HIC for FAIR-Workshop

26.07.2016 - 29.07.2016

Waldhotel, Rheingau

HIC4FAIR Workshop Detectors & Accelerators No. 2

There is enough time allocated for discussions

TIME	Tuesday 26.07.16	Wednesday 27.07.2016 Titel	Speaker	min.	Thursday 28.07.2016 Titel	Speaker	min.	Friday 29.07.2016 Titel	Speaker	min.
9:00	Arrival	Welcome+ Introduction	Kester/OBF							
		Welcome from the Technical Managing Director	J. Blaurock		**Report of the beam time (2016)**			**UNILAC**		
9:15		**Follow-Up**			- Vacuum (life time)	L. Bozyk	20	UNILAC Poststripper: Status and Decision	S. Mickat and L. Groening	20
		Phase space of CR	O. Gorda	20	- RF Systems (manipulations, h=2, beam quality)	H. Klingbeil	20	An option for a FAIR Ion Injector	U. Ratzinger	20
		Ion source road map	A. Adonin	20	- Beam Dynamics (high intensity effects)	V. Kornilov	20			
		Discussion			Discussion			Discussion		
10:30-11:00		Break (10:30-11:00)			Break (10:30-11:00)			Break (10:30-11:00)		
		Controls			**Report of the beam time (2016)**			**High current matching ring-HEBT**		
11:00		FAIR Commissioning & Control Working Group	R. Steinhagen	30	- Space charge compensation with the electron cooler	W. Stem	20	Synchrotron-HEBT (only slide)	O. Boine-Frankenheim	15
		FAIR Phase 0						**Ring Targets**		
		Planned Upgrades measures and expected beam properties	U. Weinrich	30	- Interfacing	S. Appel	20	Cryring, ESR, HESR	N. Petridis	20
		ECR development/High charge state sources	F. Maimone	20	**Radiation Damage**			**FAIR Phase 0**		
		Biophysics Experiments	M. Scholz	10	Radiation damage/lifetime for beam intercepting components	M. Tomut	20	HADES	J. Stroth	20
		Material Science	D. Severin	10				PANDA Phase 0 @ HADES	L. Schmitt	10
								Experiment schedule	T. Stöhlker	30
		Discussion			Discussion			Discussion		
13:00-14:00		Lunch (13:00)			Lunch (13:00-14:00)			Lunch (13:00-14:00)		
		FAIR Phase 0			**Slow Extraction**			**FAIR Phase 0**		
14:00		R3B	H. Simon	20	Report Workshop	O. Boine-Frankenheim	20	Beam Time Planning 2018	D. Severin/ U. Weinrich	30
		Cryring (commissioning and experiments)	M. Lestinsky	20						
		SPARC	A. Bräuning-D.	20	Proton Extraction highest Energy for CBM, SIS18/100	D. Ondreka	20	*Summary (O. Kester)*		
		MiniCBM	W. Müller	10						
		Discussion			Discussion					
16:00-16:30		Break (16:00-16:30)			Break					
		Controls			**Slow Extraction**					
16:30		Machine Experiment interfaces	R. Steinhagen	30	Beta function measurements at SIS18	V. Chetvertkova	20	*Departure at ca. 3 or 4 p.m.*		
					Slow Extraction Experiments at COSY (Jülich)	D. Prasuhn	20			
18:00-18:30		Discussion			Discussion					
18:30/19:00	Welcome Dinner	Free time			Free time					

Figure 1: Agenda of the HIC for FAIR workshop "FAIR Detectors and Accelerators"

1. FAIR Phase 0

After a long shutdown until 2018, an upgraded GSI facility with higher intensities and repetition rates will be available for the scientific community to perform the so-called phase 0 scientific program. The overall experimental schedule and particular experiments were discussed as well as the beam time planning and the planned machine upgrade activities.
The ECRIS development for the future beam delivery for the FRS and Super-FRS (super conductive, 28 GHz) is a FAIR project. The 18 GHz ECR source is required to have a decent beam delivery for FAIR phase 0. Higher intensities would be available by frequency adjustments and operation in the afterglow mode.
Different requirements on the projectiles, pulse length and possible beam time scenarios were presented by BIOMAT and SPARC. It is essential to keep a cave M to use an active scanning system for the Biophysics group and cave A for the material research. ESR and CRYRING will be the main experimental places for the SPARC ring experiments. Communities which plan to use CRYRING and ESR should specify their beam time requests as soon as possible in order to prepare a beam time schedule.
The NUSTAR community has defined a program for R3B testing. CBM has planned a MiniCBM experiment and has to clarify some issues with the magnet department as they need higher rigidities.
The PANDA community has recognised the similarities in some physics questions (hyperons). They are planning to develop and install several forward detectors at the HADES facility for phase 0.
The discussions have emphasised the necessity to define a joint strategy before the PAC call, which would include a feedback from the machine experts for the different performance aspects. Too many small parasitic experiments which require a lot of beam setup as well as parallel beam modes, which perturb each other, should be avoided. Such a process would increase the quality of the beam time planning and overall machine availability. Test runs prior to beam delivery were strongly recommended for each experiment.

