

# Report from the run coordinator

Jan Matoušek

Faculty of Mathematics and Physics  
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COMPASS Technical board  
16. 11. 2021, CERN

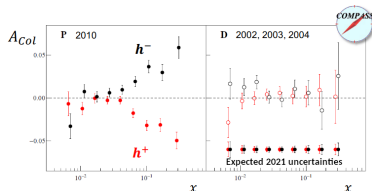


**CHARLES UNIVERSITY**  
Faculty of mathematics  
and physics

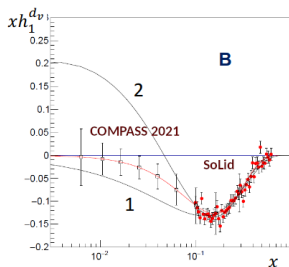




- 1 Goals of the 2021 run
- 2 Polarised target
- 3 Beam
- 4 Detectors
- 5 Trigger
- 6 DAQ and DCS
- 7 Shifts
- 8 Conclusion



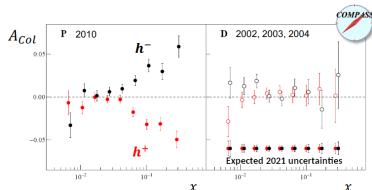
COMPASS results on Collins asymmetry with p and d.



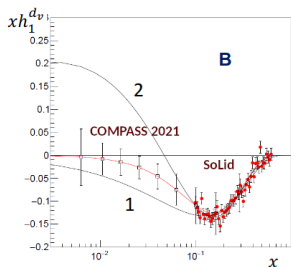
Complementarity with SoLid in the extracted transversity PDF.

[Addendum to the COMPASS-II proposal]

- Semi-inclusive DIS off transversely polarised deuteron target.
- Currently much more data on p than on d target.
- Integrated  $6 \times 10^{18}$  p on T6 is needed.
- 150 days of data taking foreseen in the proposal ( $280 \times 10^{11}$  p/minute on average).
- 2021 run split in two due to COVID delays.
- 105 days requested (1/2 of the data taking + commissioning).
- 85 days of beam were allocated to us in 2021 12. 7. – 6. 10.



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## Original plan

28. 4. Target material loading.
15. 5. Start NMR calibration.
25. 5. Switch to dilution mode.
  1. 6. Dynamic nuclear polarisation tuning.
12. 7. Ready for data taking.

- Planned with safety margins.
- 1 month for DNP tuning in particular.

## Reality

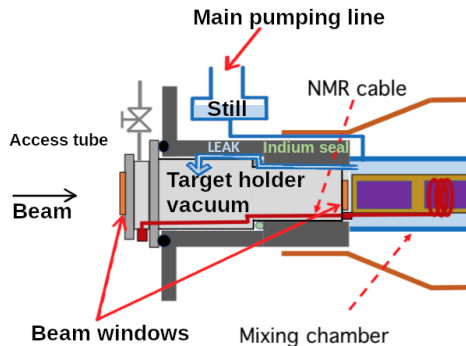
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13. 5. Ice observed on beam window.  
→ Sign of a vacuum leak. Investigation.
27. 5. Target unloading.
  1. 6. Leak tests at CryoLab and in-situ.
30. 6. Target material loading.
13. 7. <sup>3</sup>He pumping line buckled.  
(not COMPASS responsibility)
15. 7. Target unloaded, pipe dismantled.
20. 7. New pipe installed (at 280 K).  
Fridge and magnet cooling to 80 K.
10. 8. Target material loading.
20. 8. Magnet on, NMR calibration.
25. 8. Dilution mode to reach 100 mK.
26. 8. He filling problem with dipole.
31. 8. Solved by EP-DT.
  1. 9. Started dynamic nuclear polarisation.

Details: [Collaboration meeting, 16. 9. 2021]



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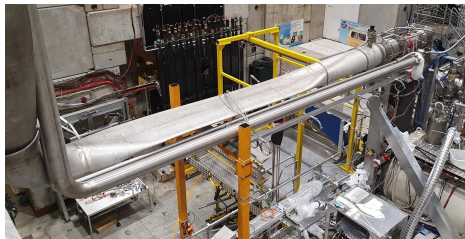
Details: [\[Collaboration meeting, 16. 9. 2021\]](#)





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Imploded  $^3\text{He}$  pumping line.

