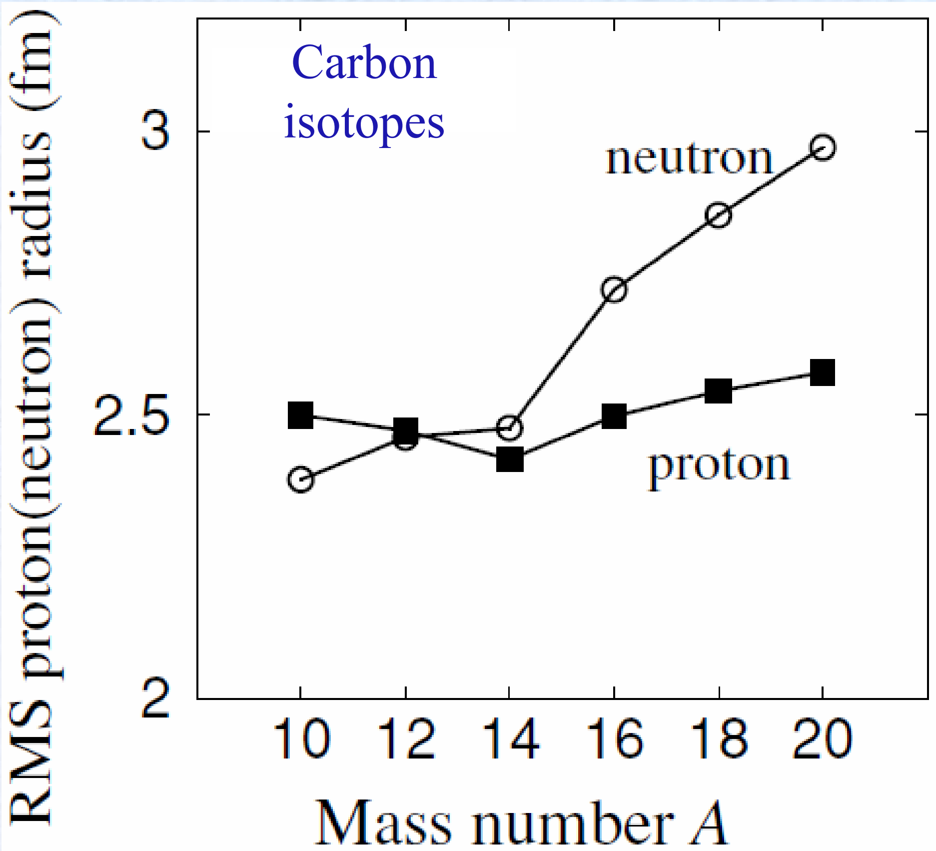
K. Oyamatsu *et al*, Nucl. Phys. A 634(1998)3



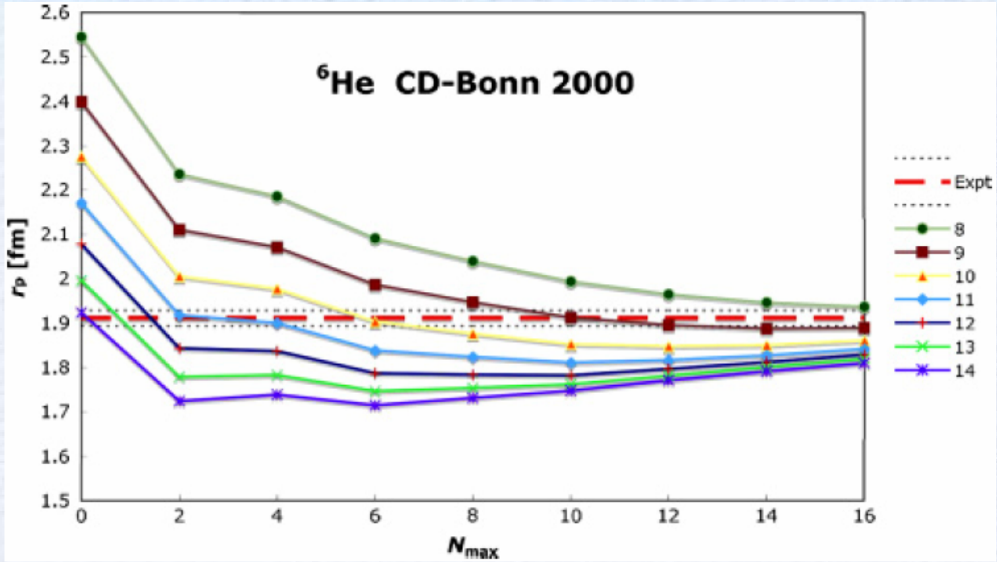
A guidance for the equation of state of asymmetric nuclear matter

