NUSTAR PAC Report

The body of research envisaged by the set of NUSTAR Proposals, reviewed by the PAC on March 14-16, 2005, represents a multi-facetted program at the frontiers of nuclear structure and astrophysics studies with exotic nuclei. Most of the research is designed to exploit the unique capabilities of the FAIR facility for experiments that, on the time horizon of 2010-2012, will not be possible elsewhere. The experiments, generally speaking, are well thought out, feasible, and complement each other. In most cases, they are well into the design stage and have well-developed and functioning collaborations. Exceptions to these generalizations will be given in the specific reports to follow.

Beam time requests generally seem reasonable. It is likely that beam time requests for high quality experiments will be significantly oversubscribed. Therefore parallel operation is essential to provide NUSTAR with adequate access to the radioactive ion beams of FAIR throughout the year.

The total cost of the experimental installations is estimated in the Proposals to be about 74M Euros. Some of this is allocated to a Phase 2. The remaining Phase 1 portion is about 59M Euros. Some cost savings might be realized by sharing, as noted above. On the other hand, instrument costs, especially when designs are at a preliminary stage, often turn out to be larger than anticipated. The PAC feels, on balance, that potential cost savings and cost increases may well roughly balance and that the present cost estimates are as reliable as can be expected at this time.

Finally, the PAC applauds the development of a common NUSTAR working group effort on DAQ. The development of similarly constituted common working groups in the area of gamma-ray detectors, particle detectors, and electronics would be well worth the coordination efforts involved and possibly lead to cost savings, through sharing of equipment or modular designs.

The PAC has a few specific comments on FAIR and the interaction between FAIR and the collaborations. It is important to note that the proposed projects will need a substantial amount of infrastructure support and a careful coordination with FAIR management and engineering groups will be necessary during the upcoming period in order to optimize final design parameters, and obtain reliable cost estimates.

The NUSTAR PAC enthusiastically endorses the proposed design for the Super-FRS. We believe the device and its specifications are optimized for the physics program to be addressed at the low-energy, high-energy, and ring branches and will realize their full discovery potential. The PAC is concerned that descoping based on financial considerations would directly impact the rate and the purity of the fragments and severely affect the scientific interests and the competitiveness of the FAIR facility.

In addition, the PAC recommends that the design of the high-resolution dispersive separator and the energy buncher for the low-energy branch be given a high priority as the beam properties directly impact the design of the instrumentation for this area. High intensity slowed down beams (~ 10 MeV/u) from the NESR are also of significant potential interest for the low energy programs, at least for relatively long-lived isotopes. Work is recommended to make such beams available and to maximize their intensities.

The PAC has a general concern that the floor space allocated for NUSTAR experimental areas is rather constricted, even for the presently planned instruments, and allows little opportunity for future initiatives and upgrades. The PAC strongly recommends that additional space either be incorporated into the base design, or at least not be precluded in the future by the proximity of other structures.

The committee considered the potentially high degree of contamination of the beam extracted from the gas cell. A mass separator as a purification stage before the very low energy experiments should be considered.

Finally, the PAC would like to thank both the FAIR management for its wonderful hospitality during our visit to GSI, and the experimental groups for their excellent presentations and their willingness to accommodate our requests for further information.

MATS

The committee found the physics compelling. Precision mass measurements are fundamental in nuclear physics research. A convincing case was made for the necessity to achieve an accuracy of 10^{-8} in several areas such as the systematic determination of proton-neutron interactions. The high precision is also essential in providing calibration points for NESR mass measurements (ILIMA) and to separate close lying isomers.

The uniqueness of this technical proposal on the scale of ~2010 relies on the fact that a large number of isotopes – including short living and refractory elements–which can be obtained in the FAIR facility—will not be produced by any other facility in sufficient amounts for performing precise mass measurements. The proposed MATS experimental system is well suited for these measurements.

The MATS collaboration represents much of the European expertise in precision mass measurements and has close ties with the ILIMA collaboration. The development and implementation of Penning traps is also very important for many applications in FAIR. For example, it may provide the only method to achieve isobaric separation for heavy nuclei, which can be useful in the low energy branch experiments.

One perceived risk is whether highly charged ions produced in EBIT can be cooled. This would be necessary to achieve the ultimate design goal of a mass accuracy of 10^{-9} or less for shorter half-lives or less abundant ions. A dedicated R&D should, therefore, be initiated in this case.

The committee is confident that this proposal is on track to have everything in place by 2010.