Minutes of the Technical Board Meeting September 4, 2017

Version of September 8, 2017

Present: Vladimir Anosov, Jens Barth, Franco Bradamante, Oleg Denisov, Nori Doshita, Andrea Ferrero, Jan Friedrich, Igor Konorov, Gerd Mallot, Caroline Riedl, Fulvio Tessarotto.

Remotely connected: Maxim Alexeev, Michela Chiosso, Bernhard Ketzer, Stefano Levorato, Angelo Maggiora, Alain Magnon, Marcin Ziembicki.

Communications. The next TB meeting is scheduled for November 7, 2017 (Tuesday). It is suggested to have another TB meeting in December 2017, possibly dedicated to the future beyond 2020. However unlike announced at the TB meeting, subgroup meetings are scheduled for December 5/6 and the AM for December 7/8, so that the TB meeting cannot take place on Dec 7. Because of the transversity workshop the following week, there are not so many remaining options: Monday Dec 4 or Friday Dec 1 (both disfavored). **The TC will send an e-mail to the TB members proposing these two options, or to cancel the December meeting**, asking for preferences or further options.

The 2018 TB meetings will be proposed at the November TB meeting.

Andrea Ferrero will join the ALICE collaboration in 2018. He will still be available to attend TB meetings for the time being. It is proposed to appoint a new TB member at the November CM, replacing Andrea. The TC will approach suitable candidates. Please let the TC know if you know of suitable candidates.

It is suggested to confirm all TB members by the end of this year. (TB members are appointed for a period of two years by the CB.)

Report from the EATM (Annika Vauth). The 2018 DY run will probably start on April 9, 2018.

There were two recent outages of CO2. During the outage in June 2017, the entire CO2 supply (1.8 tons) was used during one weekend. It was caused by a CO2 pipe disconnected at XCET 042.519, a threshold Cherenkov counter inside the H8 beam line, due to a double ring fitting not correctly installed. In July, the outage was caused a switch-over panel that failed to switch from the empty battery to the full battery (in building 907). This was due to a broken piece (a pressostat), which now has been replaced, so the situation is back to normal. It is planned to install flow-meters in different sectors of the North Area to monitor CO2 consumption and to be able to react faster.

The SLAWG (SPS Losses and Activation Working Group) reported an improvement in extraction losses after the retraction of a misaligned ZS2 cathode in mid-June 2017. This cathode of the extraction septum was protruding by $\sim$ 2mm into the extracted beam, causing beam-induced heating effects.

General news from the experiment and 888. The outside doors of building 888 are being equipped with the SUSI system, an access control system with video surveillance, requiring the use of a personal dosimeter to enter the hall. This system has been in place since a long time at for example the Prevessin test-beam hall. The installation is somewhat delayed: the system is not active yet as of early September, only some control panels have been installed.

During a test of the AULs (local emergency stops) in April 2017, various faults were found. For the time being, the AUGs (general emergency stops) have to be used. The faulty AULs will be replaced by EN-EL during the stop between the 2017 and 2018 runs (YETS). The AUGs are scheduled to be tested on February 21, 2018.

Additional cooling was added in BA82, the magnet power converter building. It will be commissioned probably during next the TS in mid-September and is expected to improve the cooling of SM2.

The GSM (mobile phone) coverage in 888 remains poor for many of us, even after an intervention (installation of repeater) in summer 2016 and further network upgrades in July 2017. On August 30, there was another meeting with Stefano Agosta from IT-CS and a poor reception was spotted in the aisle between the concrete wall Saleve and barracks. EN-EL will pull an additional cable there to improve the coverage.

Beam Monitoring Station 3 (BMS3) was forward tilted by 1.3° so that the window touched the beam pipe. Very likely this tilt had been introduced before the start of the 2017 run, when BMS3 had been moved the last time. The modified positions of the screws on the upstream holder leg were returned to their original positions on August 30, 2017 (end of period 6). The GPD analysis group will look into BMS data shortly before and after the incident.

