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Quasi-Free Scattering from Carbon and Oxygen Isotopes

Matthias Holl for the R^3B Collaboration

Spectroscopic Factors

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- spectroscopic factor S_j

$$\langle \Psi_{A-1}(\vec{r}) | \Psi_A(\vec{r}) \rangle = \sum_{j=I_A-I_{A-1}}^{I_A+I_{A-1}} c_j \psi_j(\vec{r})$$

$$S_j = |c_j|^2$$

- cross section

$$\sigma_{th} = \sum_j S_j \cdot \sigma_{sp}(nlj)$$

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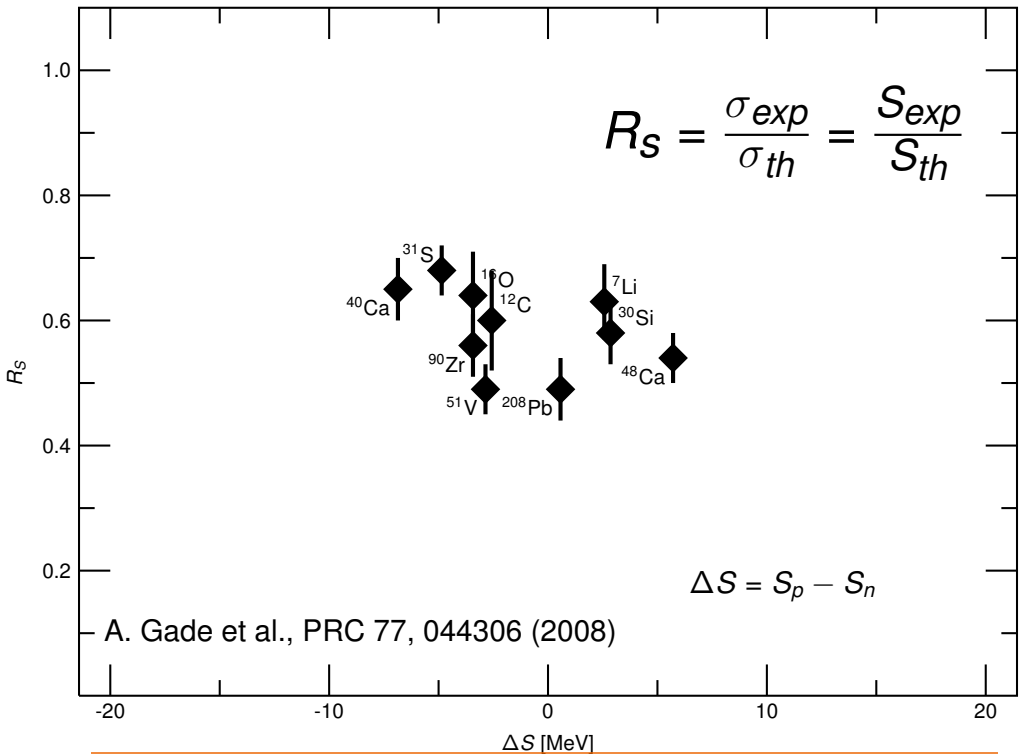

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- $R_S \approx 0.6$, "Quenching"

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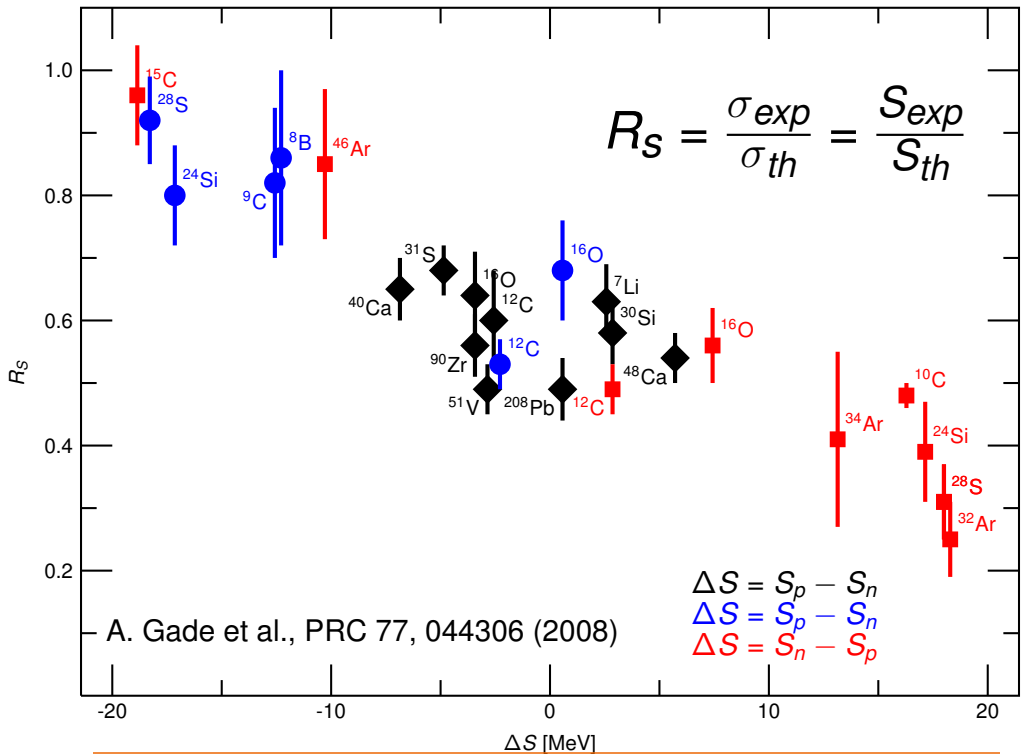

