Recommendations by the

International Review Committee for the FAIR Project

concerning the ranking of the science pillars

Introduction

An ad hoc expert group comprising independent scientists and experienced project managers was set up by the *Aufsichtsrat* of the GSI *Helmholtzzentrum für Schwerionenforschung GmbH* to inter alia evaluate the scientific relevance of the Facility of Antiproton and Ion Research (FAIR) project. Given the delayed schedule in the construction of the facility a clearly prioritized ranking of the experiments in comparison with other existing or planned future facilities should be recommended.

Consequently, the Committee reviewed the science cases of the four scientific pillars in the context of the worldwide progress in the field as well as the delayed start-up and cost increases of the FAIR Modularised Start Version (MSV). Extensive input was provided by the FAIR/GSI managements, the experiments and by the scientific committees of GSI and FAIR.

The emphasis was placed on the availability of scientific data and the competitiveness of FAIR experimental pillars around 2025.

Ranking

NuSTAR and APPA are viewed as the top priorities, as they are unique, have adapted their programmes to the Modularised Start Version (MSV), and the science questions they address will still be open and exciting in 2025.

Due to the high primary beam energies NuSTAR has world-wide unique and leading capabilities for the study of exotic nuclei that will provide important insights into the structure and dynamics of nuclei. The collaboration with its various experiments is versatile and flexible and has adjusted well to the limitations set by the MSV. The program has clear discovery potential and high impact in the areas of unique access.

APPA comprises a diverse and mostly unique set of smaller experiments with a broad scope. In many of the areas covered by the program scientific breakthroughs can be expected. The program has adapted well to the MSV limitations and developed new opportunities within this context. It can be expected to adapt equally well to possible future changes.

CBM is seen as the next priority. It has a limited discovery potential, for example with respect to the critical point of the phase diagram, but it will provide key data on hot and dense hadronic matter in an important low energy regime not accessible by higher energy facilities. In conjunction with the data from other facilities CBM will contribute to the full mapping of the QCD phase diagram. The incremental cost of the program enabled by CBM to the facility is not very large, which contributes to our ranking it above PANDA. In addition, the investment into the detector could be further exploited by using it at other facilities.

PANDA offers unique capabilities to measure properties of hadronic states not readily accessible at other facilities. However, due to the delay of the FAIR facility a substantial part of the *discovery* potential, e.g. for new resonances and exotic states, will have been lost to operating facilities where the current experiments have made remarkable progress in their capabilities (e.g. LHCb) or to facilities coming online well before FAIR (e.g. Belle-II, GlueX). The remaining physics program is still attractive but viewed in the context of the large incremental cost to implement the antiproton target, HESR, and PANDA, the priority is judged to be lower than the other science pillars.

Given the delays and constraints mentioned in the introduction, the Committee does not consider SIS300, which is unlikely to come before 2035, to be a compelling or necessary upgrade option.

16.04.2015