Minutes of the 9th Meeting of the
COSY Beam Time Advisory Committee (CBAC)

January 14 and 15, 2019
Location: Forschungszentrum Jülich GmbH, Institut für Kernphysik, 52428 Jülich, Germany

Participants:

CBAC members:

Kurt Aulenbacher,	Univ. Mainz, DE
Oliver Kester,	TRIUMF, CA
James Miller,	Boston Univ., USA (excused)
Christian Schmidt,	GSI, DE
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

1. General remarks

The 9th CBAC session took place on January 14-15 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#9. For the programme and the list of applications see the Addendum.

Closed Sessions of the CBAC members were held on Monday morning 9:20-9:40, on Monday evening 17:15-19:00 and on Tuesday morning until 11:30.

The Closed Session on Monday morning was opened by Jim Ritman welcoming the participants (see list above). First Jim informed CBAC of the latest developments regarding the transfer of IKP to GSI. The "Aufsichtsräte" of both centers, FZJ and GSI, have decided that IKP (with the exception of theory activities) will formally move to GSI with the beginning of PoF-IV. The budget will be transferred to GSI, the location of most staff will not change. COSY operation is covered with the transfer. The precise administrative boundary conditions are subject of a detailed contract between FZJ and GSI, to be worked out within the next two years. The panel reviewed the requests for beamtime and acknowledged the continued large interest in COSY and its oversubscription. The assignment of CBAC members to the proposals was confirmed. The date of the next meeting, CBAC#10, was scheduled to be July 1 and 2, 2019.

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 July 2, 2018), the current schedule and an overview of the beamtime requests to CBAC#9. CBAC#9 is charged to assign the next 6 months of COSY operation. Then Bernd Lorentz reviewed the operation and the status of COSY in more detail.

Since CBAC#8, 6 weeks of beamtime were devoted to EDM/JEDI, 6 weeks to FAIR and 5 weeks to machine development. There was essentially no downtime. Highlights include the very successful installation of the PANDA cluster target. With 7.4 x 10^{14} atoms/cm^2 it is by far the thickest cluster target in COSY ever. Detailed studies show that energy loss and emittance spread can be effectively compensated by a combination of electron cooling and stochastic pre-cooling. The orbit correction for the EDM Wien filter run is a powerful and functional tool.

Various fixes and improvements to COSY were implemented. Some hardware failures for the steerer magnet power supplies were encountered and fixed through improved slow-control, automatization and new software to control the steerer via EPICS. The COSY extraction septum can almost reach 3 GeV/c operation (2.4 kA) with the new coil, just slightly below target value. A second coil set was installed and is soon to be tested. The integration of all COSY control systems into EPICS is underway (in collaboration with COSYLAB). The advantages are already being noticed very clearly and were nicely illustrated in the talk. In this process, software development repositories have been installed and training to the team is being provided.

Until September 2019, 14 weeks of beamtime will be available; 8 weeks thereof are in the first half of 2019 (April 29 through June 17).

At noon, Sebastian Schmidt, member of the FZJ board of directors, addressed the participants of the CBAC#9 meeting. He stressed the excellent news that the TransFAIR processes of IKP (with the exception of the theory section, IKP-3) to GSI is now formally approved and funding is secured. Now is the time and opportunity to stress science again, to exploit COSY for early science at FAIR, and to define the role of IKP at GSI in the next funding period PoF-IV (which begins January 1, 2021).

Thirteen proposals were submitted to CBAC#9, asking in total for approximately 18 weeks of beam time. An overview of all the applications and the agenda of the CBAC#9 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/cbac09.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** 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
D004.6 CBM	1 week	A	A	A
D009.3 Cluster-Jet target	1 week	A	A	B
D011 Lumi-det.	1 week	A	A	A
A014.1 Orbit Feedback/BPM	1 week	A	A	A
A001.8 Accelerator stocha. Cooling	1 week	A	A	A
A002.5 COSY e-cool (status)	N/A	N/A	N/A	N/A
A.13.1 Neutron yield (HBS)	1 week + parasitic running as available	A	B	B
A010.5 Moderator efficiency (HBS)	1 week + parasitic running as available	A	B	A
E006.3/A009 PAX/Snake	2 weeks	A	A	A
E002.6 JEDI-Pol.	1 week	A	A	A
E008 Axion-EDM	1 week (two have already been granted)	A	A	A
E007.1 EDM spin Dyn.		A	A	A
D005.2 KOALA (status)	1 week	A	A	B

