

Experimental Search for η' Mesic Nuclei with the (p,d) Reaction at GSI and FAIR



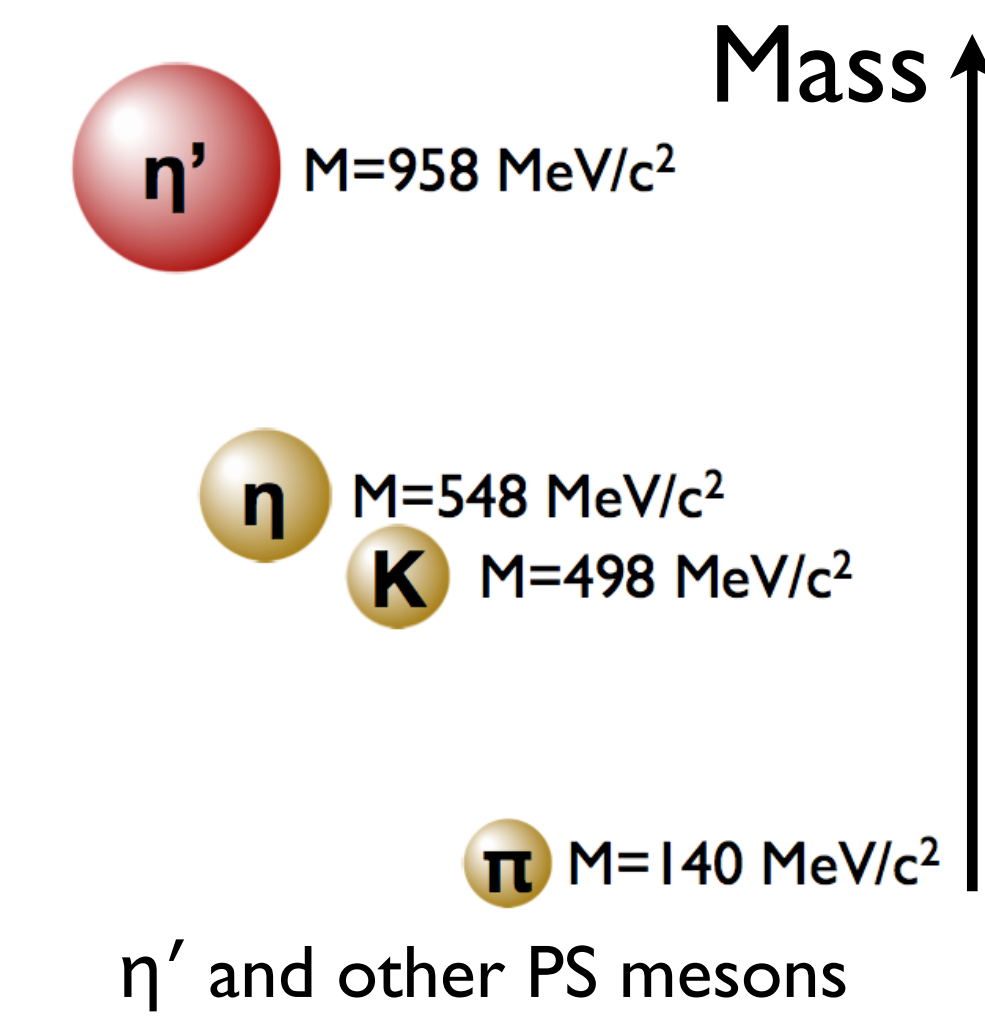
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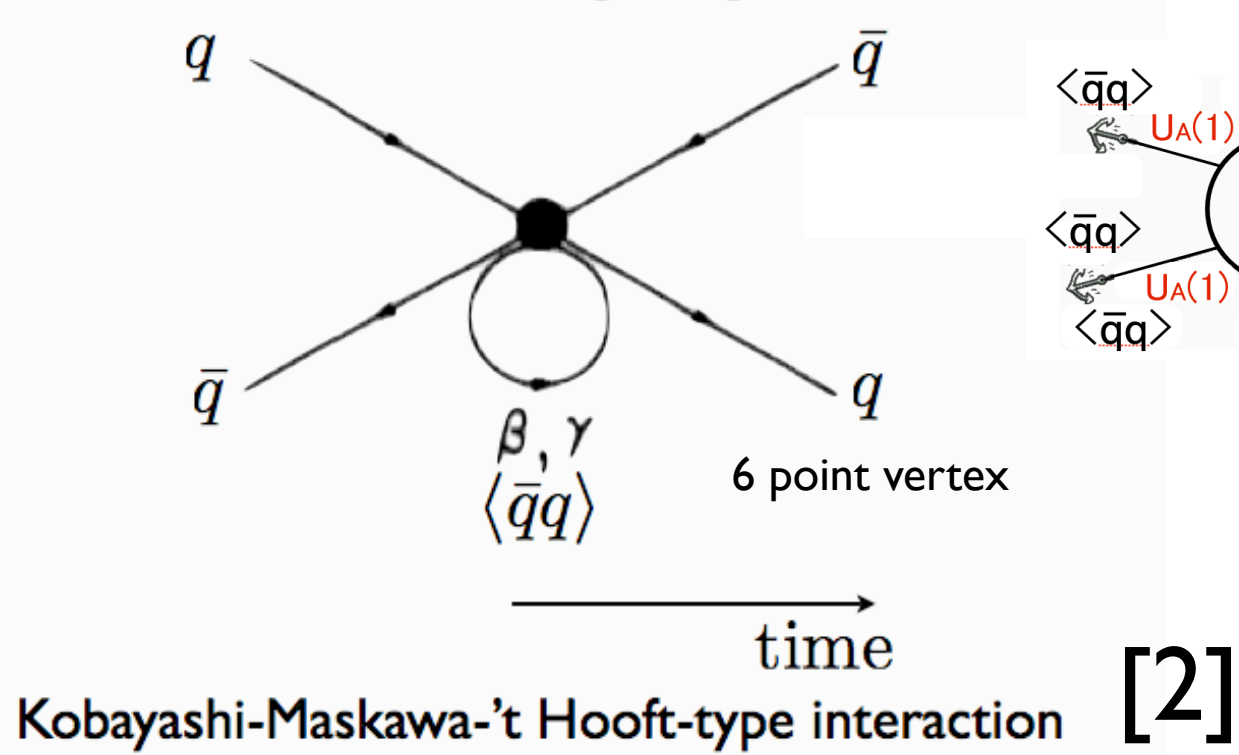
Introduction

