A beam line for schools

Great things can happen when high schools get involved with cutting edge science, and that's exactly what CERN is proposing with its new beam line for schools competition, which will form part of the laboratory's 60th anniversary celebrations in 2014. The competition will be launched in the autumn term, 2013, at which time detailed information will be provided. In the meantime, here's a taste of things to come…

CERN is famous for the discovery of the Higgs boson and the invention of the World Wide Web, but there's much more to the laboratory than that. A large part of CERN's research and development is carried out at so-called fixed-target beam lines. These projects range from investigating the inner workings of protons to probing the mysteries of antimatter. In 2014, CERN will be making a fully-equipped beam line available for schools, with beam-time being allocated via competition, just as it is allocated for all CERN experiments.

The competition is open to high-school students of 16 and older, in teams of nine. Teams may be composed of students from a single school, or a number of schools working together. Proposals will be pre-selected by a committee of CERN scientists, with the short list being sent on to the SPSC, the committee that validates all proposals for experiments at the laboratory's SPS and PS accelerators.

To enter, student teams should study the attached information about the beam line and experimental facilities, and write a brief proposal explaining why they would like to come to CERN, what they would hope to take away from their experience and what initial thoughts they might have on using the beam for an experiment. This should not exceed 2000 words. Applications will be accepted from autumn 2013, and the winning team or teams will be informed by summer 2014. The experiments should be conducted in the second half of 2014. To help teams prepare, a series of Google+ hangouts will be organized allowing entrants to ask questions of some of the people the winning team or teams will be working with.

The winning team or teams will be invited to CERN for a period of up to two weeks to carry out experiments on the beam line. The team will be divided into three groups that will rotate between three locations. Location one is the CERN Control Centre, from which all CERN's accelerators are operated. There, students will work with the machine operators to deliver the beam to the East Hall experimental area where their beam line is situated. Location two is the East Hall control room, from which students will be able to fine-tune the beam being sent to their experiment. And location three is the control room for the experiment itself. Members of the school that do not come to CERN will still be able to take part in the data analysis and participate in the experiment via the exchange of web-based data.

The CERN Proton Synchrotron (PS) T9 experimental area: technical specifications

Beam energy: up to 10GeV/c.

Beam composition: a mixed hadron/electron beam with a significant electron component at momenta lower than 5 GeV.

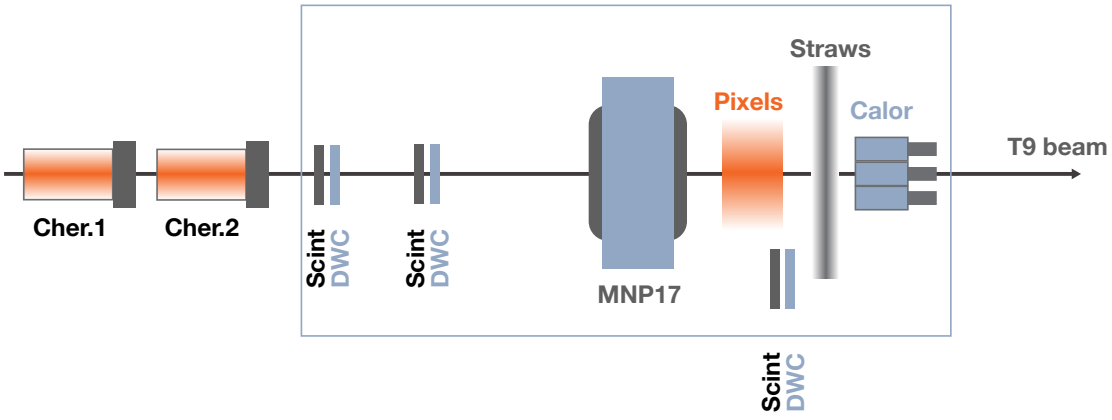
Spectrometer magnet: CERN's CERN's MNP17 large, polarity-changeable, horizontal dipole magnet with a maximum field of 0.96 T over a length of 52cm. The gap height is 30cm and the useful aperture width is 1m.

Installed measurement equipment: two threshold Cherenkov counters, a delay wire chamber and a scintillator.

Additional optional measurement equipment includes: two further scintillators, two further delay wire chambers, a six-plane Pixel telescope for position measurement, five lead-glass calorimeter blocks for energy measurement, a four-layer straw detector for position measurement.

Dimensions of the experimental area: 5m x 10m.