2c) Short reports and recommendations on individual proposals

<u>Proposal D004.6</u> **CBM**

The CBM group had it last test at COSY in Q1 2018. The test was rather successful, and it is encouraging to see ever more realistic system set-ups. The CBM test beam campaign provided, for example, crucial input for the CBM STS sensor readiness review (in April 2018) and the detailed sensor summary report (CBM Technical Note #18010). As a consequence, the tendering processes for the silicon sensors, arguably the most critical and expensive STS component, is almost completed today. Also, an important logic error in the STS readout ASIC was discovered in the beam test and led to a redesign (the STS-XYTER version 2.1) which is now completed and available in silicon.

The CBM request for Q2 2019 will inform the STS-XYTER Production Readiness Review, by a thorough test of the final STS module design, full readout electronics chain. The MUCH GEM chamber, which could not be tested in Q1 2018, will be tested as well.

The tests are of major importance and are complementary to the more limited miniCBM testing in SIS18. The requested duration of the test is relatively short. It is recommended to explore the combination of these tests with D011.

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

Proposal D009.3 **PANDA Cluster-Jet Target: Target and Beam Tests at COSY**

The cluster target is a core element of PANDA as a whole at FAIR. The device comprises complicated hardware that has been thoroughly and extensively tested in the home lab of the applicant. It is now equipped even with an optical laser and camera system to make the beam visible and allow for better beam manipulation. The prudent experimental team has prepared the cluster target in a way that left no doubt about its readiness. In the granted beam times 2018, the complex facility could be shown to operate absolutely to specifications, indeed. The cluster jet target could be fully commissioned and on top proven to surpass standard technology by at least an order of magnitude in target density. It is particularly promising that successive beam times on beam cooling, using barrier bucket as well as electron beam cooling techniques, could successfully be realized with the cluster jet target in operation. They proved the feasibility of stable beam operation even with such a high density target, so that optimization of the target towards even higher density appears desirable. This beam – target interplay optimization should not be impeded. How far up in target density can one go while the system continues stable operation through beam cooling procedures?

One week in March has already been granted. A second week in spring should be allocated. A third week in fall 2019 should be evaluated in CBAC#10. The importance grading relates to the fact that the request is less urgent than others, due to the excellent progress of the project.

Rating: Feasibility A, Readiness A, Importance B
Recommendation: 1 week in Q2 2019

Proposal D011 **HV-MAPS and DAQ tests for the PANDA Luminosity Detector**

For refinement of the PANDA luminosity determination, 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 been 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. In a second week, the tests shall be extended to include more sensors and online triggering. In 2020 an advanced set-up and final set-up should be used to measure the pp elastic scattering differential cross section for various beam momenta.

Most ingredients for a successful test in 2019 are already available, including the sensors board, beam telescope and readout software. The proposal is mature and coherent, with a clear target for 2020. Also the exploration option of a HVMOS vertex detector for future enhancements of FAIR detectors is interesting, relevant and very much worthwhile exploring on a longer time scale.

Thus CBAC would rank the proposal triple A with respect to the first request week of beam time. As mentioned above, a joint campaign with CBM should be considered.

A recommendation concerning the second week of beamtime shall be given based on a presentation of the results at CBAC#10.

Rating: Feasibility A, Readiness A, Importance A
Recommendation: 1 week of beamtime, possibly jointly with CBM

Proposal A014.1 **Orbit feedback/Beam position monitor**

The motivation for the experiments performed at COSY so far was based on the theory developed to quantify the effect of on-ramp machine model changes as well as non-systematic tune shifts on the orbit correction in SIS18. These experimental investigations have provided an important confirmation of the simulation results regarding the closed orbit correctability in the presence of model errors or tuned shifts.

