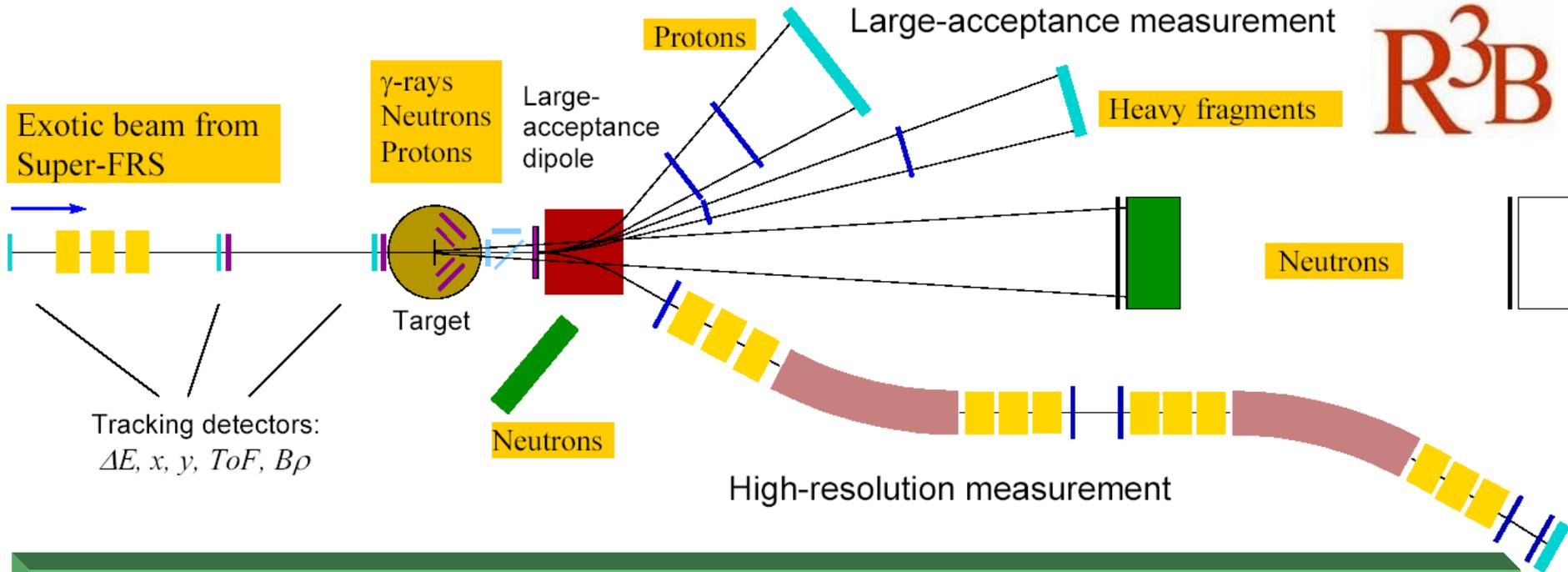


The high-energy branch of the Super-FRS:

A universal setup for kinematical complete measurements of

Reactions with Relativistic Radioactive Beams



Good news!

Evaluation of R3B by FAIR NUSTAR-PAC: 'triple A'

physics case: A

instrumentation: A

collaboration/organization: A

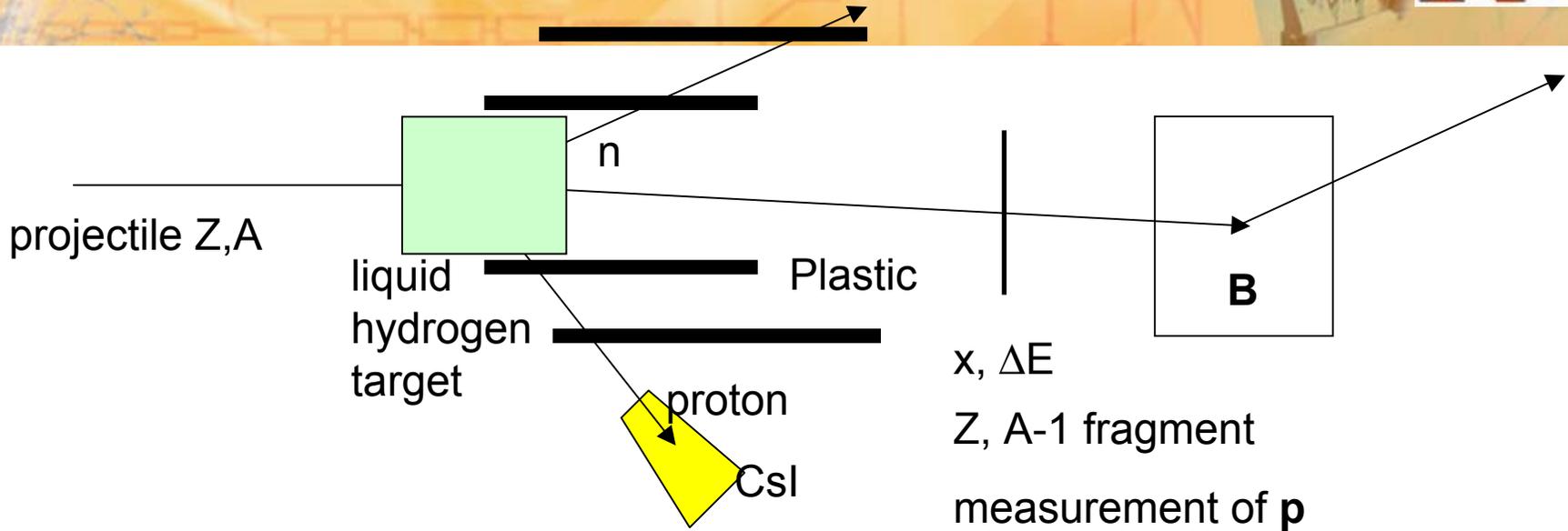
Quasi-free scattering at R3B



The R³B experiment:

- identification and beam "cooling" (tracking and momentum measurement, $\Delta p/p \sim 10^{-4}$)
- exclusive measurement of the final state:
 - 1) knockout (Be,C target) and quasi-free scattering
 - identification and momentum analysis of fragments (high-resolution mode: $\Delta p/p \sim 10^{-4}$)
 - **momentum of knocked nucleon** $\Delta p/p \sim 10-20 \text{ MeV}/c$ (typical width p,d: 100,150 MeV/c
 - coincident measurement of gamma-rays (gamma sum energy $\Delta E_{\text{sum}}/E_{\text{sum}} < 10\%$)
 - **binding energy of single-particle state** $\Delta E/E < 500 \text{ keV}$
 - coincident measurement of fast (projectile-like) neutrons with LAND
 - **binding energy of single-particle state** $\Delta E/E \sim 0.5 - 1 \text{ MeV}$
(after knockout to continuum states)
 - 2) quasi-free scattering:
 - in addition detection of proton recoil
 - angle: Si tracker: obtainable resolution $\sim 2 \text{ mrad}$
 - energy: stopping and energy measurement in CsI? obtainable resolution ?
- **redundant information on momentum of knocked nucleon and binding energy**
(plus clean trigger on reaction and reaction mechanism)

Quasi-free scattering at R3B



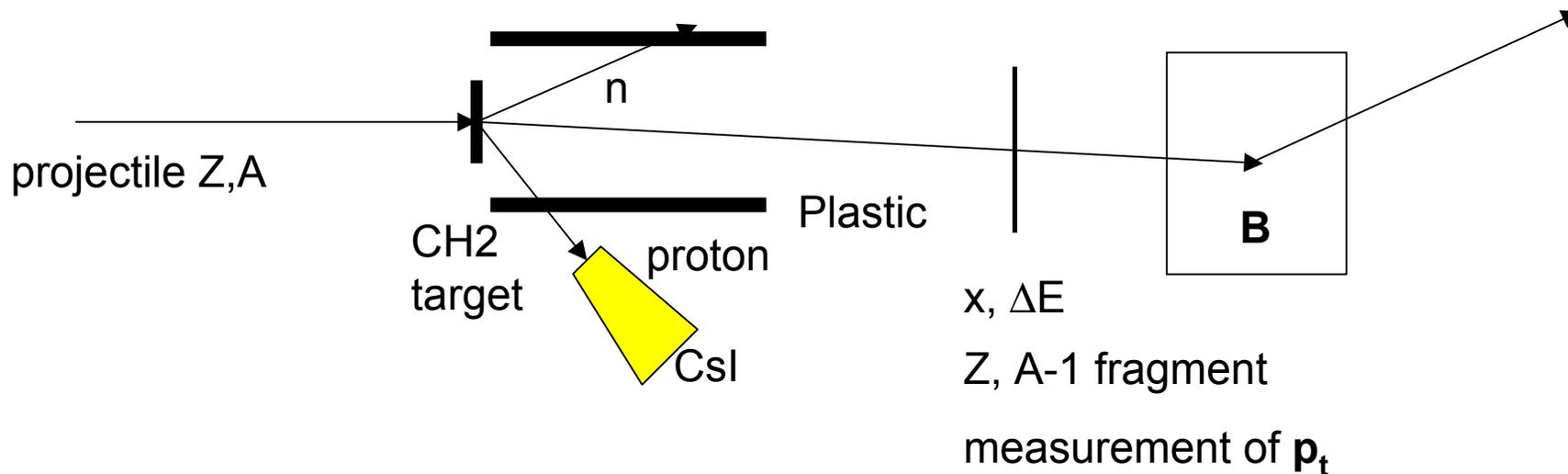
Luminosities and obtainable resolution

- liquid hydrogen target: 200 mg/cm^2 (3 cm), 3 cm diameter (10% interaction), 10^{23} H / cm^2
example: $N_{\text{reac}} = I (1/\text{s}) \times 10^{-2} / (d \text{ } \mu\text{b})$
 - straggeling: 400 MeV protons: 1.5 cm l.H. $\sigma=0.9 \text{ mrad}$
plus $300 \mu\text{m Si}$: $\sigma=1.4 \text{ mrad}$
 - detector resolution: x,y $30 \mu\text{m}$, distance of two layers 2.0 cm, $\rightarrow 1.5 \text{ mrad}$
 - energy loss: det. of interaction point $< 3\text{mm}$ \rightarrow momentum-loss diff (Z,Z-1) $< 0.5 \times 10^{-4}$
protons: energy-loss / width (1.5 cm l.H): $0.65 / 0.16 \text{ MeV (sigma)}$
- \rightarrow thick target does not limit the resolution

Quasi-free scattering at R3B



What can we do now without spectrometer, with one layer of Si detectors



^{56,68,72}Ni Experiment in Cave C ~ around March 2005

CH₂ target: angle of protons can be determined with one layer, E measurement ?
measurement of transverse momentum distribution

250 mg/cm² CH₂ (~30 mg/cm² H) → straggeling fragments ~ 1.1 mrad (fwhm)

+ detector resolution → fwhm(theta) ~ 1.5 mrad

→ momentum resolution ~ 100 MeV/c (for ⁶⁸Ni)

New proposals ??