η' meson in vacuum

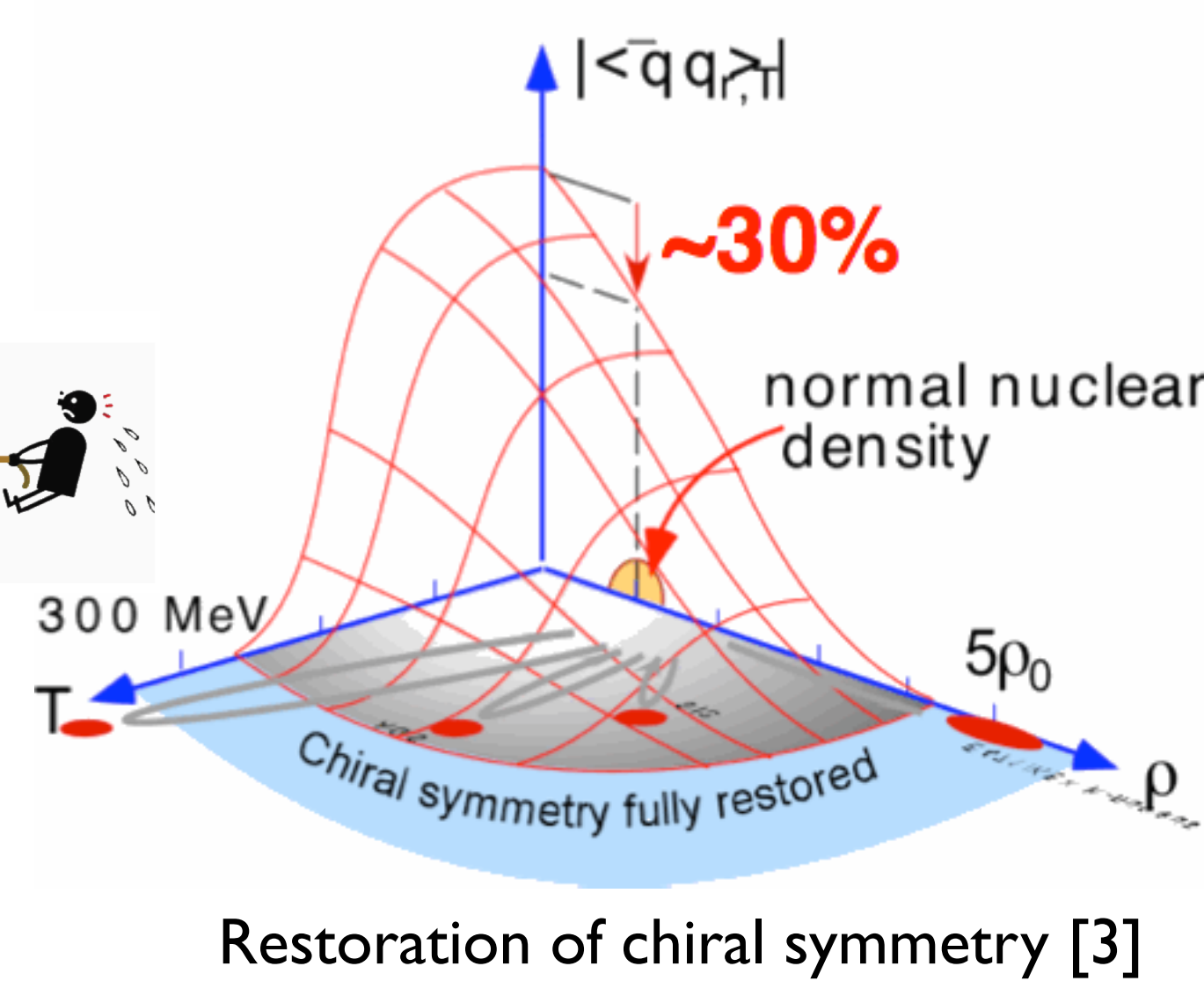


- large mass of η' meson
- $U_A(1)$ anomaly effect is contributing to the η' mass.
 - related to $\langle \bar{q}q \rangle$ through KMT interaction in NJL model [1]