- stable nuclei (e,e'p)
- $R_S \approx 0.6$, "Quenching"
- unstable nuclei
- dependence on ΔS

Knockout and Quasi-Free Scattering

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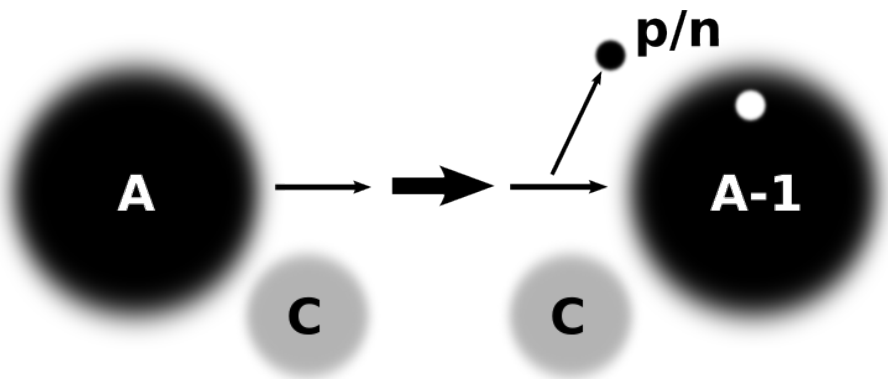

Knockout

- carbon or beryllium target
- nucleon from projectile scattered
- residual nucleus and target unaffected
- reaction concentrated on surface

Knockout and Quasi-Free Scattering

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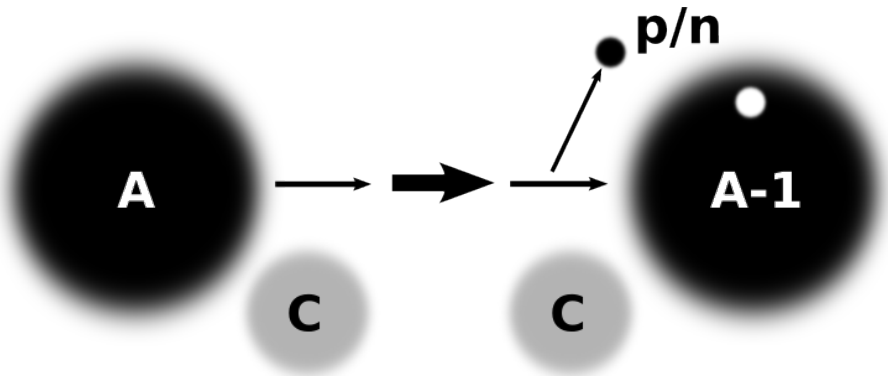

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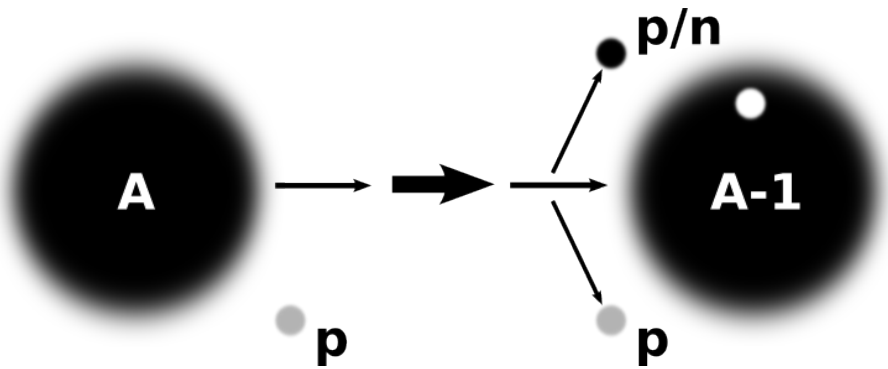

Quasi-Free Scattering

- ideally hydrogen target
- both projectile and target nucleon scattered
- investigation of nuclear interior

