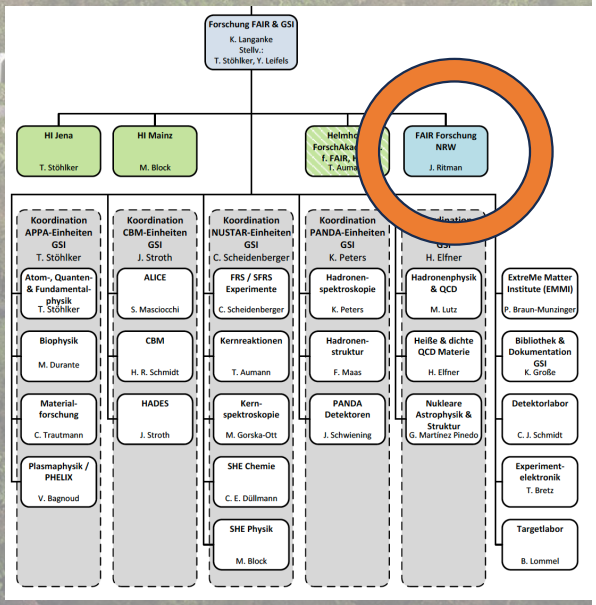
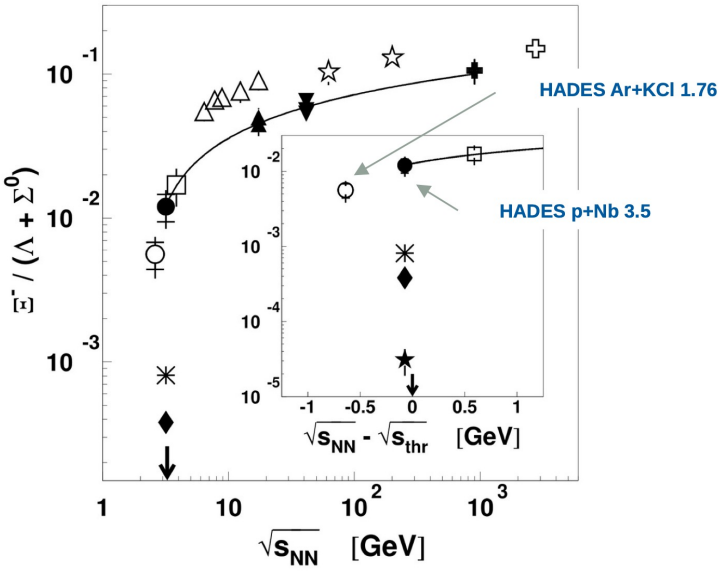
Physics Perspectives for FFN with Proton Beams from SIS100



