Referee Report Project SCAN-3

"Creation of a precision magnetic spectrometer SCAN-3
and research of non nucleon degrees of freedom in nuclei,
nucleon correlations and
nuclear fragmentation at the internal target of the Nuclotron."

This project aims to study excited nuclear matter created in nuclei by a deuteron beam. The setup is a special one, characterized by several arms placed at 90 degrees from each other (see figure 4). The discussion focuses on the creation of a bound state, either an η-nucleon or a nucleon-nucleon bound state at rest. This reminds me of the famous J/ψ experiment using

$$p + Be \rightarrow e^+ + e^- + X$$

at the Brookhaven National Laboratory. In the present case the aim is for

$$d + C \rightarrow (\eta + N) + X$$

or else for a nucleon resonance, either the Δ or the $N^*(1535)$ which decays mainly into $\eta + N$. There is however an important difference which I find puzzling, namely, for the J/ψ experiment the detectors are placed at an angle because the target is at rest, hence a boost has to be applied to get the geometry right for a resonance being produced at rest in the centre-of-mass frame, at BNL the angle is 14.6^o. In the SCAN-3 proposal this boost is not taken into account and this should be done in my opinion. It would lead to the detectors not being placed at 90^o but at a different angle to be determined by the boost to the centre-of-mass frame.

The physics case is very clearly presented, it is the overlap region between nuclear and particle physics, namely to determine the effects of heavier mesons like the η, as well as excited baryons like the Δ or the $N^*(1535)$ on nuclear matter. The authors mention the effects of the excited nuclear matter on the mass and the width of the Δ. This is a hot topic in the literature and if established would have a major impact on the physics community. The shifts are however expected to be relatively small hence it must be established with a good accuracy and this will be critical as it could be only a few MeV.

The proposal is well written and motivated and deserves to be funded. The authors need to explain the experimental setup.

Dr. Jean Cleymans
Emeritus Professor
Department of Physics
University of Cape Town
South Africa