Minutes of the 10th Meeting of the
COSY Beam Time Advisory Committee (CBAC)

July 1st and 2nd, 2019

Location: Forschungszentrum Jülich GmbH, Institut für Kernphysik, 52428 Jülich, Germany

Participants:

CBAC members:

Kurt Aulenbacher,	Univ. Mainz, DE
Oliver Kester,	TRIUMF, CA
Thomas Stöhlker	GSI, HI Jena, DE
Christian Schmidt,	GSI, DE (excused)
Marc Weber	KIT, DE

CBAC Scientific Secretary:

Frank Goldenbaum (IKP-1)

IKP:

Ulf-G. Meißner (IKP-3/IAS-4 Director) (excused)
Dieter Prasuhn (IKP-4)
Ralf Gebel (IKP-4 Acting Director)
James Ritman (IKP-1 Director, Scientific Coordinator COSY)
Hans Ströher (IKP-2 Director, IKP Managing Director)

Board of Directors FZJ: Sebastian Schmidt (excused)

1. General remarks

The 10th CBAC session took place on July 1st-2nd in the Forschungszentrum Jülich GmbH, Institut für Kernphysik. The beam time requests of the individual groups were presented on Monday in the Open Session of CBAC#10. For the programme and the list of applications see the Addendum.

Closed Sessions of the CBAC members were held on Monday morning 9:05-9:40, on Monday evening 17:20-18:50 and on Tuesday morning until 11:10.

The Closed Session on Monday morning was opened by Jim Ritman welcoming the participants (see list above). In particular, Jim Ritman welcomes Prof. Thomas Stöhlker from GSI/HI-Jena as a new CBAC member.

The details and practical arrangements of the transfer of IKP to GSI remain complex. Several very experienced COSY scientists are retiring or changing jobs, and it is great to see a significant number of young talented accelerator physicists reinforcing the COSY operation team. The contribution of IKP to the Helmholtz programs MU and MT in PoF-IV is discussed. COSY will be making visible and unique contributions to MU science.

Jim reports that the STRONG-2020 hadron community initiative was successful and COSY has been awarded EU funding to support international user.

There are a large number of strong beam time requests for COSY and the cyclotron. CBAC is charged to prioritize requests for the period of September 2019 to March 2020. The assignment of CBAC members to the proposals was confirmed. The date of the next meeting, CBAC#11, was scheduled to be February 3 to 4, 2020.

Jim Ritman started the Open Session with a brief welcome of the participants, a summary of the experiments carried out in the past run period (from January 28, 2019), the current schedule and an overview of the beamtime requests to CBAC#10. Ralf Gebel reviewed the operation and the status of COSY in more detail. JEDI has been a priority, but also the runs for FAIR detectors and COSY beam studies were rather successful. The HBS beamtime has just ended, and the HBS beam line is advancing with the result of much improved background conditions due to better beam focusing and employing new diagnostics. The EDDA detector system (which was first operated in 1993) is decommissioned. For now, no polarimeter is available, but this will soon change when the JEDI polarimeter becomes operational. Thanks to the newly installed septum coils, COSY can deliver 3 GeV beam energy again. After some struggles the machine has come up nicely after the end of year shut-down. However several water leaks, for example in the dipole power converter, led to delays and still require inventions. It is likely that all these issues can be fixed in the July machine development period. Main dipole power converter issues are mitigated by five new inductances, from which one was already tested. Finally CBAC congratulates that the COSY extraction septum is operational with a new coil set installed. Beams up to 2.95 GeV/c can be extracted now for experiments.

Twelve proposals were submitted to CBAC#10, asking in total for approximately 16 weeks of beam time. An overview of all the applications and the agenda of the CBAC#10 meeting are given in the Addendum. The electronic versions of all proposals and reports as well as the pdf files of all contributions presented in the open session are located on the web page http://www.ikp.fz-juelich.de/CBAC/documents/cbac10.html .

2. Summary of the discussion and recommendations

Below we first comment on the ranking procedure, then summarize the recommendations of CBAC, and finally conclude with a detailed report on each proposal.

2a) Procedure

The rating system applied in the past to rank the proposals is felt to be effective and adequate and will be continued. It is summarized below for completeness.

The requests are rated A (highest rank), B, and C (lowest rank) within the following three categories:

(i) **Feasibility** Here the committee judges the feasibility of the proposed test or measurement based on its expert knowledge and external input or advice. Other assessments from eg. a PoF review or accepted proposals may enter; also boundary conditions imposed by the facility have to be considered.