Frequent MCB_errors (MCB = magnet dipole corrector) occurred in the past weeks when ramping down SM2, which prevented the successive ramping up without intervention by an expert. The issue was reported at the EATM and the error was supposed to be fixed on August 30, but it occurred again on September 4 when changing the beam charge.

A water-supply inventory in 888 was carried out upon request with Bill Bannister from EN-CV-OP (Annika, Caroline).

Two parasitic experiments are carried out in the beam-dump area this year: before September 6, in a bachelor project by the Freiburg group, SiPMs and fiber detectors were tested. After September 6, the Munich group will irradiate SiPMs in preparation of the elastic muon-proton scattering experiment to be proposed for beyond 2020.

Storage of detectors and other equipment, and clean area. After the end of the 2017 run, the LH2 target, CAMERA, and ECal0 will be removed from the experimental area. It is requested to temporarily store ECal0 in the caged, former ECal0 assembly area in 888, CAMERA next to this caged area, and to temporarily place the LH2 target in the clean area.

The CERN RP group plans to set up a radio protection buffer zone in 888 before LS2. It will be used to measure materials coming from the experimental area and the beam line tunnel before transport out of 888. Some space has to be reserved (and the ECal0 cage might be a candidate).

Occupancy of the clean area (CA): the Saclay stretching machine is still set up and will not be disassembled for the time being, unless the space is claimed by someone. Close to the gate, the heavy-duty DC4/5 assembly table is still set up and there are various boxes with DC4/5 equipment. In late September / early October, the target group will need some space close to the gate for the inspection and cleaning of the 2015 target material. The LH2 target will be temporarily stored in the CA. The CEDAR group will request space in the CA in February or March 2018. The RICHwall repair might also require space in the CA. **Please let Caroline know if you also request some space in the clean area.**

Reminder by Johannes: experimental areas are not for permanent storage, also and in particular items stored on top of the beam tunnel have to be cleaned up and eventually have to be removed. In case of a magnet failure (e.g.QUAD36), there would otherwise be some serious downtime.

Johannes has made contact with EN-ACE to start a project for a new storage area close to 888. The new storage can be heated during winter to keep humidity at a low level. The new storage area will likely not be available before LS2. Many of the equipments listed above are candidates for storage in this new building. **Please send your requests (what do you want to store in the new building, and how large is the equipment?) to Caroline asap**. I will collect and send them to Johannes.

CAMERA (Andrea Ferrero). The calibration of the 2016 data using laser signals, exclusive ρ^0 events, cosmic data, and pion beams was shown. Systematic checks of the time dependence of calibrations are ongoing and the calibration of the signal amplitudes has yet do be done. The 2017 data have so far only been calibrated using cosmic data also due to a lack of an alignment file for these data, which is required for a higher-level analysis (exclusive ρ^0). The timeliness of the 2017 alignment remains problematic: the coordination between, and communication with, the four young responsible persons from Tomsk is not optimal. Basic tracking properties of the 2017 data have not yet been looked at - for example, the DIS yield per time unit. This might in a dangerous way hide problems that should ideally be spotted as soon as possible in order to correct them while the run is still ongoing.

RICH (Fulvio Tessarotto). In an intervention in early summer 2017, one missing MAPMT was fixed. To solve the cooling problems of the LV, a more powerful cooling system for the FEE was installed before the start of this year's run. After one incident in early July, new fan unit was installed and no further problems related to cooling have occurred since then.