Knockout and Quasi-Free Scattering

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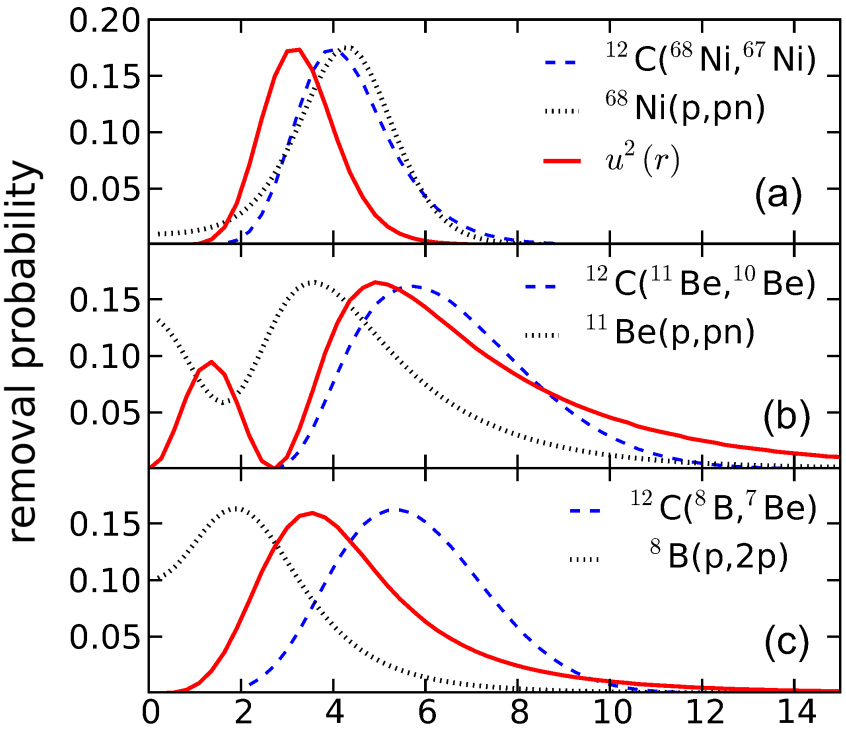

Aumann,Bertulani,Ryckebusch,
PRC 88, 064610 (2013)

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QFS in Inverse Kinematics

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- simple reaction mechanism

$\Rightarrow$ distorted wave impulse approximation (DWIA)

- inverse kinematics

$\Rightarrow$ large acceptance

$\Rightarrow$ redundant information from scattered nucleons and fragments

Overview

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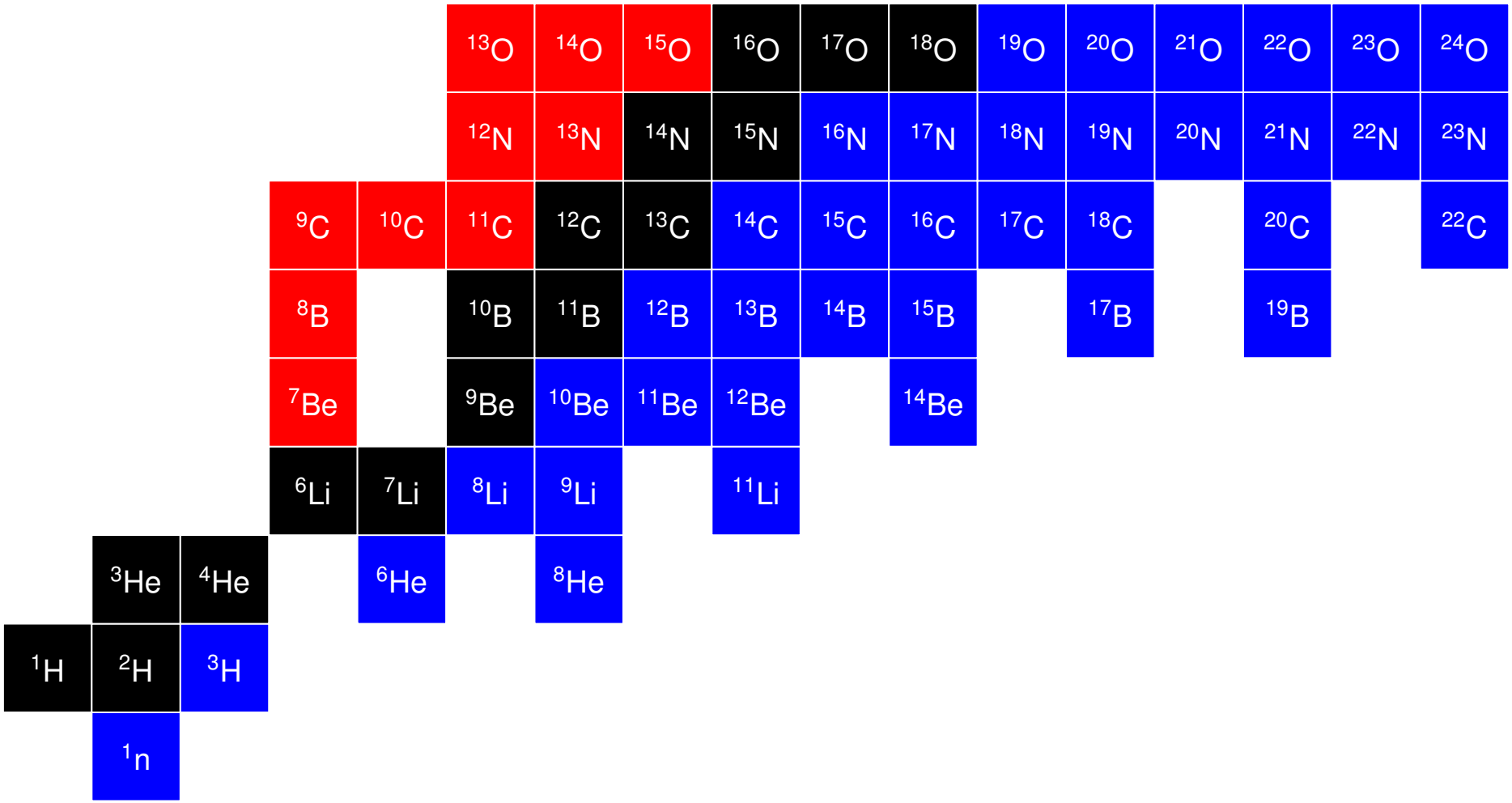