$U_A(1)$ symmetry breaking term of effective Lagrangian

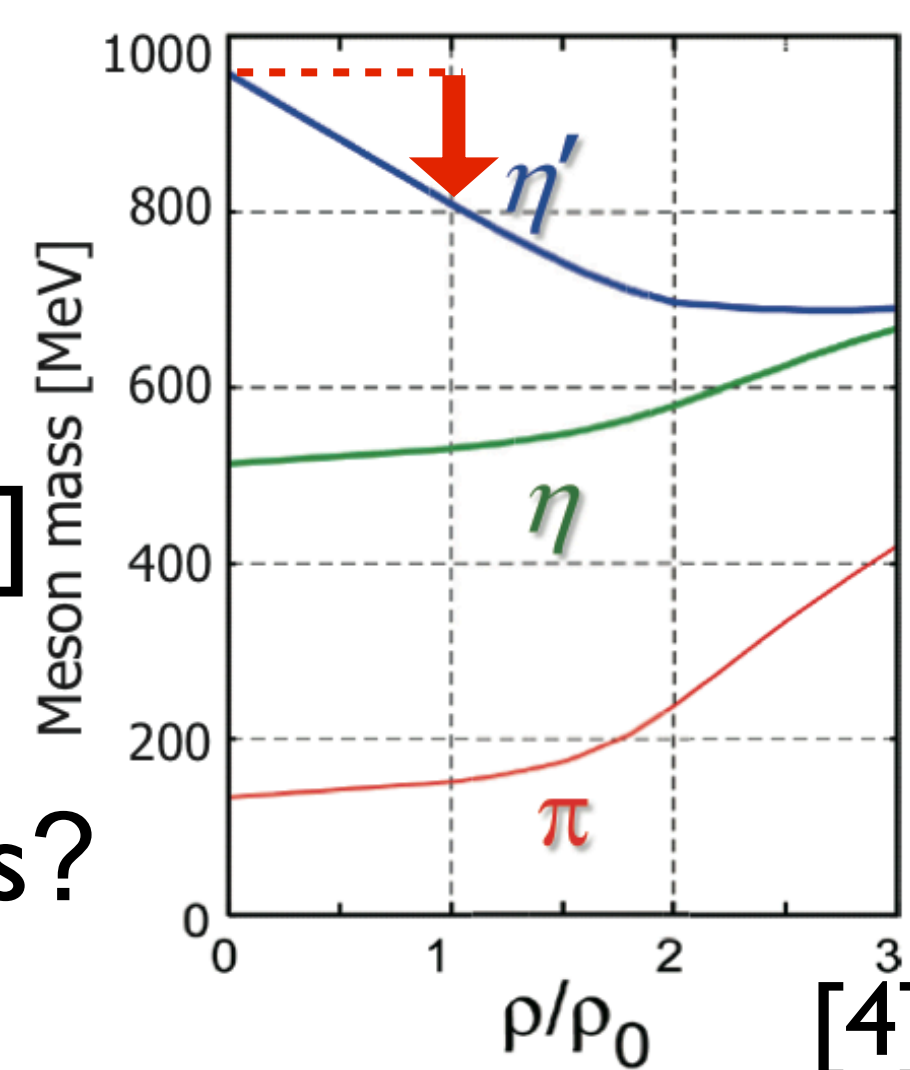


Order parameter of Chiral symmetry $\langle \bar{q}q \rangle$



η' meson in nuclear medium

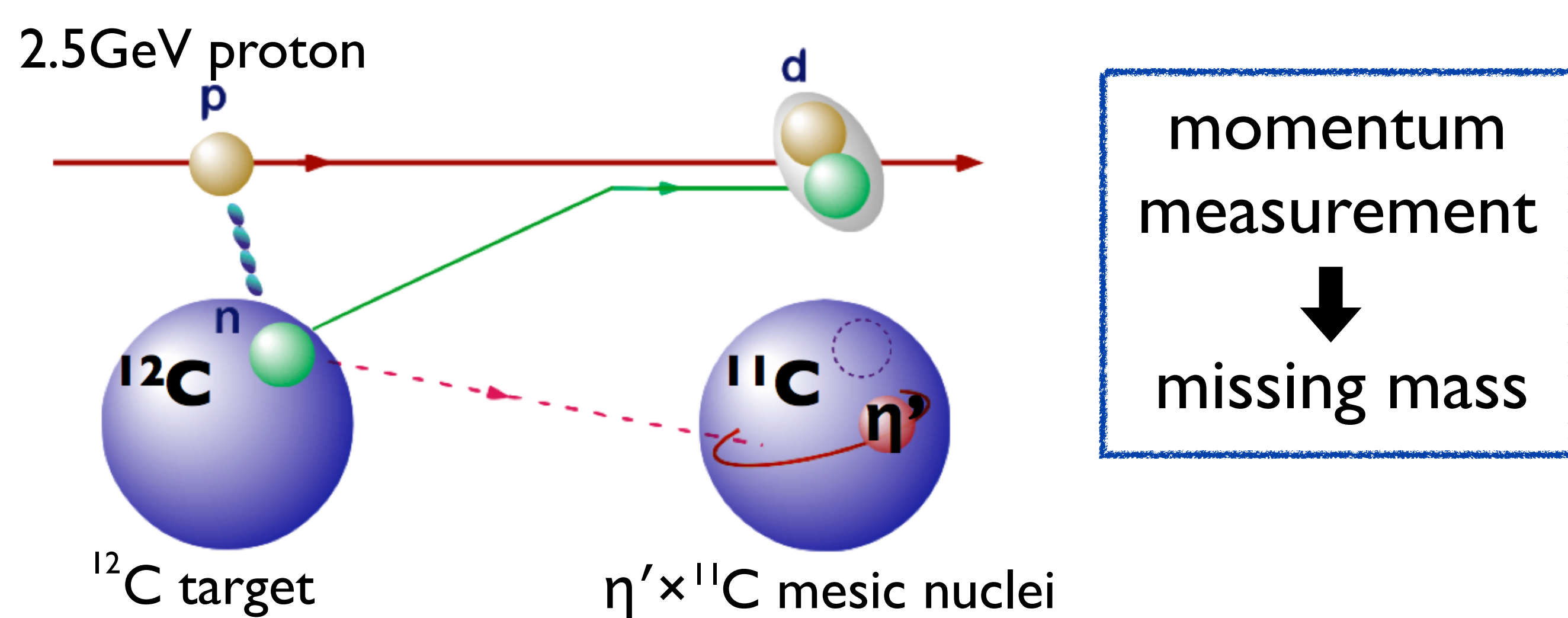
- partial restoration of chiral symmetry
- mass reduction of η' meson expected
~150 MeV reduction by NLJ model [4]
- strong attraction between η' and nucleus $\rightarrow$ nuclear bound states?
- small in-medium width of 15-25 MeV indicated by CBELSA/TAPS transparency measurement [5]