Presently there is a leak of 6 l/h from the RICH gas system. Therefore gas has to be re-filled on a regular basis. There is currently no suitable batch of radiator gas C4F10 available and therefore N2 has to be using for the filling. The current fraction is 75% C4F10 / 25% N2 and is expected to be 65% C4F10 by the end of the run. This will be a challenge for the simulation (successively changing radiation length). N2 was always re-filled *in between* two 2017 data-taking periods. There is currently a 15-20% reduction in detection of the number of photons. The PMT performance seems not affected. The reduced percentage of C4F10 moves the hadron PID thresholds to larger momenta and lower saturation angles

The reason why no suitable C4F10 is available is due to the requirement of high purity. One of the last available bottles of C4F10 has recently been purchased (C4F10 can now not be purchased any longer) and was found to have quite bad transparency. The transparency appears to remain bad also after a gas purification procedure: the results of the spectral analysis are not fully conclusive as for example for a given long-chained contaminating element, not all expected peaks are visible. There are also ongoing attempts to retrieve a suitable batch of C4F10 gas from the LHCb collaboration. Their RICH has milder requirements towards gas purity and thus in principle, LHCb and COMPASS could swop batches. A first LHCb batch turned out to not be pure enough for the COMPASS RICH. Currently the extraction of a second batch of LHCb gas is being organized. In this situation it is important to remark that the fast circulation (almost 20 l/h) has been working since the end of June.

To prevent further shorted pads in the micromegas, new filters (Swagelok 316 with 7 μm pore size) have been installed to keep micro-dust away.

LH2 target (Nori Doshita). The 2017 unpolarized target is working well with good isolation vacuum. Unlike in 2016, the diode sensor attached on the top of the target cell is connected to DCS this year and can thus be monitored. The plateau of the diode voltage reached soon after the filling of the target in May 2017 indicates that in 2017 the top of the cell is filled properly, unlike in 2016. This diode voltage has been slowly dropping from May through September. During the collaboration meeting it was pointed out by Fritz Klein that this could be caused by radiation effects in the target region. Since the diode was not monitored in 2016, it is unknown whether this effect was present in 2016. To understand the effect better, the electrical connections will be checked together with a CERN expert after the end of the 2017 run. The target density is very stable over time, with fluctuations of the order of only 0.03%.

2018 planning (Caroline Riedl, Vladimir Anosov). The 2017 beam will end on Monday, October 23. It is planned to remove CAMERA, the LH2 target, and all detectors upstream of CAMERA in that week (ending with October 27). One general consideration for the remodeling of the target region in preparation of the 2018 DY run is to make use of the various involved CERN groups before the LHC stop, after which their availability will be very limited. One specific constraint for removing CAMERA is the closure of Saclay November 1-5 (around All Saints day) and therefore the unavailability of J.Y. Rousse, the Saclay engineer. It is planned to rotate the target platform the week after (starting with October 30) and to install the hadron absorber in the week starting with November 20. The hadron absorber has to be measured by the CERN radioprotection group and approved for return to the experimental area.

The work package by EP-DT related to the target magnet was discussed at two dedicated meetings with EP-DT (July 21 and August 22) and was integrated by the TC into the COMPASS planning schedule. Ten MSS2 analogue cards will be updated. Together with the replacement of related batteries, related software upgrades, and installation and commissioning time of the target magnet, the work package amounts to total 19k CHF.

Pre-cooling of the magnet with hydrogen is scheduled to start on January 22, 2018. Cooling with helium is scheduled to start on February 19, 2018. The critical step of magnet re-commissioning should then start on March 19, 2018.

Various missing elements in the COMPASS planning were pointed out. They will be integrated and communicated with the respective responsible people. Caroline and Nori will also determine if the list of CERN groups that have to contacted for target tasks is complete. Caroline will also optimize the schedule in close collaboration with Vladimir, who has returned to CERN on September 4.

Polarized target (Nori Doshita.) The manpower available for the polarized target continues to be a serious concern. It will have to be closely followed up to avoid a lack of manpower towards the end of the 2018 run. In 2018, some support from the common fund will be paid to the target experts Nori Doshita and Kaori Kondo. At the CB meeting in June 2017, the Illinois group has agreed to send Jaakko Koivuniemi to CERN for nine months. He will be paid by the common fund. It is currently assumed that Jaakko can arrive at CERN in January 2018. Yuri Kiselev will be available for up to six months for the commissioning of the microwave system. Fabrice Gautheron will be available to a limited extent for the target-magnet commissioning. Since Fabrice has started a new job with the CERN beam department, an official request has to placed for any requests of Fabrice's time that are longer than just a few hours. The TB recommends to contact Johannes and ask him how to proceed. Werner Meyer will be available for the loading of the target material.