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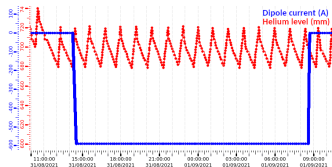
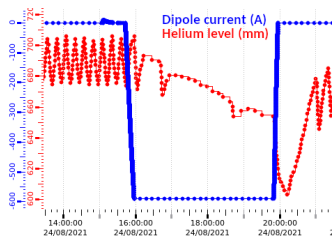
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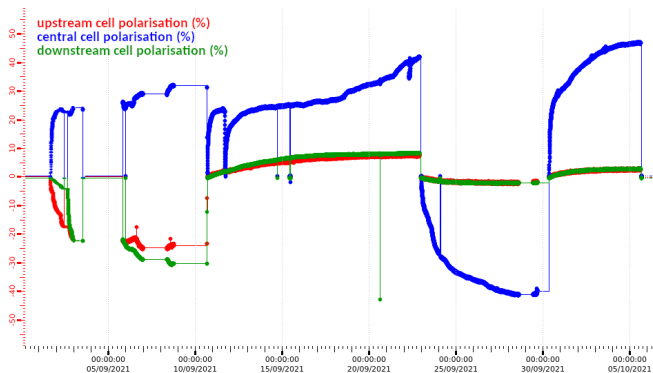


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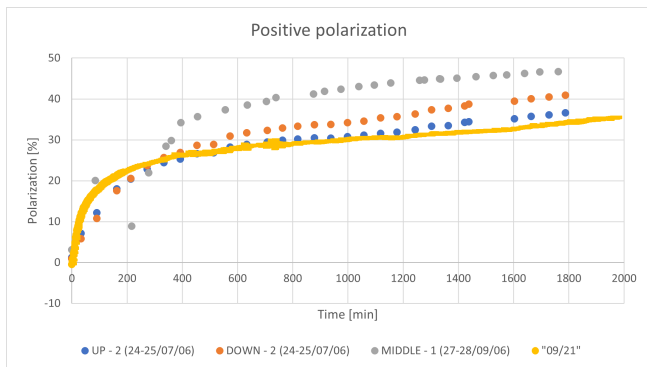
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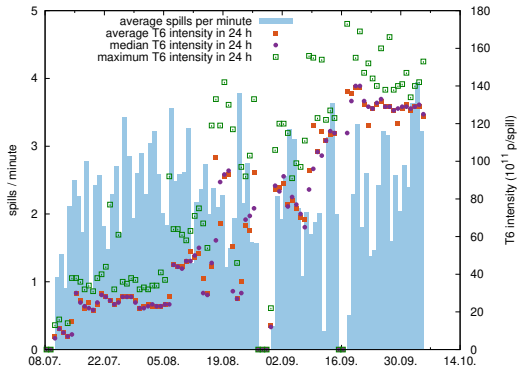




- 1 month for DNP tuning was originally foreseen ( $^6\text{LiD}$  is more difficult than  $\text{NH}_3$ )
- Started 1. 9., problems → **focus on central cell, tuning, optimization.**
- NMR calibration done in haste before the run.
- In parallel with the DNP studies we were collecting semi-inclusive DIS data with one cell longitudinally polarised.
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- 10. 7. First beam set up.
- 16. 8. First high intensity ( $I_{T6} > 100 \times 10^{11}$  p/spill).
- No impact on physics data because of our target problems, only some on the commissioning.
- 7. 9. First transverse target data.
- 11. 9. Hodoscope efficiency data.
- 18. 9. Unpolarised data (target polarisation tests).
- The last 20 days:
  - Improved stability.
  - $I_{T6} \approx 130 \times 10^{11}$  p/spill. (COMPASS could take up to  $140 \times 10^{11}$  p/spill)
  - The average number of protons on T6 per minute better than in our experimental proposal.

Integrated protons on T6:  $1.91 \times 10^{18}$  p.

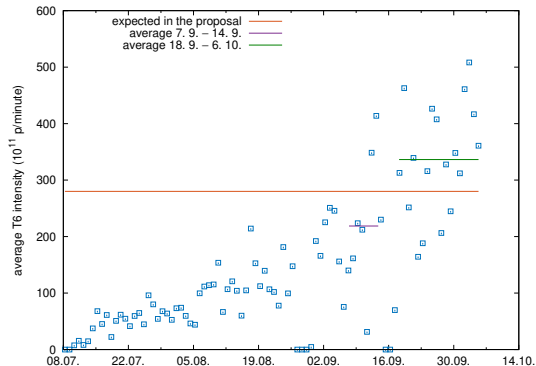
While COMPASS beam on:  $1.56 \times 10^{18}$  p (80%).