With large mass reduction and small width in medium, η' mesic nuclei may be observed experimentally.

Experimental Principle

Missing mass spectroscopy of $^{12}\text{C}(p,d)\eta' \times ^{11}\text{C}$ reaction

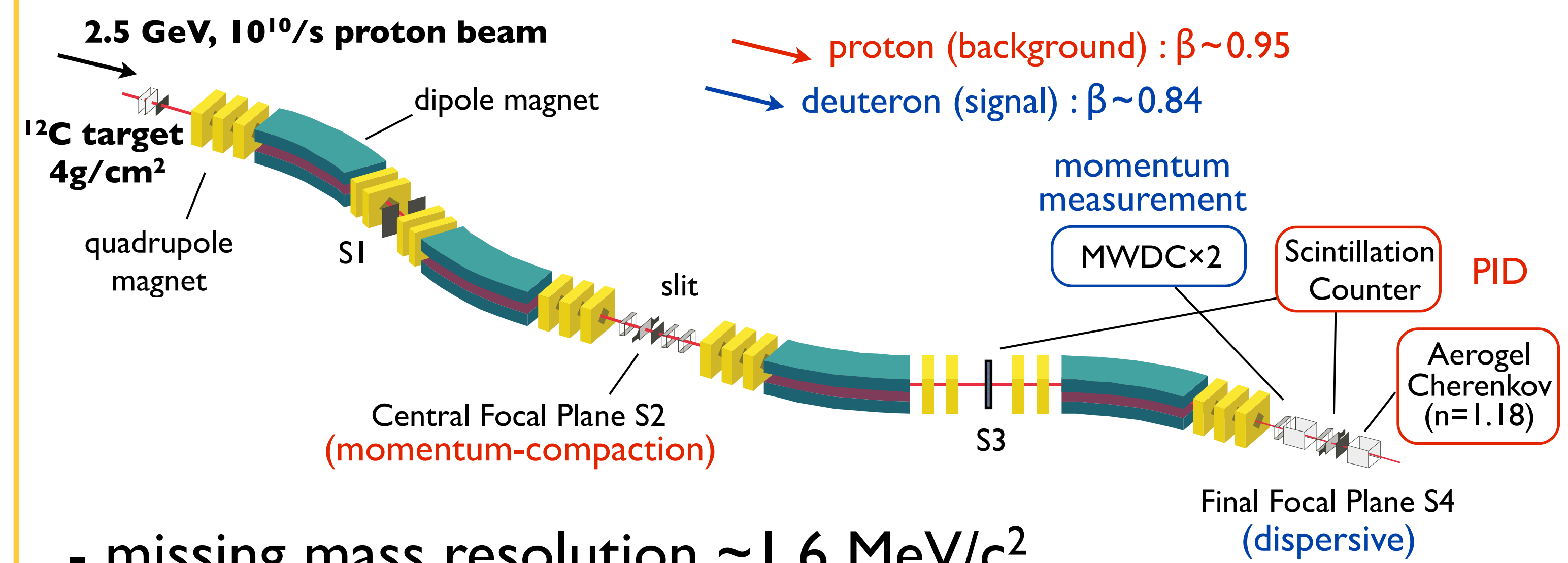


1st step : Inclusive measurement at GSI [6]

- unbiased analysis w/o assumption on decay
- small S/N ratio ~1/100 at most
 - main background : quasi free multi-pion production
 - high-statistics measurement is necessary w/ intense proton beam + thick target.

