Minutes of the 11th Meeting of the
COSY Beamtime Advisory Committee (CBAC)

February 3rd and 4th, 2020
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
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 and Managing Director)
James Ritman (IKP-1 Director, Scientific Coordinator COSY)
Hans Ströher (IKP-2 Director, IKP)

Board of Directors FZJ: Sebastian Schmidt (excused)

1. General remarks

The 11th CBAC session took place on February 3rd-4th in the Forschungszentrum Jülich GmbH, Institut für Kernphysik. The beamtime requests of the individual groups were presented on Monday in the Open Session of CBAC#11. For the programme and the list of applications see the Addendum.

Closed sessions of the CBAC members were held on Monday morning 9:00-9:35, on Monday evening 18:00 – 19:10 and on Tuesday morning until 10:30.

The closed session on Monday morning was opened by Jim Ritman welcoming the participants (see list above). CBAC was informed about the status of TransFAIR. The results and consequences of the Helmholtz evaluation of the Research Field "Matter", which took place last week, were discussed. While the risk associated with FAIR resulted in a disappointing grading of the topic "Cosmic matter in the laboratory", COSY featured rather positively. It is explicitly recommended to nurture the EDM activities at COSY.

There are a large number of strong beamtime requests for COSY and the cyclotron. CBAC is charged to prioritize requests for the period of April 2020 to mid-November 2020, corresponding to roughly 15 weeks of beam, including machine development. The assignment of CBAC members to the proposals was confirmed. The date of the next meeting, CBAC#12, was scheduled to be October 8 to 9, 2020.

Jim Ritman started the open session with a brief welcome of the participants. Vsevolod Kamerdzhiev gave a comprehensive review of the status of COSY. Almost 16 weeks of beamtime could be delivered in the past run period. All experiments were successful with the exception of the electron cooling which suffered a HV-vacuum feed-through failure that could not be fixed instantly. Several aging components mentioned at earlier meetings could successfully be renewed, improving the reliability and performance of the machine. Power converters, inductor water leaks, vacuum leaks and other incidences were fixed. There are continuous machine improvements like the recent calculations of the positions of the beam position monitors and magnets. Beam instrumentation is being improved, enabling in-situ calibrations.

The EPICS integration continues and modernization of slow control system is ongoing. The fast tune system using bunch-by-bunch beam data is a major relief. The SIBERIAN snake is now in the commissioning and test phase.

All experimental halls, Big Karl, NEMP (Jessica) are available. The new NESP cyclotron beam line for neutron yield studies is becoming an asset. Also, the irradiation studies at the cyclotron, which are not scheduled though CBAC, are a significant activity. COSY is a great place for education of students, with many theses, and as a part of accelerator physics courses at RWTH Aachen. The new category of engineering runs for education and some commissioning/testing is introduced.

Thirteen proposals were submitted to CBAC#11, asking in total for approximately 22 weeks of beamtime, excluding machine development (MD). This represents a significant oversubscription of almost a factor two. An overview of all the applications and the agenda of the CBAC#11 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/cbac11.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 and IKP science is an important criterion as is the emerging long-term 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. Four talks were status reports. An additional status report was delivered in writing. The other talks related to new proposals. As always, an important boundary condition is given by the allocated 5000 hours of beamtime per year and the six weeks of maintenance required by COSY mid-year. For the next assignment period, approximately 15 weeks of

beamtime will be available for users.

CBAC is again acting as an advisory body for requests of support to international users through the EU STRONG-2020 hadron community initiative.