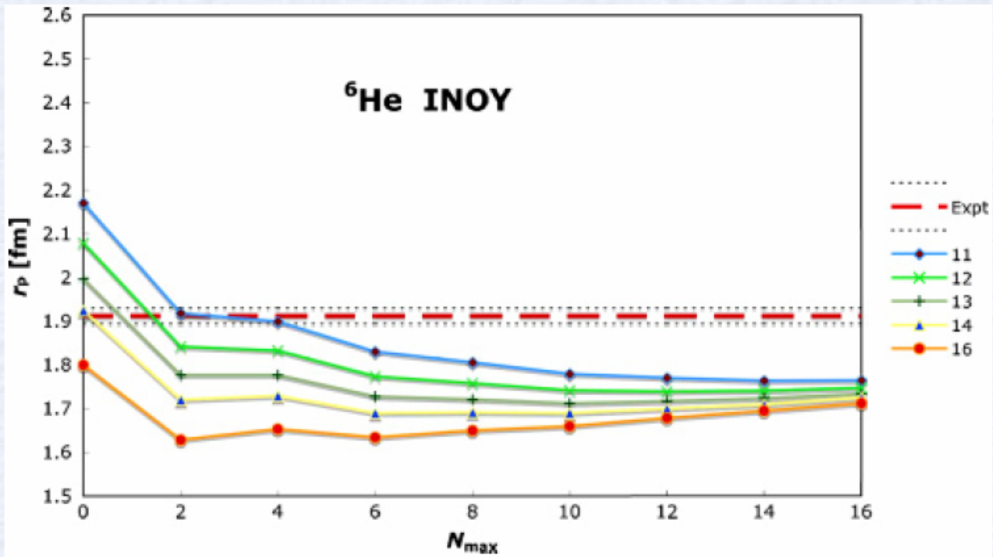
Testing new structure models : *cluster structure*