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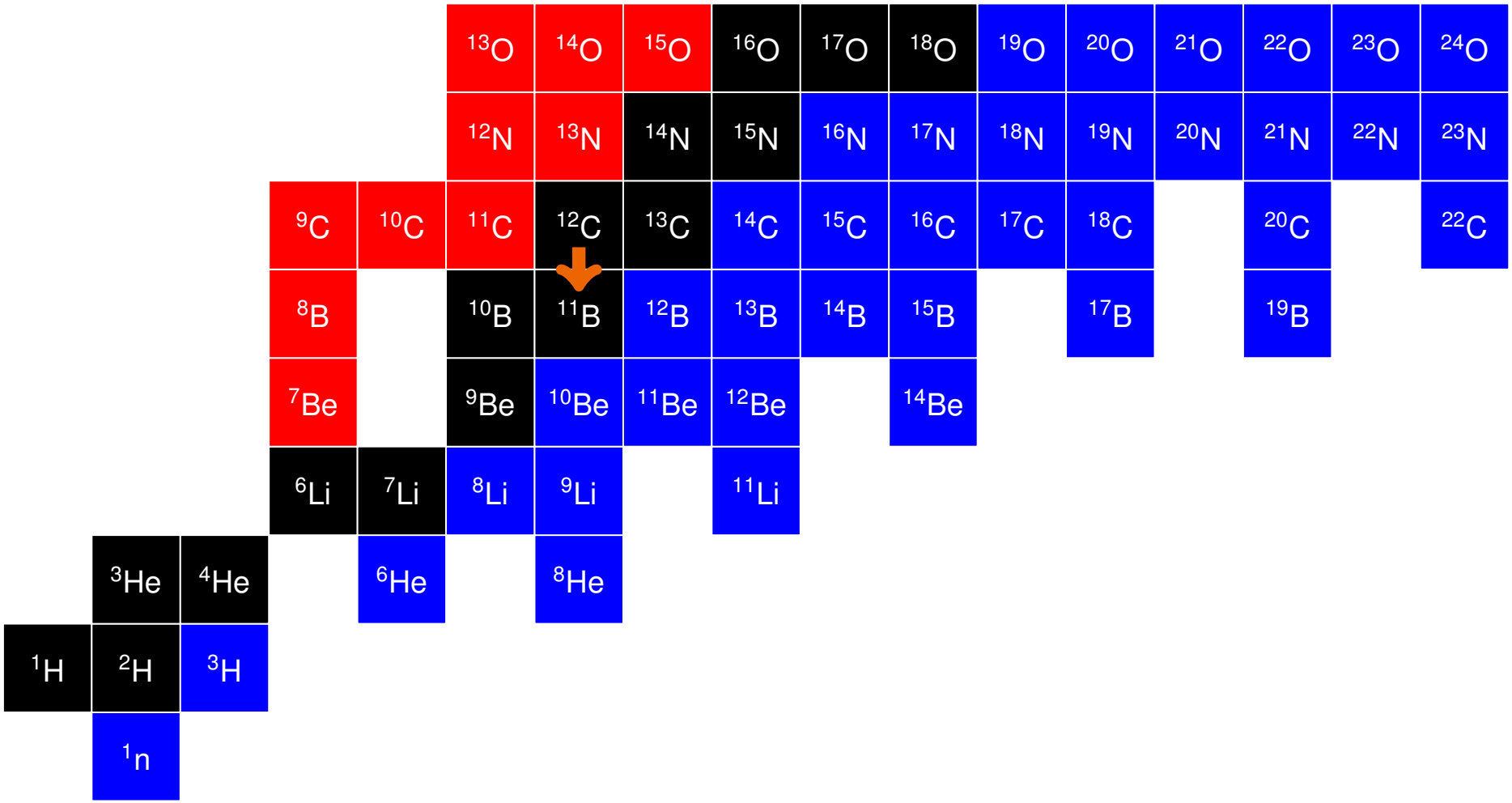

