Slowly Drifting Dipole in K12

219th Machine Protection Panel Meeting

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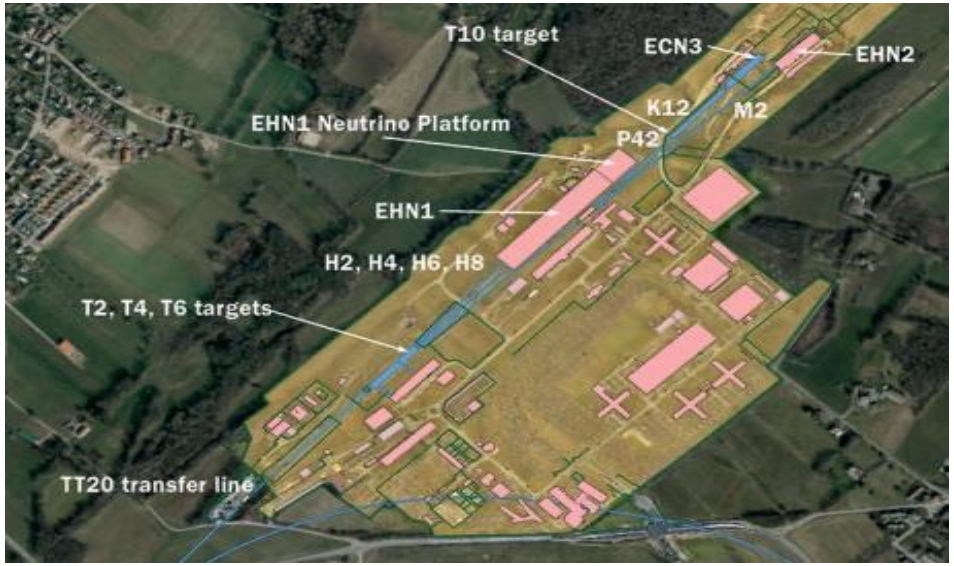
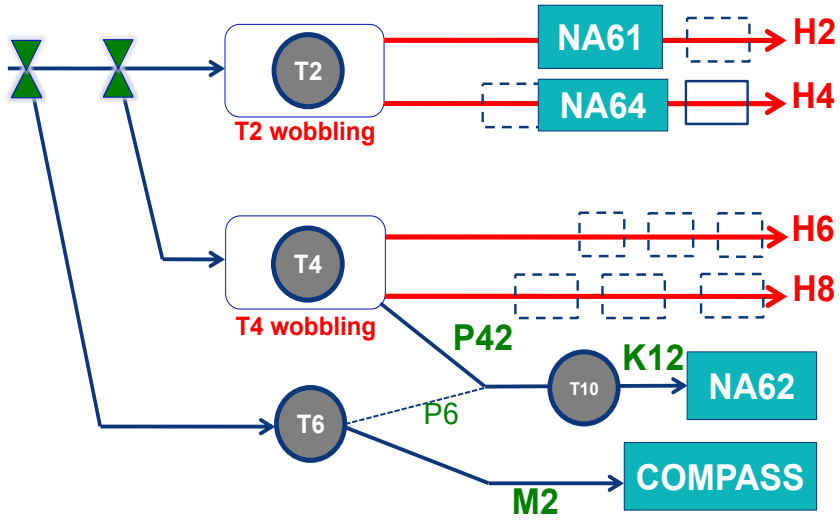
North Area Beams / Intensities