2. Controls

The goals and main topics of the FAIR Commissioning Group were presented. The commissioning of the FAIR facility will be distinguished on SAT A (without beam) and SAT B phases and will include several procedures: pilot beams, intensity ramp-up, assisted and finally regular operation. The strategy for the FAIR operators differs from the present course: handling will be not divided on separate machines, but the whole beam chain for the dedicated experiment will be served by the single operator.
A new Control System (including archiving system) and its features were discussed. The usage of the common generic API interfaces enables a flexible and user-friendly operation. CS Migration is planned stepwise for every single machine. From 2018 all existing accelerators will be running with the new system (beside UNILAC), though not all planned features will be immediately available. The supervision of the ESR machine modelling is not covered yet and has to be clarified with Machine Coordinator.
Three Beam Abort Systems will be available: slow (cycle to cycle), faster (ms) and fast (us). A demand of the Biophysics group in APPA cave for the regular spill abort was not taken into account yet (faster spill aborting if the planned dose has been reached or a beam

position per pixel is out of constrains). The support in SIS100 seems to be visible as the intensity is relative low.
Control Group requires the beam signals from the experimental detectors. This interface has to be followed-up.
The motivation for the new CS and all planned beam control features (feedback and feedforward loops to control the tune, closed orbit, macro-spill structure etc.) is enormous as the availability of the present facility is 70 – 80% and almost half of the downtime is dedicated for the beam setup. The extrapolation of the present availability to the whole FAIR complex indicates very poor values (ca 30% for the HESR) and motivates the planned Upgrade projects and activities of CS and FC2WG groups further.

3. Report of the beam time 2016

Several machine topics and corresponding experiments were presented and discussed: vacuum (lifetime), rf systems, high intensity effects, space charge compensation, UNILAC/SIS18 interfacing and beta beating.
Vacuum conditions at SIS18 are presently not optimal for high intensity operation with intermediate charge state heavy-ions. The NEG coating has to be baked and re-activated. The re-activation can be repeated only a finite number of times. That might require exchanges of the vacuum chambers in the future with newly coated ones.
All instabilities, investigated in SIS18 can be extrapolated to the SIS100 machine. Recent work on resonance crossing has indicated a head-tail instability with k=3 to be expected in SIS100 only. Presently, a factor of 4 for the intensity is missing in SIS18 for uranium beams. Possible additional beam losses and/or phase space increase due to the higher repetition rate (up to 2.7Hz) for SIS100 should be studied. At present there are no results (for low and high intensity beams) concerning the achieved emittances and bunch areas, in comparison to the requirements for SIS100 injection.
The preparation of the measurements with rf systems is very time consuming and has to be planned in advance. Hence, an early commitment for the beam time is essential for the rf group. The main goal is to support a new CS system for the beam time in 2018.
Theoretical aspects and preliminary results on first measurements for the space charge compensation with electron cooler in SIS18 were presented. Ideally, every segment in the machine would need one electron lens, which is in practise impossible due to the lacking space. The experimental efforts focus on optimized electron density profiles in order to partly compensate the space charge tune shift with the existing cooler.
In order to optimise the injection into SIS18, a multi-criteria optimisation was presented. It shall help to find the optimal transversal and longitudinal phase space beam parameters. First success was observed for the proton beam, when the maximum beam intensity was reached in SIS18 during the beam time in 2016. Further optimisation increases the requirements on the beam quality from UNILAC. A poor IH-DTL matching spoils the beam brilliance. De-bunching in front of the SIS18 prior to injection should be optimized (double drift buncher plus simulations). The new CS will help to setup the injection emittance much faster.
First beta function measurements were presented. A better BPM setup for the data acquisition was discussed as in the present mode the hard disc is overloaded quite fast. The goal of the study is to establish a routine method of the beta measurements in SIS100 and to

define an acceptable level of beta beating (space charge, quenching etc. have to be taken into account).
The continuation of the ongoing SIS18 beam physics and machine studies is planned in CRYRING and COSY.

