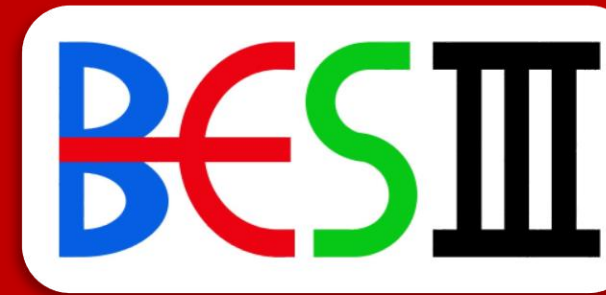


Searches for Light Dark Matter at DarkMESA and BESIII

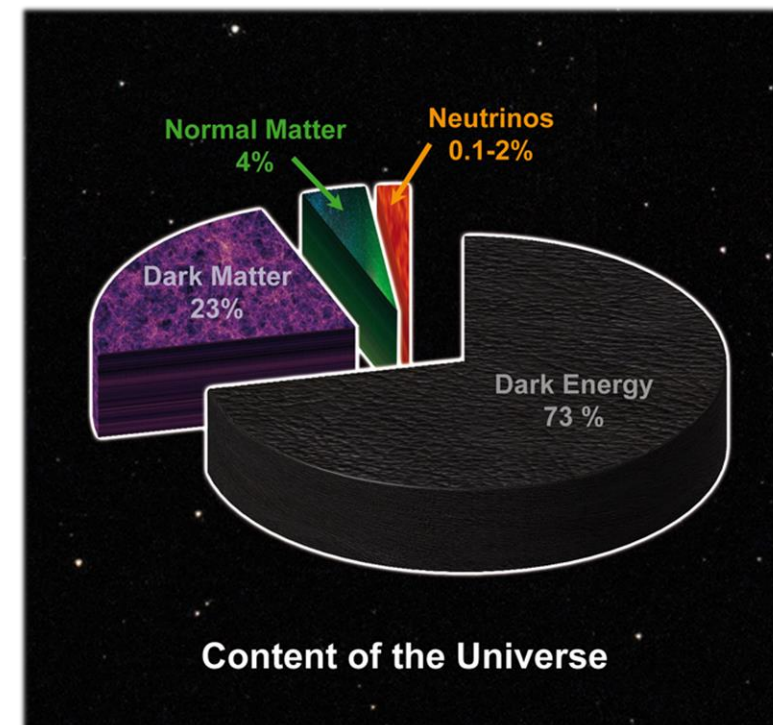
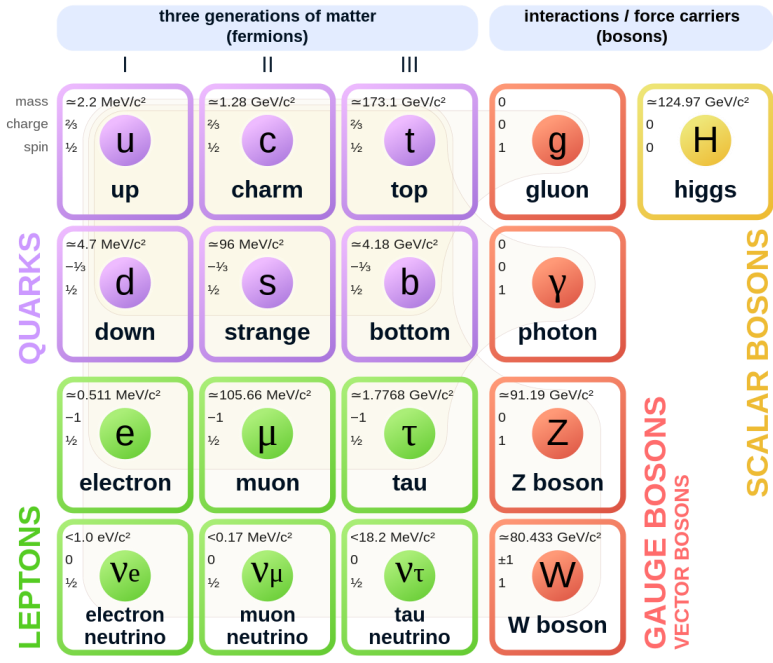
Saskia Plura | Supervisor: Univ.-Prof. Dr. Achim Denig
 ✉ saplura@uni-mainz.de



The Standard Model of Particle Physics and Beyond

- The **Standard Model (SM)** of Particle Physics describes all currently known particles and 3 of the 4 fundamental interactions
- Allows for **extremely precise predictions** and has been confirmed by a multitude of experiments
- However: **no complete theory** – can only describe about **5% of the cosmic energy density**