AMD, FMD, ab initio models



Y. Kanada-En'yo, Phys, Rev. C 71 (2005) 014310.



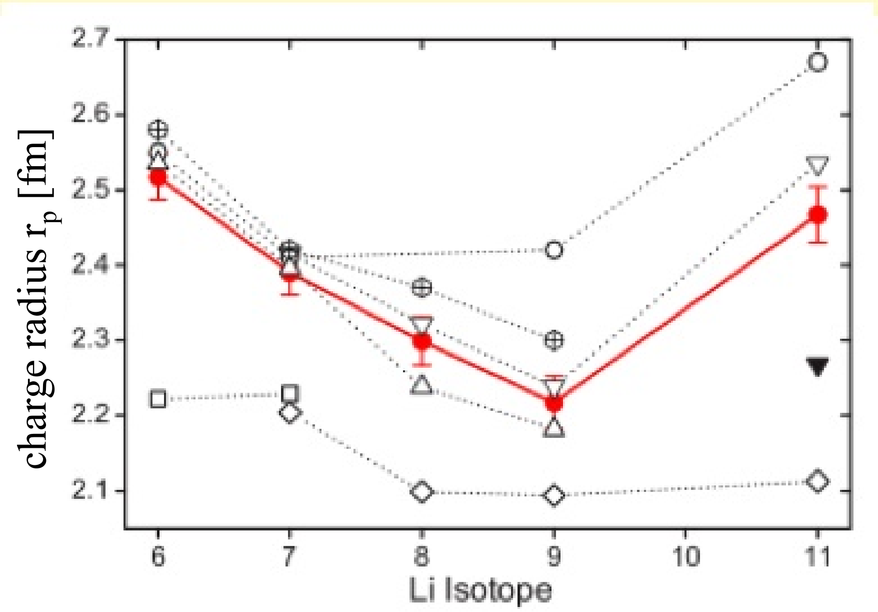


E. Caurier and P. Navratil, PRC 73 (2006) 021302.

Charge radius constrains:

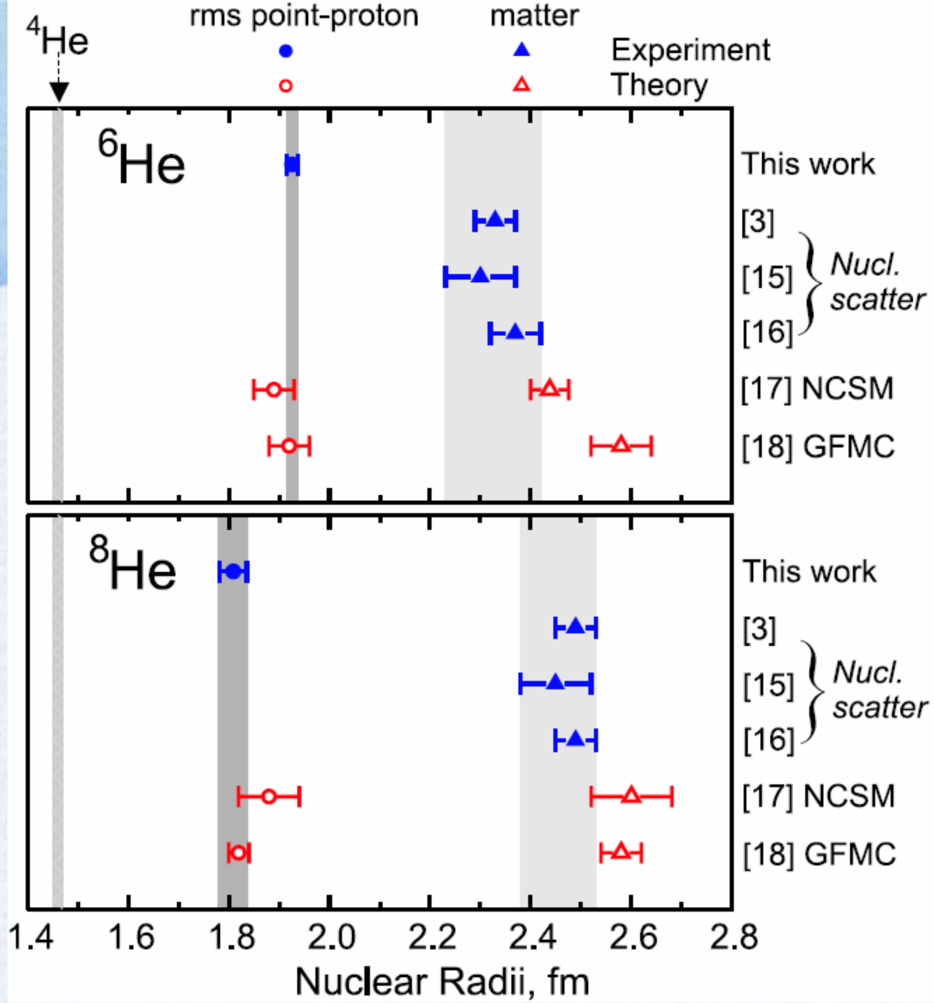
- n-n interaction
- deformation

Nucleon Correlation



Laser spectroscopy experiment with different theories

R. Sanchez et al, PRL 96(2006)033002



P. Mueller et al, PRL 99(2007)252501

$$\langle r_p^2(Z,A)\rangle = \langle r_p^2(Z,A-2)\rangle + \left(\frac{2}{A}\right)^2 \langle r_{c,2n}^2\rangle,$$