CBAC congratulates the team for the achievement. It has been shown that the closed orbit will not blow up even in the presence of significant model mismatch, depending on the start value of the tune. It could be demonstrated that the on-ramp orbit correction is always possible even for maximum model error by using the injection orbit response matrix (ORM) at extraction and vice versa. It could also be demonstrated that missing BPMs can be compensated by using the dominant modes of the ORM.

As the online tune measurements for the horizontal plane was not available and the effect of beta beating in combination with tune shifts could not be explored, another experiment should be performed. Aside from the benefit for the FAIR synchrotrons, COSY operation will profit from the measurements.

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

Proposal A001.8 **Commissioning of new HESR stochastic cooling tanks**

After the completion of the installation, the first three-dimension cooling in COSY using the new HESR cooling system was successfully demonstrated by the team. Even with a reduced system the cooling was strong enough to compensate energy loss and transverse heating of the beam by the new PANDA cluster target. It was also demonstrated that stochastic precooling improves the performance of the 2MeV e-cooler.

CBAC congratulates the team and supports the planned program for 2019. The continuation of the program will address measurements of cooling times and equilibriums with different gain settings, cooling at different energies and cooling with barrier bucket and target at higher energies as well as the combination with electron cooling. The test at higher energies will require adjustment of the delay margin for the longitudinal cooling system. The adjustment of the length of a new hollow fiber line can be the path forward.

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

Proposal A002.5 **Electron Cooling**

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

Very successful e-cooling test could be performed. E-cooling alone is not sufficient to maintain the beam in the machine while running the cluster target at high density ($>10^{15}$ cm^{-2}). Stochastic cooling is required in addition and e-cooling allows for lower momentum spread and emittance compared to pure stochastic cooling. Electron cooling is faster with stochastic pre-cooling. Running both cooling

systems, an issue with the transverse energy distribution has been detected but is not yet fully understood. No new beamtime was requested.

Ratings: N/A
Recommendation: N/A

Proposal A013.1 **Neutron yield HBS**

HBS is an important project for the neutron community and is gaining traction. The exploration of more sophisticated multi-layer targets is necessary. The improvements to the experimental setup, e.g. the addition of the quadrupole doublets are appreciated. The new setup must be commissioned. However, in line with its previous recommendations, CBAC still feels that the experiment would clearly benefit from more instrumentation. In particular, one or several more gamma detectors would make better use of the valuable beamtime. These detectors would not necessarily have to provide optimum energy resolution, if cost is an issue.

The current measurement goal of the confirmation of a 10% yield increase for a double-layer Vanadium/Tantalum target compared with a Tantalum target is not considered crucial at the current development stage of HBS. The proposed campaign is, however, rather costly in beam time. Thus CBAC recommends realizing the above experiments with additional instrumentation and grants 1 week of user beamtime.

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

Proposal A010.5 **Moderator Efficiency (HBS)**

Towards the technological optimization of a target for the HBS the moderator material Mesitylene as well as different moderator geometries are to be tested for their effective neutron moderation yields. The moderator is one key position for the effectiveness of the overall thermal and cold neutron yield per impinging proton. Whereas the reasoning is quite convincing and the issues to be investigated are clear, the experimental procedures still seem to be rather following pure trial. For the quality of Mesitylene as moderator a discrepancy of a factor of three in cold neutron yield compared to expectations is the subject of investigation. Rather than targeting a laborious study of neutron yield in a TOF setup with varying temperatures, the experimentalists should make sure that no under-moderated, thermal contaminations spoil the convincing quantitative measurement of neutron yield enhancement. It is recommended to rather focus on moderator geometry and to carefully substantiate the envisioned measurements with Monte Carlo simulations, while making sure the experimental conditions are reproducible and reliable. The need for experimental in-beam verification is fully recognized. The experimental conditions should, however, be more carefully determined.

These studies are very worthwhile. They should, however, minimize the use of valuable beam time at the COSY storage ring. Whenever possible, these experiments should be executed during COSY ring shutdown periods.