The new (compared to 2015) magnet operation procedure, which was developed (or re-discovered from SMC times) to avoid polarization losses during field rotation from solenoid to dipole mode, will be discussed with Sylvain Ravat from EP-DT on September 11.

An inspection of the 2015 target material (produced in 2011) is planned for early October, when Jaakko will be at CERN for two weeks. The plan is to remove ice and dust from the ammonia beads and then measure the weight of the cleaned material. An appropriate amount of old SMC material (produced in 1995) will then be added. The 1995 material has recently been measured by Werner Meyer in Bochum to have a relaxation time compatible with that of the 2011 material, so that a mixing is possible.

Only discussed during the CM: In 2018, two of the ten RF coils will be placed inside the target cell (the respectively center ones in each cell), while the others will be attached to the outside of the target mesh in order to maximize the packing factor. This is a compromise between the request by the Drell-Yan group to have a target-polarization measurement as close as possible to the beam, and to have more uniform measurements at the same distance to the beam compared to 2015, when four coils were inside and six outside, providing partially inconclusive results.

Fabrice should be available to perform calculations related to the homogeneity of the magnetic field.

On September 19, a target meeting will take place while Werner Meyer will be visiting CERN. The preparations for the 2018 run and for the to-be-proposed 2021 run with transversely polarized 6LiD run will be discussed.

Because the old AC units in the target pump room run on a chemical that will not be allowed any longer at CERN, new AC units running on chilled water will be purchased and installed inside the target pump room. The old units (on the roof) deliver a power of 59 kW and air flow of 9,800 m^3/h, which is considered to be overestimated. Three new units of each 9.6 kW and 4,060 m^3/h will be acquired, one of them serving as spare.

CEDAR upgrade (Marcin Ziembicki). The purpose of this project is the significant increase of the rate capability of the CEDARs for the 2018 run and beyond in order to allow identification of beam particles. In 2015, the CEDAR performance was limited by the rate tolerance. Fast Hamamatsu R11263-203 PMTs with pulses width of 2-3 ns were selected for this purpose and 20 PMTs were ordered. Since the delivery is expected only for December 2017, it is attempted to acquire as soon as possible two PMTs from the company for characterization at Warsaw University of Technology (WUT).

PMT R11265-203 has a problem with a dip in collection efficiency. As solution, the project team suggests to blow up the light spot by placing the PMT "out of focus" at a different Z-position, and to determine the Z-position after an X-Y-scan of the collection efficiency. This investigation will be carried out at the test stand at WUT.

The project team has a clear picture about how the readout should look like. It is agreed upon (also by the TB) to go for the TDC option for the monitoring of the amplitudes. A detailed work plan for the near future is presented, which includes for example the adjustment of the experimental setup at WUT and the development of an optical system for PMT gain monitoring.

The project team is in contact with Johannes Bernhard and the CERN EN-MME group. The latter has started some calculations about the thermal stabilization of the CEDARs. More details have to be communicated with them, like how to attach the PMT and the electronics to the vessel. CERN also reserved a designer for the technical drawings. An integration meeting with the CERN group is planned for the near future.

The FEE will be financed through a recent equipment fund granted to the Taipei group of Wen-Chen Chang. The project is secure in terms of funding.

2018 DAQ requirements (Igor Konorov). During Drell-Yan data taking (2015 and 2018), there are 130 k triggers/spill resulting in 30 kHz and 12% DAQ dead time. In comparison with the 2017 run, there are 85 k triggers/spill at 20 kHz and 8% DAQ dead time. There are significantly worse radiation conditions around target region compared to other years and many detectors had an unstable readout in 2015. To monitor the radiation effects, so-called BatMon monitors were installed at various places in the experiment in 2015.