Physics with Protons in FS+ as Seen by FFN

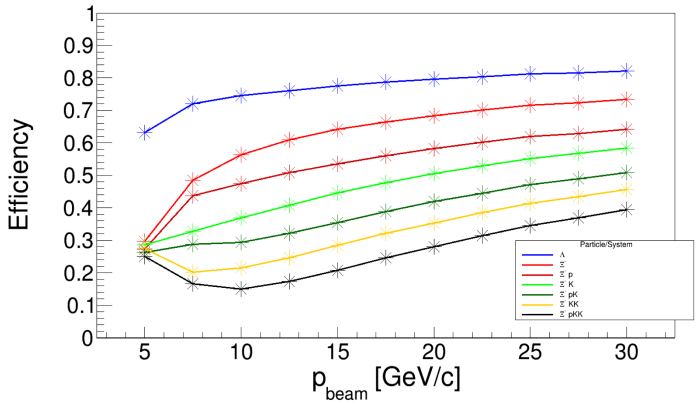
Strangeness Physics Aspects at SIS100

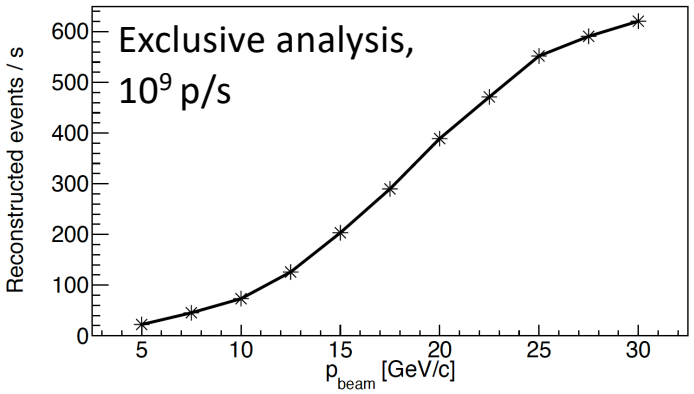
- Hyperon (Y) spectroscopy, focus on line-shape for |S|=1,2,3 to reveal their nature
- N* spectroscopy and coupling to strangeness, e.g. $N^* \to \Xi KK$
- YN, YY interactions in exclusive pp reactions and via Femtoscopy
- Hyperon structure, e.g. $Y^* \to Y\ell^+\ell^-$, precision eTFF studies
- Low-energy constants in chiral SU(3) via axial-vector transition form factors, e.g. $\Xi^* \to \Xi\pi\gamma$



Jenny Taylor, fast simulation, CBM acceptance

$pp \to \Xi^- \left(\to \Lambda \left(\to p\pi^-\right)\pi^-\right) pK^+K^+$





Inclusive reco Ξ(→ππp) is **2500 / s at p_{beam}= 10 GeV**
including background and vertex cut, 10^{10} p/s

Strangeness Physics Aspects at SIS100

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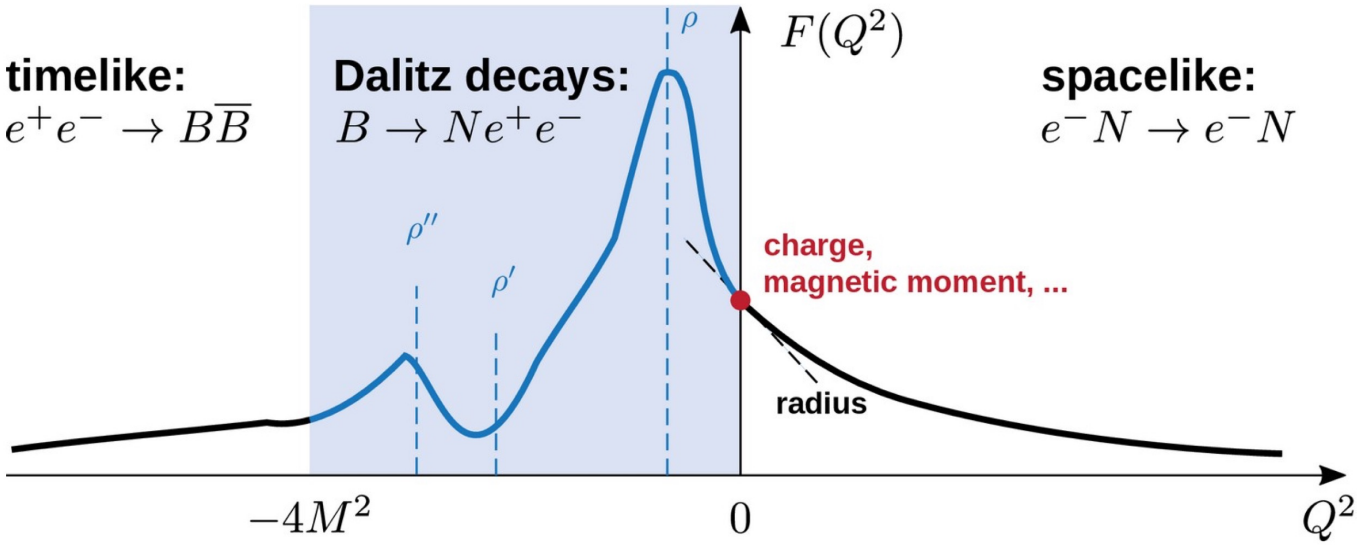
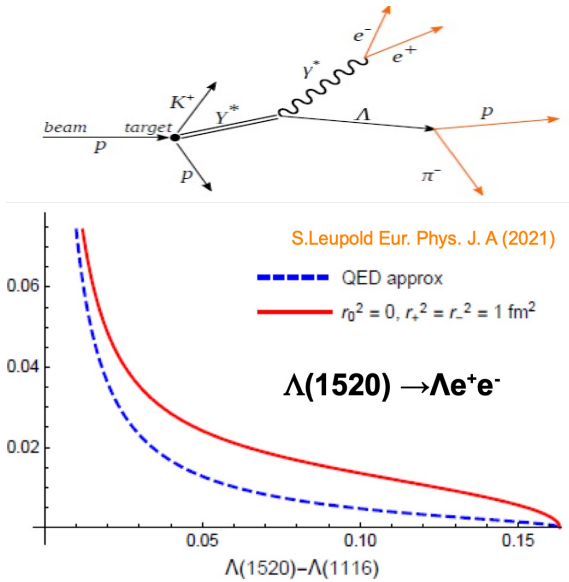