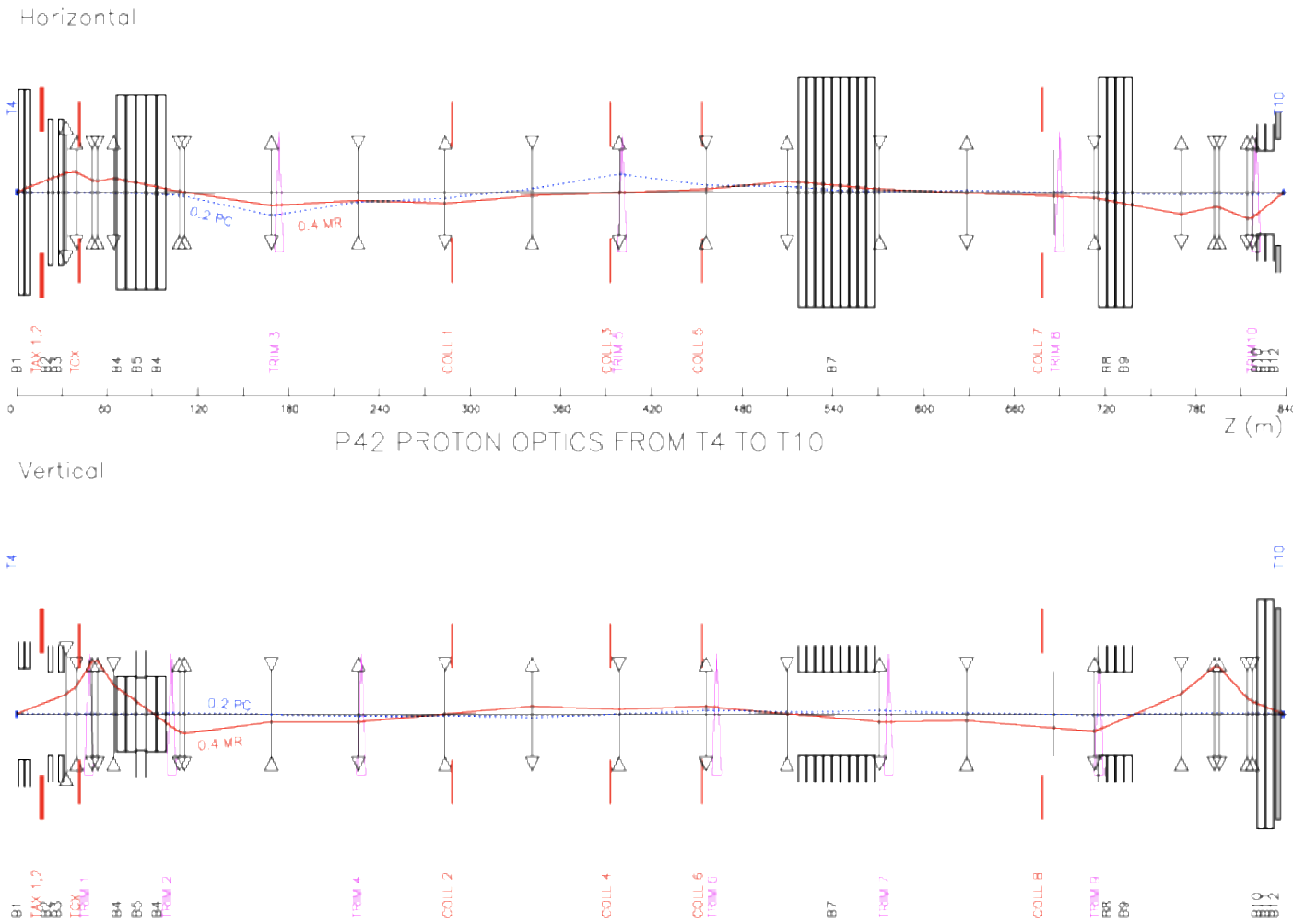
- The 400 GeV/c primary beam is slowly extracted from the SPS, typically about 2 times for 4.8 s each within a 40 s supercycle.
- The total extracted intensity of about 3e13 protons per spill is split between three production targets (T2, T4, T6) for creating secondary beams. Typically intensities are 25e11 for T2, 80e11 for T4 and up to 150e11 for T6.
- The protons not interacting in T4 are transported via the P42 beam line towards the T10 target (typically 45e11).
- From T10, the high intensity secondary beam line K12 delivers about 2e9 hadrons to the NA62 experiment at 75 GeV/c.