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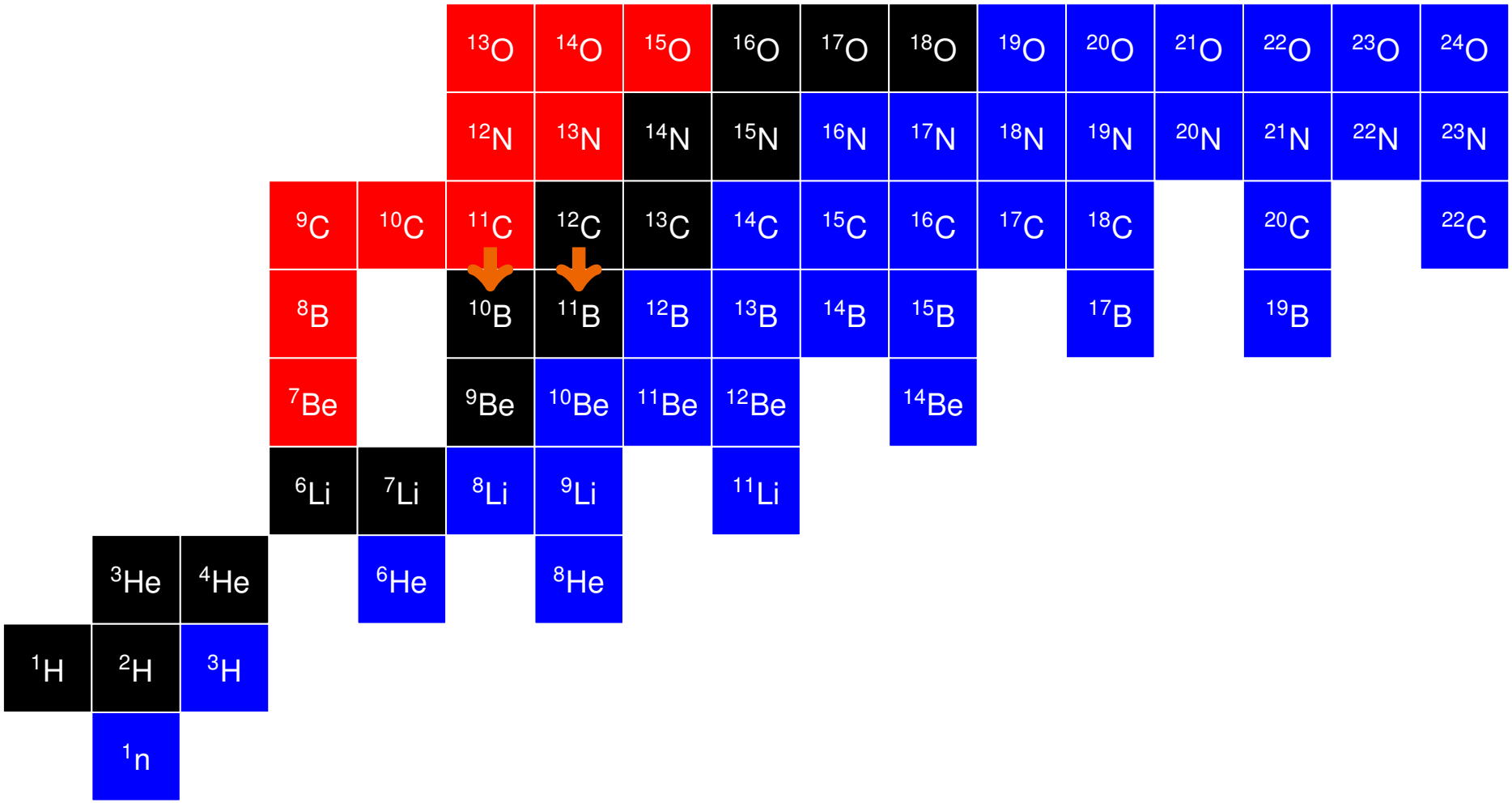