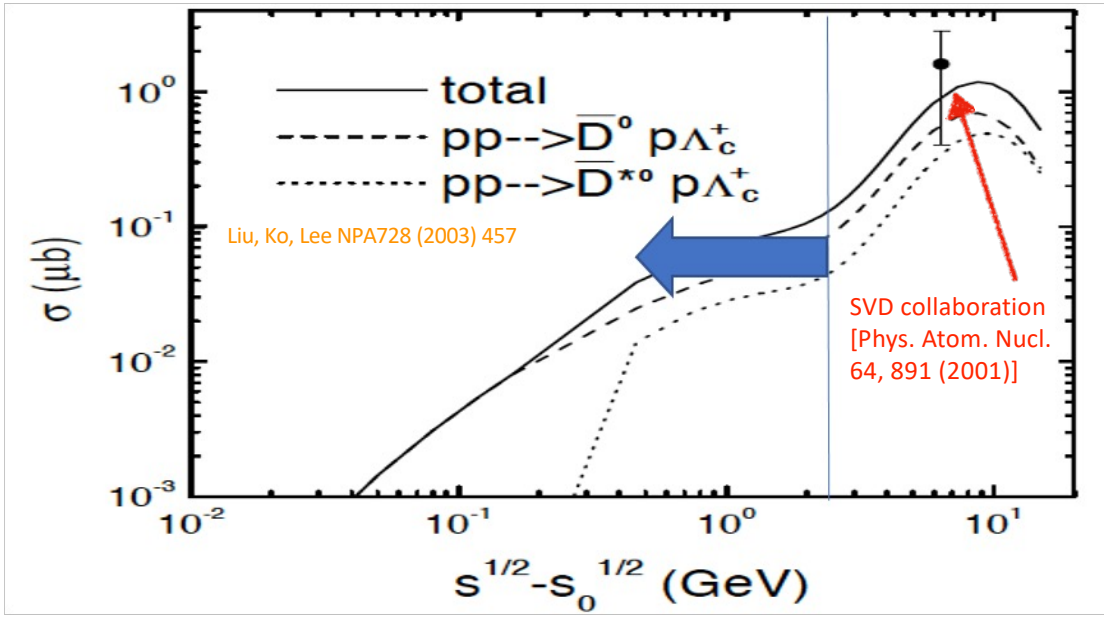


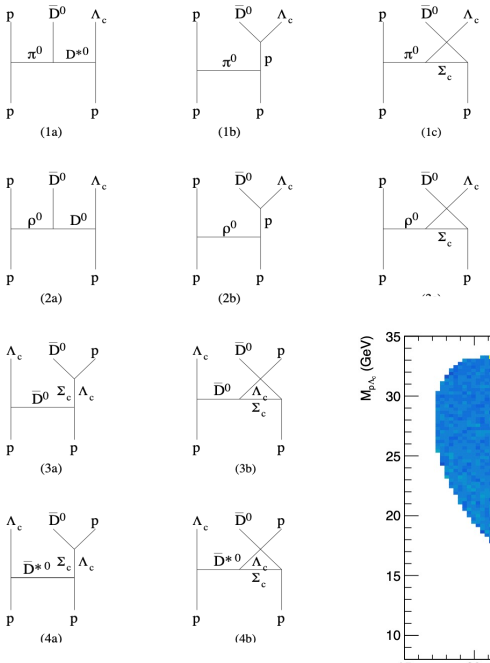
J. Messchendorp

Charm Physics Aspects at SIS100

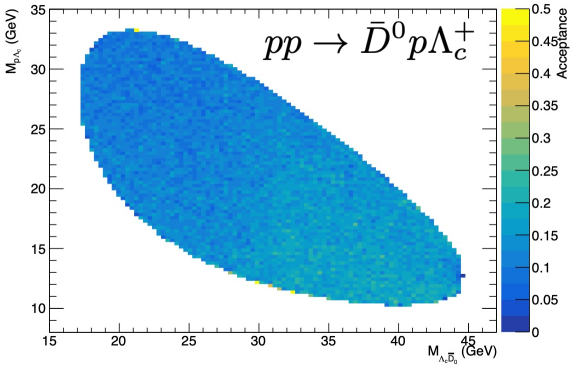
- Charm-N interactions: SU(4) dynamics
- Intrinsic charm component of the nucleon
- Mass structure of the proton

Hadronic model with interaction Lagrangian based on SU(4) flavor symmetry





J. Messchendorp, fast simulation, CBM acceptance



10^{10} protons/s (10^{11} protons/cycle) on a 5 cm LH2 target
50% duty cycle, 100 nbarn
(6.3% ($\Lambda \to p K\pi$) x 3.9% (D^0bar$\to K\pi$) x accept x eff
→ **2k Evts/day**