Table 1: *Summary of requests (for details see table in the addendum), ratings and recommendations of CBAC#11.*

Experiment	Recommendation in user beamtime/ likely schedule	Feasibility	Readiness	Importance/ Urgency
D004.8 CBM-HADES	1 week	A	A	A
D009.4 PANDA cluster jet target	1 week	A	A	A/B
D011.2 PANDA luminosity detect.	1 week	A	A	A
D012.1 SiPM	2 days (engineering run)	A	A	A
D013 Ay of elastic pp scattering	status report at CBAC#12	A	B	A
E009 JEDI-coherence time	status report at CBAC#12	A	A	A
E010 JEDI-alignment	3 weeks (before E009)	A	A	A
E005.6 JEDI-Wien filter	1 week, to be combined with E010 to save MD	A	B	A
A002.6 COSY e-cool (status)	3 weeks in total	A	A	A
A001.10 Accelerator stoch. cooling		A	A	A
A018 CR Palmer pickup	status report at CBAC#12	A	B	A/B
A017.1 Loewe-NP	1 week	A	B	A/B
A014.2 Orbit-feedback/BMP	1 week	A	A	A/B

2c) Short reports and recommendations on individual proposals

<u>Proposal D004.8</u> **CBM-HADES**

The CBM run in November 2019 in the Jessica cave was successful. One highlight is the careful characterization of a full CBM STS module that informed the Engineering Design review in Dec 2019 for the final ASIC version 2.2. The run will also inform the upcoming production readiness retreat in February 2020. Another highlight is the characterization of ultrafast silicon detectors for HADES which showed a time resolution of 58 ps (measured at room temperature).

CBM requests two separate weeks of beamtime for the characterization of the HADES mini drift chamber MCD together with the testing of an ultrafast silicon beam telescope. This request is highly relevant for the MDC FEE upgrade project, which will enable running HADES at even higher beam intensities at FAIR phase 0 and phase 1. Since the both, the MDC and the PASTREC ASIC are available the proposal is feasible. The purpose of the two requests is however too similar (different chip package

and front-end board) to warrant both of them. It is very worthwhile and efficient to combine this test with the latest ultrafast sensor beam telescope.

Testing the extremely low material sensor MIMOSIS-1 for the CBM MVD is most important. Given the oversubscription of COSY and the fact that these tests are proposed for Q3 (and may likely be carried out parasitically), the decision on this request is postponed to October.

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

Proposal D009.4 **PANDA Cluster jet target**

The cluster target is a core element of PANDA. 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 beamtimes 2018, the complex facility could be shown to operate absolutely to specifications, indeed. The cluster jet target could be fully commissioned and surpassed standard technology by at least an order of magnitude in target density. It is particularly promising that successive beamtimes 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.

The intensive work corroborating various other beam activities as well as dedicated cluster jet target beamtimes has proven how well the target operates together with the barrier bucket and the various beam cooling options. The use of an independent Schottky pickup will allow the team to measure beam properties independently during closed-loop stochastic cooling operation. The big goal of reaching the projected PANDA design target density at 2×10^{15} protons/cm^2 and thereby proving its feasibility is yet to be achieved, raising the operation density by a factor of three. This is indeed a viable goal that helps the community. It is paired with the aim to realize an operational know-how transfer to the next generation of PhD students.

The cluster beam target has had a week of beamtime every half year and in interplay with cooling beamtimes enormously profited from this activity. A week, e.g. in late spring 2020, should be granted. 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/Urgency A/B
Recommendation: 1 week

Proposal D011.2 **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 suppress 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 being 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 a new Kintex 7 based DAQ that does not rely upon SODAnet in March, already granted through CBAC#10. In a second, newly granted week, the new full-size prototype HV-MAPS devices MuPix10 are to be tested in a detector setup comprising 16 detector chips. This advanced and final set-up should be used to measure the pp elastic scattering differential cross section for various

beam momenta. The evaluation of the final size prototype detector is a prerequisite for final device submission.

Thus, CBAC ranks the proposal triple A even though a considerable program of technical assembly tasks needs to be done in preparation.

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

Proposal D012.1 **SiPM radiation hardness**

The recent irradiation tests of silicon photomultipliers (SiPMs) for the PANDA barrel showed surprisingly large radiation sensitivity at rather low doses of a fraction of a Gray. While it can be argued that the effect is less relevant for large energy depositions, further irradiations at high doses are important and urgent.

CBAC thus recommends the request to run at COSY for two days. The irradiations could be incorporated in an engineering run.