Various measures to improve the readout conditions in 2018 are presented: the installation of radiation monitors around the target region; radiation-related changes (e.g., to move the ethernet switch from the SM1 area to a different position); data-rate related changes (remove all Slink MX modules and install DAQ MUX modules); and a IFTDC test with the MWPC, which, if successful, could result in the replacement of the MWPC F1 cards by IFTDC cards.

The concept for the FEE and DAQ architecture for beyond 2020 is presented for an expected trigger rate of 100 kHz and about 3.5 μs trigger latency. For micro-pattern detectors (GEM, MM and Silicon), it is planned to base the readout on the APV25 chip. Bernhard Ketzer is in progress of purchasing the last 400 chips for COMPASS. For all other detectors, the idea is to use an FPGA-based TDC with time resolution down to 50 ps and a sampling ADC with feature extraction. *(Comment by a TB member: after the experience with DC5, is FPGA really suitable for wire chambers?)* The trigger processor will be an FPGA-module data processor with programmable coincidence, veto, and OR logic.

Igor announces a **workshop in Prague on November 9-10, 2017**, with the goal to start a **coherent development of FEEs, Trigger, and DAQ for COMPASS (and the new experiment) beyond 2020**. An organisational Vidyo meeting will take place in the week of September 11-14.

2018 shield optimization (Angelo Maggiora). The CERN radio protection group requests to decrease the integrated annual dose in 2018 by 30% (compared to 2015), a request that COMPASS will have to meet. Four possible options resulting from Angelo's FLUKA simulations are presented in order to meet this goal. The most significant radiation reduction of -18.6% (to be measured in the old control room in the barracks) is achieved through the installation of 80 cm of additional concrete and 20 cm of borated polyethylene, both materials on the top of the absorber and on the Saleve side of the absorber. For cost reasons, Angelo is asked to repeat the simulation with polyethylene instead of borated polyethylene. The remaining 12% reduction requested by RP will have to be achieved by reducing the beam intensity, in particular during the commissioning phase of the experiment. In 2015, we immediately started with the nominal intensity and used up already a lot of our annual dose at the beginning of the run even though the target was not polarized yet.

Further modifications for the 2018 setup (Caroline Riedl et al). In early October 2017, the CERN cryogenic group will move the PLC units of the target helium cold box from the upstairs Jura side to the ground level behind the concrete wall to reduce radiation and the resulting high frequency of Single Event Effects (SSE) that the PLCs were suffering from during the 2015 run.

Also the target-magnet PLCs (in the caged area next to the entrance to the experimental area) suffered from multiple SEEs during the 2015 magnet operation, some of them involving the complete loss of target polarization. BatMon monitors were installed on the PLCs in August 2015 and the PLCs were shielded in October 2015 with sheets of polyethylene. Failures were however still occurring afterwards. The effect of the shielding is not clear since there is no documentation about the exact number of failures and the data from the BatMons after the shielding installation. Caroline will try to get these measurements. Gerd Mallot remarked that failures of the PLCs also occurred when there was no beam at all, which seems to question a pure radiation effect as cause of the failures.

Angelo's FLUKA geometry file does not include the target-magnet PLC area (only the experimental area, starting from the end of the beam line). This geometry could be extended in principle, but secondary beams and the halo are very difficult to simulate. Prior to the TB meeting it was pointed out by Johannes that adding more shielding without knowing the details of the radiation effect might do more harm than profit. Polyethylene thermalizes neutrons, which then can be captured on heavy-element surfaces and produce electron-positron pairs. Instead of adding more shielding, a possible solution could be to move the PLCs up to a 100 meters, for example across the street in the clean area or in BA82. More investigations have to be performed before the TB can make a decision. Caroline has started to talk to Fabrice and Johannes about this topic and will try to come back with more information at the next TB meeting.