Charm Physics Aspects at SIS100

- Charm-N interactions: SU(4) dynamics
- Intrinsic charm component of the nucleon
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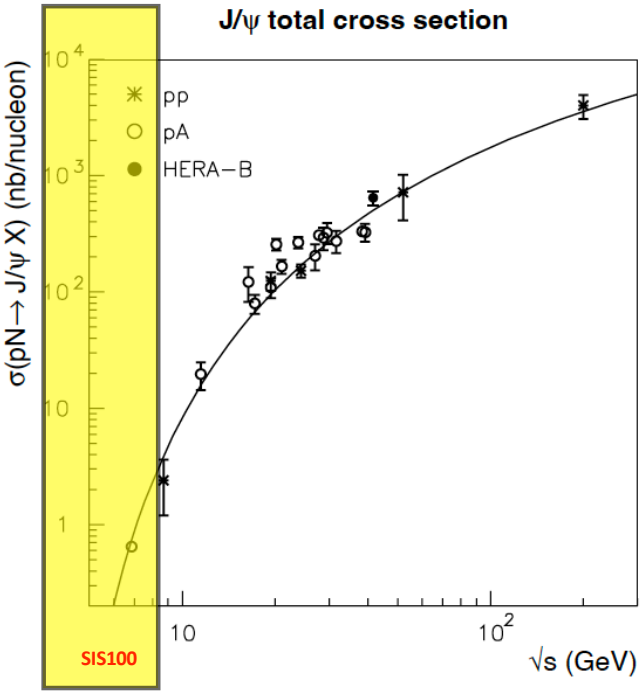
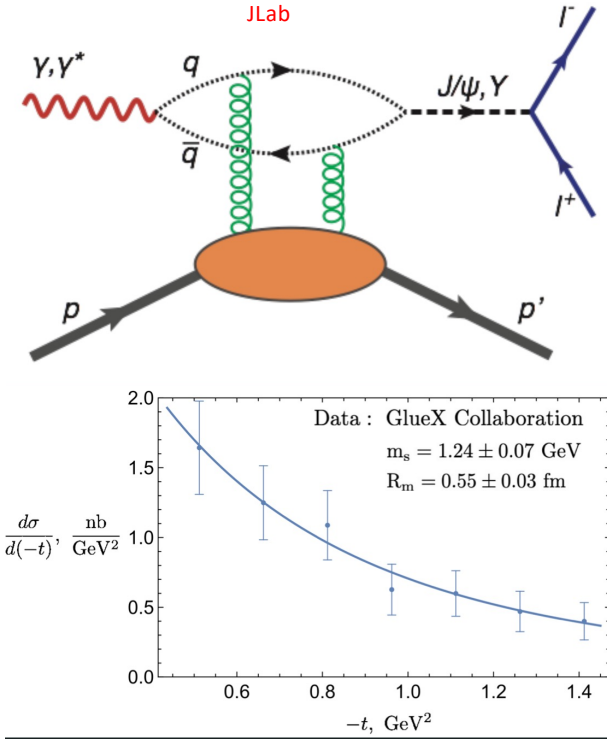
