

# Physics program with the COCOTIER LH<sub>2</sub> target

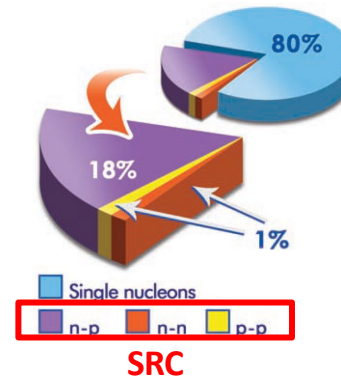
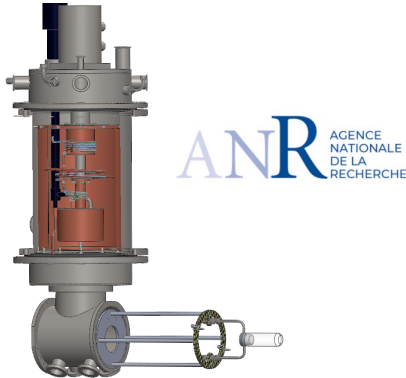
(COrrrelations de COurte portée et spin isoToplquE à R3B)

*IN2P3-CEA-GSI Collaborations Workshop*

*Strasbourg, Nov. 24th 2022*

*A. Corsi, CEA Saclay*

A **liquid Hydrogen target** and a program to study **Short-Range Correlations (SRC)** in exotic nuclei at **GSI/R3B**



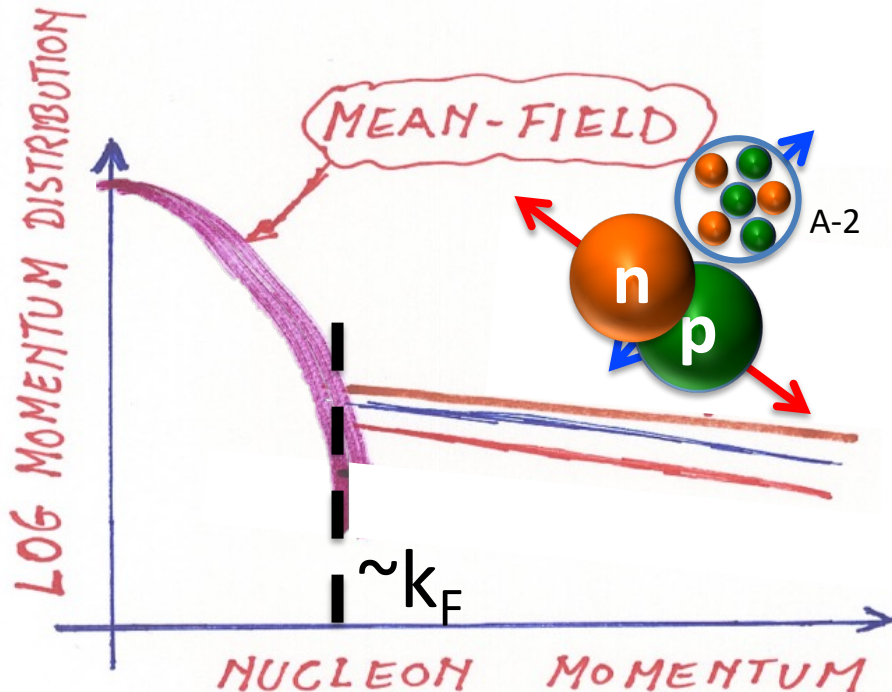
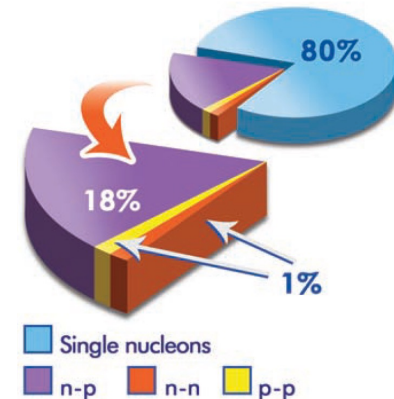
- Liquid Hydrogen ( $\text{LH}_2$ ) target is an asset to perform Quasi Free Scattering reactions
- Expertise of IRFU (PRESPEC, MINOS)
- Opportunity offered by the european facility GSI and its future upgrade FAIR
- Interest of R3B collaboration
- GSI +  $\text{LH}_2$  target + R<sup>3</sup>B: unique opportunity to perform the first study of Short Range Correlations in an exotic nucleus