4. Slow Extraction

The requirement for the spill quality of slowly extracted beam is very demanding. The macro-spill structure can be improved with help of the feedback loops (already proven at HIT, for example). The source of the signal ripple on the micro-level is still not well understood, and can be different for different machines and extraction modes, though the topic has been investigated since years at GSI and other institutions. A dedicated workshop took place in June, where all world leading experts came together to share the experience in this question. As an outcome of the workshop, a common spill quality measure was defined. There was a strong and common interest to setup a regular exchange platform. Therefore a follow-up workshop is already planned at FNAL.
As the demand on slowly extracted protons for NUSTAR and CBM is relative new and has not been included into SIS100 design, the investigation on possible restrictions was presented. For proton beam energies higher than 12 GeV the transition energy will be crossed. For slowly extracted protons the ion lattice settings are foreseen, hence a gamma-jump method will be not supported, as it is planned only for the proton lattice with fast extraction and another working point. The present investigations commit the CBM community slowly extracted protons with the energy range of 5 – 29 GeV with the possibly small exclusion around the transition energy of 12 GeV (+- 2 GeV).
Several slow extraction techniques used at COSY machine were presented. So-called 'USE' extraction (Ultra Slow Extraction with help of 'white noise') has a higher effectiveness (80-90%) than a pure resonant extraction (ca 75%) and helps to smooth the spill on the macro-level. The machine can be used for the further slow extraction investigations in collaboration with GSI colleagues.

5. UNILAC

In 2016 measurements of the uranium and proton beam parameters along the whole UNILAC were performed. They were compromised by the fact that scheduled maintenance works of the rf-power alimentation of post-stripper DTL cavity #4 reduced the achievable output energy from 11.4 to 5.9 MeV/u causing envelope mismatch and hence more brilliance dilution along the post-stripper and thereafter. Additionally, the required MAZ (quadrupole-focusing) could not be set due to parasitic physics experiments. For uranium the FAIR requirements at the injection into the RFQ have been reached. But a brilliance drop by a factor of 5.6 occurs up to the entrance to the post-Stripper DTL. It is caused by losses along the RFQ, improper matching to the pre-stripper IH-DTL along the MEBT, and by non-periodic focusing along the IH-DTL. At the injection to the SIS18 the achieved brilliance is a factor of 2.6.

Corresponding measurements with protons, provided through cracking $(CH_3)^+$ -molecules, were performed. They were compromised by the same circumstances (except MAZ) and by Coulomb-explosion of the cracked molecule during the stripping process. The achieved number of protons extracted from the SIS18 was a factor of 5.6 below the SIS18 space charge limit.
Except for the new post-stripper the UNILAC Upgrade activities are: a dedicated uranium source terminal (Terminal West) together with a dedicated LEBT (CompactLEBT), redesign of the HSI-RFQ rod-geometry, redesign of the HSI-MEBT, and the pulsed H_2-gas stripper cell. For time being none of the projects received funding.
Although there is no funding yet, the directorate decided to replace the aging post-stripper DTL. Currently three DTL-options are considered: Alvarez-type (GSI), IH-KONUS-type (U. Ratzinger, GUF), and IH-synchronous-type (H. Podlech, GUF). The pros and cons were presented as well as the time schedule and benchmark scenario to evaluate the options. A dedicated review will take place on Oct. 14th at GSI, and the committee's recommendations will be presented to the GSI council on Nov. 4th by the directorate.

6. Follow-Up

The CR and ion source developments were presented as follow-up topics from the previous workshops.

The injected bunch length from the SIS100 towards the antiproton production and SFRS targets with subsequent injection into the CR should be <25 ns bunch (rms).
In order to reduce the maximum momentum spread of the beam after injection and bunch rotation in CR, an additional 2nd harmonic RF System is foreseen for the later stages of the ring operation.
If the momentum spread after the cooling in the CR is still too large for the HESR, there are 2 possible solutions: either to use the barrier-bucket cavity in HESR for the de-bunching (still have to be proved by the simulations) or to increase the cooling time in CR.

The road map for the further Ion Source development was defined in the dedicated meeting in March'16 (protocol is available). 2.7Hz Uranium operation has the highest priority. Latest development has demonstrated very promising results: 15mA current in HSI (GUH1DT1). The production of the CH_3^+ from the MUCIS source for the proton and C beam has been established as standard operation now. A new post-acceleration gap has been designed and ready for the ordering and production. As the financing of the Terminal West and the corresponding LEBT was postponed, the new post-acceleration gap will be tested in North terminal together with an option for the shorter pulses operation.