The CNGS Facility: Performance and Operational Experience

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Abstract:

The CNGS facility (CERN Neutrinos to Gran Sasso) aims at directly detecting muon to tau neutrino oscillations. An intense muon-neutrino beam (10^17 muon neutrinos/day) is generated at CERN and directed over 732 km towards the Gran Sasso National Laboratory, LNGS, in Italy, where two large and complex detectors, OPERA and ICARUS, are located. CNGS is the first long-baseline neutrino facility in which the measurement of the oscillation parameters is performed by observation of tau-neutrino appearance. In this talk, an overview of the CNGS facility is presented. The experience gained in operating this 500 kW neutrino beam facility is described. Major events since the commissioning of the facility in 2006 are summarized. Highlights on CNGS beam performance since the start of physics run in 2008 are given.

Summary:

The CNGS beam is extracted from the CERN SPS accelerator and sent down an 840m long proton beam line with a slope of 5.6% onto a carbon target producing kaons and pions, corresponding to an average power at the target of 510kW. The positively charged pions and kaons are energy-selected and guided with two focusing lenses, the so-called horn and reflector, in the direction towards Gran Sasso. These particles decay in a 1000 m long, 2.5m diameter decay vacuum tube into muon-neutrinos and muons. All the hadrons, i.e. protons that have not interacted in the target, pions and kaons that have not decayed in flight, are absorbed in a hadron stopper. Only neutrinos and muons can traverse this 18 m long block of graphite and iron. The muons, which are ultimately absorbed downstream in around 500 m of rock, are measured in two muon detector stations. They are arranged in a cross-shaped array (see Fig. 3a), measure the muon intensity and the vertical and horizontal muon profiles which allows concluding on the intensity of the neutrino beam produced and on the beam profile. A schematic overview of the CNGS neutrino beam facility at CERN is shown in Fig. 1.

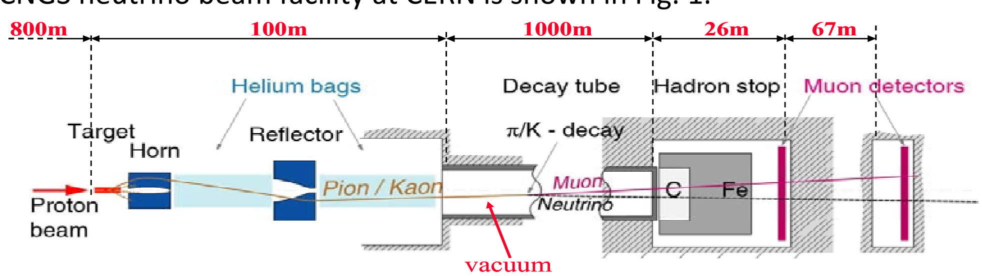

Fig. 1: Main components of CNGS.

During a nominal CNGS cycle, i.e. every 6s, there are two SPS extractions (10.5 s each, separated by 50ms) of $2.4 \cdot 10^{13}$ protons each at 400GeV/c.

After six years of construction and a successful commissioning in 2006 the CNGS facility was first operational in July 2006 for an approved physics program of five years with a total of 22.5E19 protons on target (4.5E19 protons/year).
Having resolved successfully some initial issues that occurred since its commissioning, the facility had its first complete year of physics with 1.78E19 protons on target in 2008. In 2009 so far (status 31 August 2009) 1.8E19 protons an target have been delivered (Fig. 2) and OPERA has collected more than 1929 candidate interactions in the bricks.

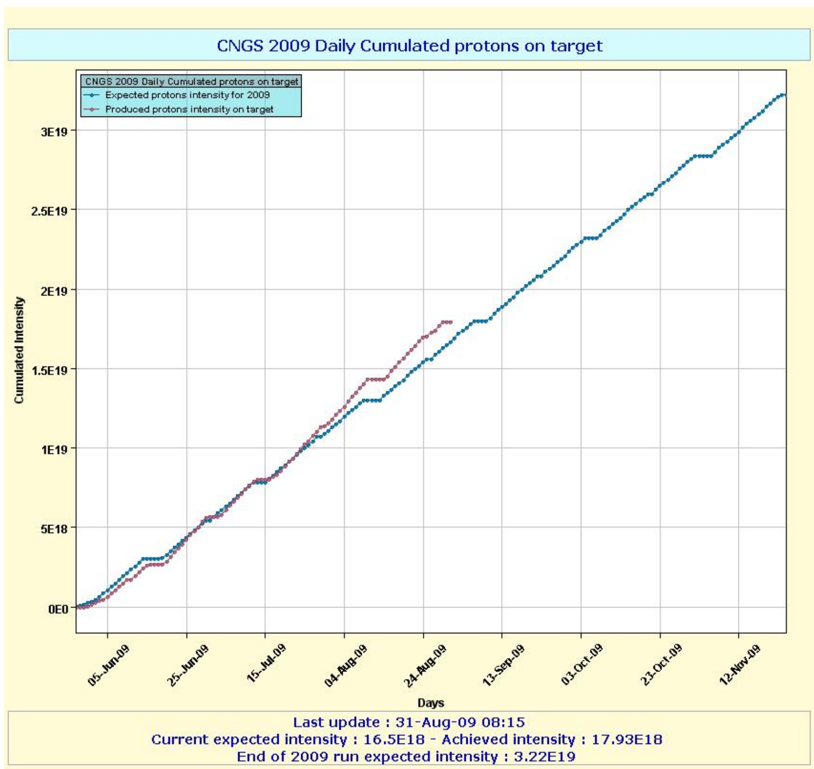

Fig.2: CNGS 2009 daily accumulated protons on target.

The startup issues faced, although successfully resolved, demonstrate the difficulty in the design and operation of such high intensity facilities. The complete and redundant monitoring capabilities built into the CNGS beam line along with the full simulation model is an important asset assuring early detection of problems, guidance to technical solutions and cross-check of beam stability as required by the experiments.