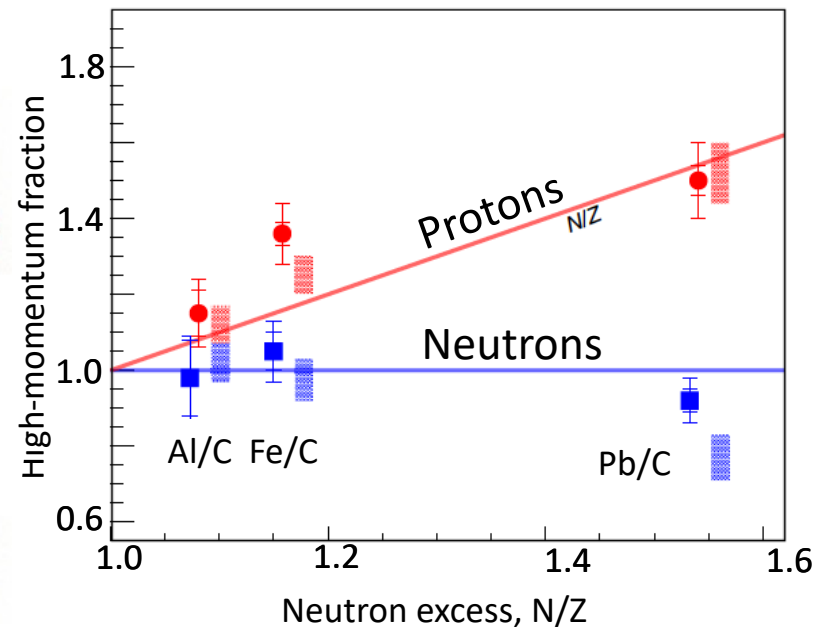
# SRC: state of the art (exp)

- High-momentum component of nuclear wavefunction
- SRC are mainly proton-neutron (pn) pairs (tensor force)
- pp/pn does not change with A