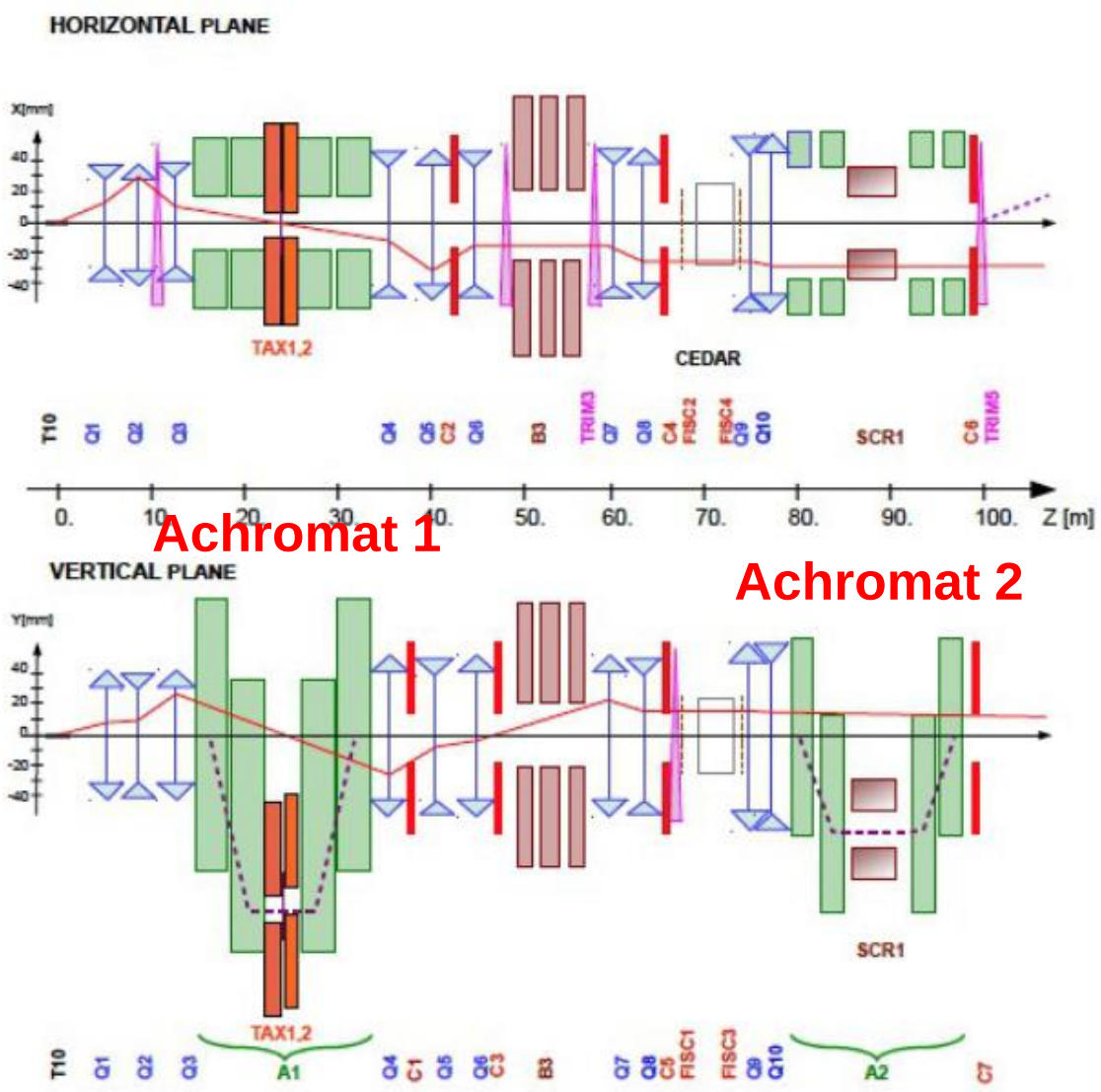
P42 Primary Beam Line

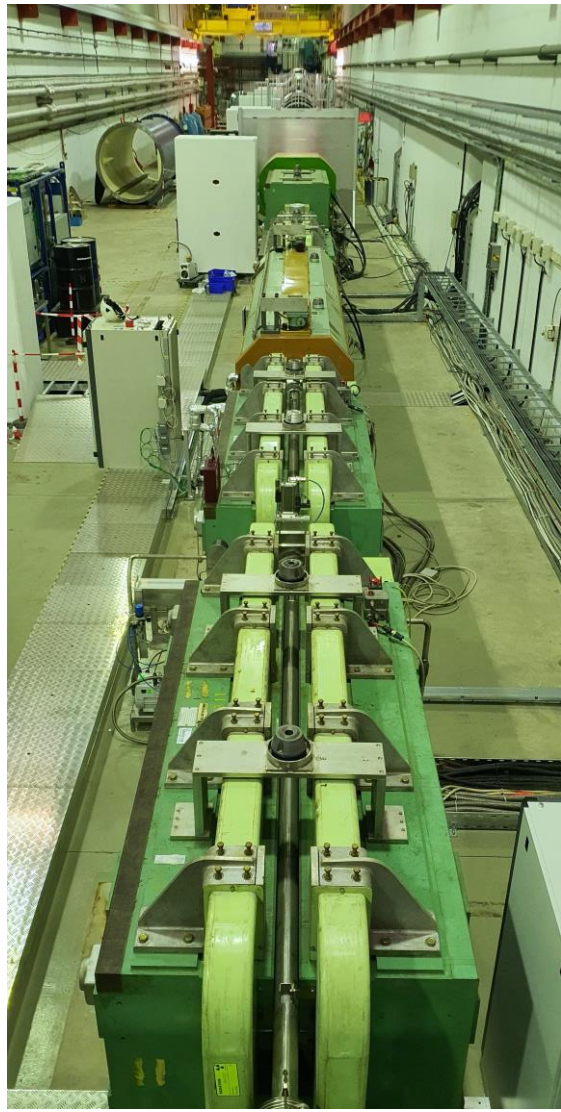
- The P42 beam transports protons from T4 to the T10 target over 838 m.
- Directly downstream of the T4 target, a spectrometer magnet distributes the secondary particles towards the H6 and H8 beam lines at different energies and deflects the primary beam into the P42 line (part of the so-called wobbling).
- Two vertically movable dumps (XTAXs) with different hole sizes select the acceptance for P42 and are used as EIS-b elements, e.g. for access to ECN3.