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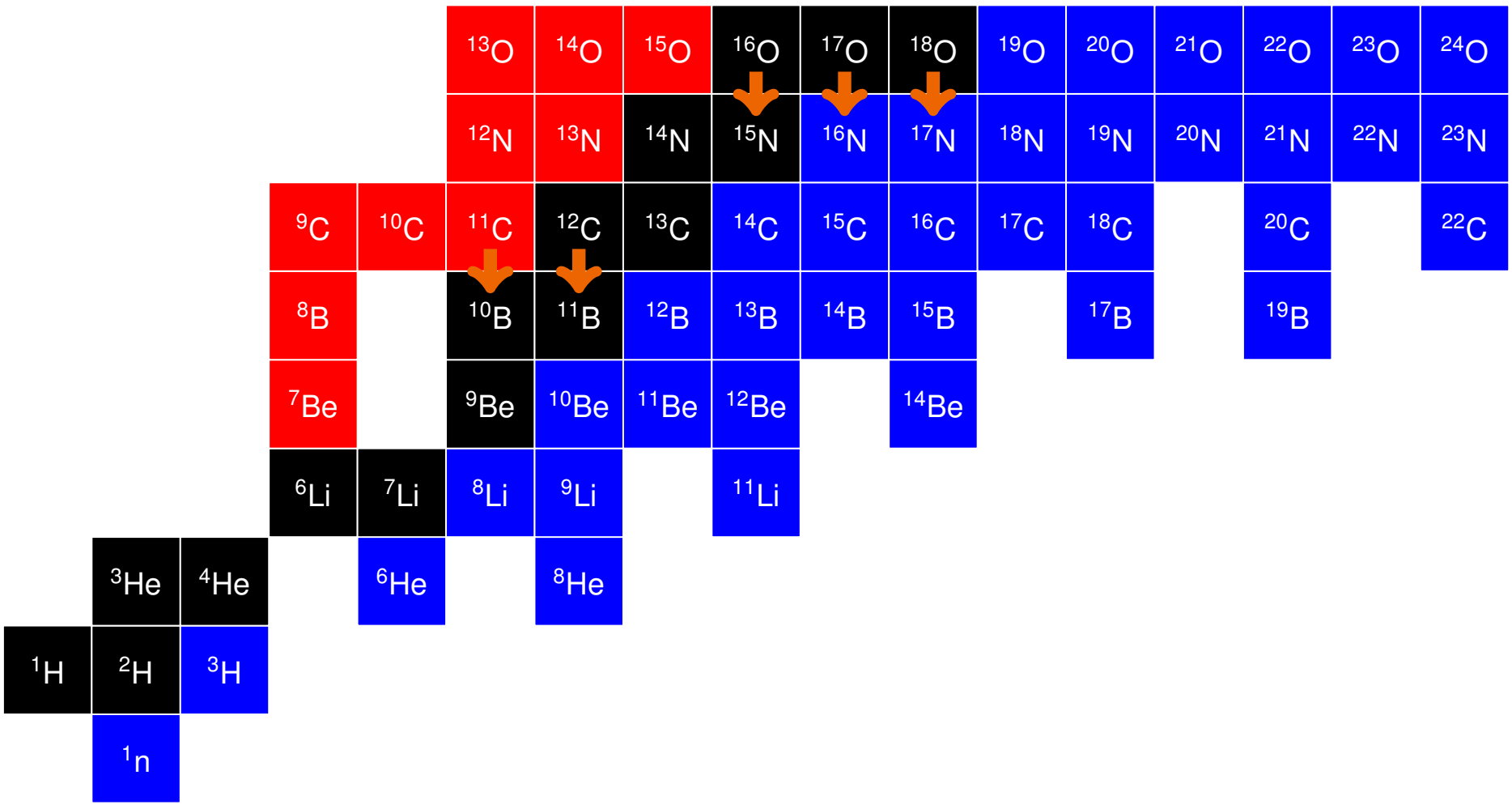

Beam Production at GSI

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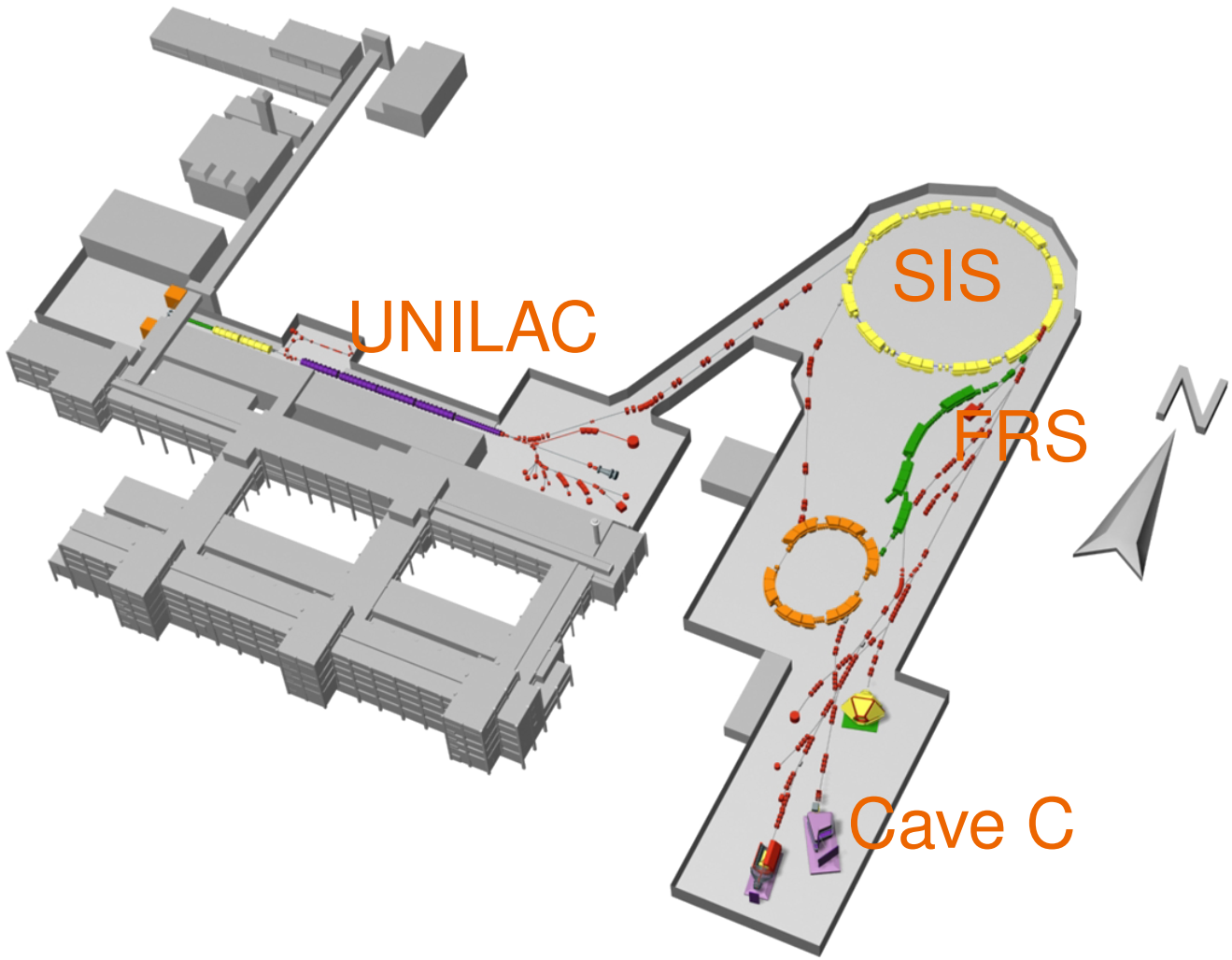