It is suggested to consider measuring the SiPMs at reduced temperatures, to characterize them as completely as possible and to seek advice by the manufacturer about the observed features. Eventually a TCAD simulation study of the SiPMs would be helpful, even if not all proprietary design and layout features will be known.

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

Proposal D013 **Ay of elastic pp scattering**

Measurement of the analyzing power A_Y of elastic pp-scattering in the Coulomb-nuclear interference region (momentum range of a few GeV/c) is a challenging endeavour and of great importance for future experiments at CERN/PS, aiming to search for polarization effects in the antiproton production process.

The preparation of the experiment at COSY is a rather complex enterprise, including various milestones for the year 2020.

CBAC recommends one week of beamtime for the proposed experiments at COSY. However, the readiness of the experimental setup should be documented at the next CBAC meeting in October 2020 before the beamtime can be scheduled.

Ratings: Feasibility A, Readiness B, Importance/Urgency A
Recommendation: Status report at CBAC#12
EU-support from STRONG-2020 is recommended

Proposal E009 **JEDI-coherence time**

The goal of this new proposal is to achieve a sufficiently large spin coherence time (SCT) of stored protons in COSY. This demonstration is very important for the design of a future electro-static ring for proton EDM measurements in frozen spin mode.
With deuterons, an SCT of > 1000 seconds was achieved which required to cool the beam and to compensate nonlinearities of the synchrotron motion by sextupoles. For protons, this task is more challenging because of the much higher anomalous magnetic moment and because the influence of intrinsic resonances is considerably enhanced. The latter leads to an increased spin tune spread that quickly destroys the coherence. It therefore has to be compensated by adequate setting of the sextupoles

which will probably require operating at large chromaticities. This, in turn, will lead to a reduction of the dynamic aperture. Given these complications, extensive experiments are therefore unavoidable. The availability of the new polarimeter is an advantage.

While CBAC is fully convinced that the proposal meets all criteria, it is evident that the experiment will benefit from the results of E010 and other machine improvements. This proposal will remain a high priority of CBAC and be reconsidered at CBAC#12.

Ratings: Feasibility A, Readiness A, Importance/Urgency A
Recommendation: Report at CBAC#12
EU-support from STRONG-2020 is recommended

Proposal E010 **JEDI-optimization of alignment**

The storage ring EDM precursor experiments are limited by control of systematic effects, which are mainly generated by misalignment of accelerator components. The already observed spin precession is an artefact from such imperfections. It has the same signature as the EDM signal and fixes an upper limit for the EDM.
Presently, the measured misalignment of the invariant spin axis at the RF-Wien filter is not in agreement with the model of COSY that was generated from geodetic measurements. During the proposed experiment the invariant spin axis shall be measured at several positions along the orbit in order to gain more information on that matter. The experiment relies on the extremely sensitive measurement of spin-tune that has been recently demonstrated at COSY. Orbit bumps will be used in conjunction with solenoid variations to generate maps of the spin tune shifts. The goal is to obtain several such maps from which misalignments could be inferred with sufficient sensitivity. Hence the discrepancies mentioned above could be resolved, which will of course also allow JEDI to improve the upper limits for the EDM at COSY. The experiment requires considerable machine development, a task where there is overlap with experiment A014.2.

CBAC strongly supports to execute the experiment as soon as possible, in conjunction with A014.2

Ratings: Feasibility A, Readiness A, Importance/Urgency A
Recommendation: 3 weeks (before E009)

Proposal E005.6 **JEDI Wien filter**

As for the last CBAC meeting, the JEDI collaboration does address beamtime to test an improved spin phase-lock feedback system with a gate for a single bunch. This will in principle allow, for the first time, the direct measurement of deuteron electric dipole moment using the frequency of oscillation of the vertical polarization. However, the required RF-gating of the system is still under development and not ready yet.