Nature Phys. 17, 693 (2021)  
 Nature 578, 540 (2020)  
 Nature 566, 354 (2019)  
 Nature 560, 617 (2018)  
 Science 346 (6209):614 (2014)  
 Science 320(5882):1476 (2008)  
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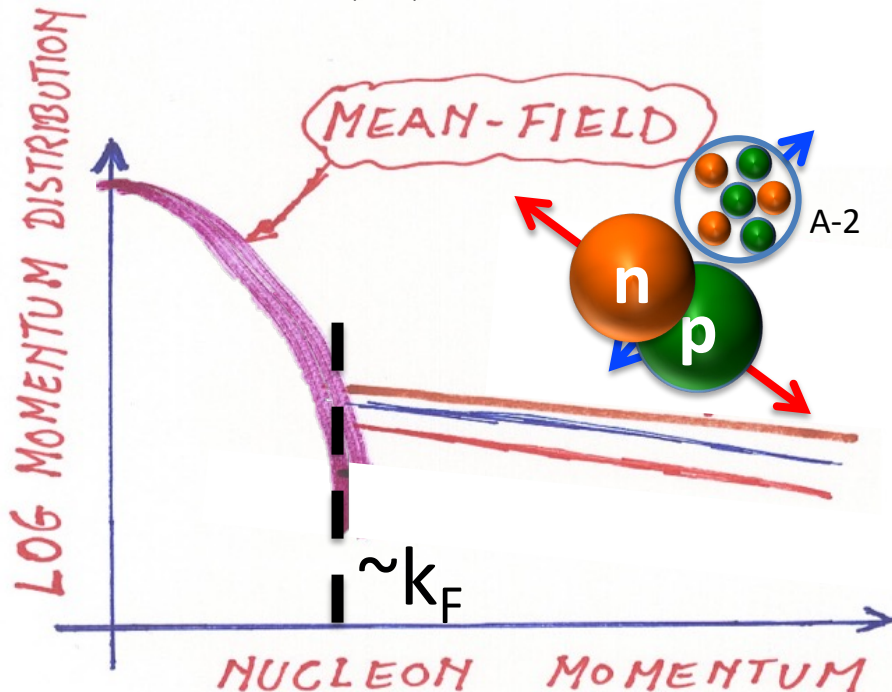
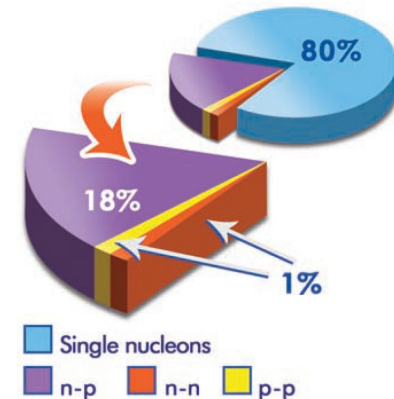
⇒ The fraction of **high momentum protons** increases for nuclei with  $N > Z$