H. Esbensen et al, PRC 76(2007)024302

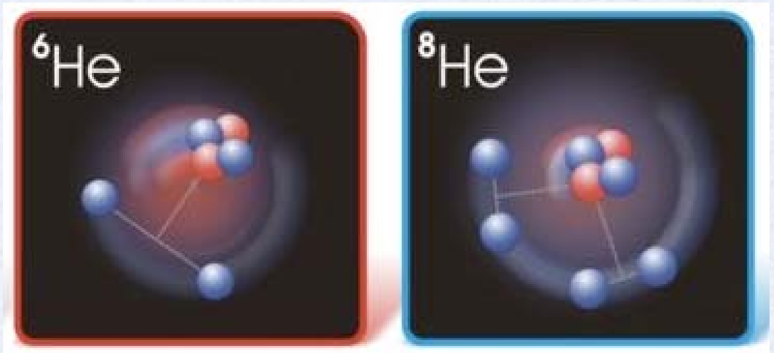
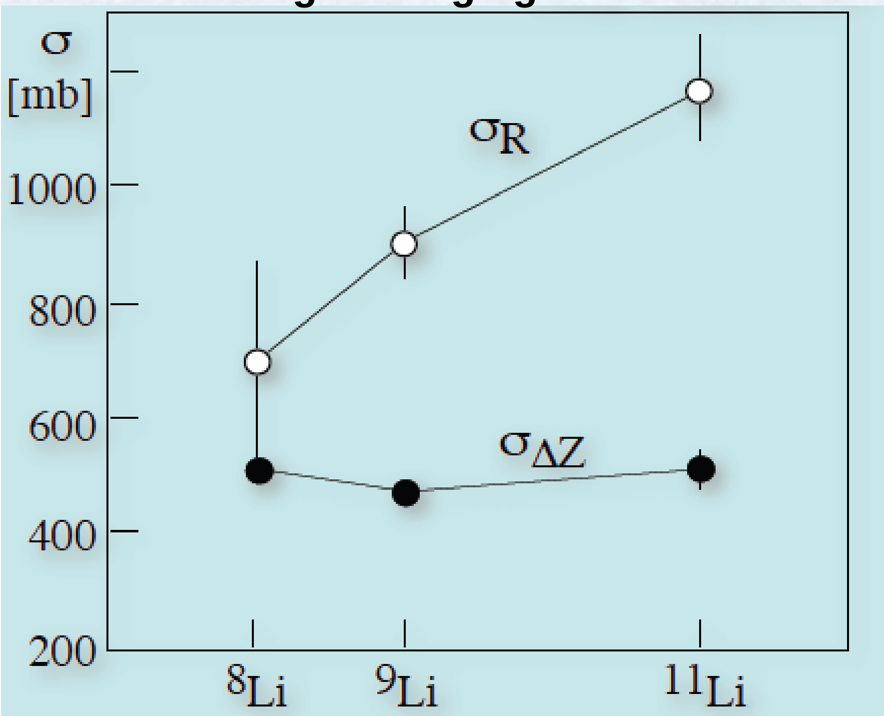