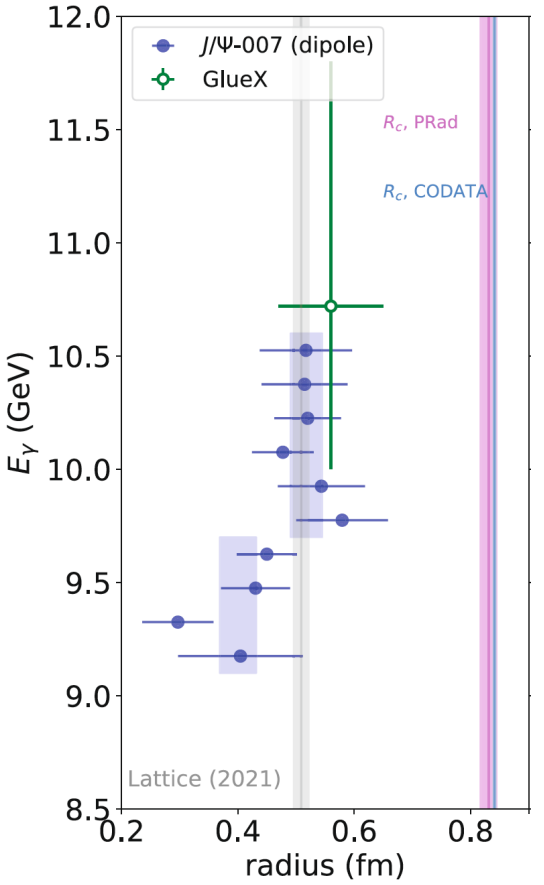


JLab

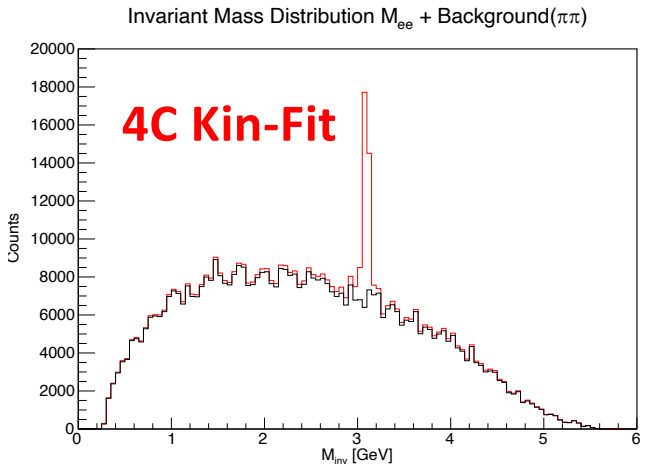


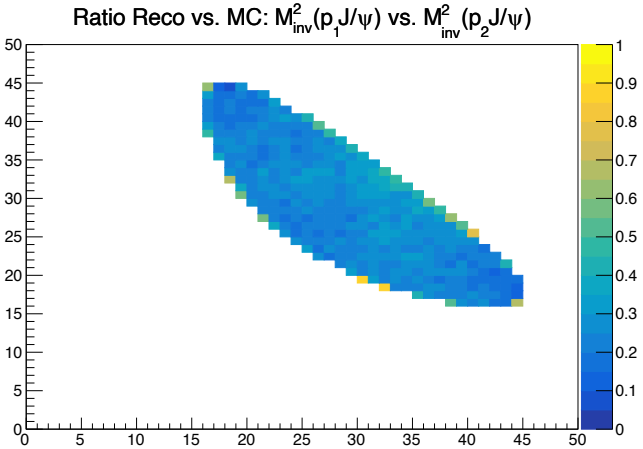
Duran et al., Nature 615, 813 (2023),
"Determining the gluon gravitational form factor of the proton"