Experimental Setup

FRS (Fragment Separator) used as spectrometer



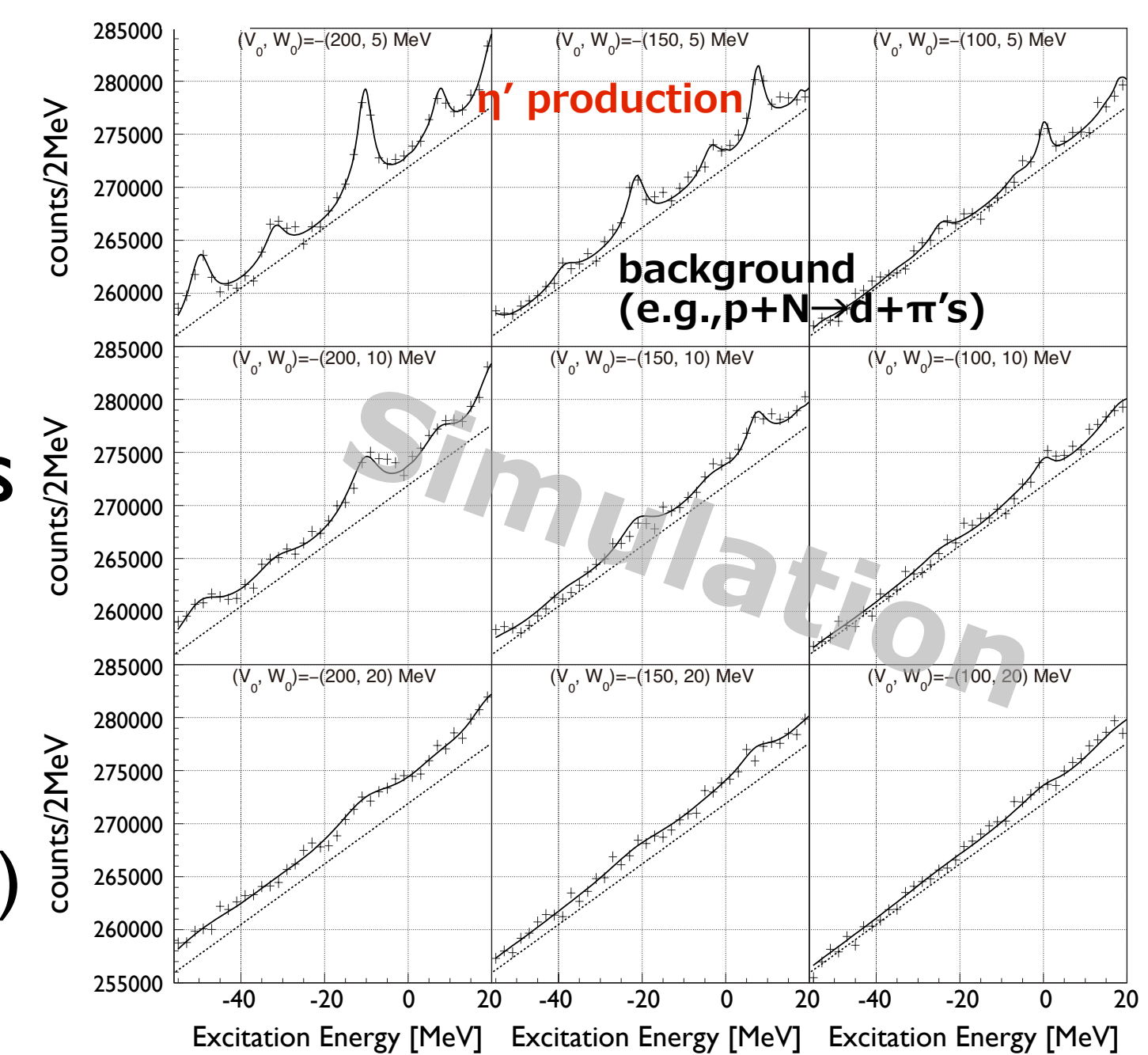
- missing mass resolution $\sim 1.6 \text{ MeV}/c^2$
- $n=1.18$ aerogel [7] Cherenkov was developed and tested.
- new FRS optics mode was designed.