Standard Model of Elementary Particles

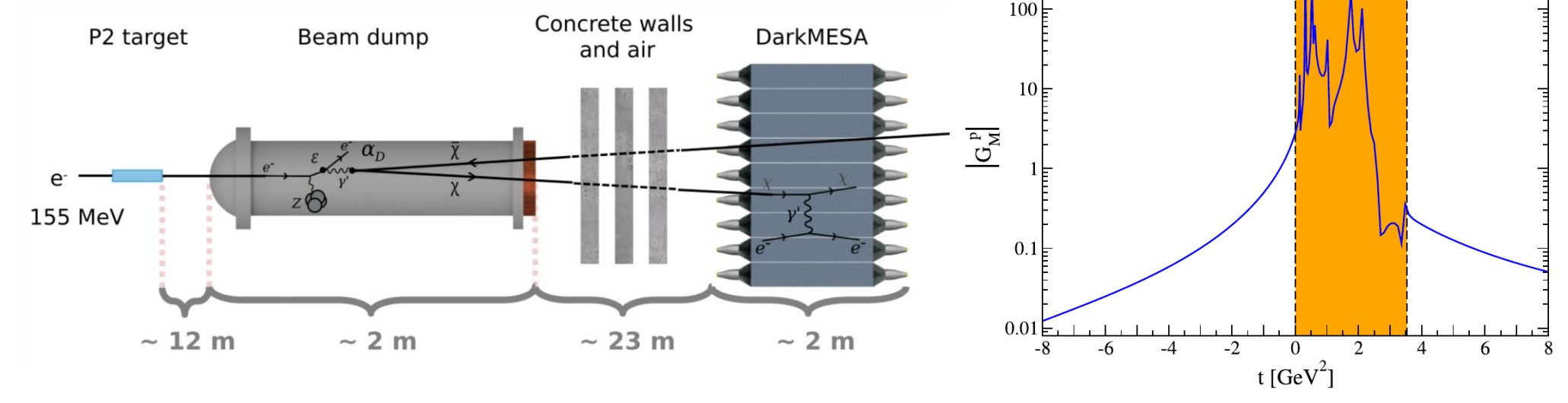


- **Dark Matter** is a large focus point in searches for **Physics Beyond the Standard Model (BSM)**
- Current situation: many different Dark Matter models
- Dark Matter Models with Standard Model interactions allow for **direct Dark Matter searches**
- Large parameter space for Dark Matter **makes different experiments necessary**

Searching for New Physics and Testing the Standard Model

- Non-accelerator experiments search for **scattering processes of cosmic Dark Matter inside the detector** (direct searches)
- Accelerator experiments (like the LHC/CERN) try to **produce Dark Matter and detect it through different processes** (indirect searches)
- **Collider experiments** look for direct decays of Dark Matter
- **Beam dump experiments** (like DarkMESA) look for scattering processes of Dark Matter in the Detector