Integrated Ion chamber 2:  $13.5 \times 10^{12}$   $\mu$  and  $\pi$ .

Events – transversity:  $0.88 \times 10^9$ .

Events – unpolarised:  $6.64 \times 10^9$ .

Events – calibration:  $2.55 \times 10^9$ .



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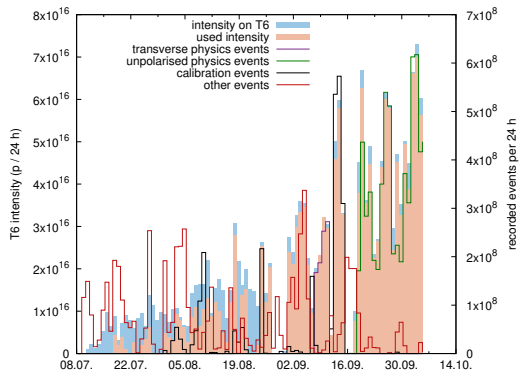
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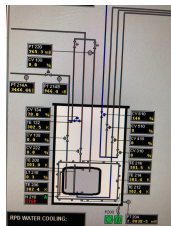
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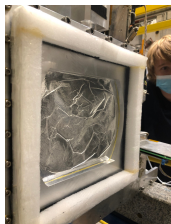
Beam telescope platform building. Beam telescope platform finished.

Mobile AC unit.

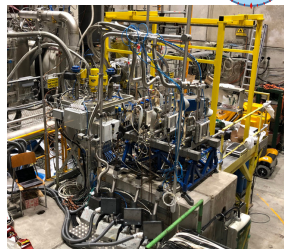
- Experts: Rainer Joosten (BMS, SciFi), M. Ziembicki, R. Kurjata, A. Rychter (SciFi 55).
- BMS waiting for beam on 9. 7.
- SciFi (except BT) also ready for beam.
- FI 8 and 55: communication problem with discriminator card. Solved in September.
- SciFi 6–7: 12 new PS with wrong polarity (positive instead of negative).
  - 3 kV,  $10 \times 3$  mA,  $2 \times 1$  mA.
  - Correct ones rented from E-pool. **Have to be returned!**
  - Old PS could be used as a backup.
- AC in BMS barracks not sufficient
  - Mobile unit deployed for the run.
  - **Permanent solution to be defined with EN-CV.**
- All SciFis (except BT) and BMS operational by end of July.
- Beam telescope platform built 13. 8.
- FI15 and FI02 operational in a couple of days.



Valve box PLC.



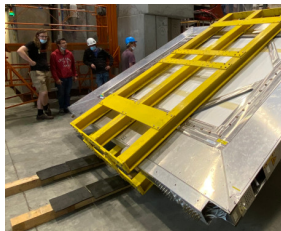
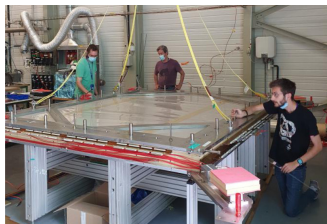
Beam window after over-pressure.



Silicons installed in temporary location.

- Experts: Christian Dreisbach
- Cooling system refurbishment (Cryo, Saclay and Munich).
- Installed next to the loading platform 6. – 9. 7.
- Troubleshooting of the new system (problems with valves and PLC).
  - Mid-July: Fast cooling of one station to 50 K below operating  $T$ , large gradient. No damage to the wafer.
  - $\approx 20. 7.$  leak on station 2 transfer line (O-ring).
- Overpressure during nitrogen flushing, but no serious damage.
- Ready for beam (HV on, sending data) and pedestals taken by 30. 7.
- Beam telescope platform built 13. 8., Silicons working in one week.
- Sometimes not enough pressure ( $< 1.8$  bar) in LN<sub>2</sub> line to re-fill the valve box (depending on He liquefier workings cycle).

Pressurizing device on the large Dewar or on the transfer line?