(ii) **Readiness** The committee assesses the possibility that critical elements or components required for the test are not available in time. It should be noted that CBAC as an external group cannot make a complete assessment of all possible delays. The proponents are asked to comment in detail on the readiness of their proposals.

(iii) **Importance/Urgency** The relevance to PoF-III and IKP science is an important criterion as is the emerging strategy beyond PoF-III and, for instance, the strategic project HBS. External users with exciting scientific projects are encouraged to use COSY when compatible with other constraints but external requests may be ranked lower in importance. Importance in many cases also has the connotation of urgency and may consider the overall schedule the respective projects are embedded in.

The recommendations consider the written requests, the oral presentations, and the related questions and answers during the open CBAC session. Following the open session, a detailed comparative discussion takes place in the closed session.

2b) Summary of the Recommendations

The projects presented in the Open Session on Monday (see Sec.1 and the addendum) and the recommendations of CBAC are listed in Table 1. Two talks were predominately status reports, the other talks related to new proposals. As always, an important boundary condition is given by the allocated 5000 hours of beam time per year and the six weeks of maintenance required by COSY mid-year. For the next assignment period, approximately 12 weeks of beam time will be available for users.

Table 1: *Summary of requests (for details see table in the addendum), ratings and recommendations of CBAC#9.*

Experiment	Recommendation in user beam time/ likely schedule	Feasibility	Readiness	Importance/ Urgency
D004.7 CBM	1 week	A	A	A
D005.3 KOALA	1 week	A	A	B
D011.1 Luminosity detector	1 week in Q1 2020	A	B	A
D012 SiPM radiation hardness	2 days at the cyclotron	A	A	A
E002.7 JEDI polarimeter	1 week	A	A	A
E005.6 JEDI Wien Filter	1 week	A	B	A
A002.6 Electron cooling	1 week	A	A	A
A001.9 Stochastic cooling	1 week	A	A	A
A015.1 JEDI beam-based alignment	3 weeks	A	A	A
A010.6 Moderator eff. (HBS)	1 week at the cyclotron	A	A	A
A016 JuSPARC	1 week at the cyclotron	A	A	A
A017 Loewe-NP	present at CBAC #11	B	B	A
A009 Siberian snake	2 weeks	A	A	B

2c) Short reports and recommendations on individual proposals

Proposal D004.7 CBM

CBM reported on the huge and very successful effort for mini-CBM (mCBM) at SIS18. Many CBM subsystems, for example the mTOF, mSTS, mMUCH, mRICH, mTRD, T0 detector, the readout and data transmission system were installed and tested in high-rate (10 MHz) operation. At the April run at COSY, ultrafast silicon detectors (UFSDs) for precise timing were investigated. Also the space resolution and the drift velocity map of the HADES mini drift chamber (MDC) were studied at COSY.

CBM requests 1 week of COSY beamtime for Q4 2019 to characterize STS detectors equipped with the new STS-XYTER v2.1 ASIC. This replaces the run from Q2 2019 which could not take place. Also the latest board of the fault-tolerant monitoring & control system (FTLMC) with commercial Cortex R5F

processors shall be qualified for operation in a radiation environment. Finally the studies of UFSDs shall be continued.

Considering STS and CBM production schedules, this is an important and urgent request. CBAC suggests to be ambitious in the targeted USFD performance and try to achieve and demonstrate 30 ps rather than better than 100 ps resolution. Also the radiation and SEE tests of the FTLMC should be performed to very high rates, since the suitability of the CORTEX R5F is not obvious, despite applying sophisticated redundancy techniques.

Given the excellent preparation through mCBM and the run in April 2019, the feasibility and readiness are beyond doubt.

Rating: Feasibility A, Readiness A, Importance/Urgency A
Recommendation: 1 week

Proposal D005.3 **KOALA**

KOALA took one week of beam time in March to verify experimentally the full PANDA luminosity detection concept and to test the detectors. While the tests provided valuable insights regarding the suppression of MIP background and the precision of the energy measurement, the tests also suffered from a poor vacuum of 10^{-6} mbar instead of ~ 10^{-8} mbar, which prevented the running of the Germanium strip detectors. It also turned out that beam cooling is mandatory for a reasonable estimate of systematic errors. KOALA will take 1 week of beam time allocated earlier and requests an additional week to compensate for the difficulties encountered in March.

The request is fully justified. The detector is essentially ready and will have been exposed to beam in August 2019. There is a good chance that major progress regarding the systematics of the precision measurements, and in particular measurement of low energy protons, can be made. Thus CBAC recommends an additional week of beamtime in Q4 2019 or Q1 2020.

