Minutes of the Technical Board Meeting November 7, 2017

Present: Vladimir Anosov, Jens Barth, Nori Doshita, Andrea Ferrero, Angelo Maggiora, Alain Magnon, Gerd Mallot, Caroline Riedl, Fulvio Tessarotto, Annika Vauth.

Remotely connected: Maxim Alexeev, Michela Chiosso, Jan Friedrich, Bernhard Ketzer, Igor Konorov, Marcin Ziembicki.

Communications. The next TB meeting is scheduled for Monday, December 4, 2017. It will be dedicated to the future of COMPASS and a COMPASS-like experiment at the M2 beam line beyond 2020. The **2018 TB meeting**s were agreed to be on the following dates: February 20, March 27, June 5, September 4, and November 6.

Andrea Ferrero has joined the ALICE collaboration and will not be available any longer as TB member in 2018. The TC proposes Stephane Platchkov as new TB member. The TB endorses this decision.[1]

Six of the current TB members were confirmed or introduced at the CB meeting in December 2015: Andrea Ferrero, Igor Konorov, Daniele Panzieri, Fulvio Tessarotto, Bernhard Ketzer, and Jens Barth. Marcin Ziembicki replaced Horst Fischer in June 2016, and Gerhard Mallot replaced Caroline Riedl in June 2017. The TB memberships of Igor, Daniele, Fulvio, Bernhard and Jens will have to be confirmed by the CB in January 2018, as written in the MoU.[2] All of them have expressed their continued availability.

Report from the 88th - 90th EATM (Annika Vauth). The distilled and raw water will be stopped between December 20, 2017 and March 12, 2018, the chilled water between December 19, 2017 and March 9, 2018. In the context of the North Area consolidation, an upgrade of the gas detection system is planned, which will mean an **outage of flammable gas in 2019**. Please let Caroline and Annika know if this will be an issue for you. It is currently assumed that flammable gas will rather be needed in 2020, in preparation of the 2021 SIDIS run.

The new cooling system for **SM2** in the power converter building BA82 is now operational. SM2 had multiple malfunctions during the 2017 run: it did not ramp up again after our regular polarity switches (μ^+ / μ^-) and a piquet had to be called each time.

[1] *Stephane Platchkov was confirmed as new TB member at the Nov. 16 CB meeting.*

[2] *"The [...] TB members are appointed for a period of two years by the CB on proposal by the Technical Coordinator and the Spokespersons. A re-appointment is possible, subject to the same rules that apply to the re-election of spokespersons." ... "The Spokespersons are elected for a term of 2 years with the possibility of re-election. The Spokesperson may, however, serve for more than two consecutive terms only on explicit approval by the CB, upon nomination, and as expressed by an absolute 2/3 majority of voting members of the CB."*

This was caused by a bad cabling in the main circuit breaker and eventually repaired. A longer outage occurred in September 2017, when the power converter tripped randomly with MCB Wrong Status Fault. This glitch was due to water pressure sensor alarm caused by strong vibrations of the chokes. In a preliminary fix, the interlock was short-circuited. For the long-term fix, a silent block will be installed this winter. No incidents occurred after September 29. Tests for the new card to run SM2 at 4800 A in 2018 (instead of @4000 A in 2017) will be carried out in the week of November 27. Communication with Felix Bergsma from EP-DT-EF about the calculation of the SM2 field map will be re-established in the nearest future (AC and TC). Felix had been in contact about this topic with the previous TC Nick earlier this year. [3]

General news from the experiment and 888. A water leak on a heating pump occurred in 888 on September 30, 2017, close to gate 1. The fire brigade was called and the leak was temporarily fixed. The pump fitting had corroded and needs to be replaced. A spare has been ordered by Bill Banister (EN-CV-INJ). At around September 30, the central CERN heating was turned on. The pump had been noisy already in spring time before the heating was turned off. Even though water was dripping into the barracks closest to the leaking pumps, no major equipment damage was reported by the responsible COMPASS groups.

The winter cooling the DAQ barrack was activated on November 14, 2017, in order to anticipate the known outage of CERN cooling water during the winter break and beyond. The installation of the new AC units in the target pump room started middle of November and will in total take three weeks since the removal of the old AC units requires an enforcement of the roof of the pump room.