- Experts: Saclay (Yann Bedfer, Damien Neyret...)
- Help from Vincent and Marco (Illinois), travel issues for Saclay until end of June.
- **Some power supplies rented from E-pool** (LV Wiener, HV CAEN crate + 4 modules)
- DC04
  - Repaired in spring (Saclay).
  - Again broken wire, repaired in July (Illinois, Yann, Stefano, Michael, Christophe)
  - Back in beam by 6. 8.
  - **Recurring problems with noise.** Source unknown, to be investigated. Grounding?
- PMM ready for beam on 9. 7.
- DC 0 V beam killer tripping – can be ramped up for alignment only by expert.
- Mix-up between HV channels (DC 0, DC 4).
- Recurring problems with PMM source Id 380.
- PMM transition cards fuses exchanged 5 A → 7 A (often burnt, cards OK).
- PM03 has X, Y and U all connected to one HV channel.



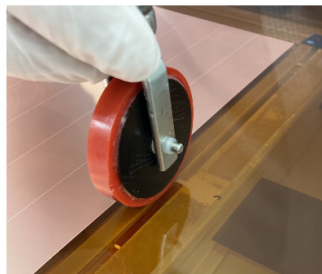
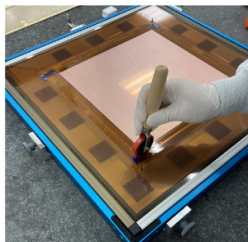
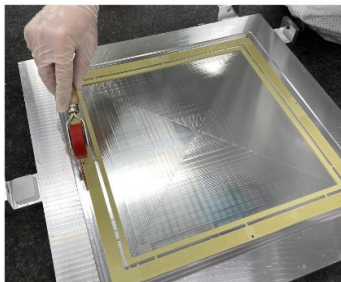


## DC 5

- Experts: Illinois (Vincent Andrieux, Marco Meyer), front-ends: Taipei.
- Broken wire preventing the use of both Y-views.
- **Repair not managed before 2021 run, to be scheduled in YETS.**
- June: problems with large noise, solved.
- Problem with different timing in different parts (to be solved in software).
- Ready for beam on 9. 7.
- HV problem of X' in the week before 13. 8., broken HV cable soldered in situ.

## Straw

- Experts: Illinois (Vincent, Marco), Prague (Kamil Augsten)
- New CAEN HV power supply installed and cabled.
- No problems during the run.
- Ready for beam on 9. 7.



Glueing the new stations.

- Experts: Bernhard Ketzer and his team
- 10 GM and 2 GP stations this run.
- New Rohde & Schwarts LV PS installed by 16. 7.
- Recurring front-end problems with GP and GM04.
- New centre HV switches, mix-up discovered in the week of 10. 9.
- **2 new stations were built this year, to be installed during YETS.**



- Experts: Trieste INFN team (Fulvio Tassarotto, Stefano Levorato, Silvia Dalla Torre...)
- All detectors on HV by 23. 7.
- $C_4F_{10}$  filled only for the physics run (September).
- No problems during the run.
- $C_4F_{10}$  gas recovery finishing.
- Gas for 2022 to be cleaned.



RW drift tubes (March).



RW installation (June).

- Experts: Torino team (Michela Chiosso, Antonio Amoroso, Davide Giordano...)
- Large repair (all drift tubes dismantled, checked and repaired).
- Assembling finished by 11. 6. Moved in position by 18. 6.
- Front-end electronics not sending data to DAQ.
- Main multiplexer exchanged, one card upside-down discovered by 23. 7. Still many errors in Murphy TV.
- Fully working by 10. 9. (fuses, fixed mapping...)



- Experts: Torino team (Michela Chiosso, Antonio Amoroso, Davide Giordano...)
- One chamber had been planned to be equipped with new electronics, but it was ready too late.
- Numerous front-end problems at the beginning of the run (PA04, PA05, PS01, PB05)
- Most issues resolved by 13. 8.
- **Not enough spare electronics!**
- One chamber has is being fitted with new electronics and will be tested during AMBER pilot run. If OK, the dismantled front-ends become spares...



- Experts: Carlos Azevedo, Pedro Correia
- Travel issues, limited presence on site and to the documentation (on paper at CERN).
- New HV PS.
- Station 3 V1 broken wire discovered (to be investigated now).
- Dark currents observed. Correlation with humidity in the hall, but only in the first weeks.
- Leak found in the  $\text{CF}_4$  filter in the week before 23. 7.
- Connected to the Straw  $\text{O}_2$  and humidity meters.
- Large  $\text{O}_2$  contamination (above 1000 ppm) in August.
- Recycling disabled.
- Switched from  $\text{CF}_4$  to  $\text{CO}_2$  in October, no improvement.
- Still not clear...