Ratings: Feasibility A, Readiness A, Importance/Urgency B

Recommendation: 1 week

Proposal D011.1 **PANDA luminosity detector**

For refinement of the PANDA luminosity determination (LMD), silicon sensors rather than scintillators shall measure elastic low-angle scattering with very high resolution and supress background reactions. For optimum resolution, a thinned HVMAPS forward detector shall thus be placed in the vacuum tube, 11 m downstream of PANDA. HVMAPS technology is well-established and mature, although it is not yet used in experiment. In a first beamtime, MuPix8 sensors developed for the Mu3e experiment and designed by Ivan Peric, shall be tested in a hadron beam for track resolution and efficiency, together with the MuPix beam telescope and DAQ

As recommended in CBAC#9 a first experiment-week was carried out in May 19 which was partly done in conjunction with the CBM detector tests. The results have been encouraging, and the correlations between different pixel-sensor layers have been demonstrated. On the other hand, problems at high rates have occurred. Later analysis suggests that this can be resolved by modifying the read-out firmware. Another week of test beam is scheduled for September during which a more complex arrangement of up to 8 Mupix detectors with the associated TRB-boards will be tested.

The proponents have asked for two more weeks around the end of the year. CBAC thinks that there is a good chance that the September results will resolve the present issues but the readiness for the additional runs is not completely assured. Moreover, several topics from the run time proposal (cluster finding, hit sorting) can be performed without additional beam. It will be beneficial to have some time for data analysis and preparation for the next run after the upcoming beamtime. CBAC therefore supports

additional beamtime of one week in the beginning of 2020.

Rating: Feasibility A, Readiness B, Importance/Urgency A
Recommendation: 1 week of beamtime in Q1 2020

Proposal D012 **SiPM radiation hardness**

The PANDA barrel ToF is important particle identification and will be readout by silicon photomultipliers (SiPMs). The radiation exposure of the detector, while not huge, is significant, and the candidate SiPMs (as well as the scintillators) must be carefully characterized for radiation hardness. A series of relatively short measurements at JULIC and COSY are proposed.

CBAC recommends the requested beamtime on cyclotron and suggests focusing on tight control of the systematics by irradiating powered SiPMs, implementing temperature control, enabling for in-situ measurements of I-V curves and quantum efficiency measurements, etc.

Rating: Feasibility A, Readiness A, Importance/Urgency A
Recommendation: 2 days of beamtime

Proposal E002.7 **JEDI polarimeter**

Due to some delays caused, for instance, by problems in the manufacturing process of the exit window, the dedicated JEDI polarimeter has not seen commissioning run yet. The LYSO based polarimeter is presently being installed at the former EDDA site. It is supposed to become operational during summer. The JEDI polarimeter will offer advantages with respect to the WASA polarimeter used so far, and it is therefore highly desirable to commission it as soon as possible. The new polarimeter will then be an important support for the next runs with the JEDI Wien filter where accurate measurement of spin precession is mandatory.

Ratings: Feasibility A, Readiness A, Importance/Urgency A
Recommendation: 1 week for commissioning
EU-support from STRONG-2020 is recommended

Proposal E005.6 **JEDI Wien Filter**

In the tests with the JEDI Wien filter, the collaboration recognized that the spin phase-lock feedback loses its track of the spin signal once the spin has been rotated into the vertical direction. The conclusion is that the RF Wien filter should be switched off when the spin tune is measured, and corresponding test beam time is requested. Upon success, the direct measurement of the deuteron electric dipole moment using the oscillation frequency of the vertical polarization could be mapped out as a function of the Wien filter phase and solenoid field for the first time.

The method for an improved phase-lock feedback loop is the gating on one bunch out of the four in the machine. Thus, the pilot bunch should not see any field from the Wien Filter and can be used for the spin tune determination. As the RF amplifiers are not designed for wideband, according modification is under way. CBAC recognized that this is another test that is required to prepare the precursor EDM experiment in 2020 and is in support.

Ratings: Feasibility A, Readiness B, Importance/Urgency A
Recommendation: 1 week

Proposal A002.6 **Electron cooling**

The high-energy electron cooling at COSY made significant progress. The EPICS integration of the e-cooler is completed and is essential for the efficient operations. The integration is helpful during beam-time, allowing easier tuning, status monitoring and advanced data evaluation features.

Fast momentum cooling is achieved in about 18 s, significantly faster than the transverse cooling time. E-cooling alone could not compensate the heating imposed by the target in transverse direction. Stochastic cooling is baseline anyhow and in view of FAIR the e-cooling will be mainly required to reach a low momentum spread for running the high-resolution mode of the HESR.