Schematic diagram of the T9 experimental area



T9 beam characteristics

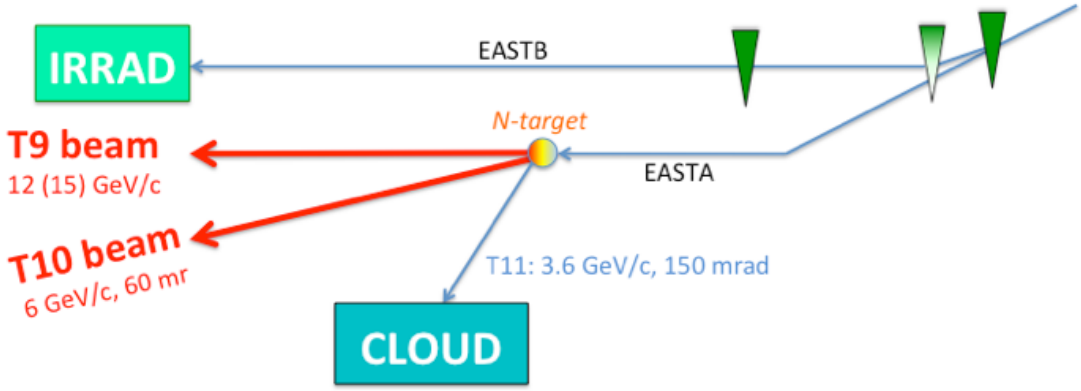
The T9 beam is a secondary beam line produced from a 24 GeV/c primary proton beam slowly extracted from the Proton Synchrotron. The T9 beam can be operated in the energy range between 0.5 and 10 GeV/c and has a momentum resolution of just over 0.5%. The maximum momentum band is +/- 8%. The T9 line can transport either positive or negative particles. The beam is a mixed beam. Depending on the beam momentum and sign chosen there are pions, (anti)-protons, e+ or e- and at the percent level also kaons and muons. In the negative beam mode the fraction of electrons can be as high as 80% at 0.5 GeV/c but drops to ~5% at 5 GeV/c, for the electron enriched target. With the hadron target the electron fraction is much lower. The absolute rate of e^+ is the same as for e^- at the same momentum, but relative to hadrons the fraction of e^+ in a positive beam is lower than e^- in a negative beam. The beam is delivered uniformly over a burst of 0.4 seconds. Depending on scheduling such a burst is provided typically once or twice per ~15 seconds. The maximum particle rate per burst of 10^6 is achieved for a +10 GeV/c positive beam. For negative beams the rates are typically 2-3 times lower and the rates drop significantly at lower energy.

More details can be found at:
http://sba.web.cern.ch/sba/BeamsAndAreas/East/East.htm .

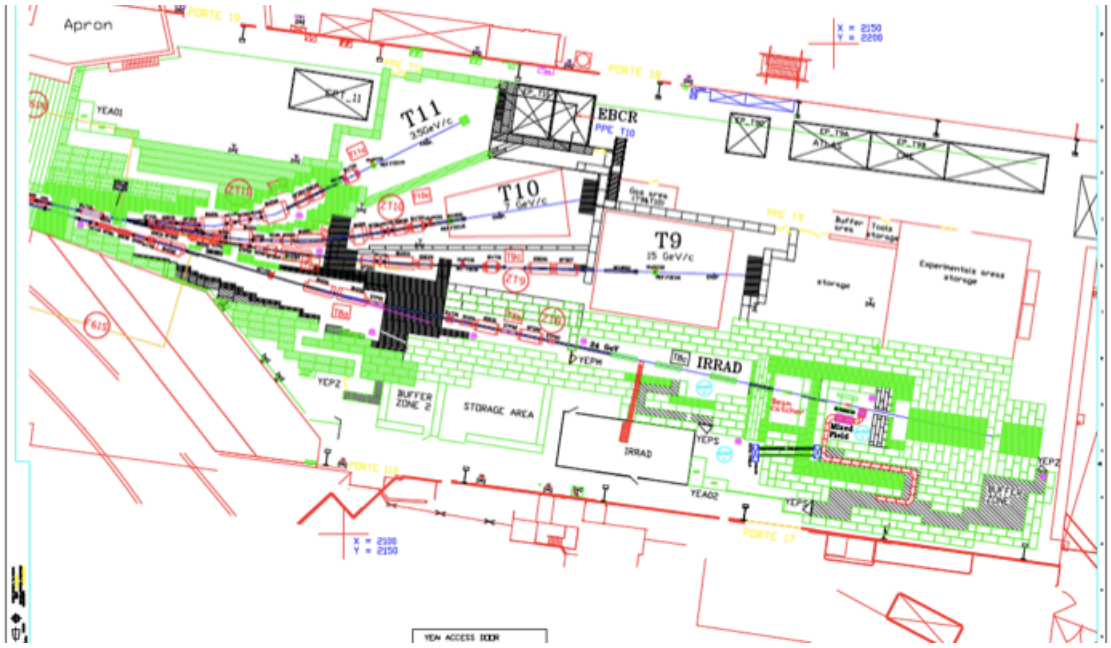
T9 parameters

Parameter	T9
Maximum Momentum [GeV/c]	15
Production angle [mrad]	0
Distance target- reference focus [m]	55.8
Beam height above floor [m]	2.5
Angular acceptance Horizontal [mr] Vertical [mr]	±4.8 ±5.8
Acceptance solid angle [μsterad]	87
Theoretical momentum resolution [%]	0.24
Maximum momentum band [%]	±10
Magnification at ref. focus (X, Y)	1.0, 1.2
Protons on North target per spill	$15\ 10^{11}$
Maximum flux (depending on p, Q, ..)	10^6

Synoptic of East Area beams in 2014



CERN PS East Hall layout



Some photographs of the experimental facilities

The MNP17 magnet

The end of the T9 beam line

Collimator controls in the East Hall control room

A pixel telescope