## MW1

- Experts: Viktor Abazov, Aliaksei Piskun, Georgy Golovanov
- Gas and HV set up by local team without problems.
- Expert arrived 20. 7.
- Large parts of several planes missing in cool. Finally solved with the help of Vladimir Frolov and Bakur by exchange of electronics and cables by 13. 8.

## MW2

- Experts: Victor Konstantinov, Dmitrii Ereemeev
- Ready for beam by 9. 7.
- Good operation during the run.
- Some problem HV Station 2 ch. 2 in August.
- September: 4 HV channels with dark currents.



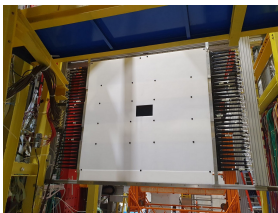
## ECALs

- Experts: Protvino team (Sergey Donskov et al.)
- New LED monitoring of ECAL1 – long installation and debugging.
- ECAL1 PS for Olga and Mainz ordered in July, waiting for custom clearance, finally delivered end of July.
- ECAL2 cabling finished by 16. 7., ready for beam by 23. 7.
- Calibration with  $e^-$  beam planned for the first weeks of beam.
- ECALs not ready and beam non enough intensity (31. 7. with  $30 \times 10^{11}$  p/spill no  $e^-$  seen in ECAL2).
- ECAL1 ready by September.
- Some confusion with the correct position.

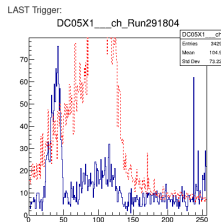
## HCALs

- Experts HCAL1: Dubna team (Oleg Gavrishchuk), HCAL2: Protvino team
- HCAL1 ready for beam by 9. 7.
- HCAL2 lower priority than ECALs, later made ready quickly.
- HCAL calibration with muon beam (8. – 9. 8.)





H1 hodoscope.



Peak from halo tracks.

- Experts: Moritz Veit, Jens Barth
- H1
  - Fully refurbished, assembled by 18. 6., moved in 24. 6., PMTs installed by 9. 7.
  - Cabled and ready for beam by 30. 7.
- 10. – 23. 7. troubleshooting (exchanged PMTs, veto fan-out module...), first timing, all hodoscopes except H1 had profiles in cool.
- 30. 7. BT, MT, LT timed in and working (OT HV scan difficult with unstable  $30 \times 10^{11}$  p/spill).
- Trigger efficiency: dedicated runs with  $\pi$  beam to illuminate outer parts.
- 13. 8. ECAL2 discovered to be in the beam, causing large trigger rates.
- 3. 9. Peak in large trackers explained: halo tracks firing triggers due to a bad slab in VO.
- Final tuning by 10. 9.



## DAQ

- Good performance this run. No big problems.
- Smooth switch from CASTOR to CTA.
- Issues with run logger (runs not appearing in logbook).
- Problems with DIALOG communication library – solved now.
- New feature: detection of ‘incidents’, requiring acknowledgement and suggesting solutions to shifts.
- Shift instructions still could be improved.

## DCS

- Many new/exchanged components connected (power supplies, SI etc.)
- No problems during the run.



Group	Due	Given	Assigned	Done
AVEIRO, University of Aveiro	12	12	9	9
BOCHUM, Ruhr University	8	0	0	0
BONN, Rheinische Friedrich-Wilhelms University	57	85	91	91
CALCUTTA, Matrivani Institute of Experimental Research and Education	16	17	1	1
DUBNA, JINR	77	57	43	43
FREIBURG, Albert-Ludwigs University	8	1	1	1
GENEVA, CERN	8	9	0	0
LISBON, LIP	16	31	24	24
MAINZ, Johannes Gutenberg University	24	23	25	25
MOSCOW, Lebedev Physics Institute	8	19	16	16
MUNICH, Technische University	61	37	33	33
PRAGUE, Joined Czech group (JCzG)	69	74	70	70
PROVINO, IHEP	37	35	36	36
SACLAY, CEA/IRFU	33	27	29	29
TAIPEI, Academia Sinica	12	12	11	11
TEL-AVIV, University	4	0	0	0
TOMSK, Polytechnic University (TPU)	16	24	25	25
TORINO, University/INFN	45	44	43	43
TRIESTE, University/INFN	82	87	95	95
URBANA-CHAMPAIGN, University of Illinois	33	27	28	28
WARSAW, National Centre for Nuclear Research and University of Warsaw	20	23	18	18
WARSAW, Technical University	20	21	21	21
YAMAGATA, University	37	39	39	39
<b>Sum</b>	<b>703</b>	<b>704</b>	<b>658</b>	<b>658</b>

- Period: 28. 6. – 6. 10.