R^3B-LAND Setup

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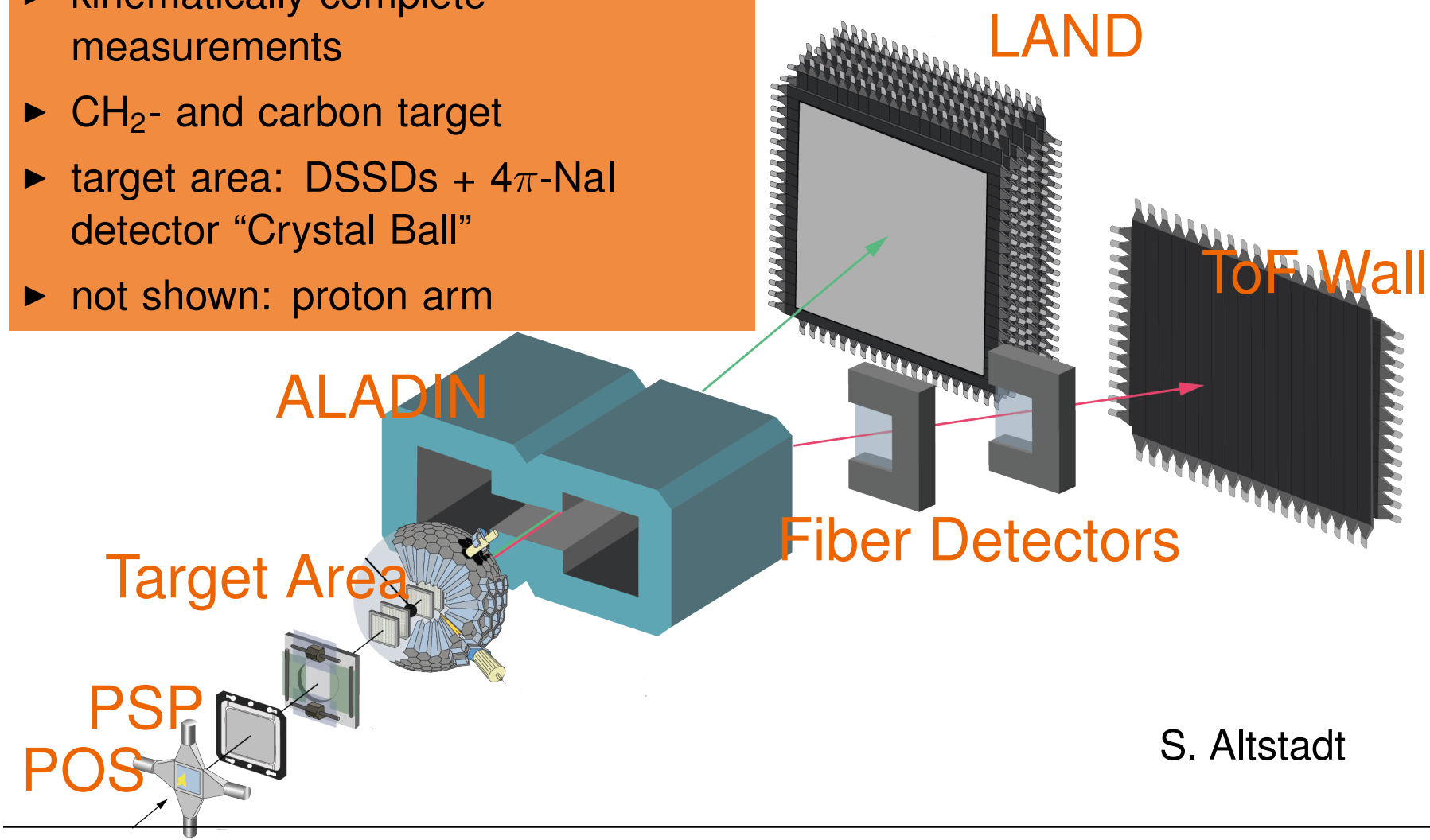
- kinematically complete measurements
- CH_2- and carbon target
- target area: DSSDs + 4π-NaI detector “Crystal Ball”
- not shown: proton arm



S. Altstadt

Prototype Experiment: ^{12}C(p,2p)

