FIXED TARGET PROGRAMME @ PS

SINCE 2001

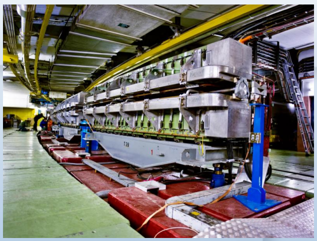
DIRAC & CLOUD

ANS / JAHRE / ANNI CERN

60 YEARS OF SWISS SCIENCE AT CERN

THE PS ACCELERATOR

The 25 GeV Proton Synchrotron (PS), with a circumference of 628 metres, was CERN's first synchrotron, accelerating protons first time on 24 November 1959, and was for a brief period the world's highest energy particle accelerator. Ever since, the PS has accelerated protons, alpha particles, oxygen, sulphur and lead nuclei, electrons, positrons and antiprotons. Today, the PS supplies protons and lead ions in the pre-injector chain for the LHC. The PS also supplies protons to a target where antiprotons are generated for the Antiproton Decelerator. The DIRAC and CLOUD experiments use proton beams from the PS and are situated in the CERN East Hall, located adjacent to the PS. DIRAC uses a primary proton beam and CLOUD uses a secondary charged pion beam from a proton target in order to simulate galactic cosmic rays.

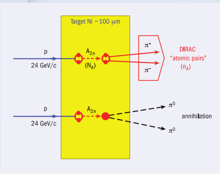


DIRAC – DImeson Relativistic Atom Complex

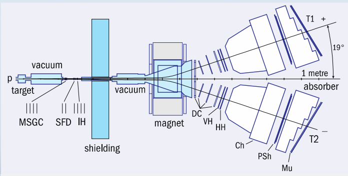
The DIRAC experiment measures Hydrogen-like atoms consisting of a charged meson pair at the PS. Dimesons, such as the $\pi^+\pi^-$ ($A_{2\pi}$) and the πK atom ($A_{\pi K}$) – provide a unique tool for exploring low-energy hadron-hadron interactions.

DIRAC observed DIMESON ATOMs and measured their lifetime:

$$\tau_{A_{2\pi}} = 3.15^{+0.28}_{-0.26}\ \text{fs} \qquad \tau_{A_{\pi K}} = 2.5^{+3.0}_{-1.8}\ \text{fs}$$



$A_{2\pi}$ (pionium), produced in Ni, is detected through its breakup (ionization). Alternatively, the $A_{2\pi}$ annihilates (decays).



The **magnetic double-arm spectrometer** detects and identifies $\pi^+\pi^-$ (π^-K^+ and π^+K^-) pairs with small relative c.m. momentum.

n_A = # "atomic pairs" measured
N_A = # $A_{2\pi}$ produced calculated
} → $n_A/N_A = P_{br}$ breakup probability

• Breakup probability depends on atom lifetime: $P_{br} = f(\tau)$ => $\tau = f^{-1}(P_{br})$

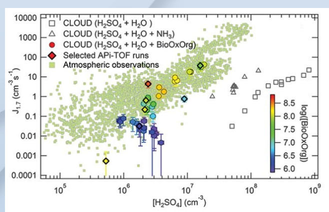
The measurement of dimeson-atom lifetimes provides information on SCATTERING LENGTHS – the basic parameters in low-energy *QCD*, to be compared to results from *ChPT) and *lattice QCD*.**

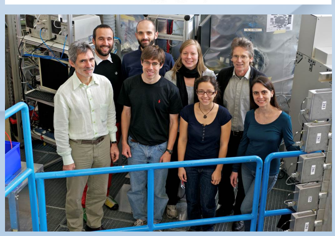
*) Chiral Perturbation Theory

DIRAC Collaboration with SWISS members:

CLOUD – Cosmics Leaving OUtdoor Droplets

The CLOUD project investigates the possible influence of galactic cosmic rays on the aerosol-cloud-climate interaction. For this the proton synchrotron is used producing pions to simulate atmospheric ionization conditions from ground level to the upper free troposphere. The 27m³ cloud chamber is designed to allow for precisely controlled experi-ments with a very low contamination background and close to atmospheric conditions. The unique combination of resources allows us to run experiment of high relevance to understand aerosol and cloud formation and therefore their influence on climate.





Our studies have shown so far that the main driving force of aerosol nucleation – sulfuric acid – cannot explain ambient nucleation rates (1). We showed that additional ingredients are needed, such as dimethyl amine (2) and oxidized organics (3). Also ions influence the nucleation rates, being especially important at very low nucleation rates (1,3). However, a full assessment of the importance of ions first needs a more detailed exploration of the full experimental space.

References:
(1) Kirkby J. et al., Nature 476, 42, 2011
(2) Almeida J. et al., Nature 502, 359, 2013
(3) Riccobono F. et al., Science 344, 717, 2014

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SPS/CHIPP ANNUAL MEETING 2014

Fribourg, 30 June – 2 July 2014

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