Figure courtesy : P. Mueller, ANL

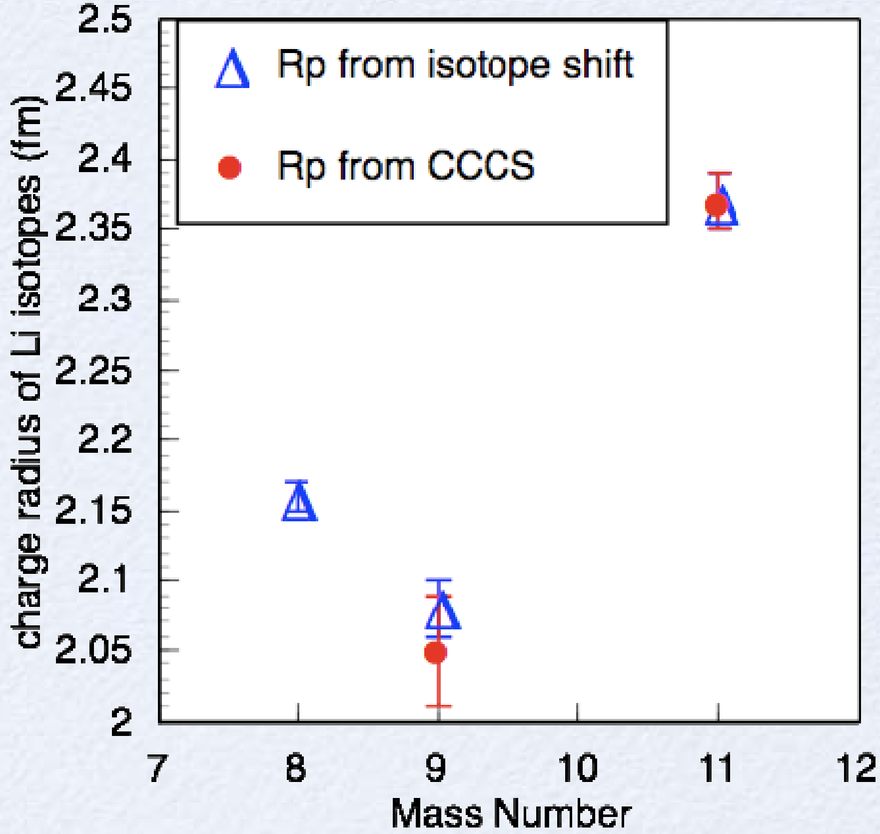
Halo neutrons are on the same side of the core