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- spectrosocopic factors in agreement with previous measurements
- 65 % of expected spectroscopic strength observed in ^{12}C(p,2p)^{11}B
- >80 % observed in ground state
- excitation spectrum shows sensitivity to knockout from s-shell

V. Panin, publication in preparation

^{11}C(p,2p)

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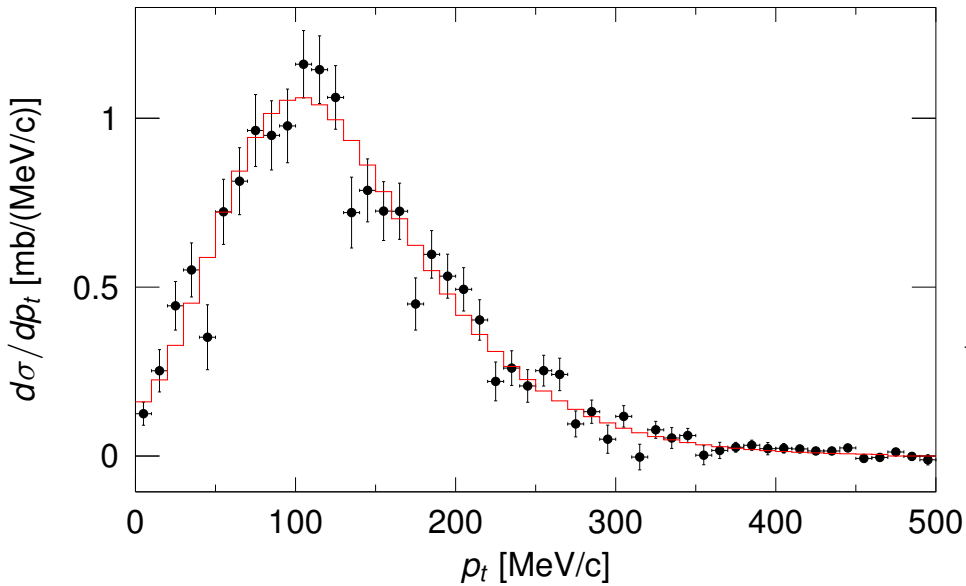

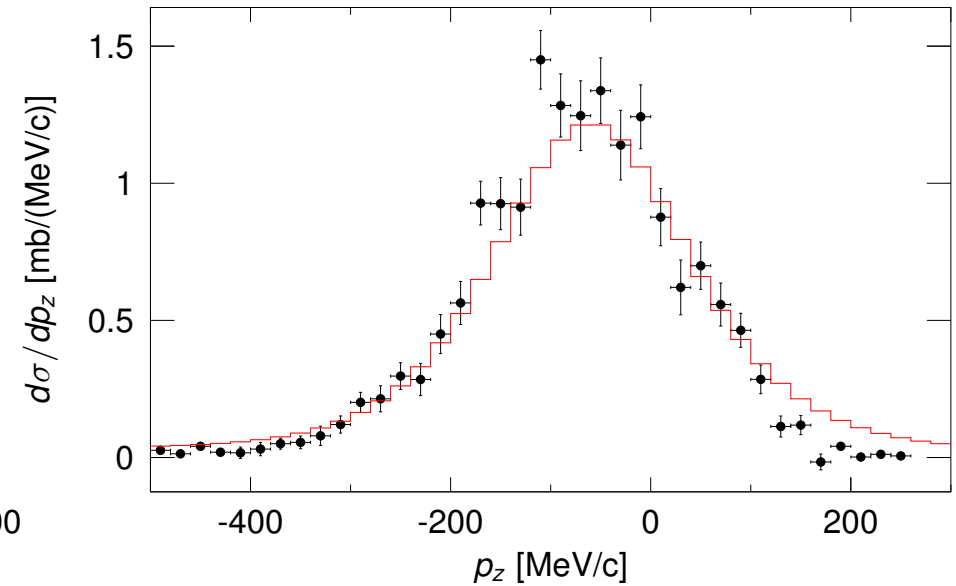

- comparison to DWIA calculations by C. Bertulani
- assumption: knockout from $p_{3/2}$-shell

^{16,17,18}O(p,2p)

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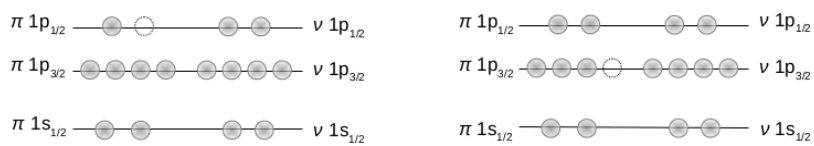
- cross sections for ^{16,17,18}O(p,2p)^{15,16,17}N obtained
- analysis of $^{19-21}$O(p,2p) ongoing



L. Atar, priv. comm.

Summary

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- (p,2p) in inverse kinematics is a tool to obtain spectroscopic information
- succesful prototype experiment using ^{12}C
  - very good agreement with (e,e'p) and (p,2p) in direct kinematics
  - indication of knockout from s-shell
- examples of further carbon and oxygen isotopes
  - ^{11}C(p,2p): application to unstable nucleus
  - $^{16-18}$O: beginning of systematic study

The R^{3}B Collaboration

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Thank you for your attention!