- The XTAXs are also closed when an interlock on magnet currents occurs.



K12 Secondary Beam

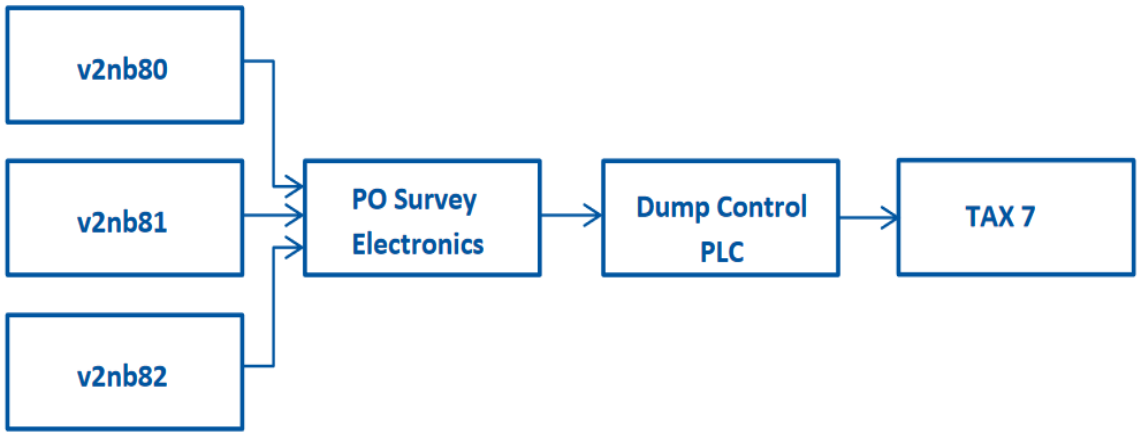
- The K12 beam line transports hadrons from T10 to NA62 over 102 m.
- Two achromats are used to define and measure the beam momentum of 75 GeV/c, while the other elements of the line are used to clean the beam from hadrons outside of the NA62 acceptance, as well as of positrons and muons.
- Also here the power supplies are interlocked, acting again on the P42 XTAX upstream.

