Introduction

This newsletter is a summary of recent events and information regarding the FAIR-NUSTAR project and activities of the various NUSTAR committees.

Note that any information on highlights or upcoming meetings can be found on the NUSTAR@FAIR web page (see http://nustar.fair-center.eu). You can send your material to NUSTAR@fair-center.eu. Suggestions are always welcome.

Upcoming meetings (selection)

- February 27 – March 3, 2017: NUSTAR Annual Meeting 2017
- June 19-20, 2017: 3rd FAIR/GSI Joint Scientific Council meeting
- July 4-5, 2017 5-6: 22nd FAIR Council meeting
- September 25-29, 2017: NUSTAR Week 2017
- November 6-7, 2017: 4th FAIR/GSI Joint Scientific Council meeting
- December 5-6, 2017: 23rd FAIR Council meeting

News from the Boards and Committees

BR (NUSTAR Board of Representatives)

For the NUSTAR Board of Representatives the second half of 2016 turned out to be a busy period (especially for the NUSTAR Spokesperson). In partnership with the members of the NUSTAR Collaboration Committee (see below) several issues have been worked on:

- The BR welcomed the arrival of the new Scientific Managing Director, Paolo Giubellino, at FAIR/GSI (see press release here). Although the official start of his term is on January 1, 2017, P. Giubellino visited FAIR/GSI on a regular basis and also met with representatives of the experiment collaborations. The BR is looking forward to an exciting 2017.
- The BR was also very happy with the NUSTAR Week in York (see report below). They particularly welcomed the attendance of Jörg Blaurock, Technical Managing Director of FAIR and GSI, as the Phase 0 program was discussed during the meeting in a dedicated session. The next NUSTAR Week will take place in Ljubljana, which will support the colleagues in Slovenia in their effort to contribute to NUSTAR. The location of the subsequent NUSTAR Week in 2018 will be decided at a later time. For the upcoming NUSTAR Annual meeting 2017, a draft program for a dedicated theory session has been shaped. Details will be announced soon.
- Another hot topic was the newly formed Joint Scientific Council (JSC) at which the present status of the experiments, and ideas as well as physics cases for FAIR Phase 0 were the main issues. N. Kalantar gave presentations for NUSTAR at both meetings in June and November. For the latter meeting, a questionnaire from the JSC was
answered (in cooperation with the NUSTAR Collaboration Committee) in order to give more details to the JSC members. Furthermore, the Super-FRS Experiment was a special topic during the NUSTAR session of the last JSC meeting. The JSC confirmed the scientific merit of the Super-FRS Experiment program and the FAIR Council subsequently gave a green light for the evaluation of TDRs from the Super-FRS Experiment. However, it was also stressed, that further points have to be addressed before the Super-FRS Experiment officially becomes a FAIR experiment.

- The BR is also happy with the new project structure, where the Technical Coordinators have the role as sub-project leaders for the FAIR experiments (e.g. Jürgen Gerl for NUSTAR). A lot of work was done on the planning of the experiments and the connection to the civil construction and accelerator time schedules. The first consolidated schedule (called Level-1 schedule) was presented during the FAIR Council meeting in December 2016.

- Together with the other FAIR experimental pillars, the contributions from Russia to the experiment funding and a re-distribution among the various work packages were discussed. This was also related to the question on how to expedite the writing and signing of in-kind contracts, since many contracts are delayed.

- Finally, the NUSTAR BR is looking forward to the election of new BR members. In January 2017, the NUSTAR Council members will elect three new members. While Luis Fraile is eligible for re-election for a second two-year term, Thomas Aumann and Ari Jokinen will step down after having served their second two-year term in the BR.

CC (NUSTAR Collaboration Committee)

As mentioned above, the NUSTAR Collaboration Committee discussed together with the NUSTAR BR the following main topics:

- The status of the experiments was reviewed. In short: While R³B is looking for a new spokesperson and its preparations for the Phase 0 at GSI are ongoing, the EXL collaboration has chosen its new leader, Thomas Aumann, together with Rene Reifarth and Haik Simon as Deputy Spokesperson and GSI liaison, respectively. It is planned to work on the possibilities to operate EXL at the various storage rings at FAIR/GSI. ILIMA is working on the TDRs of its detectors, since the TDR of the Collector Ring (CR) has recently been finalized and thus provides the boundary conditions for ILIMA. LaSpec is moving part of the equipment to ANL for its Phase 0 program (see below) and MATS is working on the adaption of work packages for the installation and operation in the LEB building. HISPEC/DESPEC is performing tests at various facilities and detailed discussion on the Phase 0 at GSI took place. And finally, Super-FRS Experiment is working hard on its TDRs and other details to provide input to the FAIR management regarding its approval as a FAIR experiment.
The funding of the experiments and missing items was on the agenda for discussion at the Board of FAIR Collaborations (BFC). The BFC was asked to prepare a list of items that were initially missing in the cost tables (but which are critical for the operation) and items that are supposed to be financed by the experiments although funding would be more suitable to come from civil construction or the accelerator part. Discussions with the management will commence in January 2017.