The outside doors of building 888 are still not equipped with the SUSI system, an access control system with video surveillance, requiring the use of a personal dosimeter to enter the hall. The cameras have been installed in late October and there will be a VIC ("Visite d'Inspection Commune") on November 23 for the cable pulling. The pulling of an additional cable to improve the GSM (mobile phone) coverage in 888 has been delayed into 2018.

Storage of detectors and other equipment. Detectors and other equipment are in general not supposed to be stored permanently in CERN experimental areas. To meet the COMPASS need of more storage space, Johannes Bernhard has identified a company that offers modular industrial buildings. The new building will be erected

[3] *"For a new and complete field map Felix requires a grid in X Y Z and if possible further information about the shape of the coils. Apparently the blue prints have disappeared from the archives. Felix also would be interested in re-measuring the field in late 2018 to compare it to the upcoming simulations. The further steps will have to be discussed with him."*

close to building 888. The idea is to heat it during winter time to keep humidity at a low level. The new storage area will likely not be available before LS2. **Please send your requests (what do you want to store in the new building, and how large is the equipment?) to Caroline by the end of the year 2017**. I will collect and send them to Johannes. So far, only inputs from the Warsaw, Torino, and Illinois groups have been received.

NA64 beam test. During the last two days of 2017 beam, colleagues from NA64 carried out measurements to determine the pion contamination (high momenta around 160 GeV) in the M2 muon beam line. The LH2 target was warmed up for this purpose Saturday October 21. A first analysis of the data shows that the muon contamination is less than 10^{-5} (communication by Vladimir Poliakov) from data with hadron absorbers in the beam. Data were also taken with these absorbers moved out of the beam, but the results were not yet available at the time of this TB meeting.

CEDAR upgrade 2018 (on behalf of Marcin Ziembicki). The mechanical design has been fixed and the design of the optical system is in progress. Two Hamamatsu R11263-203 PMTs were delivered to Wen-Chen Chang (Taipei group) and shipped to Warsaw for characterization. A planning meeting took place on October 4 to detail the schedule and to update the progress on the thermal stabilization (Serge Mathot from EN-MME-DI).

Changeover to 2018 DY run (Caroline Riedl). The 2017 beam was stopped to the COMPASS hall on October 23. A survey of the target showed that it is perfectly straight on (0,0), however the tracking data indicate that the target is tilted towards Saleve. The tilt is present in the data both taken before and after the CAMERA movement in June 2017. This disagreement will have to be further investigated by the GPD analysis group.

In the first week of the changeover, CAMERA, ECal0, the LH2 target, and the silicon detectors were removed from the experimental area. VI02, FI02, the start counter, FI01, and FI15 were moved out of the way to prepare the rotation of the target platform on Tuesday October 31 of the following week. On the same day, the target magnet was surveyed and the target-loading platform was installed to allow work on the polarized target from the upstream side. This platform will only be removed after the successful loading of the target material in March 2018, after which date the beam telescope can be moved in place.

The steps that are related to the polarized-target preparation and that are following the **rotation of the target platform** are detailed in the dedicated target paragraphs

below and concern the preparation of the target-magnet running in early 2018. Close collaboration and communication with representatives from CERN EN-HE heavy handling (Catarina Bertone), the cryogenic group (Olivier Pirotte), the survey group (Pascal Sainvitu), EN-EL (Marcin Szewczyk), and EP-DT (Giovanna Lehmann). On the EP-DT side, the isolation vacuum is maintained by Pascal Blanc, the magnet programming by Sylvain Ravat, and the magnet hardware by Laurent Deront. The interactions with EN-HE are coordinated by Vladimir Anosov on the COMPASS side and Didier Cotte is required for almost every action in 888 involving mechanical handling. The changeover is well on track.

It is mandatory to leak check the isolation vacuum to the downstream end before the **hadron-absorber installation** on November 20/21. The absorber has been stored in building 954 since the end of the 2015 DY run. It was visited by Kurt Weiss from RP (Radio Protection), Oleg Denisov and Caroline on September 22, during which time Kurt found the radiation level to be OK for the moving of the absorber to 888. The vertex detector will not be installed in 2018. Fiber FI04 will be moved from its position downstream of the absorber to the beam telescope.