In 2015, the beam telescope consisted of FI01 (X,Y), FI15 (X,Y,U), and FI03 (X,Y,U), resulting in eight planes. Catarina Quintans showed that if ≥ 5 hits are required, the average reconstructed beam tracks per event is 2.1, while it is only 1.7 if 1 plane is lost. Thus the beam telescope is at the threshold of redundancy and it was decided by the Drell-Yan group to add another detector with a U-plane to the beam telescope. The favorite candidate is FI04, which will have to be moved from downstream of the hadron absorber. At its 2015 position, FI04 does not contribute to the tracking (as shown in Catarina's simulation). A recent simulation by Vincent Andrieux shows that adding FI04 to the beam telescope has a significant impact on the redundancy of beam-track reconstruction.

A new support frame will have to be built. The current frame cannot be moved since it is shared with the PixelGEM. The details will be figured out in the near future together with Vladimir Anosov and Rainer Joosten, and also the Saclay group will be involved because FI04 is currently integrated into their detector complex.

The Drell-Yan group is also discussing the improvement of the neutron (aka Li6) absorber, the improvement of the nuclear targets for 2018, and the moving of the vertex detector. **The group has to make final decisions upon these points in the nearest future.** Otherwise modifications will not be feasible due to time limitations. The TB recommends to come back only after decisions have been made.

The vertex detector FI35 was in 2015 installed between target and hadron absorber and was overwhelmed by showers from the hadron absorber. Its hits were not useful for track reconstruction and were excluded from the coral reconstruction of the 2015 data. The movement of FI35 to the 2015-location of FI04 downstream of the hadron absorber has recently been simulated by Vincent. The active area of FI35 is larger than that of FI04. Yet in only 30% of the DY events, one or more hits are registered in FI35. The overall impact on the track reconstruction is marginal: neither the track χ^2, nor the sigma of the track time are improved to a level that could be considered worthwhile. Moreover, one selling argument of the original FI35 position was to have a point upstream of the absorber for better target pointing and to avoid multiple scattering in the hadron absorber. The micromegas directly downstream of the hadron absorber are probably already doing "a good enough job". Is it worth the effort to move FI35? It would be extremely challenging to install FI35 at the FI04 position. The current huge support frame of FI35 would have to be removed since it seems impossible to fit it into the detector-frame-complex currently surrounding FI04, at least according to a first site visit (Vladimir, Didier Cotte and Caroline on September 5).

Looking at the reconstructed z-vertex of the 2015 data, the aluminum target is somewhat shadowed by the tungsten plug. After the removal of FI35, more freedom would be gained to position the Al target (which in 2014/2015 was placed exactly in the middle between FI35 and the upstream end of the tungsten plug). The Drell-Yan group proposes to make the Al target thicker and to move it upstream in order to significantly increase the statistics collected on Al in 2018. Also Ca, Ni, and Fe targets are considered. During the discussion it is pointed out that the highest priority must be to make sure that the polarized target remains protected against backsplashes from any newly introduced or modified material. These backsplashes can decrease the target polarization. While light materials such as aluminum have a protective effect against backsplashes from the tungsten plug into the target, this is not the case for heavier targets. A simulation is mandatory, which does not exist to date. It is also remarked that the removal of FI35 might have a negative effect - FI35 has no active area in the beam passage, but there is a plastic window that might keep backsplashes away from the target.

Nothing should be changed for the 2018 setup that could harm the polarization-dependent measurement. Therefore it might be the best solution to leave FI35 where it was in 2015, but just not to operate it any longer (rename "vertex detector" to "protective layer").

The modification of the Li6 absorber was not discussed at this TB meeting. Angelo had given his final presentation on this subject on the July 13, 2017 DY meeting. *Remark by TC: The remark about not modifying the setup too much also concerns the two layers of Li6 absorber and one layer of polyethylene, which worked very well in 2015. It was actually demonstrated by Alain Magnon that removing one of the two layers of Li6 immediately results in the return of poor efficiency in DC0. This exercise was done on June 10, 2015, during the commissioning of the 2015 DY run. I am very hesitant to modify the 2015 neutron absorber configuration based on solely a simulation.*