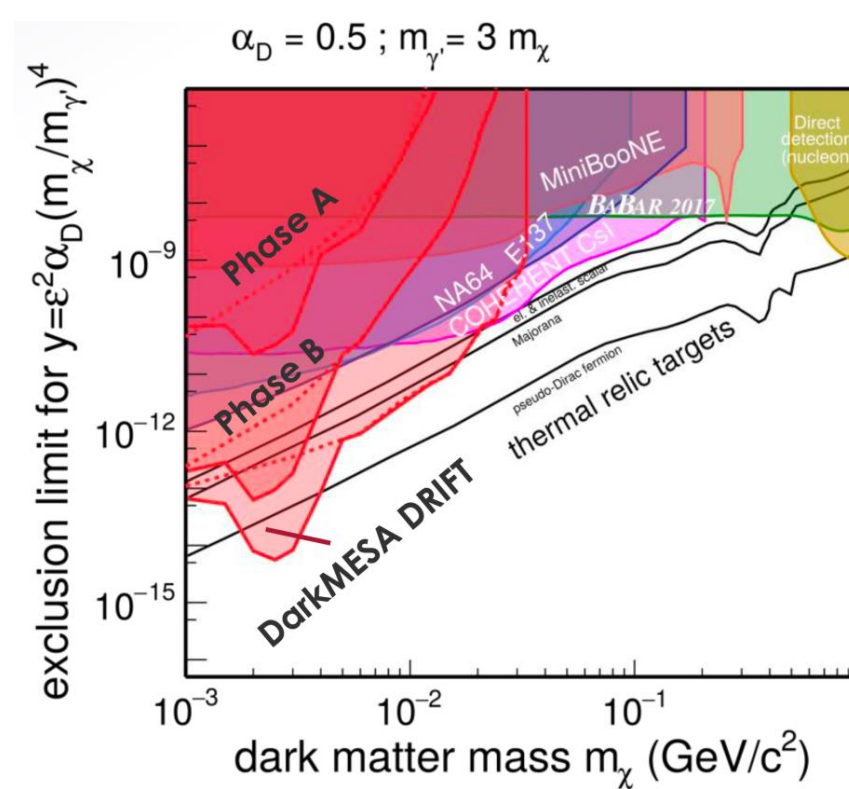
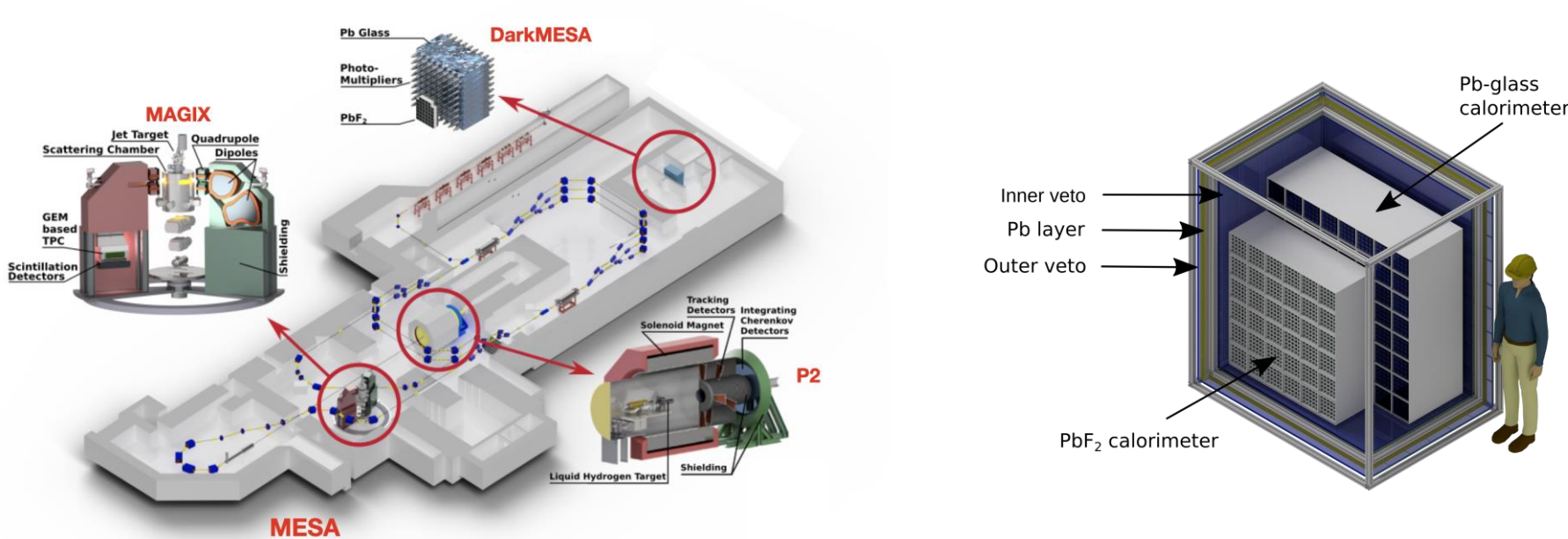
Setup of the DarkMESA Beam Dump Experiment at MESA



- Searching for Dark Matter requires **large data sets** and **minimal background** from other decays
- Large data sets also allow for **precision measurements** of Standard Model quantities in addition to **rare decay searches**
- The **time-like proton form factor in the unphysical region** has never been measured before, but is vital for **accurate predictions of decay probabilities** of processes involving protons

Project 1: Searching for Axions at DarkMESA

- **DarkMESA** is located at the upcoming **MESA** accelerator at the JGU Mainz
- MESA has a **beam energy of up to 155 MeV** with a maximum current of **0.15 mA**, making for **high beam intensities of 3×10^{22} EOT per year**
- DarkMESA is a **beam dump experiment** and will be able to produce a large data set for Light Dark Matter searches in a short amount of time