However, in the previous beam study an unexpected asymmetric shape of the transverse energy distribution within the electron beam was observed. This effect may explain the comparatively slow transverse e-cooling. This measurement needs to be repeated in a more systematic way in order to benchmark the numerical simulations of the cooling process and to identifying the additional heating term suggested by earlier simulations.

The requested 2 weeks of beam are dedicated to the beam dynamics with electron cooling, to perform simultaneous application of electron and stochastic cooling, in particular effects on beam stability and to do studies of transverse energy/velocity distribution across the electron beam. CBAC fully supports these investigations.

Ratings: Feasibility A, Readiness A, Importance/Urgency A
Recommendation: 1 week

Proposal A001.9 **Stochastic cooling**

Stochastic cooling at 3 GeV/c could be demonstrated as well as running with different target densities and in combination with electron cooling. CBAC commends the team for the continuing improvements and successful tests.

However, longitudinal cooling was not as strong as expected and the reason, a bad connection at the new air-filled coax-line, has been found. Other issues were unexpected pick-up and kicker phase behavior and not sufficient cooling power for target densities above 10^{15} atoms/cm^2. It might be not sufficient RF power installed so that the simplified system established as COSY beam is not capable of delivering the required performance.

In addition, strong coherent lines in the Schottky spectra of the stochastic cooling pickup appeared, when stochastic cooling and the 2MeV e-cooler were switched on at the same time. There is no clear explanation, but a beam instability is unlikely.

Based on the results achieved, the program for the requested beam time comprises systematic measurements of cooling times and equilibriums with different gain settings and comparison with simulations. Test measurements with target and barrier bucket at different energies and measurements together with the 2MeV e-cooler are needed to clarify the origin of the coherent signals. CBAC recommends one week beam time for this program.

Rating: Feasibility A, Readiness A, Importance/Urgency A
Recommendation: 1 week

Proposal A015.1 **JEDI beam-based alignment**

Orbit deviations in quadrupoles create radial magnetic fields on the orbit which limits the sensitivity of the planned JEDI-EDM precursor experiment. Whereas the RMS orbit deviations are of the order of 1 mm presently; an improvement by a factor of 10 is the goal for the precursor experiment which leads to a corresponding increase in sensitivity.

Beam based alignment (BBA) has already been applied to 12 quadrupoles with associated BPM's. The method requires minimizing the sum of the quadratic differences in the BPMs when the k vector is changed by plus/minus Δk. A 20% improvement has been achieved after optimizing about 20% of the quadrupole in COSY. Since quadrupoles need to be individually varied one power supply per quad would be ideal, but this is out of scope for budget reasons. Therefore, the estimation for the time needed to adjust the complete orbit is three weeks.

CBAC acknowledges the importance of this approach. It is of some concern if a once optimized orbit will remain stable, or if drifts of positions will occur, for instance due to mechanical forces applied during installations in the ring. It would be desirable to check the stability of the situation in the 12 quadrupoles which have already been set, and/or to wait until the scheduling for the precursor is fixed so that the optimization of all quads is performed directly before the run without further interventions in the ring.

Rating: Feasibility A, Readiness A, Importance/Urgency A
Recommendation: 3 weeks, ideally placed directly before the JEDI precursor experiment

Proposal A010.6 **Moderator efficiency (HBS)**

The team has made great progress in improving the beamline by adding sufficient beam focusing strength and by this supressing background by up to a factor of ~ hundred. Thus control of experimental systematics is much better than before. With a new moderator design, improved detector system with better shielding and with the hardware almost available, a precision measurement of the effect of moderators with different para-hydrogen and ortho-hydrogen fractions is now possible. CBAC is endorsing these measurements and recommends exploring a bit wider range of ratios than suggested for better systematics control.

CBAC is also looking forward to the analysis of the latest HBS target optimization runs.

Ratings: Feasibility A, Readiness A, Importance/Urgency A
Recommendation: 1 week

Proposal A016 **JuSPARC**

The generation of polarized, energic proton beams (up to GeV) is an important goal of the ATHENA project. Whereas the experiment is expected to be performed in 2020 at the Shanghai Superintense Ultrafast Laser Facility (SULF), it relies on a dedicated nuclear-polarized hydrogen target (to be prepared at IKP) as well as on a new proton polarimeter based on solid-state nuclear track detectors (SSNTDs). The latter shall be tested, calibrated and possibly been optimized on the basis of a COSY beamtime at 45 MeV. CBAC endorses the well-prepared proposal and underlines its necessity and urgency in view of a first experiment at Shanghai in 2020.