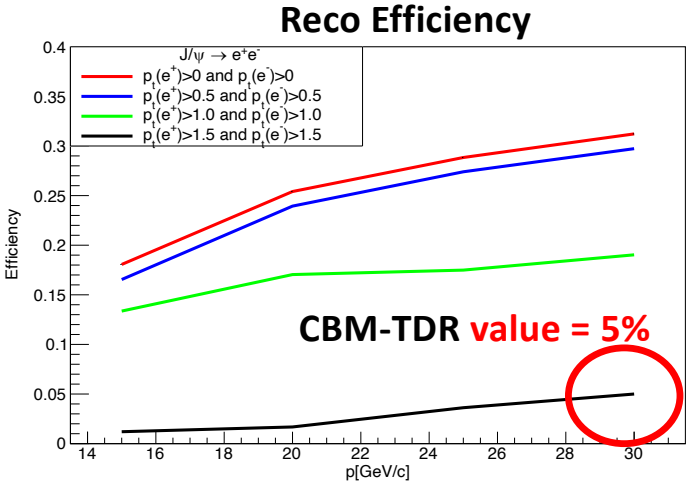


J. Messchendorp

Fast-Simulation: $pp \rightarrow ppJ/\psi$ CBM Acceptance







Signal	Cross Section [μb]
$pp \rightarrow ppJ/\psi(\rightarrow ee)$	10^{-3} (×0.06 BR)

Background	Cross Section [μb]
$pp \rightarrow pp\pi^+\pi^-$	1000 ($\times 10^{-6}$, $\pi\pi$ mis-ID)

Ömer Penek, fast simulation, CBM acceptance

10^{10} protons/s (10^{11} protons/cycle) on a 5 cm LH2 target
50% duty cycle, 1 nbarn BF (6% ($J/\Psi \rightarrow ee$) x accept x eff
Background: $pp\pi^+\pi^-$ (1 mb) with 10^{-3} mis-ID per pion
→ **11k Evts/day**

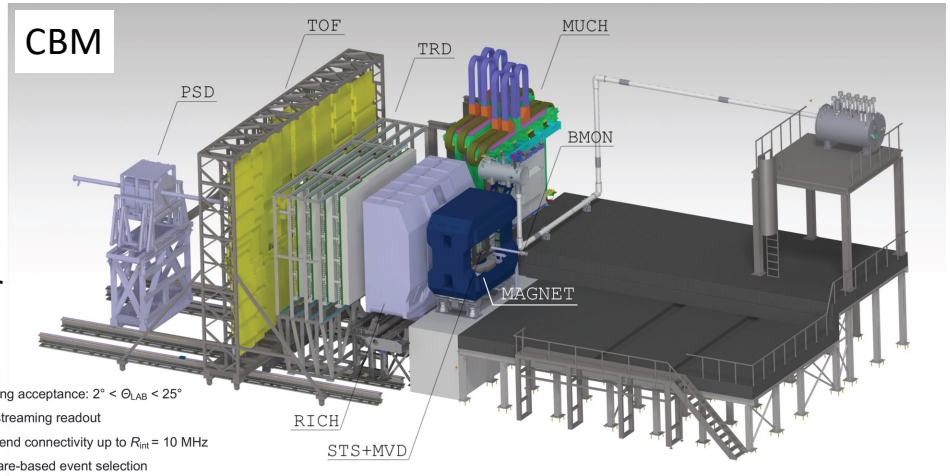
Potential Contributions of FFN to CBM

Gas system for the TRD Detector

- TRD system
  - Volume: 1.36 m^3 with 4 layers
  - Modules: 216
  - Gas mixture: Xe/CO2 (85/15)
  - Mechanical limit of 1 mbar gas overpressure in each chamber
  - Stringent limits on overpressure, gas purity, leak tightness