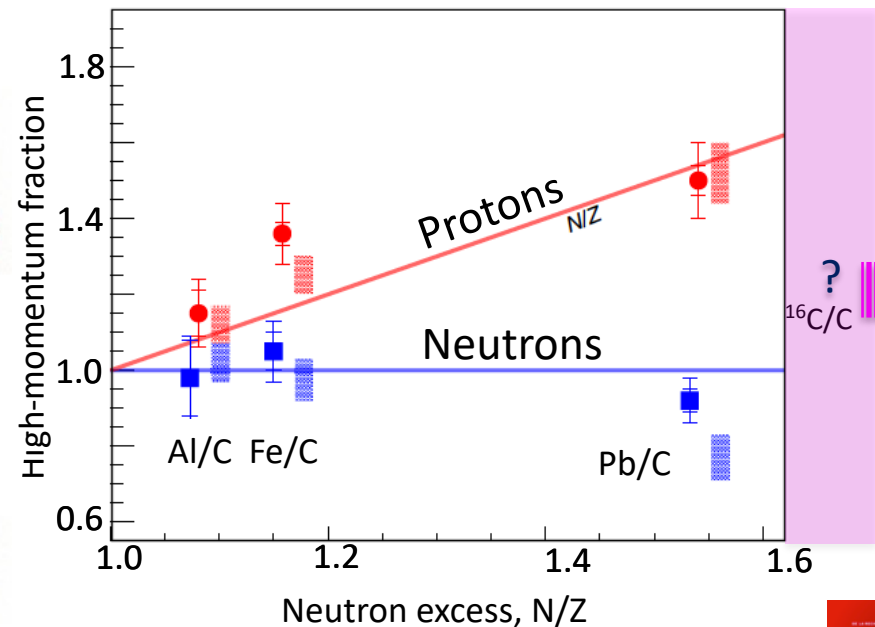
# ... + R3B experiment

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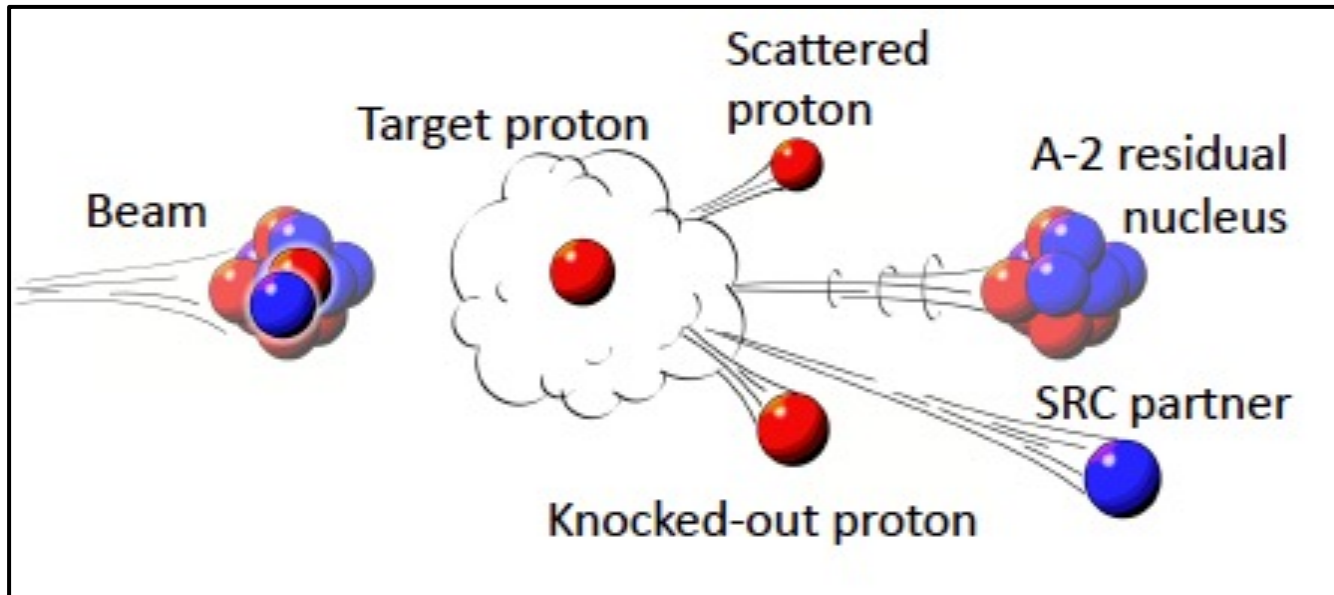
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- Pilot experiment at Dubna in 2018 with  $^{12}\text{C}$  beam [Nature Phys. (2021)]
- Experiment at R<sup>3</sup>B in May 2022

