The AMBER Experiment at CERN

Rita Silva[a,b], Guilherme Almeida[a,c], Catarina Corte-Real[a,b], Catarina Quintans[a], Christophe Pires[a], Marcin Stolarski[a] , Pietro Faccioli[a]

[a]LIP-Lisbon; [b]IST, Univ. Lisboa; [c]FCUL, Univ. Lisboa

Apparatus for Meson and Baryon Experimental Research

FCT Fundação para a Ciência e a Tecnologia

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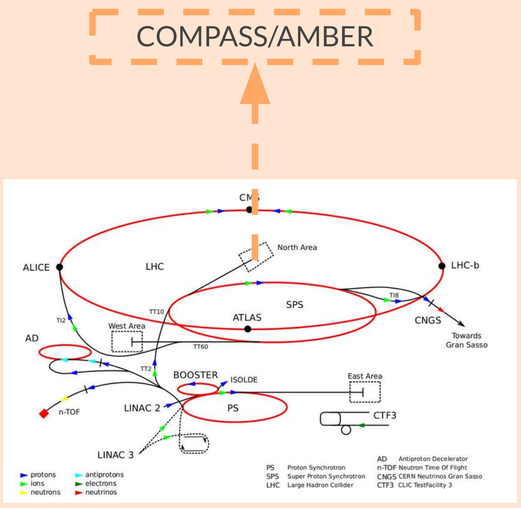
The AMBER Experiment

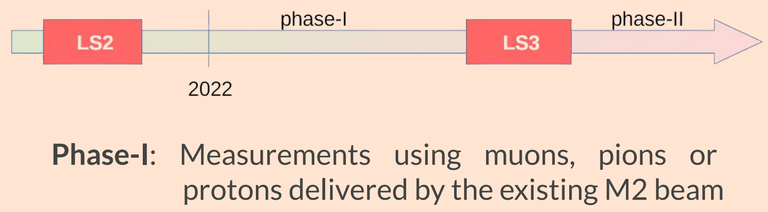
AMBER is a fixed target experiment located at the M2 beam line at CERN using muon and hadron beams of both charges. These are secondary or tertiary beams in the energy range 50 - 280 GeV, obtained from the collisions of the 400 GeV protons extracted from the SPS on a primary target.

Physics goals:

- Hadron structure: meson PDFs (pion and kaon)
  - Hadron radii: proton, pion and kaon
    - Kaon polarizability
  - Hadron spectroscopy: strange sector
  - Antiproton production cross-section



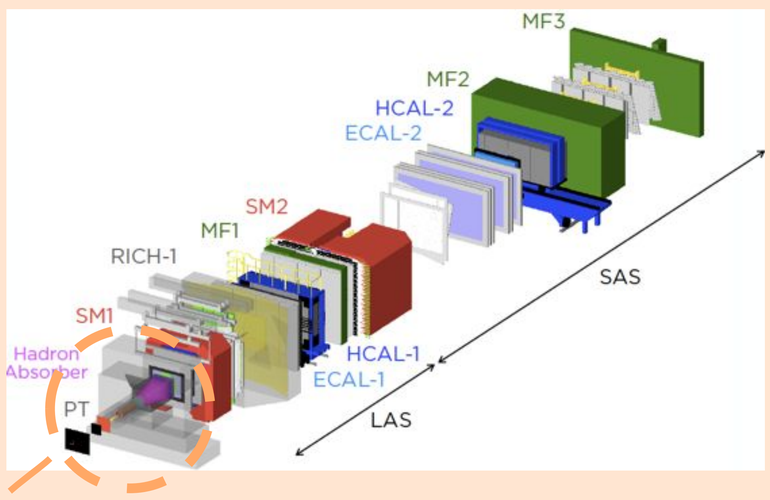
COMPASS/AMBER



Phase-I: Measurements using muons, pions or protons delivered by the existing M2 beam line

Phase-II: Upgrade of the M2 beam line by equipping it with radio-frequency (RF) separation to produce kaon and antiproton beams of high energy and high intensity.

Spectrometer

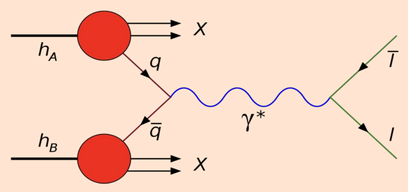


Modular setup, adapted to the physics goals of each data taking.