Phase 0 of NUSTAR was discussed during the NUSTAR Week in York and in sub-collaboration meetings. In particular, those NUSTAR experiments, which will make use of beam time at GSI for testing and first experiments starting in 2018, have been asked to provide feedback on required beams and other needs. The call for proposals is expected early in 2017. Further information on the guidelines and the newly formed PAC for the GSI beam times will be given in due course.

A new database for the NUSTAR members has been put in place (originally designed by the R³B collaboration) and all NUSTAR members and interested scientists are asked to sign up. Furthermore, the NUSTAR experiments were asked to use the EDMS document system in order to better organize and archive material, also to make it available to collaboration members.

TB (NUSTAR Technical Board)

The NUSTAR Technical Board has decided to meet more frequently in the future, in order to better monitor the progress of work packages and the project planning. Recently, the layout of the Low-Energy Branch (LEB) building was discussed in detail, since the plans have to be frozen very soon. The work focused on the required infrastructure and the interfaces to civil construction and accelerator components. Specifically, the planning of HISPEC/DESPEC has to take into account the details of the energy-buncher/spectrometer and beam instrumentation from the Super-FRS.

In the case of the cryogenic stopping cell, it was finally decided to keep the system at ground potential and radioactive ions will be transferred to MATS and LaSpec as 5 keV bunches using a pulsed drift tube. This scheme will be tested in Phase 0 of LaSpec at ANL (see experiment news below).

Planned two-stage construction of the FAIR facility (north area in blue, south area in orange).

At the NUSTAR Week in York, the present status of the civil construction part of the FAIR project was shown. The start of construction is envisaged in 2017 with first works on the SIS-100 tunnel (blue area) followed by the south area (orange area). For the north area the
call for tender has already been released and in 2017 the one for the south area is expected. The overall FAIR plan (level 1) will be further refined in the first quarter of 2017 and the work-package leaders will be informed afterwards on a regular basis.

### RB (NUSTAR Resource Board)

The **NUSTAR Resource Board** reviewed the funding status in preparation for the 6th FAIR-RRB meeting which took place at FAIR/GSI on November 29-30, 2016. The main focus was Phase 0 and Phase 1 of NUSTAR, i.e. the operation of NUSTAR equipment before the availability of beams from Super-FRS and equipment for the start phase at FAIR. This will be further refined before the next FAIR-RRB meeting.

The NUSTAR MoU (for construction) is still planned for the end of 2017. There are still some key issues to be sorted out before a draft can be distributed. For example all TDRs that are relevant for Phase 1 of NUSTAR have at least to be submitted. Furthermore, work packages have to be assigned to a partner institute and funding of critical items has to be clarified.

The RB also monitored the progress of in-kind contracts with the FAIR shareholders. A lot of requests to the FAIR Council have been made and more than ten contracts are in the making. This concerns contributions from Finland, France, Germany, India, Russia, Romania, Sweden and UK. Further requests and assignments of in-kind contributions are planned in 2017.
NUSTAR Week 2016

NUSTAR Collaboration meeting in York

The NUSTAR Collaboration met in York, UK, from September 26 to 30 during the NUSTAR Week 2016. This was the 8th meeting in the series after the meetings in Dubna (2009), Lund (2010), Bucharest (2011), Kolkata (2012), Helsinki (2013), Valencia (2014), and Warsaw (2015) this time hosted by the University of York at the King’s Manor.

More than 80 scientists attended the NUSTAR Week 2016, which focused on the Phase-0 program of NUSTAR. The meeting started with sub-collaboration meetings of Super-FRS Experiment, HISPEC/DESPEC, and MATS/LaSpec, where technical issues, status of construction and planning as well as plans for Phase-0 operation at GSI or other facilities were discussed. This was followed by two days of plenary sessions with status reports and news on the latest scientific results.

The new organizational structure of GSI/FAIR and the substantial progress of the FAIR project were positively recognized by the attendees. The recent developments around FAIR intensified the interest in NUSTAR Phase-0 experiments at the upgraded GSI facility from 2018 onwards.

For details see conference web page.
LaSpec Phase 0: The LaSpec collinear atom beamline will be moved to Argonne National Laboratory

The TRIGA-LASER beamline, which will be used as the collinear optical pumping laser-spectroscopy beamline of the LaSpec experiment, was dismantled and removed from the experimental hall of the TRIGA research reactor at the University of Mainz. Within one day of very efficient and smooth construction work, the whole setup was moved to a storage room at the nuclear chemistry institute. This was one of the first steps towards measurements of the nuclear charge radius of $^8$B at the Argonne National Laboratory near Chicago using the ATLAS linear accelerator facility, which will be one of the major milestones in the Phase 0 of the LaSpec experiment. Afterwards, the beamline will be moved to the Californium Rare Isotope Breeder Upgrade (CARIBU) until the LEB hall at FAIR is ready for installation and the Super-FRS starts its operation.

For the installation at FAIR, the beamline still requires an upgrade to a new charge exchange cell and an improved optical detection region that can be floated to higher voltages, since it has recently been decided to transport the beam from the stopping cell to LaSpec with moderate energies of a few keV only in order to relax the demands on the stopping cell installation. The ions must then be accelerated to the required 30-50 keV for collinear spectroscopy when they arrive at the charge exchange cell. Therefore, the CARIBU and ATLAS facilities are ideal testing grounds since the beams are transported there with similar energies. The experimental setup will be shipped overseas in the first quarter of 2017.