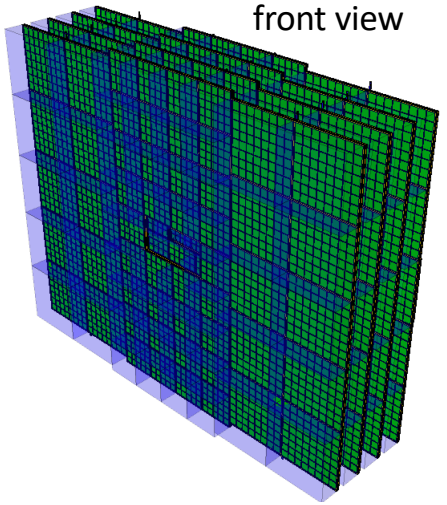
- Gas system
  - Closed-loop and recirculating gas
  - Overpressure regulation 0.7 $\pm$ 0.3 mbar
  - 5 overpressure regulation lines at different TRD heights
  - Oxygen and moisture sensor and filtering
  - Xe recovery station by removing accumulated N_2
  - Software development for gas control system
  - Interface to slow control system for experiment

Peter Wintz & PhD

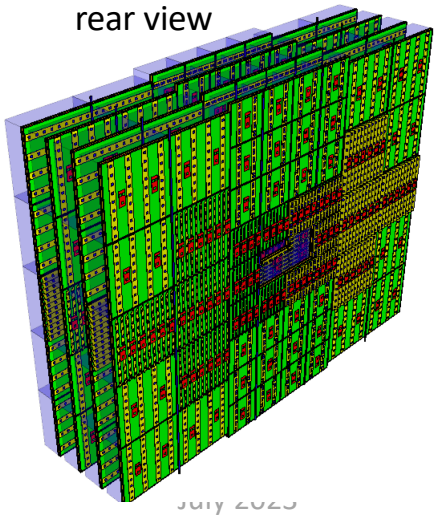


TRD

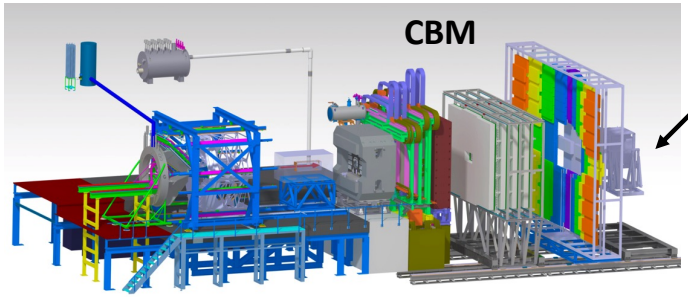
front view



rear view



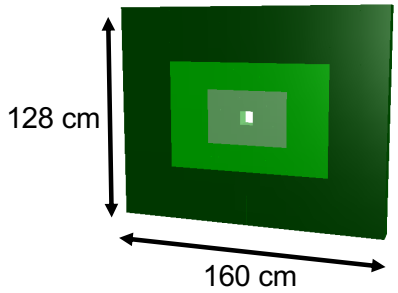
Light Readout and Calorimeter for the FSD



Determination of:

- Collision centrality
  multiplicity of projectile spectators
  → impact parameter
- Collective flow
  spectators position and energy
  → reaction plane orientation
- Exclusive events
  → increase acceptance to low Q
  → low-t elastic scattering

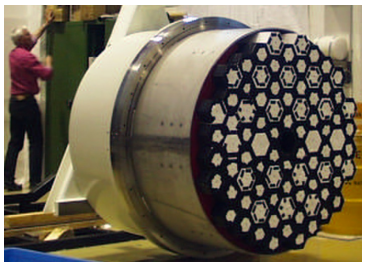
FSD concept : segmented scintillator



Modules:
Small: 4x4 cm^2
Medium: 8x8 cm^2
Large: 16x16 cm^2

neutron detector

Ø 126 cm
84 modules, l = 45 cm
plastic scintillator
n-detection efficiency ≈ 30 %



