August 25, 2009

Presidente Commissione Nazionale *III*
Prof. Angela Bracco
Via Celoria 16, 20133 Milano

Subject: Letter of Intent (*LoI*), Study of the KN and KD interactions at low K momenta.

Dear Prof. Angela Bracco,

after careful consideration over the course of the last year, and after learning a valuable experience with FINUDA, we hereby express our interest in continuing the hadron interaction studies at LNF - Frascati. We seek to strengthen scientific excellence in studying the $K^{\pm}N$ and $K^{\pm}D$ reactions at kaon momenta below 127 MeV/c. Namely, we put forward for consideration the following measurements:

a) All the final channels induced by negative kaons $K^-p \to K^-p, \overline{K}^0 n, \pi^0\Lambda$, $\pi^+\Sigma^-, \pi^0\Sigma^0$ and $\pi^-\Sigma^+$;
b) The non-resonant scattering process $K^+p \to K^+p$;
c) The $K^{\pm}D$ channel, with the aim at examining the elementary Kn interaction. In addition, the study of the $\pi\Sigma$ invariant mass from $K^-D \to \pi\Sigma n$ will shed light on the nature of the $\Lambda(1405)$ resonance because of its direct coupling to the $\pi\Sigma$ decay channel.
The data dealing with the reactions a) and b) will be acquired at the same time as well as the data from the c) reaction.

All these reaction studies should be made possible for the following reasons:
1. The availability of a copious number (about $10^3 K^{+(-)}$/s) of low-energy kaons (p_K <127 MeV/c) delivered by DAΦNE via the $\Phi \to K^+K^-$ decay (ratio 50%);
2. The possibility of utilizing the external tracking system of KLOE as well as the KLOE electro-magnetic calorimeter;
3. Developments made in constructing the vertex detectors of FINUDA and ALICE-SSD, both based on silicon technologies;
4. The considerable knowledge gained on the KA interaction during the

FINUDA age.
This research initiative is also stimulated by the severe lack of low-energy $K^{\pm}N$ and $K^{\pm}D$ data, which makes the cross-sections of the reactions described in a), b) and c) almost unknown. This situation reflects the world unavailability of mono-kinetic low-momentum kaons; as an example, JPARC the modern K-factory being built in Japan is unable to deliver such kaons.

In DAΦNE, kaons are the byproduct of at-rest Φ decays $\Phi \rightarrow K^+K^-$. As a result, K^+K^- pairs are emitted in opposite directions and $K^{\pm}$'s are nearly mono-kinetic. These properties are an asset to DAΦNE, now being revisited as a *low-energy $K^{\pm}$-beam facility.* In fact,
i) Kaons are present with both polarities, which allows one to study the a) and b) reactions simultaneously;
ii) Kaons are produced with momenta below 127 MeV/c; however, their momenta at the KN(D) interaction point will be determined through a vertex detector. These features are both primary features for the proposed studies;
iii) K^+K^- pairs are emitted in opposite directions, a distinctive aspect to obtain a background-free beam;
iiii) The DAΦNE CRAB configuration provides about $10^3\Phi$/s, which allows the experiment to be completed with an integrated luminosity of about 2-3fb^{-1}/target (assessment based on a daily luminosity of 15pb^{-1}/day).

The above properties make DAΦNE a unique K-$facility$ for $K^{\pm}N$ and $K^{\pm}D$ studies. The $K^{\pm}$-beam will be monitored by a multi-layer silicon detector, which will embed a H or D target. The inner layers will trace the $K^{\pm}$ trajectories up to the target, the outer layers will reconstruct secondary vertices of the K-induced reactions or the trace of diffused kaons. The silicon layers will also be used for particle mass identification. The complete measurement of the particles in the exit channel will rely on the tracking system and the electro-magnetic calorimeter of KLOE. As a final note, $p_K < 127$ MeV/c kaons call for a single-layer thickness of about 200μm, which makes the realization of the vertex detector a challenging task. However, we expect to have it ready in 3-4 year period of time.

With our best regards,

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