Does it work ? $\sigma_{cc} \rightarrow r_p$
based on Eikonal approximation

Charge-changing cross sections Li

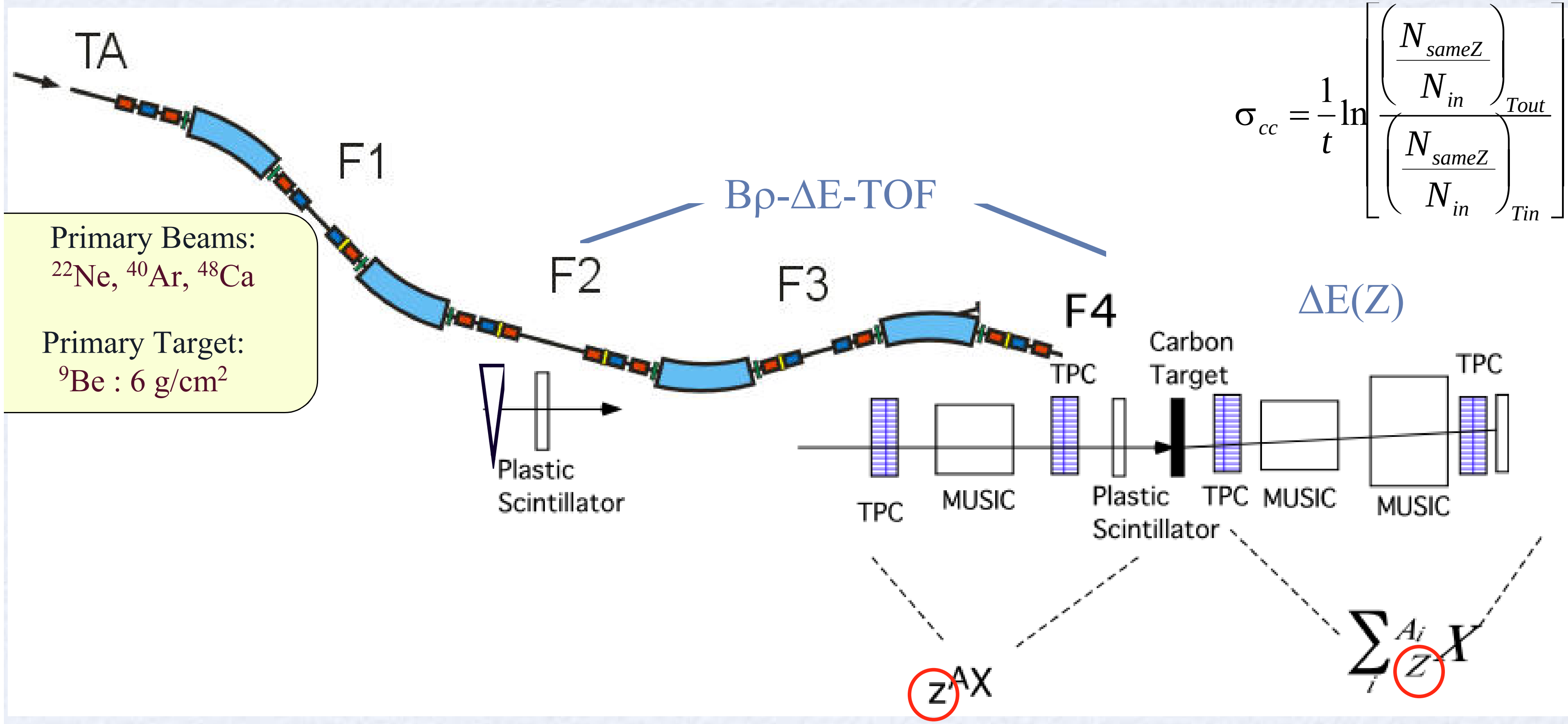


B. Blank et al., ZPA, 343 (1992) 375.



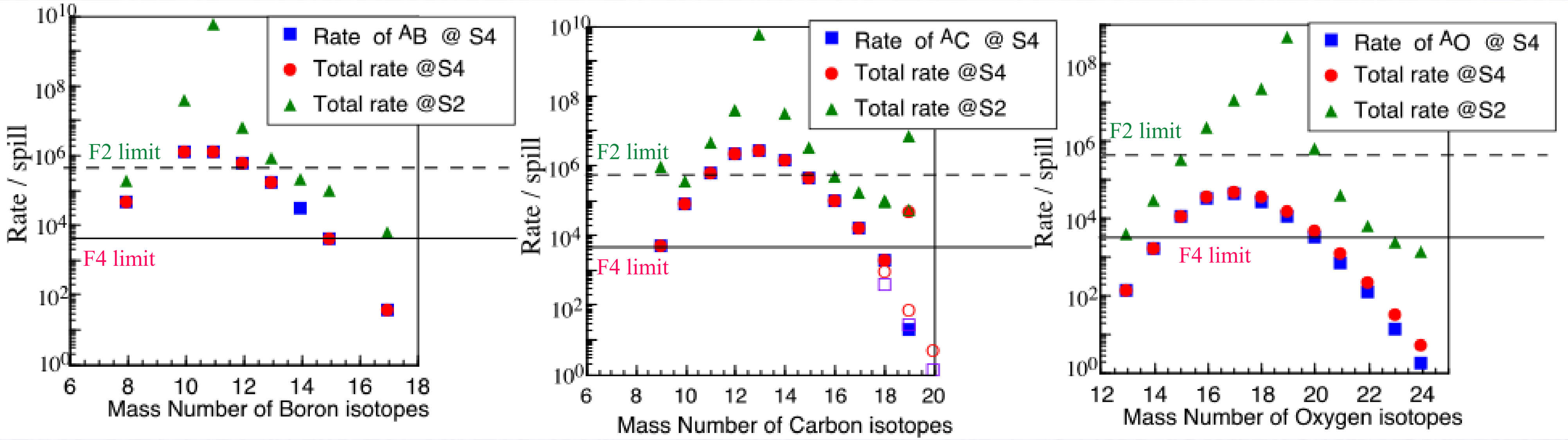
Excellent agreement establishes the method