The Drell-Yan group has been discussing since several months the **exchange or improvement of the 2015 secondary nuclear target** inside the hadron absorber, accompanied by Angelo Maggiora's FLUKA studies. Not least due to the recommendation by the Technical Board, nickel and copper plugs were discarded due to their ferromagnetic and/or activation properties. At the time of the November 7 TB meeting, there are still the options to either exchange the 2015 aluminum plug with a plug of stainless steel, to make the aluminum plug longer, and/or to move it more upstream in order to decrease the shadowing impact of the tungsten plug[4]. After the removal of the vertex detector, there is more freedom to place the nuclear target.

The planning for the **target-magnet cooling** is tailored in such way that the magnet and COMPASS spectrometer can be ready for the first beam on April 9, 2018. This includes running the cold box providing liquid helium from January 15 on, precooling with liquid nitrogen to 80 K starting on January 22, cooling with liquid helium (LHe) to 4 K starting on February 5, and commissioning of the target magnet for five weeks between February 12 and March 19. The five weeks of commissioning are justified by EP-DT considering the new MSS2[5] input cards, the new power converter, the software upgrades, and the new operation sequence. Lastly, each one week is planned for empty target calibration; loading of the target material and deinstallation of the loading platform; and loaded-target calibration and installation of beam instrumentation. The necessity to run the cold-box compressor to provide LHe from January 15 on **severely collides with the planned maintenance of the cooling-water tower**, which is

[4]On November 21, 2017, the existing aluminum plug was moved upstream by 10 cm in the hadron absorber and this will be the 2018 configuration.

[5]Magnet Safety System 2 also used at the LHC

scheduled to be completed earliest on February 23. The LHe consumption per hour is estimated to be ∼6 l before February 5, and at least 50 l after that date. If no alternative source of cooling water or LHe can be found, this would constitute a **delay of at least six weeks in the commissioning of the polarized target**. The compressor needs about 45 m^3 cooling water per hour at around 4 bar. This is way beyond the long-term (in the order of weeks) capacity of the firefighting water. *A first discussion about this topic with the deputy group leader of the firebrigade, Yann Lechevin, took place immediately after the November 7 TB meeting. The overall capacity of firefighting water on the CERN Prevessin site is 120 m^3/h over a short period (during an emergency). It is highly questionable whether more than a few m^3 per hour can be provided over a longer period. They have initiated an analysis of the dynamic flow rate and pressure of the water network and also simulate what will happen if they need water resources at the same time at another Prevessin point.* If the compressor cannot be operated before late February, delivery of LHe in dewars will have to be considered including a very resourceful consumption of the LHe.

Target (Nori Doshita.) **LH2 target:** the voltage of the diode sensor attached on the top of the target cell has been slowly dropping throughout the 2017 run. To understand this effect, the target was evacuated in fast-empty mode on October 20. The sensor was annealed and electrical connections were checked. After this procedure, the sensor voltage had returned to its original value from May 2017.

The **preparation of the polarized target** is well on track. After the rotation and upstream movement of the target platform by about two meters on October 31, electrical and water connections were re-established. The target-magnet and diffusion-pump cables and the 3He pumping lines were installed in early November. Leak checks of the diffusion pump vacuum have started.

In 2018, 6 of the 10 **NMR coils** will be inside the target cells (edge coils and center coils) in order to sample at the beam location, and to disentangle the effects of depolarization from microwave leakage on the one hand side and beam on the other. Kaori is in close contact with the Bochum workshop about the method of fixture.

The 2014/2015 **target material was cleaned** in early October by Nori, Jaakko (visiting for two weeks at that time), Kaori and Genki. About 3.7 g (of in total 400 g) of impurities and water ice were removed, all of it from the downstream target cell, which was the part affected by the 2015 target-filling incident. The procedure was carried out in the clean area using the RICH-group glove box. It is planned to add some old 1995 SMC material to account for the removed portion.

