ILC SITING IN RUSSIA, DUBNA REGION AND ILC RELATED ACTIVITY AT JINR

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Abstract

The investigations on ILC siting in the Dubna region and ILC technical activity at JINR are presented. International intergovernmental status of JINR, stable geological and plain relief conditions comfortable location, well developed infrastructure create powerful advantages of JINR among other possible sites. Shallow layout of tunnels and experimental halls could significantly reduce the cost of conventional facilities. Besides JINR physicists take part in several fields of activity in ILC: works on photo injector prototype, participation in design and construction of cryomodules, laser metrology, etc. [1].

INTRODUCTION

Taking into account that the ILC project is considered by the international scientific community as a strategic priority in the field of high energy physics after the LHC era, the Scientific Council of the JINR has supported the idea of collider siting in Dubna region and has recommended taking part in preparation of the collider project. In 2006 the Committee of Plenipotentiaries of the JINR Member States has approved these decisions.

- The ILC linear accelerator, up to 50 km long, is proposed to be placed in the northern part of Moscow region to the north-east from the existing scientific centre JINR in the town Dubna (Fig. 1). This area is thinly populated, the path of the accelerator traverses only two small settlements and a railway with light traffic between the towns Taldom and Kimry. The region is mainly covered with forest with small inclusions of agricultural lands. There are several advantages for the ILC in Dubna:
- One is the presence of JINR as a basic scientific and organizational body.
- The proposed territory is extremely thin populated and practically free of industry, rivers and roads. There are no reserves and monuments at the site. The site does not affect national parks. The proposed position of the accelerator tunnels is in relatively dry drift clay, which excludes the influence of the groundwater distribution.
- The area is absolutely seismically steady and has stable geological characteristics.
- A flat relief and the unique geological conditions allows to place ILC close to the sur-face (at a depth of about 20 m) and performs a construction of the tunnels, experimental halls and other underground buildings at low cost. Even cut-and-cover construction is possible over nearly the whole length.

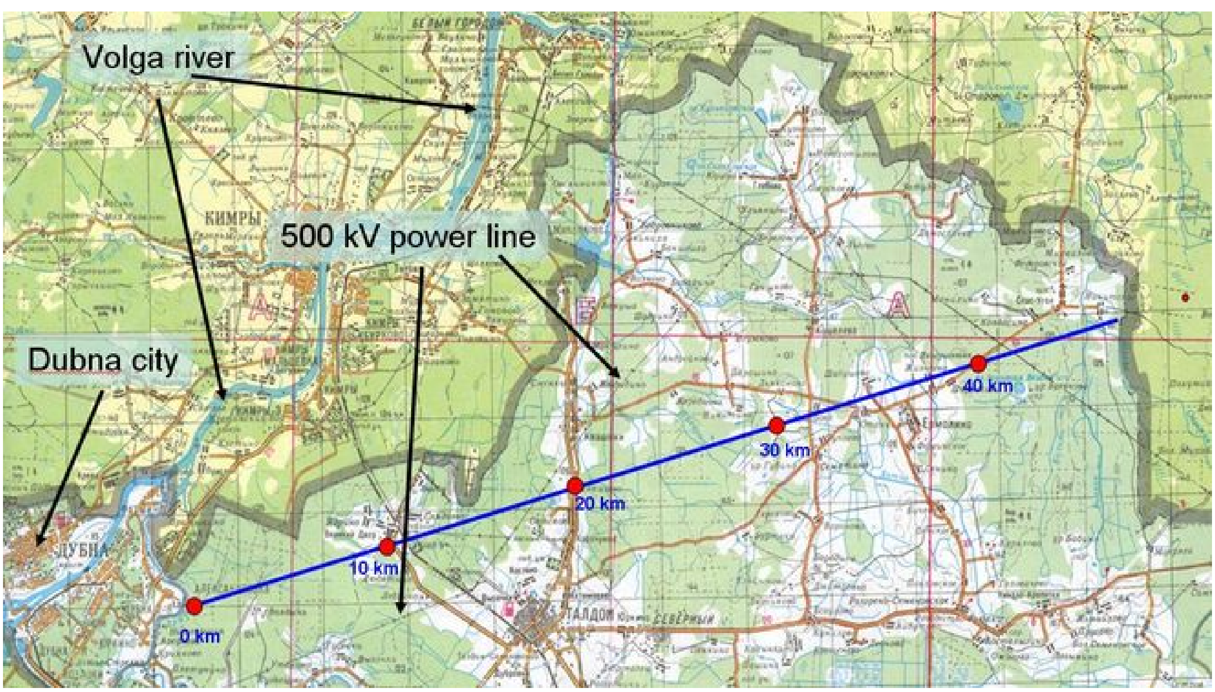

Figure 1: Planned location for ILC near Dubna, Moscow region.