The original plan to study the multi-bunch operation of the RF Wien filter during the E005.6 JEDI-experiment, scheduled for week 5 in 2020 could not be realized due to the insufficient bandwidth of the amplifier. Therefore, CBAC supports the beamtime later this year to allow for the preparation of the RF-gate. A prototype has been realized, implemented and tested. The additional four switches are planned to be available in summer 2020. The optics element alignment using orbit bumps (E010) can be combined with the requested beamtime.

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

JEDI overview (status report)

Jörg Pretz gave an overview of the ongoing EDM research and the related beam time requests. These mostly aim at better understanding of systematics, e.g. by spin tune mapping, using the recently installed polarimeter "JEPO" and the separation of a pilot bunch that is supposed to be uninfluenced by the Wien filter. Moreover, operation with protons is proposed. This is an impressive program that should prove extremely helpful for the planned precursor experiment expected at the end of 2020 or early 2021.

Proposal E002.7 **Jedi polarimeter (status report)**

After extensive testing, the JEPO was installed and commissioned at COSY in the second half of 2019. In addition, the degradation of the silicon photomultipiers with absorbed dose was investigated. The polarimeter has already demonstrated its functionality. CBAC is convinced that the new instrument will play an important role during the ongoing EDM campaign.

Proposal A002.6 **COSY e-cooling (status report)**

This status report addressed the issues of the failed operation of the 2 MeV cooler in November 2019 mentioned above. A high voltage feedthrough that uses Vespel® as insulator degraded over time and failed. The cooler will be reassembled soon and is being put back into operation.

Simultaneous operation of stochastic cooling and e-cooling results in artefacts and the origin was planned to be identified by systematic studies of different pick-ups and particle numbers. As the beam time in 2019 failed, it needs to be done in 2020. Also, the observed issues with transverse energy distribution within the e-beam will be further investigated. One week overlap with stochastic cooling is required.

Ratings: Feasibility A, Readiness A, Importance/Urgency A
Recommendation: 2 weeks, one in overlap with A001.10

Proposal A001.10 **Accelerator stochastic cooling**

Stochastic cooling is now available in the momentum range of 1.5 GeV/c up to 3.2 GeV/c, the team is commended by CBAC. The proposal addresses tests of the stochastic cooling system with the optimized software that allows an automated adjustment of the cooling loops available. Additional measurements of the coherent lines appearing during the simultaneous use of the 2 MeV e-cooler and stochastic cooling were not yet attainable due to failure at the 2MeV e-cooler. Therefore, another attempt is planned in the requested beamtime, which is supported by CBAC and should have overlap of one week with A002.6.

Rating: Feasibility A, Readiness A, Importance/Urgency A
Recommendation: 2 weeks, one in overlap with A002.6

Proposal A018 **CR Palmer pickup**

The final design of the Palmer pickup for the FAIR collector ring (CR) was finished in 2019. It is dedicated to cool the very hot secondary beams from the Super-FRS. Due to the high charge state of the hot fragments, stochastic cooling is very efficient, and no cryo-modules are needed for the Palmer pickup. All components have been ordered and the Palmer pickup is currently assembled in the clean room of ZEA-1. Moreover, the vacuum tank is currently been tested at GSI and will be delivered in February/March 2020. It is foreseen to install the Palmer pickup in COSY during summer shutdown 2020 at the position of the former horizontal pickup station.

CBAC recommends one week of beamtime for the tests planed at COSY. However, the readiness of the Palmer pickup should be documented at the next CBAC meeting in October 2020 before the beamtime can be scheduled.

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

Proposal A017.1 **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 Monte Carlo codes and determine which is best suited for the simulation of neutron generation by TNSA ion beams or low energy protons and deuterons.

Based on the recommendation of the last CBAC review, the collaboration has elaborated their experiment proposal in more detail and has provided a detailed list of proton beam energies and targets for the measurement of double-differential neutron production cross-sections.

CBAC recommends one week of beamtime for this program. After successful completion of this first experiment campaign, the collaboration may ask for a continuation of the experiment based on the already achieved results.