Example of COMPASS DY setup, taken as starting point for DY @ AMBER.

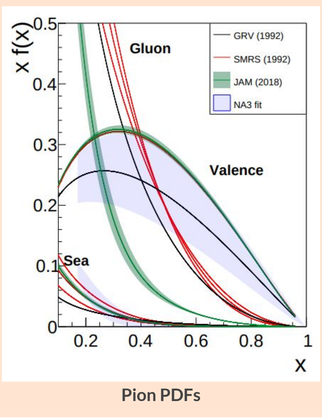
Drell Yan (DY) Process

A quark and an antiquark provenient from two different hadrons annihilate, producing a virtual photon. In the final state a dilepton is created.
This process' cross-section contains information about the Parton Distribution Function (PDF) from these two hadrons.



DY cross-section

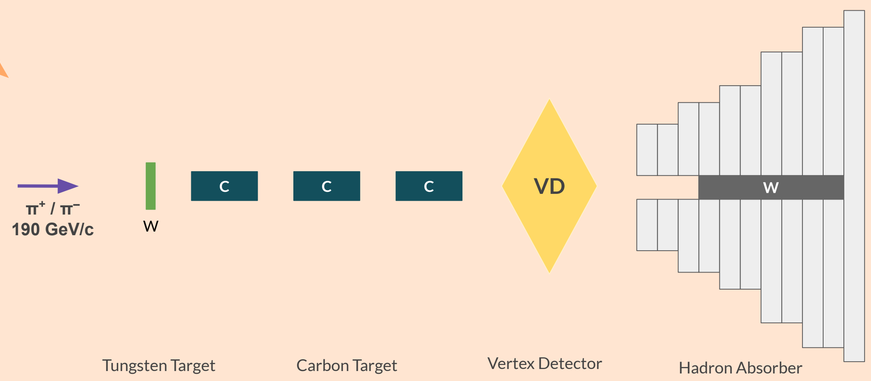
$$\sigma^{DY} = \sum_{ab} \int dx_a \int dx_b \; \underbrace{f_a(x_a, Q^2)}_{\text{PDF}} \underbrace{f_b(x_b, Q^2)}_{\text{PDF}} \hat{\sigma}_{ab\to l\bar{l}}(x_a, x_b, \dots)$$

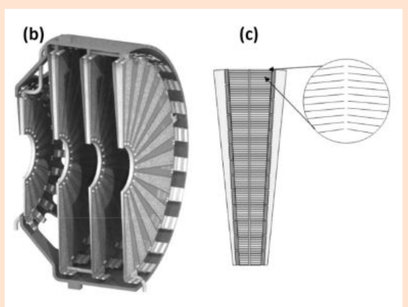


Pion PDFs

Target Region

The target region will consist on a tungsten target and a carbon target composed of three cells. The AMBER collaboration is currently studying the introduction of a Vertex Detectors (VD) and the type of technologies to use. One of the options would be to use an already existing detector of silicon microstrips, the detector FVTX from the PHENIX experiment, in USA.

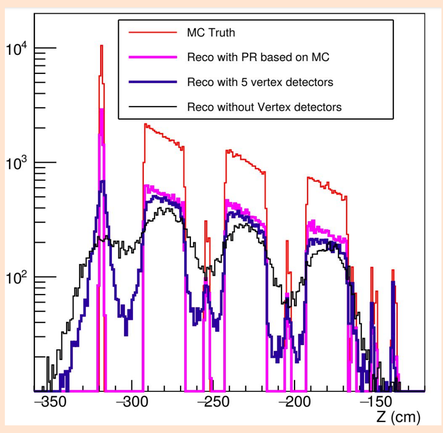




FVTX

Preliminary Studies

The inclusion of the Vertex Detectors will improve the experimental resolutions.
For the AMBER proposal, preliminary studies were done to evaluate the impact of the VDs in the reconstructed vertex position, and reconstructed dimuon invariant mass.



Monte Carlo truth / Reconstructed Z position for DY vertices

Simulations

The first step to implement the Vertex Detector in the simulations was to use the GEANT4 package. After that, a dedicated simulation tool, including both the Physics event generator Pythia 8 and GEANT4, was used for the Monte Carlo of the Drell-Yan process at AMBER. At LIP-Lisbon we are studying the reconstruction of MC Drell-Yan events using the VDs information. Our goal is to test different detector pixel sizes, geometries and positions, in order to obtain the ideal configuration.