CHANGING EXPERIMENTS AT THE πE3 AREA

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The distribution of the experiments in the various experimental areas attached to the high energy accelerator (590 MeV) is determined together with the experimentalists at the beginning of the year, during the Users' meeting. The start and duration of each experiment is defined in the annual program and usually not changed during the year. The exchange between two experiments in the same area is usually so well planned that it can be done during one service day. Therefore, the beam time can be optimally used by the experimentalists, with minimal loss of beam time. One challenging task for all the infrastructure groups involved was the exchange between the MuCap and the MuLan experiment in the πE3 area on one single designated day.

AREA

The πE3 beam line delivers pions and muons in the momentum range from 10 to 250 MeV/c. It is the only secondary beam line with a vertical bending plane, the experimental area being 6 m above the floor level of the experimental hall. The channel views the thick Target E at an angle of 90°, images more than half of the 4 cm long target, and is therefore also an excellent beam line for surface and cloud muons.

PREPARATION

Such an exchange between two relatively big experiments requires precise planning and a lot of preparation. The MuCap experiment, designed to measure the negative muon capture in hydrogen, is led by the University of Illinois (USA) and PSI with collaborators from Gatchina, Munich, Louvain-la-Neuve, and Berkeley. The MuLan experiment measures the positive muon lifetime. It is also led by the University of Illinois with collaborators in various other American universities. Both experiments are aiming at very high precision results and are thus relying on perfect detector placement as well as very good muon beam. The preparation could not be done much in advance, because some parts of the new apparatus were just arriving from the USA and required some last minute changes. The πE3 area is located 6 m above the hall ground. Therefore, all equipment, detector, material and tools have to be moved in and out the area by the main crane. The experimental hall assembly crew (Hallendienst), one of the sections in the technical support department, coordinates the preparations and performs the work in cooperation with the other infrastructure groups.

DISASSEMBLY OF MUCAP EXPERIMENT

The work in the area starts with the dismounting and securing of the MuCap apparatus. The removal of cables and other small parts such as the gas system is done by the experimentalists themselves. The various PSI collaborators, such as electricians, cooling group and vacuum group specialists are then brought in together with the assembly crew to dismount various components and the beam line. Using the crane, all the material is brought down onto an intermediate storage place in the experimental hall.

For large and heavy apparatus such as the MuCap electron detector (4 x 1 x 3 m^3, 3.5 tons) the assembly crew has designed and built a special transport frame. This allows us to extract such a big apparatus without dismounting and furthermore, to bring it back the following year faster and more efficiently.

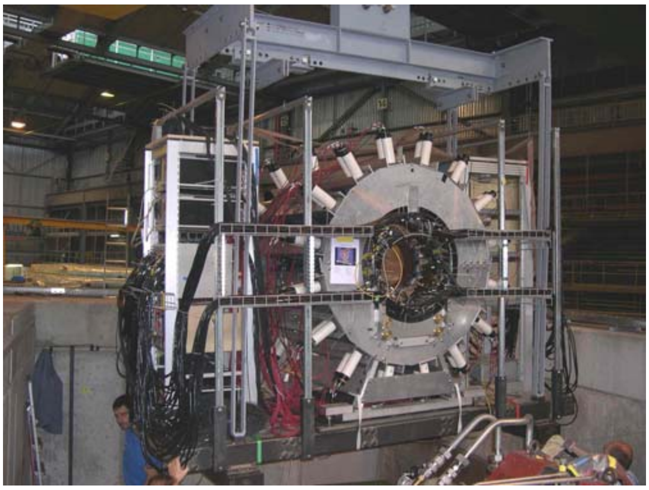

Fig. 1: The MuCap experiment detector transported outside the area in one piece.

Once all the parts of the MuCap experiment were removed from the area, the first task was to move the last quadrupole magnet triplet by 600 mm downstream, to correctly match the beam optics for the MuLan experiment. This move was not originally foreseen and was thus performed with the help of the survey group to ensure that the triplet was perfectly centered on the beam axis. It delayed the overall operation by approximately one hour.