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

Proposal A014.2 **Orbit-feedback/BMP**

In the orbit correction (OC) operation some non-optimum steerer-corrector calibration were noted. The goal of the requested beam time is to check steerer calibrations using BPM data and tests with closed orbit bumps. The corrector magnets of the 2 MeV cooler must be included in the next step towards an optimized orbit control. Also, the closed orbit correction has not been performed at injection energy level yet, which could improve the injection efficiency and reduce MD time.

A suite of characterization measurement is planned in this beam time, steerer calibration at injection level, ORM determination to compare with the model and OC configuration to optimize the injection orbit for higher intensities. The final goal is to compare and match the measured ORM with the model also for on- and off axis and at injection energy. CBAC supports this proposal.

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

Proposal A005.3 **KOALA (status report)**

The fully installed Koala setup has had an overall of three weeks of beam time over the course of 2019. Considerable data sets could be collected at four different beam momenta. The analysis showed that both, the recoil and the forward detector signals beautifully correlate so that the background suppression strategy proves successful. Further, barrier bucket and stochastic cooling have successfully been implemented for KOALA operation. The instrument is on a very good track.

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 thirteen requests for, in total, approximately 22 weeks of user beamtime and complemented by several weeks of machine development. Several statements of interest beyond this scheduling period were already given. The thirteen requests relate to

- detector tests for FAIR (D004.8, D009.4, D011.2, D012.1, D013),
- accelerator physics experiments, which are driven by either FAIR or EDM (A001.10, A002.6, A14.2, A018),
- R&D for a laser-driven neutron source (A017.1) and
- to preparations for the determination of the EDM (E005.6, E009, E010).

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

Given the ever increasing sophistication of COSY and the visibility of COSY's EDM research program, the next few years of research on the way to the EDM precursor experiment will be very exciting and be widely noticed.

Next CBAC session

The CBAC#12 meeting is scheduled to take place on October 8th and 9th 2020 at GSI.

Marc Weber (CBAC Chair)

AGENDA

Monday, February 3rd, 2020

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	V. Kamerdzhiev	Status of COSY

Proposals are scheduled for 15' presentation + 10' discussion

10:00 – 10:25	D004.8	CBM	J. Heuser
10:25 – 10:50	D009.4	PANDA Clas.Jet tg.	A. Khoukaz
10:50 - 11:10	**Coffee**		
11:10 – 11:35	D011.2	Lumi-det.	M. Fritsch
11:35 – 12:00	D012.1	SiPM rad. hardness	D. Grzonka
12:00 – 12:25	D013	Ay of elast. pp scat.	D. Grzonka
12:25 – 12:40		JEDI-overview status	J. Pretz
12:40 – 14:00	**Lunch Break**		
14:00 – 14:25	E009	JEDI-coherence time	V. Hejny (tbc)
14:25 – 14:50	E010	JEDI-opt. alignm.	A. Saleev
14:50 – 15:15	E005.6	JEDI-Wien-Fil.	J. Slim
15:15 – 15:25	E002.7	JEDI-Polari.(status)	I. Keshelashvili
15:25 – 15:40	**Coffee**		
15:40 – 16:05	A002.6	COSY e-cool (status)	V. Kamerdzhiev
16:05 – 16:25	A001.10	Acce. stoch. cooling	R. Stassen
16:25 – 16:45	A018	CR Palmer-Pickup	R.Stassen, C.Dimopoulou
16:45 – 17:10	A017.1	Loewe-NP	S. Scheuren
17:10 – 17:35	A014.2	Orbit-feedback/BMP	I. Bekmann
17:35 – 17:45	D005.3	KOALA (status)	H. Xu
17:45 – 17:55	RWTH Lab. Courses: Accel Physics		A. Lehrach

18:00 – 18:45	Closed session (IKP, room 311)
parallel:	Internal coordination planning for installations at COSY (IKP, room 312)
19:00 – 20:30	**Dinner** (location to be announced) also for speakers
20:30	Bus transfer to Stadthotel Jülich (for CBAC members)

Tuesday, February 4th, 2020

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**	