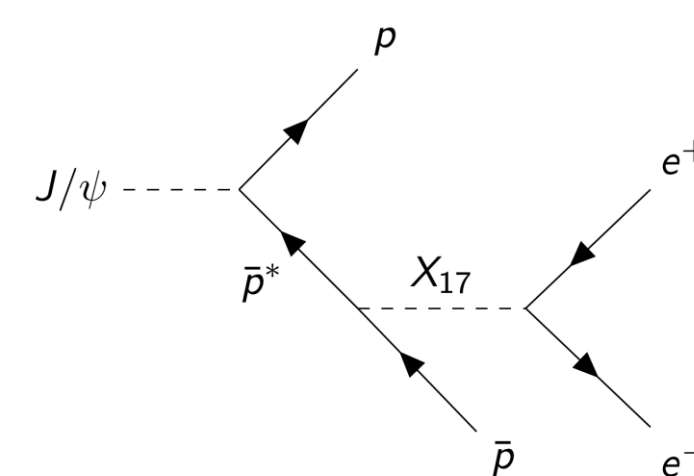
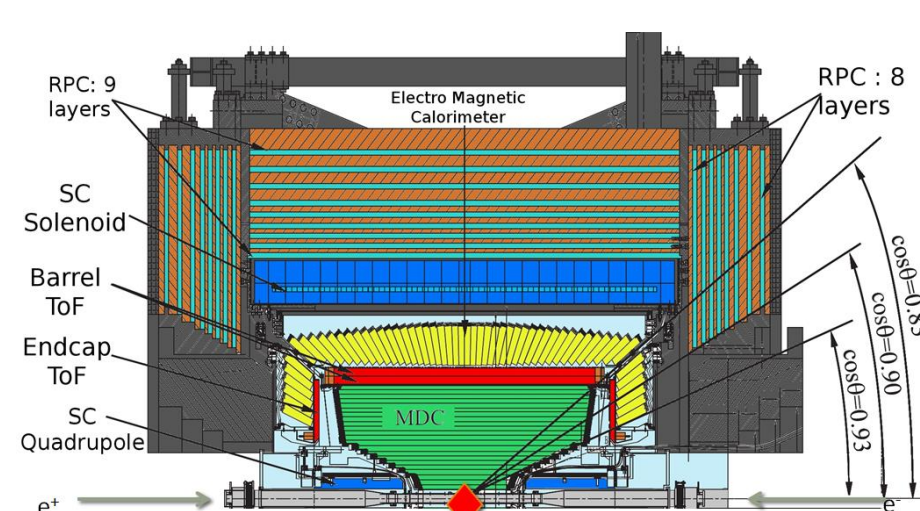
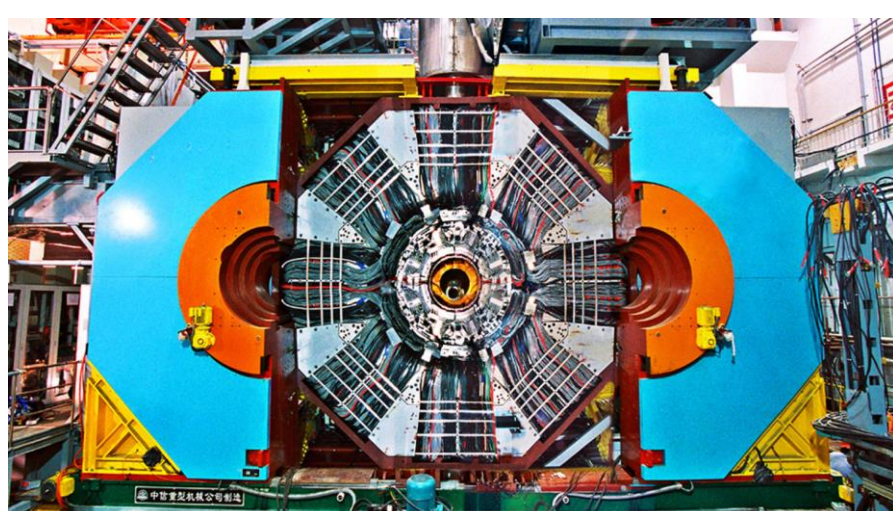
- Evaluation of the **experimental range** is necessary before the start
- **Monte Carlo Simulations** needed to estimate the accessible parameter space in relation to specific Dark Matter models
- Simulations serve as comparison for future data analyses

Tasks:

- Conduct **low energy (55 MeV) studies**
- **Expand the current simulation** with Axion Dark Matter models
- **Determine detector acceptance and sensitivity**
- **Optimise the experimental setup**
- **Extend research programme to Axions!**

Project 2: Searching for $J/\psi \rightarrow p\bar{p}e^+e^-$ Decays at BESIII

- **BESIII** is located at the **BEPCII** accelerator in Beijing, China
- BEPCII is an e^+e^- **collider experiment** with a center-of-mass energy of **2 – 5 GeV**
- BESIII holds the **worlds largest peak J/ψ data set** with 10 billion events
- J/ψ decays are ideally suited to search for New Physics and conduct precision measurements of Standard Model quantities



- $J/\psi \rightarrow p\bar{p}e^+e^-$ decays are interesting candidates for both BSM searches and SM measurements
- **BSM process** offers the possibility to search for Dark Matter mediator particles like the **X17 Boson**
- **SM process** allows to measure the **time-like proton form factor in the unphysical region**

Tasks:

- **Extract $J/\psi \rightarrow p\bar{p}e^+e^-$ decays** by developing a new analysis algorithm
- Study the **efficiency of the tracking detector**
- **Extend my Monte Carlo Generator** to new models for both processes
- **Measure the time-like proton form factor!**
- **Search for New Physics!**

Sources:

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