- An additional attractive feature of placing the ILC complex on this territory is the opportunity of using the land without additional cost. Prevalent legal practice makes it possible to get the land at the ILC location for permanent free use just as it has been done for JINR, according to an agreement with the Russian Federation government.
- There are sources of the electric power of sufficient capacity in this area, i.e. a 500 kV power line and two power stations.
- There is a developed system of transport and communication services.
- Presence of a modern communication infrastructure, including one of the largest satellite communication centres in Europe.
- A special economic zone established in Dubna in December 2005 provides preferential terms for development and manufacture of high technology technical production.

SITE INVESTIGATION

In October-November 2008 team of The State Specialized Projecting Institute (GSPI) has performed the preliminary complex engineering prospecting on the territory along the tunnel route [2]. This investigation includes:

- boring of 3 wells in depth of 36 to 47 m with full core extraction;
- selection of 40 soil monoliths and 16 disturbed soil samples for investigations of their physical-mechanical properties;
- selection of 10 ground water probes for chemical analysis;
- 35 points of vertical electric sounding;
- gamma-ray logging, thermometry and vertical seismic profiling in borehole;
- high-resolution surface seismic survey using shear wave reflection method.

Figure 2 shows a detail of the geological cut for the Dubna sample site together with soil boring profiles. This area is within the Russian plate, a part of the Eastern European ancient platform. This is a stable, steady structural element of the earth's crust. The characteristic feature of this territory is the uniform and monolithic character of the surface. The surface deviation from the curvature of earth, like single hills and ridges, has smoothed shapes, soft outlines and small peaks. The absolute surface marks range from 125 to 135 m with regard to the Baltic Sea level. The whole area is waterlogged.

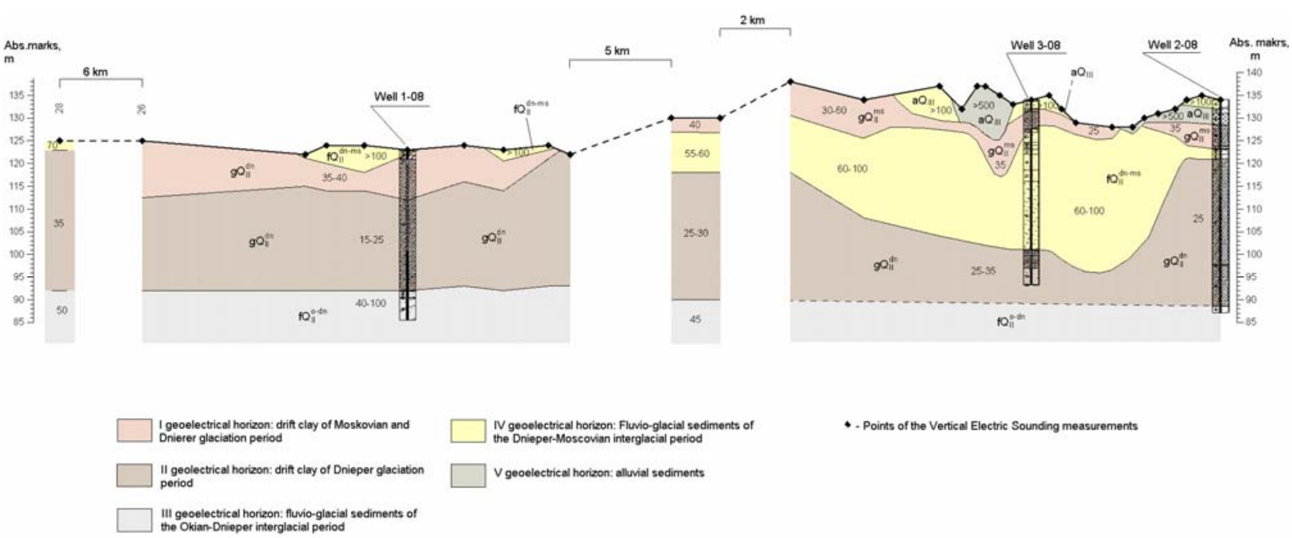

Figure 2: Detail of the geological cut for the Dubna sample site together with the soil boring profiles.

The obtained data (geological structure and hydro-geological conditions, geotechnical soil properties, weak development or absence of adverse natural and engineering-geological processes) are favorable for placing the linear collider in the investigated territory. The results contained in the GSPI Soil Boring Report supports the positioning of a site that is compatible with the current ILC criteria in the Dubna area and supports a near surface design solution.

THE ONE-TUNNEL DESIGN

One-tunnel solution for the accelerator structure and convention facilities is possible for Dubna site (Fig. 3). The main technological tunnel with accelerating structures will be put on depth of ~ 20 m so that from below and above the tunnel there will be an impermeable stratum preventing break of underground waters. Communication tunnel will be placed directly above the technological one near the ground surface at the depth of 3-4 m practically following its form. This tunnel is necessary for power supplies, RF power sources, data storage devices, electronic and control systems, etc.