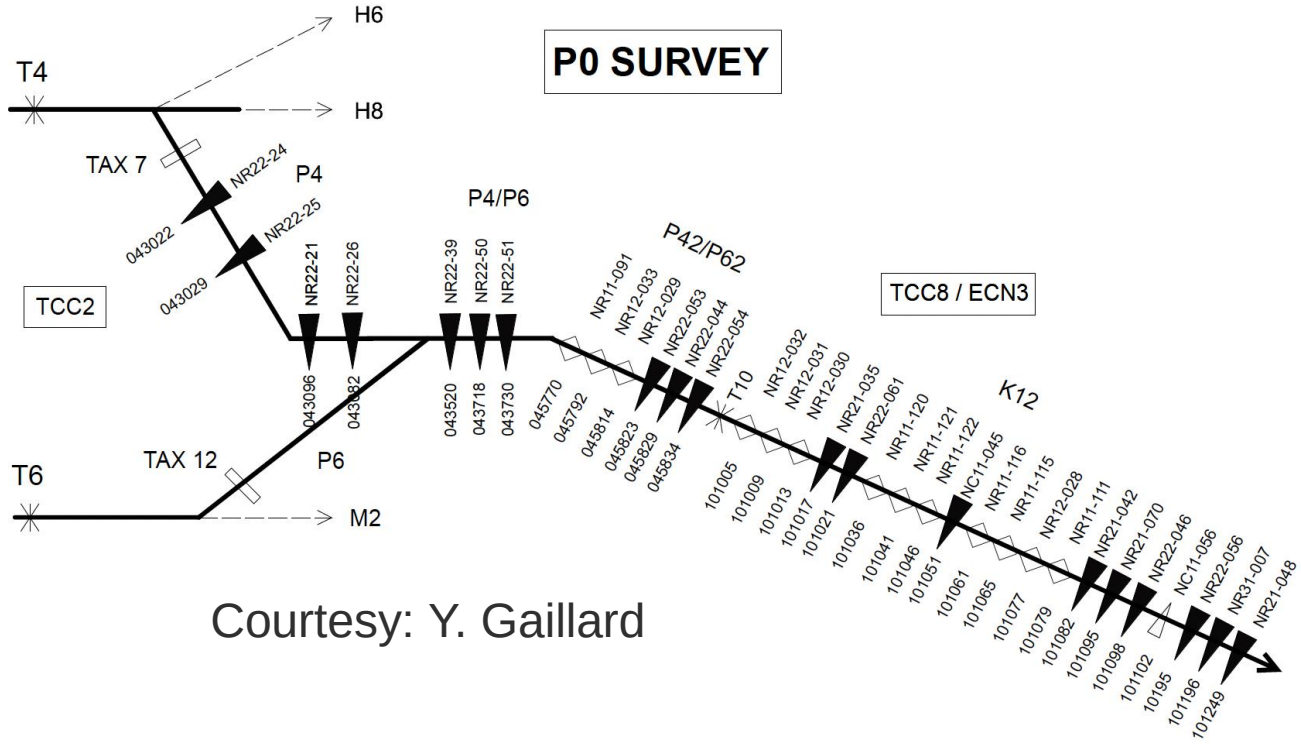




Interlock – P0survey

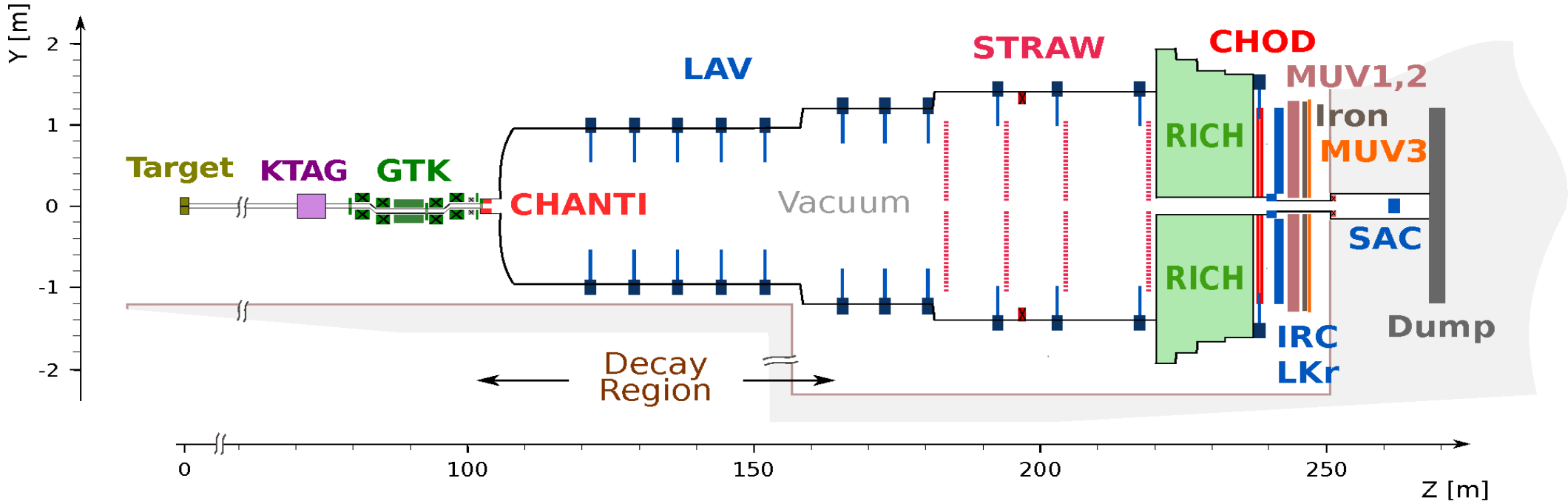
- The primary proton beam has a sufficiently high intensity to do serious damage to the beam elements, in case it is misdirected due to magnet failures.
- The currents in a selected set of about 33 bending and quadrupole magnets are continuously monitored by a special surveillance system, P0survey.
- Actual currents are compared to reference values within a programmable tolerance.
  In case of deviations outside the tolerance, the P42 XTAXs are closed.