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

Proposal E006.3/A009 **Towards a longitudinal spin-filtering test at COSY: commissioning of the full PAX detector and of the Siberian snake**

A009 is a long pending experimental issue to test a solenoid with a variable field integral of 4.5Tm which will stabilize the longitudinal spin axis in COSY. Spin dependent scattering experiments such as polarization build up (PAX) and measuring T-violating analyzing powers in the TRIC experiment depend on the successful operation of the snake. The experiments have several times been recommended by CBAC. The proponents have stressed the opportunity to a) install the snake and to test its capability to observe its functionality and b) to install the fully equipped PAX detector (E006.3) in the ring in order to demonstrate its functionality as a polarimeter with transversely polarized beam and an unpolarized deuterium target in its storage cell. In the long run this will allow using the PAX-detector with longitudinally polarized target for polarization build up and analyzing power measurement. In case a) the snake will be adjusted to half integer spin tune with the goal to demonstrate that no losses occur if the beam is accelerated to a momentum of 911 MeV/c. A polarimeter for this experiment will be available. We recommend a beam time in the second half of 2019 for case a). The beam time for case b) should be scheduled after completion of a successful first run.

Ratings: Feasibility A, Readiness A, Importance A
Recommendation: 2 weeks

Proposal E002.6 **JEDI: Towards the EDM Polarimetry**

The LYSO based calorimeter JEDI polarimeter has been tested thoroughly with external beam. The experiment was deferred in CBAC#8 until it would become available in the ring which is now expected in the near future. The device will undoubtedly prove expedient for the spin dynamics and the PAX tests. Two weeks of beam time were requested but at this point it seems not reasonable to explore details like accurate measurements of analyzing powers.

Recommendation one additional week of run time prior to the beamtime for E007/E008.

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

Proposal E007&E008 **JEDI: Axion-EDM/EDM spin dynamics**

For E007 two important questions need to be answered: Can there be a long lifetime in-plane polarization without e-cooling? The answer will have a significant impact on the resources needed for a future dedicated EDM storage ring. Earlier studies were inconclusive due to the lack of cooling leading to a large bunch size. It is now proposed to use barrier bucket compression to reduce the size of the beam without e-cooling.
The other question: what is the impact on polarization due to high beam currents? Understanding the systematics of high currents will also dictate design of a future ring.

As has been noted before, the axion search (E008) is a novel use of the unique facilities at COSY, offering sensitivity to a range of extremely low mass axions that are so far not accessible by other experiments. The velocity of the polarized beam is swept to try to match the frequency of the axion field, the latter frequency being proportional to the axion mass.
At resonance, the polarization can quickly accumulate a vertical component. The trick is to sweep over frequencies without missing the resonance. A major assumption is that the axion field is coherent over the COSY facility. Four bunches would be used in order not to miss the phase of the axion oscillations.

These experiments have been recommended by CBAC and two weeks have been scheduled for Q1/2019. The proponents have noted that the proposed series of measurements may also serve as a feasibility study for the axion coupling to an EDM. They have therefore extended their request by two weeks. Given the fact that the axion experiments could lead to important scientific output of COSY already in the midterm future, CBAC considers this approach as justified. It seems reasonable to join this run with the commissioning of the JEDI polarimeter.

Ratings: Feasibility A, Readiness A, Importance A
Recommendation: 1 week, extending the already scheduled time to three weeks total.

Proposal D005.2 **KOALA (status)**

Koala intends to experimentally verify the full PANDA luminosity detection concept with recoil detector and small angle forward scattering detector which in the final PANDA setup on HESR will be done with the "luminosity detector". To this end the existing recoil detector has been equipped with a forward detector arm comprising four scintillator paddles arranged in vacuum around the forward beam.

The operation of the recoil detector has been shown in the past. With the availability of the forward detector, the principle operation of the two detectors for luminosity measurements can now be shown.

It has convincingly been shown that the setup is ready for beam which will be realized in March, where the system is to be shown to work. An additional week of beam time is solicited to prove background suppression through the forward branch. The second beam time should be separated in time to allow for corrective actions after initial operation and thus is less urgent.