Contact: Wilfried Nörtershäuser (TU Darmstadt)
Super-FRS

First x-slit system for Super-FRS fabricated

Altogether 12 horizontal (x-slits) and 6 vertical (y-slits) slit systems are required for the Super-FRS. The x-slit pre-series was designed and fabricated by KVI-CART and the acceptance test is almost completed. It consists of two stopping blocks made by a tungsten heavy alloy; each block has dimensions of 200 x 180 x 250 mm³ (L x H x W) and a mass of 166 kg, is moveable perpendicular to the beam direction and is operated in vacuum; the total system is almost 500 kg.

The system has various features such as a quick release of the blocks, the capability to absorb a beam power of up to 500 W (expected beam power at the mid-plane of the Pre-Separator due to primary beam charge states which were not caught by the beam catchers), remote/robot handling, etc. Full opening of the slits is +/-200 mm with a position accuracy of +/-0.1 mm; the opening/closing time over the whole range is less than 120 s.

3D model of the x-slit system (left) as well as the fabricated pre-series device during the Factory Acceptance Test (FAT) at KVI-CART.

Several of the features could already be verified on the prototype-slit system. Some tests regarding the vacuum compatibility of the Super-FRS are still running. In parallel, also the y-slit pre-series is in production and expected to be ready for tests early 2017. After the successful acceptance tests of both systems the series production will be conducted by KVI-CART in the following years.

Contact: Chiara Nociforo (GSI)

Super-FRS

FDR approval of the SC multiplets for Super-FRS

During 2016, an extensive design phase of the SC multiplets for the Super-FRS was conducted. Our provider, ASG Superconductors SpA, Genoa, concentrated on the design of the most complex multiplet module which contains altogether 9 individual magnets including two types of quadrupoles with superimposed octupole coils, sextupoles, and y-steerer magnets. It has a total length of approximately 7 m, a diameter of around 2.5 m and
a total weight of 60 tons. Already in July we could release the so-called Preliminary Design Review (PDR) which included the complete magnetic design of all individual magnets, a manufacturing sensitivity analysis, a preliminary mechanical design, as well as the assembly concept. This preliminary design was then detailed in the following months so that we could also release the Final Design Review (FDR) for the pre-series multiplet in the beginning of December. The FDR included detailed calculation reports on all relevant subsystems, the quality assurance documentation, the 3D model (contains more than 20,000 individual parts) and the main production drawings (more than 300 drawings were approved), a Factory Acceptance Test (FAT) Plan, and the report on already prepared mock-ups and specimen of various sub-components.

![3D model of the long (pre-series) multiplet as presented during the FDR. The multiplet contains 9 individual magnets. It will be 7 m long, 2.5 m in diameter and has a weight of ≈60 tons.](image1)

In 2017, we plan to manufacture the first pre-series multiplet. ASG started negotiation with sub-providers for all purchased parts like SC wire, yoke steel lamination, current lead systems, beam tube, etc. An existing yoke press was already refurbished and a specimen quadrupole quarter-yoke was produced successfully (it is planned to have a second yoke press once we start the series production). Coil winding processes were studied producing a sextupole coil and a 1:1 mock-up for a y-steerer magnet is in preparation which requires a special support tube which integrates a cos-theta dipole coil.

![Measures towards the pre-series production (from left to right): refurbishment of yoke press, quadrupole quarter yoke mock-up, sextupole coil winding, and y-steerer support tube.](image2)

**Contact:** Martin Winkler (GSI)
Contract for the design of the Super-FRS target chamber and its plug inserts signed

During the summer of this year, a collaboration contract was signed with KVI-CART to design the Super-FRS target chamber and its plug inserts. It is expected that the design phase will run until Q1/2018. A preliminary design of the target chamber is already available. The chamber will be approximately 2.1 m long and it will comprise five plug inserts including the production target which is a rotating carbon wheel. Each plug insert consists of the functional unit which is shielded to the top by a 1.6 m high iron block. The weight of one plug is up to 4.0 t. All plug interfaces (electrical power, cooling water, etc.) are located on the top of the plug which will be accessible by a maintenance tunnel. Here, also vacuum pumps will be placed which are coupled to the target chamber via a knee and are in the backward direction to minimize the radiation level on the top of the chamber.

3D model of the preliminary target chamber design (drawing by Michel Lindemulder, KVI-CART).

The plugs will be inserted into the target chamber from the top by means of a special transport flask (not part of this work package) and must then be guided into the chamber. It is also part of the contract with KVI-Cart to manufacture a 1:1 mock-up to demonstrate the feasibility of the plug-guidance system.

Another feature - also covered by the present contract - is the integration of a thermal imaging system for diagnostic purposes of the beam spot on the target. Basically, it will consist of a mirror system which will guide the light out of the high-radiation zone where it will be coupled to an IR camera.

Contact: Helmut Weick (GSI)