Courtesy: Y. Gaillard

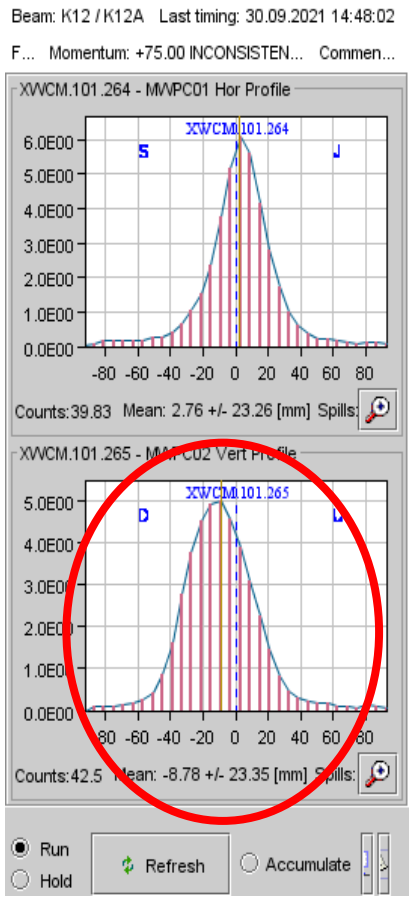
NA62 Experiment



- NA62 is an experiment to search for ultra-rare decays of kaons in flight.
- Background subtraction is key to the measurement, so many detectors are constructed around the beam and very close to the beam. This means that a deviation of the set currents in bends and quadrupoles can deviate the beam (or parts of it) inside of the detectors.
- Several of the detectors are extremely sensitive and irreplaceable (e.g. lKr), so potential damage has to be avoided at all costs.