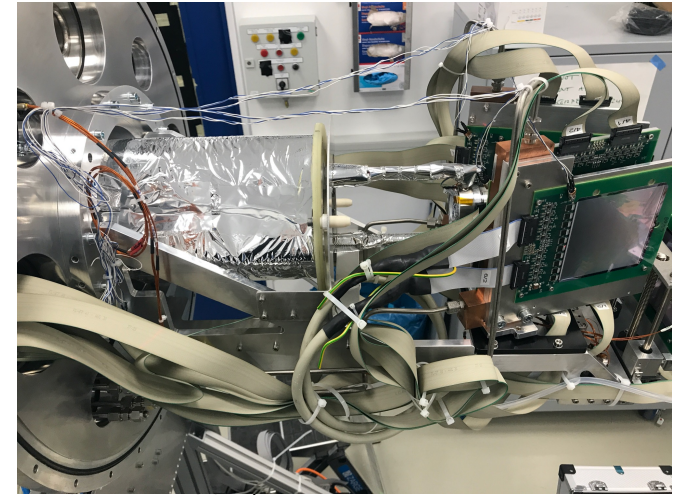


## Goals:

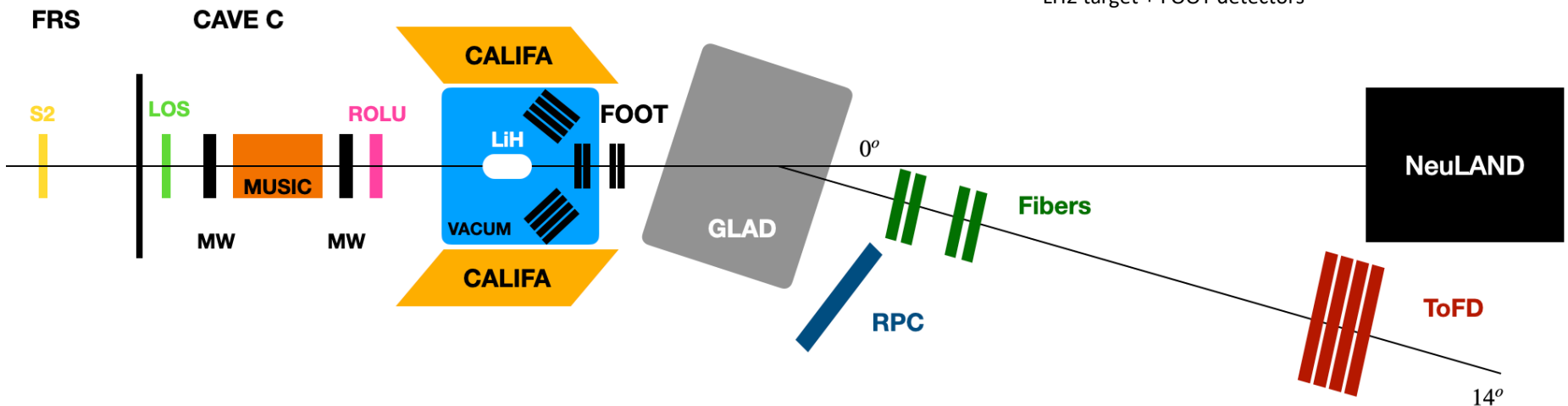
- 1<sup>st</sup> exotic nucleus  $^{16}\text{C}$  @ 1.25 GeV/u
- direct comparison of isotopes  $^{16}\text{C}/^{12}\text{C}$
- test lower limit in momentum transfer

# Short Range Correlations at R3B

- Run between May 17<sup>th</sup> and May 31<sup>th</sup>
- 61h of  $^{16}\text{C}$  beam, 39h of  $^{12}\text{C}$  beam at 1-1.5 pps  
=> desired statistics achieved !
- About 80 participants on site + shifts from remote, 6 identified PhD Thesis (up to now) on S522-S509 data



LH2 target + FOOT detectors





March: commissioning of R<sup>3</sup>B setup (wo LH2 target)

April: installation and commissioning of 5-cm LH<sub>2</sub> target

May: campaign of 2 experiments

- A.Corsi, O.Hen et al., Study of SRC in exotic nuclei
- O.Sorlin et al., Study of multi-neutron configurations in atomic nuclei towards the neutron drip line

⇒ 88 days of 8 CEA physicists/engineers to GSI (out of 100 obtained)

⇒ 1 CEA student for 7 month at GSI with the GETINvolved program

⇒ 0 days of GSI physicists/engineers in CEA



- Analysis of SRC data (PhD thesis A.Lagni at DPhN and 5 more students of the collaboration)
- Collaboration meeting
- Support to R3B experiments using  $\text{LH}_2$  target (installation, operation of  $\text{LH}_2$  target, shifts)
  - M.Petri et al, Study of SRC via (p,pd) reaction
  - R.Gernhauser et al., Commissioning

⇒ 65 days of 6 CEA physicists/engineers to GSI

- Join the effort for the developement of the new generation of (p,2p) tracker

⇒ 20 days of 4 GSI physicists/engineers to CEA



- Assure operation of  $\text{LH}_2$  target in  $\text{R}^3\text{B}$  experiments
- Pursue SRC physics program: scan in energy (0.75 and 1.9 GeV/u)
- Contribute to the transfer of  $\text{LH}_2$  target system to high energy cave
- Spectroscopy of exotic unbound nuclei (*eg*,  $^{22}\text{Si}$ )