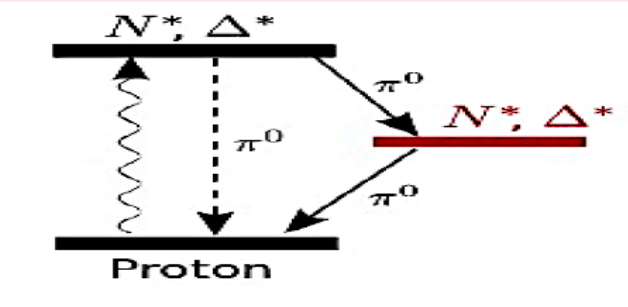
Dieter Grzonka & PhD

Intermediate Program of FFN

- FAIR-Phase0 Experiments with p and π Beams at HADES
- PANDA system Tests in Cave-C

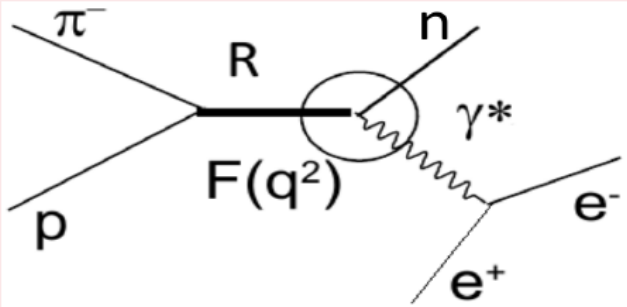
FAIR-Phase0 with p and π Beams at HADES

Baryon-Meson couplings



- $\pi\pi$N, ωn, ηn , $k^0\Lambda$, KΣ, ...
- Sparse database (PWA)
- Resolve baryon structures: Double resonances, Cascade decays, ηn couplings

Time-Like Electromagentic Baryon Transitions



$\pi^- \mathbf{p} \rightarrow \mathbf{n} e^+ e^-$

- Broad range of $q^2 = (M_{ee})^2$ $\rightarrow$ ETFF
- Confirmation for VMD (ρ, ω)
- Extract SDMEs

Cold matter studies (C, Ag targets)

- ω absorption, ρ spectral function
- Strangeness production

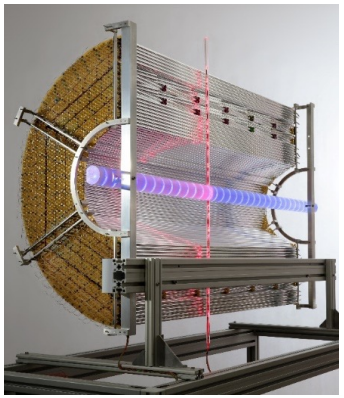
Pion and Proton Beam in 2025-2028

Operation of the STS1 & iTOF

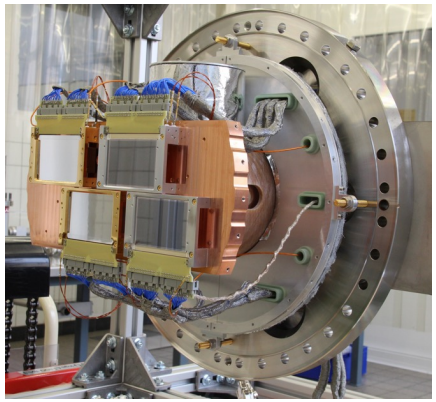
Ahmed Foda

PANDA System tests in Cave-C

- Installation of some PANDA (sub-)systems in Cave-C under consideration
- Proton beam up to T=4.5 GeV needed for the tests



- FFN could provide:
  - 1 sector of the STT



  - KOALA recoil detector
    to confirm LMD performance

Summary

- FFN is investigating a pivot to proton induced reactions at SIS100
  - Charm and multistrange exclusive events at CBM
  - Hardware/software contributions towards FS+
- FAIR-Phase0 experiments with p and π beams at HADES
- Detector tests at Cave-C