Manpower for the polarized target: Nori Doshita and Kaori Kondo (both Yamagata) will be stationed at CERN for the preparation of the 2018 run and the actual run. Jaakko Koivuniemi (Illinois) will return to CERN for a period of seven months in

January 2018 and then again for a shorter period in October / November for the end of the 2018 run. Yuri Kiselev (Dubna) is available for about six months for the commissioning of the microwave system. Fabrice Gautheron will be available to a limited extent as consultant during the target-magnet commissioning in February and March 2018. This has been clarified in October during a meeting with Fabrice's new group leader in the CERN beam department, the target coordinator, and the spokespersons. Michael Pesek (joined Czech group) will be the 2018 deputy run coordinator and will also be available to assist with target tasks. Genki Nukazuka (Yamagata) will arrive at CERN after his PhD defense in February. Support from the Bonn group and the availability of Jan Matousek (joined Czech group) is still being negotiated.

Improved shielding for target PLCs. A meeting with Ruben Garcia from EN-STI-FDA, an expert on radiation-related influence on electronics involving stochastic so-called single-event effects, took place on October 17. The meeting was attended by Nori, Caroline, Christophe, and representatives from EP-DT and the cryogenic group. COMPASS summarized the PLC failures during the 2015 magnet operation in the presence of beam that were not caused by well-understood reasons such as power cuts: 2 failures of the cold-box PLC, 3 failures of the magnet PLC, and 4 failures of the isolation-vacuum PLC. Each of these events caused a loss of polarized-physics data of about 48 hours. In 2015, BatMon monitors[6] were installed on the rack of the target-magnet PLCs to measure the fluence of thermal neutrons and high-energy hadrons (HEH) per cm^2 over a period of 6 weeks. The integrated fluence per cm^2 of thermal neutrons was $1.7 \cdot 10^7$ and the fluence of HEH was lower by a factor of 10. To improve the PLC situation in 2018, the following modifications will be applied: The cold-box PLC will be moved from its current upstairs Jura location to the ground level behind the existing concrete walls. It will be surrounded (from outside to inside) by a layer of 2 cm polyethylene to thermalize neutrons, and a 5 mm boron-carbid sheet to absorb thermalized neutrons. The isolation-vacuum and the target-magnet PLCs will be moved from their 2015 locations - upstairs Saleve barracks resp. caged area next to entrance to the experimental area - into a new concrete bunker next to the caged area. The 80 cm of concrete will reduce the high-energy neutron flux by a factor of 10 and the thermal neutrons by a factor of 3. Inside the bunker, the PLCs will be surrounded by polyethylene and boron-carbid.

[6]BatMoon monitors are the battery-powered version of the RadMon, which includes RadFETs for Total Ionising Dose (TID) measurements, silicon p-i-n diodes for the 1-MeV equivalent neutron fluence, and SRAM memories for the HEH and thermal neutron fluence. Spiezia, Giovanni et al., *The LHC Radiation Monitoring System - RadMon*, Proceedings of the 10th International Conference on Large Scale Applications and Radiation Hardness of Semiconductor Detectors, Florence, Italy, July 6-8, 2011, PoS, RD11 (2011) 024.

2018 radio protection (Angelo Maggiora). Various FLUKA simulations have been performed by Angelo in the past few months to calculate the radiation levels for the 2018 run. The backward flux on the polarized target was estimated to be of the order of 1%, independent of the used nuclear target and shielding. The FLUKA geometry was extended beyond the Saleve wall of building 888 and additional air volumes were included. The hourly doses in the old DAQ control room in 888 and on the street between 888 and the clean area, and the yearly integrated dose measured at the environmental radiation monitor at the far-Saleve side towards the public meadow (SMS824) were calculated. These simulations were performed on Blue Waters using 320 CPUs and generating 1.6 M primaries, compared to Angelo's laptop with 8 CPUs and 40 k primaries, improving the statistical precision significantly with no increase in running time.