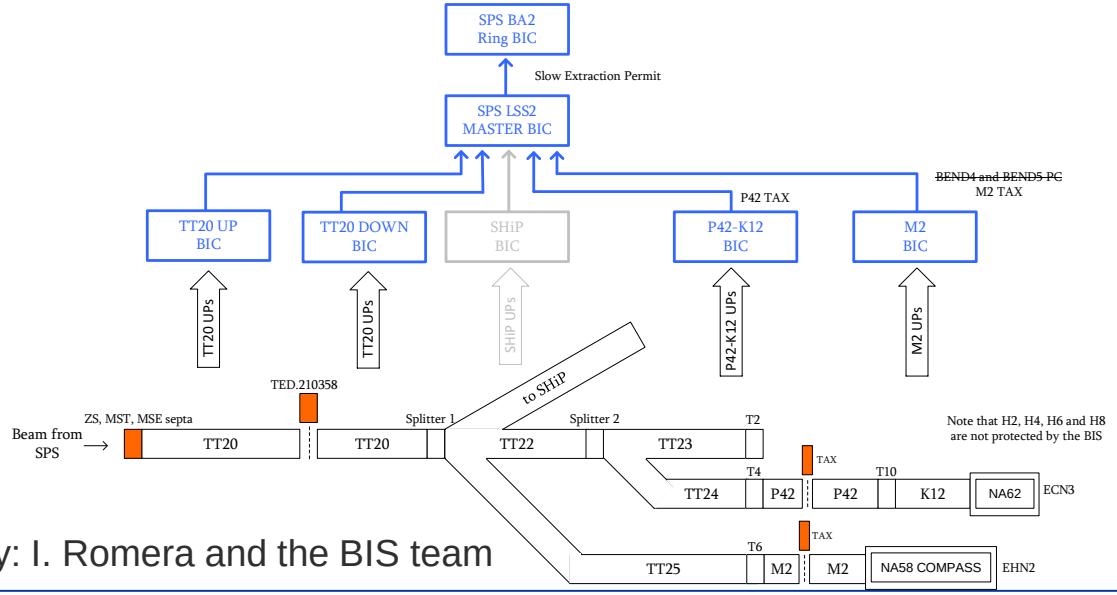
Issue with Slowly Drifting Bend

- During two occurrences in the past run, the vertical beam position measured at the end of the experiment was found drifting.
- Investigations showed a wrong current at the level of the magnet, somehow not detected by the DCCT of the power supply. Thus, P0survey did not act and the beam started drifting into the detectors.
- On both occasions, it was tried to adjust the current manually each time, but we reached the maximum current of the power supply. The deviation is in the order of a few A for a nominal current of 832 A.
- Changing a regulation card helped in both times, however the error could not be reproduced when the previously used card was put back for a test.
- The SPS SIS includes now also a monitoring of the vertical beam position, however this is intrinsically less reliable (single detector, no direct measurement, software).
- In the start of the run, something similar happened for the MNP33 spectrometer magnet, staying undetected with P0survey. The experiment found wrong values in their reconstruction, which then made us notice the issue.