Setup at FRS

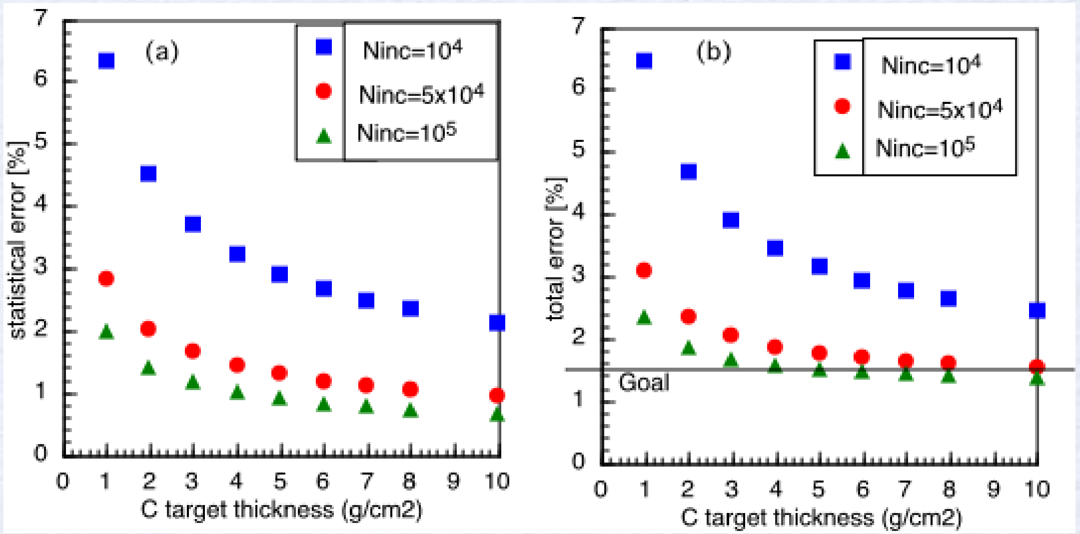


- Tracking of outgoing same Z particles
- Efficiency of same Z detection
- Accuracy of **1.5%**

Experiment Conditions



- Total rate at F4 limited by trigger rate
- Total rate at F2 limited by detector



- 1.5% accuracy –> 10^5 incident nuclei

Beamtime Request

Jobs	Primary beam	Secondary Beam	Time per isotope (hours)	Total time (hours)
σ_{cc}–data taking (target-in + target-out)	^{22}Ne	^{8-15}B	1.5	12
σ_{cc}–data taking (target-in + target-out)	^{22}Ne	^{17}B	4	4
σ_{cc}–data taking (target-in + target-out)	^{22}Ne	^{9-17}C	1.5	13.5
σ_{cc}–data taking (target-in + target-out)	^{40}Ar	^{18}C	1.5	1.5
σ_{cc}–data taking (target-in + target-out)	$^{40}Ar/^{22}Ne$	^{19}C	5	5
σ_{cc}–data taking (target-in + target-out)	^{40}Ar	^{20}C	93	93
σ_{cc}–data taking (target-in + target-out)	^{48}Ca	$^{13-21}O$	1.5	13.5
σ_{cc}–data taking (target-in + target-out)	^{48}Ca	^{22}O	2.5	2.5
σ_{cc}–data taking (target-in + target-out)	^{48}Ca	^{23}O	10	10
σ_{cc}–data taking (target-in + target-out)	^{48}Ca	^{24}O	68	68
Magnet settings (target-in + target-out)			1	37
Intial calibrations and setup with beam				24
Total beamtime				284 ~ **36 shifts**

- Achieve 1.5% accuracy
- Beam tuning ~ 30 min each
- Calibration and initial setup: 1 day

36 shifts main user (24 approved)

Beamtime Requested

Approved beamtime : 24 shifts *(Category A)*

Primary beams required : ^{22}Ne, ^{40}Ar, ^{48}Ca

Energy : 1*A* GeV

Isotopes to be studied : B, C, O

Experiment location : FRS (F4)

Preferred running time : 2010