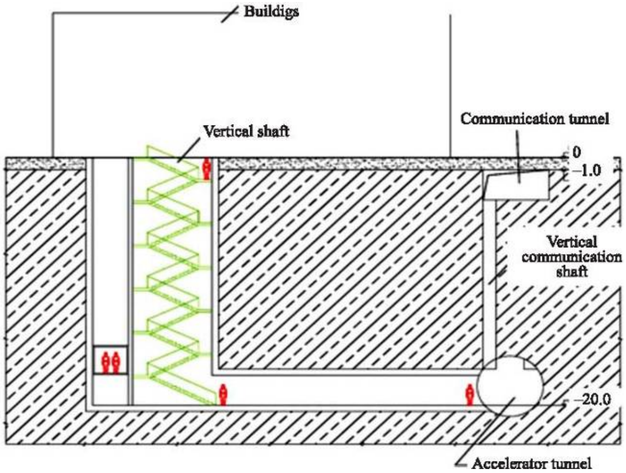

Figure 3: One tunnel solution.

Technological connection between the accelerator tunnel and collector will be provided by vertical shafts of various diameters made by drilling. Connection of ground and underground structures will be provided by vertical and horizontal shafts (stairs, elevators, etc).

ILC ACTIVITY AT JINR

The JINR is carrying out active work to develop international cooperation in the ILC project and in the related projects XFEL and CLIC. The scientists from JINR participate in all international forums and committees on the ILC. JINR has successfully organized wide cooperation in Russia in order to perform experimental and theoretical investigations on the project with Russian research centers: BINP of Siberian Brunch of RAS, Institute for Applied Physics (IAP) of RAS (Nizhniy Novgorod), GSPI, Physical Institute of RAS etc.

JINR in collaboration with KEK (Japan), DESY (Germany) and IAP of RAS is carrying out research and design works for creation of the injector, an electron source on the base of a photoemissive gun. Creation of the test bench to study properties of photocathodes, new materials and also creation of new unique laser system are planned. The test bench on the base of the linear accelerator of electrons LINAC-800 for adjustment of beam diagnostics tools will be made in JINR. The injector will be a part of the bench.

Explosion Welding of Bimetal Tubes

JINR in collaboration with RFNC (Sarov), INFN (Pisa) and FNAL are working on designing the fourth-generation cryomodule for the ILC [3]**.** The problem to be solved was to join the helium supply pipe made of stainless steel (SS) and the helium Dewar vessel made of titanium (Ti)**.** Ti and SS cannot be welded together by conventional welding methods**.** A technology for making a bimetallic Ti+SS tube transition element by the explosion welding method has been developed and implemented for the first time (Figure 4)**.**

All produced bimetallic Ti+SS samples were subjected to the metallographic analysis and the joints were tested for strength and leaks at different cryogenic temperatures at RFNC, JINR, INFN, and FNAL [3]**.** The tests showed their compliance with the ILC cryomodule specification. The leak rate at the liquid helium temperature (1.8 K) was less then 10^{-11} Pa·m^3/s**.**

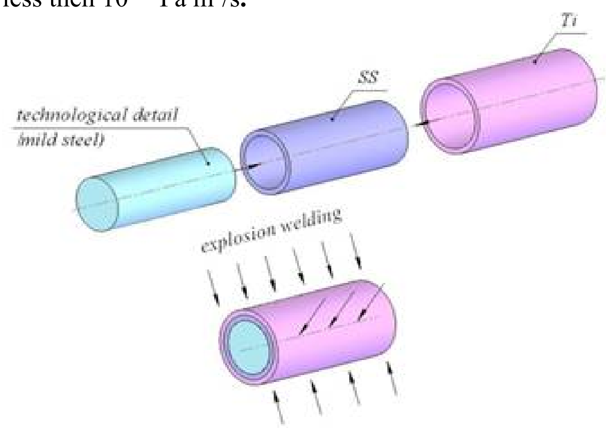

Figure 4: Welding of bimetal tubes.

The next step is to make use of the advances achieved by the collaboration for the following task in the redesign of the cryomodule: by employing the explosion welding method**,** to make a Nb+SS transition element to be used in a superconducting RF cavity for the future ILC accelerator**.** The first four samples of Nb+SS joints were manufactured at RFNC-Sarov by two versions of the explosion welding method**:** internal explosion welding (explosion inside the Nb tube) and external explosion welding**.** The samples were subject to preliminary leak tests at RFNC and macro- and microanalyses**.** The Nb+SS joint made by the explosion method turned out to be strong and tight enough: the leak rate was $Q \approx 10^{-9}$ atm cm^3/s. The metallographic analysis did not reveal any structural anomalies of the welded components: in the narrow Nb–SS contact zone 0.2÷0.25 mm wide microrigidity of ≈4.4 GPa arises**.**

In the tests at INFN (Pisa**)** under extreme conditions (thermal cycling in liquid nitrogen**,** exposure to ultrasound) only the upper limit of the leak rate was found for all samples**:** $\boldsymbol{Q} \leq (3 \div 5) \cdot 10^{-10}$ atm·cc/sec.

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