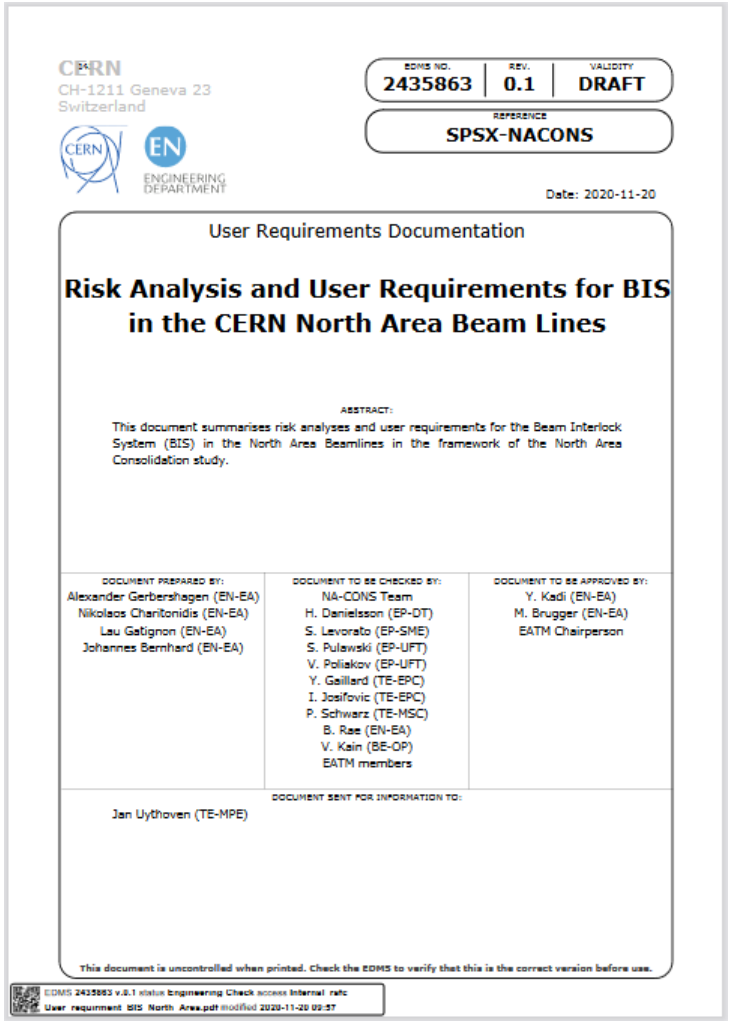


Consolidation and BIS

- NACONS project: In the future, a consolidation of all power supplies (> 40 years old) is foreseen, as well as deploying a BIS system for the North Area.
- For the secondary beams and P42, this is not planned before LS4.
- A risk assessment and user requirements document is available via EDMS 2435863 and the “North Area Interlocking Task Force” working group is looking at the technical specifications and implementation.



Courtesy: I. Romera and the BIS team



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User Requirements Documentation

Risk Analysis and User Requirements for BIS in the CERN North Area Beam Lines

ABSTRACT:

This document summarises risk analyses and user requirements for the Beam Interlock System (BIS) in the North Area Beamlines in the framework of the North Area Consolidation study.

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Short Term Solutions – Discussions

- The fully analogue power converters use one DCCT and the signal is split into two channels: one for the controller card and one for the P0survey interlock. In the past, a second DCCT was made available at certain locations (e.g. BA80), but electronics and the system was dismantled during the last update of the power supply control in the early 2000s → not an option anymore.
- Most likely the amplifiers on the concerned controller card are drifting → to be verified in the lab.
- In K12, the main bending magnets are most critical, comprising in total seven circuits → exchange the amplifiers on the controller cards for at least these circuits.
- The SIS relies solely on the readout of one wire chamber → Add another wire chamber to create redundancy for the SIS interlock and → Setup a dedicated SIS of the North Area, to be independent of the SPS system.
- BIS comes only during LS4 for the beam line in question, can this be anticipated? → Very much linked to the consolidation of the power supplies, which means unlikely reprofiling of several 10ths of MCHF.

Short Term Solutions – Actions

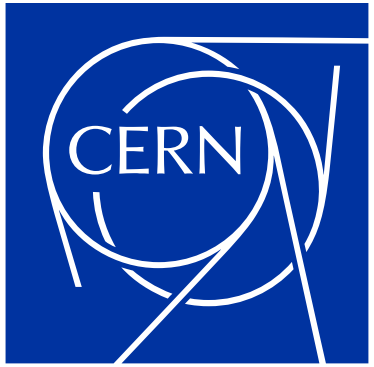
- BI has been informed and a second wire chamber will be installed during the YETS. ✓
- The amplifiers of the controls cards of the most critical seven circuits (the two achromats and dipoles) will be exchanged. ✓
- The deployment of a dedicated SIS instance for the North Area has been requested from CSS and is underway. ✓

1	Bend 1	BEND.101.017	NR21_035
2	Bend 2	BEND.101.021	NR22_061
3	Bend 4	BEND.101.082	NR21_042
4	Bend 5	BEND.101.095	NR21_070
5	Bend 6	BEND.101.098	NR22_046
6	MNP 33/1	BEND.101.195	NR22_056
7	MNP 33/2	BEND.101.196	NR31_007

Critical circuits for K12 operation

Medium Term Solutions – Discussions

- The BIS crate will be implemented in LS3, but the power converters (BA82) will only be replaced in LS4. Taking into account the workload of EPC for LS3 and the required reprofiling of resources, it seems unrealistic that the change of the concerned power converters could be advanced. ✗
- BLM could be added close to the experiment, which could provide a redundant interlock signal to the SIS. Currently no BLMs are installed in the North Area, so no infrastructure for BLMs is available. → Reinforcement of interlock strategy that could be envisaged for the medium term. ✓
- The experiment could provide a beam permit signal to the SIS derived from the conditions of their detectors. → Not possible during YETS 21/22, but possible for 22/23. ✓
- An additional collimator would be the ideal element to protect the experiment. → The experiment is designed as hermetic and adding a collimator would compromise the detector acceptance. ✗
- Possibly more amplifiers on the other control cards could be replaced → To be investigated.



Thank you very much for your attention!

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