- 600 shifts

- 15 week coordinators

- 32 target shifts.

- In total 703 points.

- Problems to find people at the beginning.

- Some cancelled ( $^3\text{He}$  pipe).

- To be improved: shift crew training.

- All slots covered!

- Special thanks to:

- Andrea Moretti & David Spülbeck (14).
- Vladimir Kolosov & Mathias Wagner & Jan Paschek (13).
- Bonn group (91/57),
- Moscow group (16/8),
- Tomsk group (25/16),
- Lisbon group (24/16),
- Trieste group (95/82).



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LISBON, LIP	16	31	24	24
MAINZ, Johannes Gutenberg University	24	23	25	25
MOSCOW, Lebedev Physics Institute	8	19	16	16
MUNICH, Technische University	61	37	33	33
PRAGUE, Joined Czech group (JCzG)	69	74	70	70
PROVINO, IHEP	37	35	36	36
SACLAY, CEA/IRFU	33	27	29	29
TAIPEI, Academia Sinica	12	12	11	11
TEL-AVIV, University	4	0	0	0
TOMSK, Polytechnic University (TPU)	16	24	25	25
TORINO, University/INFN	45	44	43	43
TRIESTE, University/INFN	82	87	95	95
URBANA-CHAMPAIGN, University of Illinois	33	27	28	28
WARSAW, National Centre for Nuclear Research and University of Warsaw	20	23	18	18
WARSAW, Technical University	20	21	21	21
YAMAGATA, University	37	39	39	39
<b>Sum</b>	<b>703</b>	<b>704</b>	<b>658</b>	<b>658</b>

- Period: 28. 6. – 6. 10.
- 600 shifts
- 15 week coordinators
- 32 target shifts.
- In total 703 points.
- Problems to find people at the beginning.
- Some cancelled ( $^3\text{He}$  pipe).
- To be improved: shift crew training.
- All slots covered!
- Special thanks to:
  - Andrea Moretti & David Spülbeck (14).
  - Vladimir Kolosov & Mathias Wagner & Jan Paschek (13).
  - Bonn group (91/57),
  - Moscow group (16/8),
  - Tomsk group (25/16),
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  - Trieste group (95/82).





Group	Due	Given	Assigned	Done
AVEIRO, University of Aveiro	12	12	9	9
BOCHUM, Ruhr University	8	0	0	0
BONN, Rheinische Friedrich-Wilhelms University	57	85	91	91
CALCUTTA, Matrivani Institute of Experimental Research and Education	16	17	1	1
DUBNA, JINR	77	57	43	43
FREIBURG, Albert-Ludwigs University	8	1	1	1
GENEVA, CERN	8	9	0	0
LISBON, LIP	16	31	24	24
MAINZ, Johannes Gutenberg University	24	23	25	25
MOSCOW, Lebedev Physics Institute	8	19	16	16
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Thanks to all the shift crews and week coordinators!



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- Manpower shortage in several areas.
- Several detectors needed large interventions (H1, RW, DC4, SI...)
- Polarised target accidents and problems.
- Not optimal beam conditions.
- Small but great team on site.
- Detector experts able to do extreme amounts of work during short visits.
- All these people did a great work. I hope that next year it will be in better conditions.



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## Used protons calculation

- Ion chamber 2 taken with muon calibration everywhere.
- Criterium for COMPASS beam on: Ion chamber 2  $> 20^8$  and Ion chamber 2 / T6 intensity  $> 5000$ .
- It is an approximation.

## Notes

- Transversity events: with transversely polarised target.
- Unpolarised events: one cell longitudinally polarised, while we were studying dynamic nuclear polarisation.
- Calibration events: detector calibration, trigger calibration and hodoscope efficiency measurement.
- Other events: DAQ test, detector tests...