Simulation of inclusive spectra

- production of $\eta' \times ^{11}\text{C}$ and background processes
- 4.5 days DAQ assumed
- V_0, W_0 : potential parameters

$$V_{\eta'}(r) = (V_0 + iW_0) \frac{\rho(r)}{\rho_0}$$

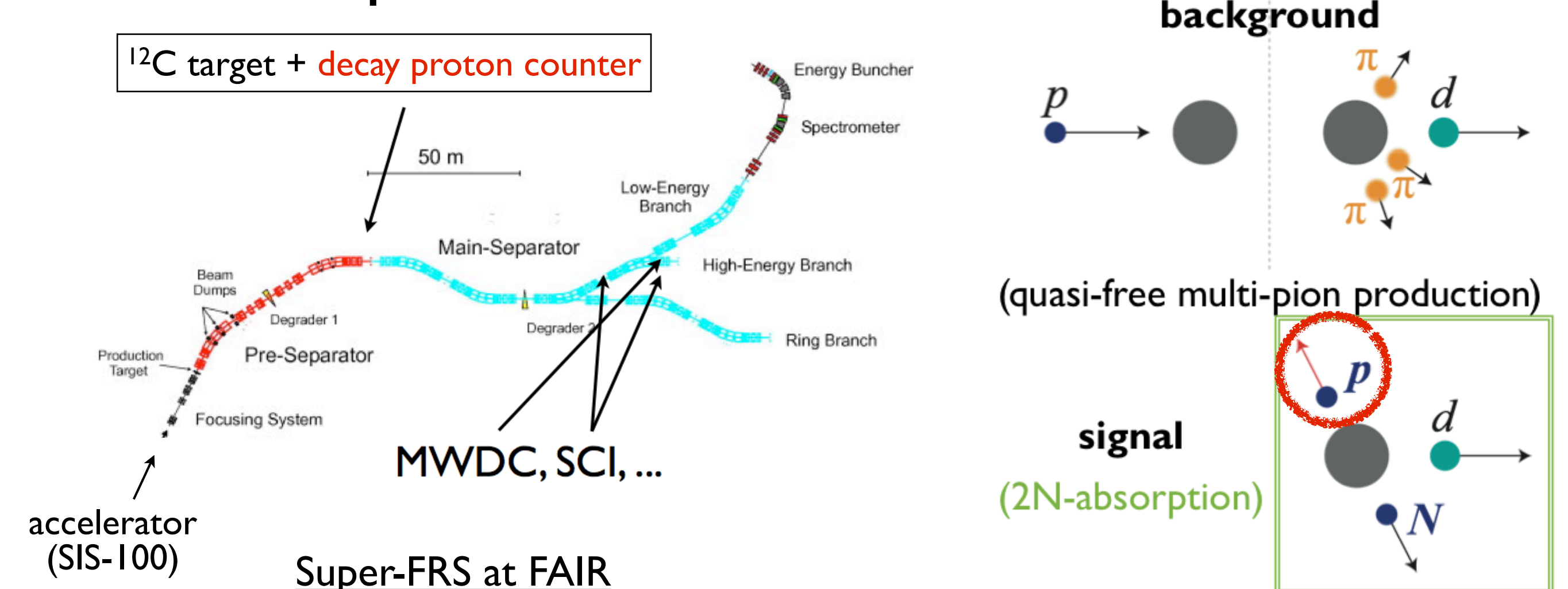
- $|V_0| \sim 150 \text{ MeV}$ (NJL prediction)
- $|W_0| \sim 7.5\text{--}12.5 \text{ MeV}$ (CBELSA/TAPS)



Future Plan at FAIR

2nd step : Semi-exclusive measurement at FAIR

- missing mass measurement w/ Super-FRS
- tagging fast protons ($>400 \text{ MeV}$) from decay of η' mesic nuclei to improve the S/N ratio



Summary and Future Prospect

- We plan missing-mass spectroscopy of η' mesic nuclei at GSI.
- With large mass reduction $\sim 150 \text{ MeV}$ (NJL) and small width $\sim 20 \text{ MeV}$, η' mesic nuclei may be observed experimentally.
- Detectors are ready in 2013. First run expected in 2014.
- Semi-exclusive measurement by tagging proton is planned at FAIR.

References

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