ASSEMBLY OF THE MULAN EXPERIMENT

To build up an experiment of these dimensions during just one day, it is mandatory to engage the survey group, which has the right equipment and all the knowledge required to correctly adjust experiments in the experimental hall. To do the alignment procedure within half a day, the survey group used a local 3D fix-point-network, which is defined through discrete points evenly spread throughout the πE3 area. These points define a local coordinate system, which is based on old measurements and survey marks. The network measurements took place during another survey task about four months previously. The position (most common is a symmetrical position on the theoretical beam axis) of all components are known in this system.

Another fundamental survey task is the basic measurement of the experiment. The aim is to reference the midpoint of the experiment, or the position of the future experimental target, and to reference points which are mounted on the apparatus, usually directly above the adjustable devices. To find out the midpoint of a detector, a survey of the geometry is the most useful procedure, even though it is just an approximation because the definition of surveyed points depends on the material, construction and a steady hand. Thereby, the survey people are defining lines and shapes just out of single points. These points are measured with a high precision industrial tachymeter (TC2002) or with an even more precise instrument, the laser tracker (LTD500).

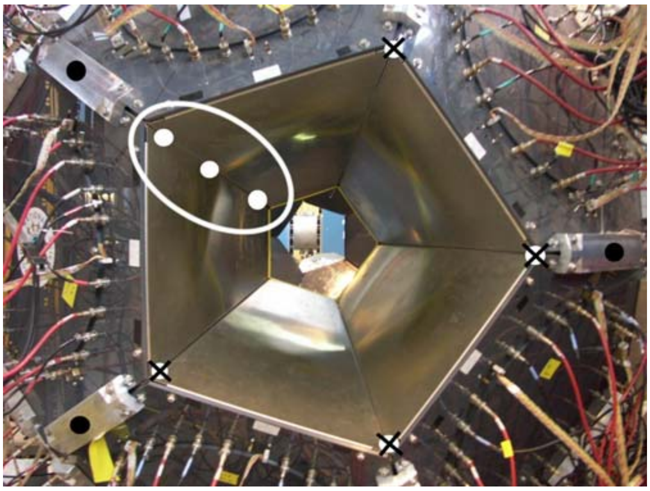

Fig. 2: Reference measurement of the MuLan detector: White points define a line, black crosses a plane, and black points a spherical shape.

After computation and evaluation, the three dimensional offsets from the midpoint to the outer reference points become known. With these offsets, the survey group was able to align the experiment to its correct position in the πE3 area. Immediately before setting down the whole experiment on the rails with the special transport frame, the survey group aligned the height of the rails using a precision level tool (N3).

The final alignment procedure was also done with an industrial tachymeter, whose position was determined in the local coordinate system with a 3D free station transformation. With this known station, the reference points are measured. Following a nominal to actual comparison, the difference value is minimised with an iteration loop. In the end, the experiment was placed at its final position within a global accuracy of ±1 mm.

For an experiment to be able to use the beam, much more work is required such as exchanging the barracks, connecting the cooling system and mounting the vacuum connections. The rest of the experimentalists' material must also be craned up inside or around the area.

The work was nicely finished in the evening, as carefully planned. However, due to an independent incident in the accelerators, a long beam interruption occurred. The MuLan first run with beam could only take place four days later. In total, the exchange of the two experiments required 56 in and out crane movements.

Fig. 3: Installation of the MuLan experiment detector in the πE3 area.

Such an exchange between the experiments would not have been successful without having been able to move the kicker inside the area a few days earlier. This installation alone took the most part of one half of a day for the assembly crew and the surveyors.

SUCCESS

It is only with good advance planning that such a major work, involving various local technicians and specialists as well as the experimentalists, can be done in one single day. The co-operation of everyone involved is imperative.

We must mention that we continue to be happily surprised at the goal driven quality and motivation of the external group collaborators. Despite some language problems, the common work is successful and carried out in a friendly atmosphere.

Fig. 4: The completed beam line in the πE3 area. Coming from the right, the beam crosses the separator, the kicker with its four visible high voltage tall cabinets, two quadrupole magnet triplets separated by a slit pair and finally arrives at the MuLan detector.