DEAR

DAΦNE Exotic Atom Research

The scientific goal of the DEAR experiment is the determination at the percent level of the antikaon-nucleon scattering lengths via the measurement of the 1s strong-interaction shift and width of the Kα x-ray transitions in kaonic hydrogen and kaonic deuterium. This will represent a breakthrough in the phenomenology of low-energy kaon-nucleon interaction and will allow the determination of the kaon-nucleon sigma terms and the strangeness content of the proton.

Laboratori Nazionali di Frascati

Kaon beam from ϕ-decay in the DAΦNE collider.

Intensity: 1100 s^{-1} at the design luminosity of $5x10^{32}$ $cm^{-2}s^{-1}$,

Monochromaticity: $\delta p/p \cong 10^{-3}$, Purity: π:K ≅ 1:1.

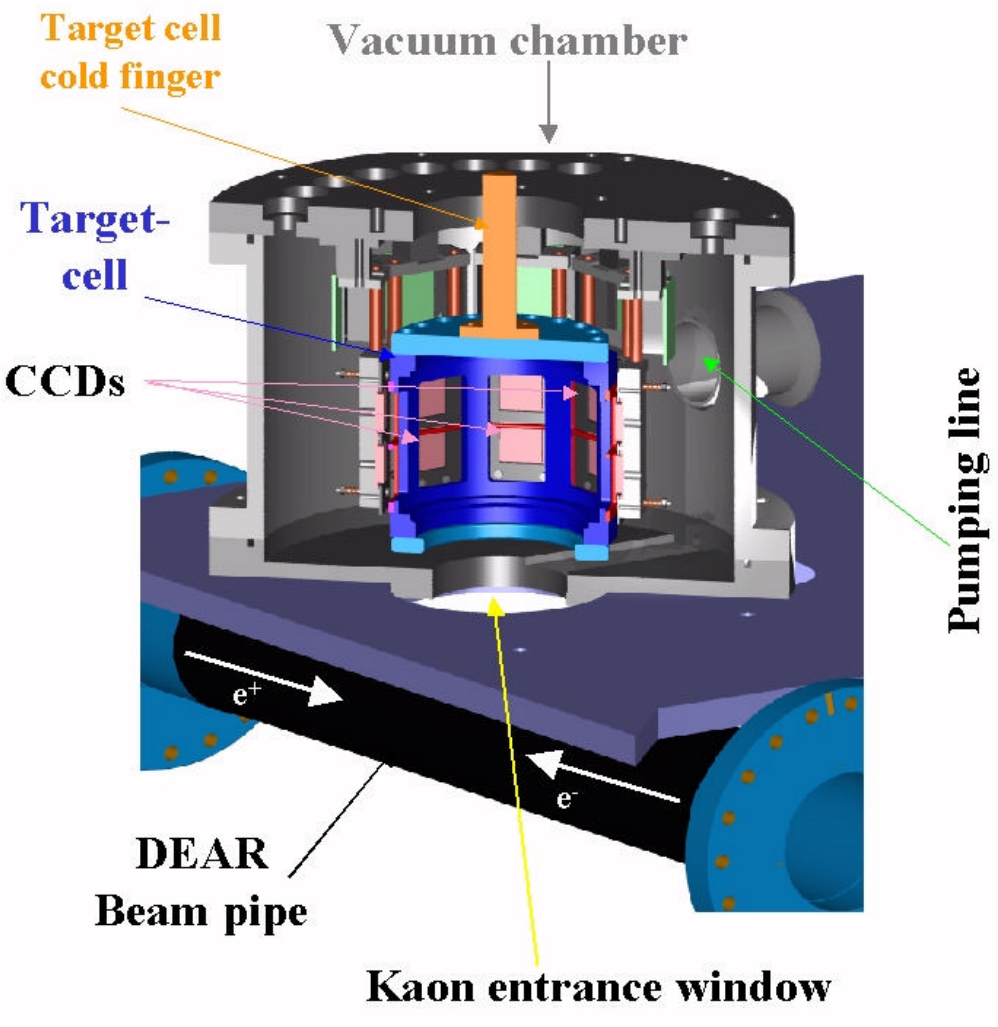
International Collaboration:

- Institute for Medium Energy Physics, Austrian Academy of Sciences, Vienna, Austria
- Univ. of Victoria, Dept. of Physics and Astronomy, Victoria, Canada
- **Laboratori Nazionali di Frascati dell'INFN, Frascati, Italy**
- **Univ. degli Studi di Trieste, Dip. di Fisica and INFN Sezione di Trieste, Trieste, Italy**
- Tokyo Institute of Technology, Tokyo, Japan
- Univ. of Tokyo, Dept. of. Physics, Tokyo, Japan
- Inst. of Physical and Chemical Research (RIKEN), Saitama, Japan
- KEK, High Energy Accelerator Research Organization, Tokyo, Japan
- Inst. of Physics and Nuclear Engineering - " Horia Hulubei ", Bucharest, Romania
- Univ. de Fribourg, Inst. de Physique, Fribourg, Switzerland
- Univ. de Neuchâtel, Inst. de Physique, Neuchâtel , Switzerland
- W.K.Kellogg Radiation Laboratory, California Inst. Of Technology, Pasadena, USA
- Department of Physics and Astrophysics, California State Univ., Northridge, USA.

