The aim of the NA48 experiment is a measurement of the direct CP-violation parameter \( \delta' \) by a determination of the double ratio:

\[
\frac{\Gamma_{DKS}}{\Gamma_{DKL}} = \frac{\Gamma_{B_sDKS}}{\Gamma_{B_sDKL}} = \frac{\Gamma_{B_sDKS}}{\Gamma_{B_sDKL}} \cdot \frac{\Gamma_{DKS}}{\Gamma_{DKL}}
\]

To achieve an overall accuracy of 2 \( \times \) 10^{-4} on \( \delta' \), an intense neutral kaon beam is used to produce long-lived and short-lived neutral kaons, \( K_L \) and \( K_S \), in the same fiducial volume. Their decays are recorded simultaneously with a magnetic spectrometer and a liquid-argon electromagnetic calorimeter. The identification of a decay as originating from \( K_L \) or \( K_S \) is done by tagging the protons which are directed onto the \( K_S \) target.

Since 1997, the experiment has recorded more than two million \( K_L \to \pi^0 \pi^0 \) decays. A preliminary result, based on this data set (roughly 10 \( \% \) of the total statistics), is \( \delta' = (18.5 \pm 4.5 \text{stat} \pm 4.3 \text{syst}) \times 10^{-4} \), favouring a large value for \( \delta' \), and signalling CP violation in the decay of quarks.

### CP Violation in B Decays

- Magnetic spectrometer (10-300 mrad)
- Vertex in HCAL interaction point
- Flexible trigger optimized for B physics

#### Decay modes

- \( B_s \to D^+ \pi^- \)
- \( B_s \to D^0 \pi^- \)
- \( B_s \to D^{*0} \pi^- \)
- \( B_s \to D^{*+} \pi^- \)

#### Performance

- Efficiency (after 10^7 s)
- Uncertainty

#### Exotic Atoms

- Antiprotonic Helium and Hydrogen Atoms

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Decay mode</th>
<th>90% Confidence (after 10^7 s)</th>
<th>Expected signal properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>( B_s \to D^+ \pi^- )</td>
<td>( B_s \to D^0 \pi^- )</td>
<td>( B_s \to D^{*0} \pi^- )</td>
<td>( B_s \to D^{*+} \pi^- )</td>
</tr>
<tr>
<td>( D^+ \to K^+ \pi^+ \pi^- )</td>
<td>( D^0 \to K^- \pi^+ \pi^- )</td>
<td>( D^{*0} \to K^- \pi^0 \pi^0 )</td>
<td>( D^{*+} \to K^- \pi^0 )</td>
</tr>
<tr>
<td>3.5 ( \times )</td>
<td>10^{-3}</td>
<td>( \text{detected (after 10^7 s)} )</td>
<td>( \text{predicted from Chiral PT to 2 loops} )</td>
</tr>
</tbody>
</table>

### Chiral QCD

#### DIRAC

**Di-meson Relativistic Atomic Complexes**

The aim of the DIRAC experiment is the measurement of the difference between the Clebsch-Gordan coefficients \( \gamma_{1,1} \) and \( \gamma_{2,2} \) from the scattering of the \( \pi^- \) at \( \Lambda \). The recoil scattering length can be predicted from Chiral Perturbation Theory to 3 loops approximation:

\[
\gamma_{1,1} \approx \gamma_{2,2} \approx \frac{2\pi \rho}{f_{\pi}^2} \left( 1 + \frac{m^2}{f_{\pi}^2} \right)
\]

**Signature of \( \gamma_{1,1} \) atoms:**

- Low recoil \( \gamma_{1,1} \) atom:
  - Low recoil energy:
  - Low scattering angles:
  - Low energy levels:
  - High recoil density:

30,000 events expected in DIRAC (275 keV at Seraphim)

**Data taking:** Autumn 1998 - 2001

### CPT Tests

**Antiproton Decelerator (AD)**

- Antihydrogen Spectroscopy

**Antiprotonic Helium and Hydrogen Atoms**

\[ \text{ASACUSA} \]

This experiment will capture and cool antiprotons from the AD in a Penning trap. The cold antiprotons will then be accelerated and brought to contact with either helium or hydrogen gas jets at pressures to produce antihydrogen. Helium and antihelium production in vacuum.

The aim of this experiment, in the study of the structure and formation process of antihelium atoms, Laser and microwave spectroscopy of \( \text{He}^\text{+} \) and \( \text{He}^\text{++} \) will allow the precise determination of basic properties of the antihelium. Use its masses, charge and magnetic moment, as has been shown by the last results of the PDG89 experiment at JARA.

**Data taking:** Autumn 1998 - 2001

**ATHENA - ATRAP**

- Antihydrogen Detection
- Antihelium Production
- Antihelium Laser Spectroscopy

In a second stage, the atomic structure of antihelium atoms in helium (\( \text{He}^\text{++} \)) will be explored by laser spectroscopy.