The strategy of improving the 2018 shielding compared to 2015 was discussed by Angelo, Vladimir and Caroline in meetings with Heinz Vincke from the **CERN radio protection (RP) group** on October 19 and November 3. It was pointed out by Heinz that it is mandatory to stay within the limits imposed to supervised radiation areas and non-designated areas. Building 888 is a supervised area and can only be accessed with a dosimeter. After moving the COMPASS control room to building 892, we do not aim any longer to make 888 a permanent work space (>400 h/year, 3μSv/h), however the hourly limit of 15μSv has to be obeyed (low-occupancy area). All areas outside of 888 are non-designated areas, which can be accessed without a dosimeter (for example, external contractors), except for the Jura-side area immediately next to building 888, which is blocked by a fence when beam is present. The allowed hourly dose is 2.5μSv/h, if not more than 400 hours per year are spent there (low-occupancy area).

Heinz from RP also started some FLUKA runs to provide an independent cross check. Both he and Angelo found excellent agreement between the measured **integrated dose at the environmental monitor** (0.745 mSv in 2015) and the simulation with 2015 configuration (Angelo: 0.74 ± 0.08 mSv/year), i.e. only 75% of the yearly limit of 1 mSv. The **hourly dose on the street** between 888 and clean area for the 2015 configuration was found to be at the limit, or slightly above the limit, of 2.5μSv/h, depending on the applied integration volume. To estimate the conditions for the 2018 run, the expected total number of pions was projected by assuming the spill supercycle to be similar to that in 2017, the average number of pions per spill to be the same as in 2015 ($3.9 \cdot 10^8$), the SPS efficiency to be similar to that in 2017, and the number of total beam days to be 217 compared to 203 in 2015, i.e. an increase of 7%.

The results for the hourly dose on the street are still under discussion at the time of the technical board meeting, including various scenarios with additional concrete shielding (target umbrella or increase of Saleve wall separating experimental area and barracks). Adding more shielding directly around the hadron absorber was demonstrated by the

simulations to not be effective because the bulk of the leaking radiation is escaping in upstream direction, thus the additional concrete and polyethylene shielding around the absorber has been discarded.

Repair of RICHwall (Maxim Alexeev, Daniele Panzieri, Vladimir Anosov). It is planned to replace or repair eight problematic RICHwall tubes before the start of the 2018 run in February 2018 at CERN with four people from Torino and Dubna. Details have to be communicated with Vladimir and the TC. The detector is scheduled to be back in beam position in the 2nd week of March. SM2 can be moved back in nominal position only after that date.

Status of Saclay DCs (Alain Magnon with material from Charles Naim). Efficiencies, RT relations, and resolutions for DC00, DC01, and DC04 at the nominal HV from 2017 data were shown. DC00 performs fine except for low efficiencies in DC00X2 and DC00U2. Some planes have to be re-calibrated for DC01, this is work in progress. DC01U2 has 1 non-functioning ASD8 and it should be considered to replace it. DC04 performs fine in general. There is a slight decrease of efficiency in DC04V1. During the 2016 run, a baseline current occurred on the DC04V cathode, which is rising linearly with the increase of voltage difference between the cathode and the beam killer. As a compromise and in order to be able to operate the V-view of DC04 in 2016 and 2017, the cathode HV was lowered from nominally 1,675 V to 1,625 V, and the beam-killer HV was raised from nominally 900 V to 1,325 V. This results in a current of around 1.6 μA, a current that has been stable over the months. Also the Y-view has such leak, however smaller at 0.6 μA. The leaks are not accessible while DC04 is installed because they are between the protection boxes and G10 frames, or even deeper in the detector. A repair would require at least bringing DC04 horizontal in the clean area, potentially opening it. Due to a lack of manpower, a repair after the 2016 and 2017 runs did not take place.

Test of new FEE card on MWPC 2017 (Maxim Alexeev). Due to a problem with consecutive triggers, noise is generated in the analog part of the currently used FEE cards on the MWPCs. This limits the DAQ dead time. Furthermore, regular interventions had to be undertaken during the 2017 run due to issues with the RJ45 connectors on the FEM boards. Because of these problems, and in view of preparations for running the experiment also beyond 2020, it is desirable to prepare an exchange of the FEE. A beam test with a new prototype FEE card containing Igor's FPGA-based TDC and separate digital and analog parts was carried out on one MWPC during the last days of the 2017 beam. These data are currently being analyzed and the plan is to test the new card on one chamber (PA05) in 2018.