

S. Caiazza for the MAGIX collaboration March 27 2017 – La Biodola (I) 2nd LDMA Workshop







• A4: Parity violation (Replaced by MESA)



MAINZ ER SUPERCONDUCTIVE ACCELERATOR









Internal Gas Target



Focal Plane Detectors

A high-precision multi-purpose experimental setup









High resolution on low momentum electrons

•1 < p < 100 MeV

•
$$\frac{\Delta p}{p} \approx 10^{-2}$$

• $\Delta \theta \cong 0.9 \,\mathrm{mrad}$

Recoil particle detection

•Detection of recoil protons and alphas necessary for some planned experiments (e.g. DP invisible decays)

Material reduction

- •Uncontained gas target
- •No window before the magnet
- •Thin detector design

High rate capability

• With a CW operation rates up to O(1 MHz)• Count rates of $O(100 \ KHz)$













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Cluster target prototype

- 40K Hydrogen
- 4 bar injection pressure
- >15 cm long contained beam
- Integrated density to be measured

A1 target test

- Target prototype to be installed on A1 in September
- New proton radius measurement with ISR and reduced background



















Quadrupole + Dipole

- •200 MeV maximum momentum
- •45 MeV momentum acceptance@100 MeV
- •120x30 cm² focal plane

Performance simulation

10⁻⁴ relative momentum resolution
0.9 mrad scattering angle resolution
Assuming 50 µm resolution at the focal plane



Currently developing a few additional variants













Short drift TPC

- 2 Layer Hodoscope
- Simple detector to built
- Uniform and high position resolution
- Moderate material thickness
- Only 2 reconstructed points

- Challenging at very high rates
- Minimal material thickness
- Multiple samples and full track reconstruction possible









Challenges

- Multiple scattering of 10 100 MeV electrons between layers less than $\Delta \theta \approx 0.9$ mrad
- Detection of protons of momentum < 50 MeV in the first tracking layer

Foil readout

- Kapton foil readout planes in the first hodoscope layer
- Single layer padded strip layout

Thin GEM

- •Thin copper coating or chromium coating
- Some chromium coated GEM being characterized in the lab

Inert material reduction

- •Vacuum membrane has cathode
- Single gas volume for the two layers





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Recoil detectors

- Silicon strips integrated in the scattering chamber
- Detection of recoil protons and alpha at low momenta

Trigger and PID

- Fast scintillators for triggering and timestamping
- Time-of-flight measurement to reduce cosmic backgrounds

0-degree tagger

- Measurement of forward photons
- Integrated in the first bending dipole after the experiment



27-May



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Hadronic structure

- Proton form factors (electric and magnetic)
- Nuclear polarizabilities
- Light nuclei form factors (Deuteron and helium)

Few-body physics

- Deuteron and ³He breakup
- ⁴He monopole transition factors
- Test of effective field theories
- Inclusive electron scattering

Precision cross-sections

• ¹⁶O(e, e'a)¹²C S-factor

Search for exotica

- Direct dark photon search
- Invisible decaying dark photon search
- Beam dump experiment (technically is not MAGIX but involves the same group)









Dark sector mediator

- Massive U(1) boson
- Same quantum numbers of the SM photon
- Can undergo kinetic mixing with the SM photon (parameterized by ϵ)
- Magix can search for invisible or visible decays (possible when there is no DM particle kinematically accessible)





















Full kinematic reconstruction

- Spectrometer for electron
- Second detector for the proton

Work in progress

- Spectrometer efficiency for proton detection
- Do we need a separate recoil detector?













Construction schedule

- Earliest availability of MESA: 2020
- First MAGIX operation: 2021-22

Design timeline

- R&D projects ongoing
- Physics book to be published in autumn
- TDR before the end of 2017

Financing

- Accelerator and experiments financed by the German science council and the PRISMA cluster of excellence
- PRISMA funded by the Rheinland-Pfalzstate and by the Mainz university









MAGIX: a versatile experiment

- Experimental setup for high precision measurements
- Rich physics program under development

Dark matter searches

- Sensitive to Dark Photons with mass of about 10-60 MeV
- Sensitivity to couplings of the order of 10⁻⁴
- Full simulations under development
- Beam dump experiment included in the program

Open and expanding collaboration

- Currently 4 institutes involved
- First collaboration meeting 15-17 February 2017
- Open to new physics proposals to make the project long-lasting
- Open to new collaborators to realize the Magix



ISFB書 C PRISMA

THANK YOU FOR YOUR ATTENTION!

http://magix.kph.uni-mainz.de

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Ult









ASTROPHYSICAL CROSS-SECTIONS



Low energy nuclear cross-sections

- Relevant for astrophysical modelling
- ${}^{12}C(a,\gamma){}^{16}O$ important to model late stellar burning
- •Thermal energy at burning point (Gamow peak energy) ~300 KeV
- Very low cross-section $\sim 10^{-16}$ barn

Inverse reaction ${}^{16}O(\gamma, \alpha){}^{12}C$

- •2 orders of magnitude cross-section improvement $10^{-16} \rightarrow 10^{-14}\,\text{barn}$
- Time-reversal correlation with the previous reaction
- Poor data coverage at 1 MeV and below
- \bullet MAGIX can measure this cross-section at E_{cm} < 1 MeV
- Presented on Monday by S.Lunkenheimer