Total number of researchers: 40
Number of Italian researchers: 7

Spokesperson of the collaboration and Italian responsible:
Carlo Guaraldo e-mail: Carlo.Guaraldo@lnf.infn.it

The DEAR setup

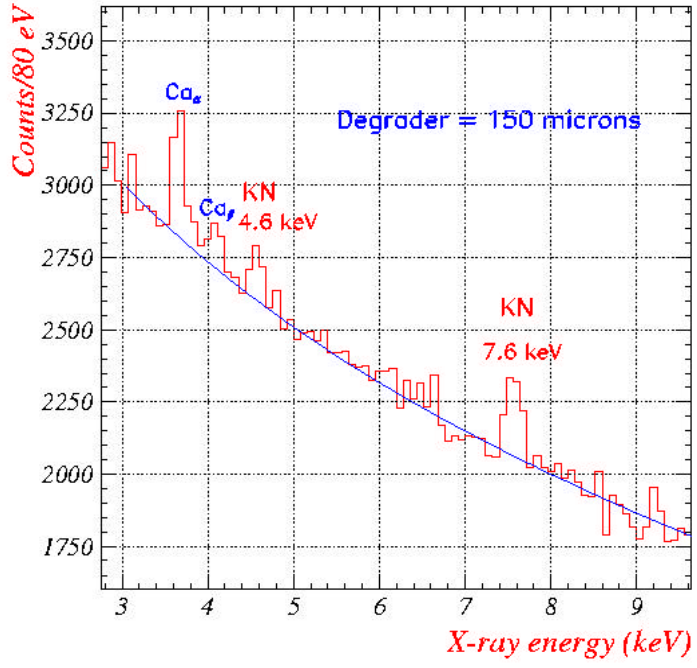


- **Kaons, which are decay particles of f's produced in the interaction point of DAF NE e^+e^- collider, pass through the thin DEAR beam pipe, enter via the kaon entrance window the target and are stopped in the gaseous hydrogen(deuterium), where kaonic atoms are created.**
- **Charge-coupled devices (CCDs), made out of 1.430.000 individual pixels per chip are used as detector for soft X rays (£ 20 keV). Selecting single-pixel hits (which are due to X rays) allows one to reduce the background made of charged particles (which produce multi-pixel events) to a large extent.**
- **The cryogenic target cell operates at 25 K and 3 bar (corresponding to a density of about 40 r_{NTP} and about 1/20 r_{LH}) and filled with ultra pure hydrogen or deuterium.**

Measurement of the kaonic nitrogen spectrum with DEAR

The first stage of the DEAR scientific programme is the measurement of kaonic nitrogen, due to the high yields of the transitions, allowing so a faster feedback. The measurement was performed in May 2001 and the result represented a good demonstration of feasibility of the "DEAR techniques" i.e., of the capability of the experimental setup to create and identify kaonic atoms using the kaons from decay of the φ produced by DAΦNE. The previously unmeasured transitions $7 \rightarrow 6$ at 4.6 keV and $6 \rightarrow 5$ at 7.6 keV of kaonic nitrogen showed up clearly together with many others lines from the setup materials. The result has been published as test measurement in "A new method to obtain a precise value of the mass of the charged kaon", (Physics Letters B, Vol. 535 (2002) 52). Following the indications from the measurement, a new setup was built to be used for kaonic hydrogen. The setup is characterized by a target cell made uniquely by kapton, with an improved electronics and new CCDs (type 55-30). The setup was tested by re-measuring the kaonic nitrogen spectrum in April 2002. The global improvement of the detector and of machine allowed a dramatic background reduction of more than one order of magnitude. This turned out in a breakthrough in the quality of the measurement of kaonic nitrogen with a result of noticeable statistical significance. Out of an absolutely clean spectrum, where the Ca lines are the only residuals of the materials excitations, in the region of interest, the two relevant transitions are well evident above the continuous background (see figure). The empty target subtracted spectrum shows the 4.6 keV line with 7σ statistical significance, and the 7.6 keV line with statistical significance of 12σ.

CCDs energy spectrum



Empty target subtracted spectrum