Rating: Feasibility A, Readiness A, Importance/Urgency A
Recommendation: 1 week/cyclotron

Proposal A017 **Loewe-NP**

Within in the framework of the LOEWE Nuclear Photonics project, the development and design of a laser-driven neutron-source by utilizing the TNSA mechanism is one particular goal. For this purpose, the proposed experimental campaign is to benchmark various different MC codes and determine which is best suited for the simulation of neutron generation by TNSA ion beams or low energy protons and deuterons. This endeavor is highly appreciated by CBAC and the team is encouraged to elaborate in more detail the planned experiment at COSY with particular focus on the experimental setup. CBAC expects a more detailed presentation at its next meeting.

Rating:	Feasibility B, Readiness B, Importance/Urgency A
Recommendation:	More specifics on the planned experiment need to be given before approval. Please present at CBAC #11.

3. Summary and Conclusions

We would like to thank all speakers and participants for an inspiring day of scientific presentations. It is a pleasure to see the steady progress of many projects, some genuine research highlights, and the interest of new groups in COSY beamtime.

This year CBAC received twelve requests for, in total, approximately 16 weeks of user beam time. In addition, several statements of interest beyond this scheduling period were already made. The twelve requests relate to

- detector tests for FAIR (D004, D005, D011, D012),
- accelerator physics experiments (A001, A002),
- R&D for the HBS neutron source project (A010, A016)
- and to preparations for the EDM (E002, E005, A015, A017).

In addition CBAC recommends investing two weeks of beamtime to the exploration of the Siberian snake (A009).

It should be noted that several requests relate to the use of the JULIC cyclotron and very significant progress was made in the optimization of the beamline for R&D on HBS.

As always, the detailed scheduling of the prioritized proposals is left to the local COSY coordination committee.

It is important to preserve the competence of COSY accelerator physicists, in particular with view on completion of the program, the commitments in PoF IV and FAIR and in view of the unique capabilities of the COSY accelerator complex. CBAC commends that young talent has been identified and is given responsibility. It will be important to start a process for filling permanent staff positions to keep the unique know-how for the community and for FAIR.

Next CBAC session

The CBAC#11 meeting is scheduled to take place on February 3rd and 4th 2020 at IKP of Forschungszentrum Jülich GmbH.

Marc Weber (CBAC Chair)

4. Addendum

AGENDA

Monday, July 1st, 2019

08:30	Bus transfer Stadthotel Jülich to IKP (for CBAC members)	
09:00 – 09:30	**Closed session**	(IKP, room 311)
	J. Ritman	Welcome, issues t.b.d., …
	M. Weber (chair)	Organization, committee work
	Open session	(IKP, room 312)
09:30 – 09:40	J. Ritman	Welcome
09:40 – 10:00	R. Gebel	Status of COSY

Proposals are scheduled for 15' presentation + 10' discussion

10:00 – 10:25	D004.7	CBM	J. Heuser
10:25 – 10:50	D005.3	KOALA	H. Xu
10:50 - 11:10	**Coffee**		
11:10 – 11:35	D011.1	Lumi-det.	M. Fritsch
11:35 – 12:00	D012	SiPM rad. hardness	D. Grzonka
12:00 – 12:25	E002.7	JEDI-Pol.	I. Keshelashvili
12:25 – 12:50	E005.6	JEDI-Wien-Fil.	J. Slim
13:00 – 14:00	**Lunch Break**		
14:00 – 14:25	A002.6	COSY e-cool (status)	V. Kamerdzhiev
14:25 – 14:50	A001.9	Acce. stoch. cooling	R. Stassen
14:50 – 15:15	A015.1	JEDI-BBA	T. Wagner
15:20 – 16:00	**Coffee**		
16:00 – 16:25	A010.6	Moder. Effi.(HBS)	P. Zakalek
16:25 – 16:50	A016	JuSPARC	C. Zheng
16:50 – 17:15	A017	Loewe-NP	B. Schmitz

17:15 – 17:25	Overview (irradiation) activities at the JULIC cyclotron
17:30 – 18:45	Closed session (IKP, room 311)
parallel:	Internal coordination planning for installations at COSY (IKP, room 312)
19:00 – 20:30	**Dinner** (FZ-Seekasino) also for speakers
20:30	Bus transfer to Stadthotel Jülich (for CBAC members)

Tuesday, January 15th, 2019

08:30	Bus transfer Stadthotel Jülich to IKP (for CBAC members)	
09:00 – 11:45	**CBAC closed session** (IKP, room 311) representatives of the experiments should be available for additional information or questions	
	Open session (IKP, room 312)	
11:45 – 12:15	Summary of CBAC Recommendations	M. Weber
12:30 – 14:00	**Lunch (for CBAC members) (IKP, room 310) /** **End of meeting**	