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

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 COSY is again oversubscribed with a request of 18 weeks of user beam time. This required the committee to prioritize, shift some proposals into Q3 and Q4, and to suggest exploiting synergies and combining requests.

The requests relate to

- detector tests for FAIR (D004, D005, D011),
- accelerator physics experiments (A001, A002, A0014),
- R&D for the HBS neutron source project (A10, A13)
- and to preparations for the EDM (E002, E005, E007, A015), longitudinal spin-filtering in the context of SPINforFAIR and time-reversal invariance tests (E006), and axion searches (E008).

As always, the detailed scheduling of the prioritized proposals is left to the local COSY coordination committee. The beam time recommendations for the period Q3 and Q4 of 2019 will be subject of a detailed evaluation by CBAC#10. The backlog of approximately 6 weeks of non-scheduled requests from CBAC#8 could be resolved.

This year (2019) will be crucial to define the research program of the research field “Matter” in PoF-IV. The strategic evaluation will take place in January 2020, a full proposal for the strategic evaluation needs to be submitted in November 2019, and the key elements of the proposal must be available in summer 2019 the latest. With the very positive review of IKP’s research in the recent scientific evaluation and the decision of the steering boards (“Aufsichtsräte”) of FZJ and GSI to transfer the science of IKP-1, IKP-2 and IKP-4 to GSI, it is now possible and, indeed, urgent to start shaping the future of COSY in PoF-IV and in the FAIR context.

The COSY infrastructure and understanding of beam operation at COSY has been improving steadily over the past years, and, in the view of CBAC, COSY is a highly versatile and highly performing machine. Apart from its world-leading research towards the determination of the electric dipole moment of charged hadrons, COSY is now well-prepared to make significant contributions to “Matter”. CBAC proposes to generate the discussion of COSY’s role as

a) a test beam facility for FAIR detectors and detectors and electronics in general

b) as an accelerator testbed for FAIR

c) as a unique and affordable instrument for fundamental physics measurements, eg. precision measurements of time invariance or the search for axions and axion-like particles.

For the purpose of the evaluation, not only the balance between these uses of COSY, but also specific milestones and the programs, to which COSY will contribute, will have to be discussed and defined within the next months.

Next CBAC session

The CBAC#10 meeting is scheduled to take place on July 1 and 2, 2019 at IKP of Forschungszentrum Jülich GmbH.

Marc Weber (CBAC Chair)

AGENDA

Monday, January 14th, 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
09:30 – 09:40	**Open session**	(IKP, room 312)
	J. Ritman	Welcome
09:40 – 10:00	B. Lorentz	Status of COSY

Proposals are scheduled for 15' presentation + 10' discussion

10:00 – 10:25	D004.6	CBM	J. Heuser
10:25 – 10:50	D009.3	Cluster-Jet target	A. Khoukaz
10:50 - 11:10	**Coffee**		
11:10 – 11:35	D011	Lumi-det.	M. Fritsch
11:35 – 12:00	A014.1	Orbit feedb./BPM	S.H. Mirza
12:00 – 12:25	A001.8	Acce. stoch. Cooling	R. Stassen
12:25 – 12:35	A002.5	COSY e-cool (status)	V. Kamerdzhiev
12:40 – 12:55	Words of Board of Directors VS-1		S.M. Schmidt
13:00 – 14:00	**Lunch Break**		
14:00 – 14:25	A013.1	Neutron yield HBS	M. Rimmler
14:25 – 14:50	A010.5	Moder. Effi.(HBS)	P. Zakalek
14:50 – 15:15	E006.3	PAX/snake	P. Lenisa
15:20 – 16:00	**Coffee**		
16:00 – 16:10		JEDI status report	J. Pretz
16:10 – 16:35	E002.6	JEDI-Pol.	I. Keshelashvili
16:35 – 17:00	E008/E007.1	Axion-EDM EDM spin Dyn.	E.Stephenson /S. Park E.Stephenson (tbc)
17:00 – 17:10	D005.2	KOALA (status)	H. Xu
17:20 – 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**	