Conventional Facilities and Siting

Global Group #4

The follow is a list of comments to the "Himmels List of Questions developed at the Snowmass 2005. The list of comments has been assembled with input from the Asian, European, and America Conventional Facilities and Siting (CFS) Teams. Please address all comments and questions to: Jean-Luc Baldy <jean-Luc.Baldy@cern.ch> 榎本 收志 <atsushi.enomoto@kek.jp>Victor R. Kuchler <kuchler@fnal.gov>

HIMELS No		DISCUSSION POINTS FROM SNOWMASS 2005 (HIMEL's LIST) 3rd Final Draft 10-24-05
3		**Main linac starting gradient, upgrade gradient, and upgrade path**
	3A	Phasing the tunnel construction is attractive with both fiscal funding and schedule impacts. The benefits to this approach can only be fully realized if the majority of technical equipment does not need to be relocated after a tunnel upgrade (from 500 GeV length to 1 TeV length) and that the vibration criteria is not so restrictive to not allow tunneling during operations. Note; Phasing of the tunnel construction refers to matching the tunnel construction to the upgrade path of the accelerator upgrade from 500 GeV center of mass to 1 TeV center of mass. The energy upgrade could be several years after the completion of the initial project. Due to escalation and other cost impacts the total cost for a phase project would be substantially more than a single project. This question is directly related to questions 48 and 49.
	3B	Similarly (to 3A), for both European sites, one end of the linac tunnel is fixed. Therefore, in case of phasing, one should know from the start the overall final length, as once the experimental area is positioned, the whole infrastructure layout will be frozen (Central shaft and experimental hall cannot be moved later!). In case of phasing of the tunneling works, a large number of precautions will be need to be taken to carry out phase 2, while the phase 1 machine is running.
	3C	Some study on propagation of vibration caused by TBM will be necessary before impacts of phasing of the tunnel excavation is fully understood. A cursory study indicated that it is feasible, however, a thorough study of specific site is required to fully understand its implications.
4		**Straight or follow earths curvature**
	4A	Laser straight will have deeper shafts towards the center of the project requiring more piping in shaft & pump head, but overall cost impact is expected to be minimal.
	4B	The impact of a laser straight layout on cryogenic equipment and subsequent cost need to be assessed.
	4C	In the case of horizontal access as for some Asian sites, the impact of an increase of depth as much as 50m at maximum is quite small.
	4D	Drainage in the laser straight alignment will not be that much different than that of a earth curvature following alignment. The laser straight drains naturally toward the center, but this may not be the panacea that it seems to be. Water will have to flow 5km (or whatever the distance between shafts). A 1/4" to 12" slope is recommended for drainage. There may be problems in the extremely long runs. In the case of the CERN site, incoming of water into the drains is expected to be very low as the surrounding rock is watertight. (on 95% of the tunnel length at least).

	4E	For northern Illinois rock tunnel solution in the galena formation a segmented or earth curvature alignment would allow the positioning of the tunnel(s) in a known zone of the galena bounded by two clay seams which is expected to be a dry zone. Constructing a curved ILC would be better than a straight ILC from a hydrogeologic standpoint. The curved ILC would keep the tunnel between the Maquoketa shale above and the bentonite clay layers of the Dunlieth Formation below and would avoid numerous water bearing bedding plane fractures. Keeping the tunnel in the middle of the Wise Lake formation would reduce water influx during excavation, especially considering the de-watered state of the top of the Galena-Platteville along the north/south alignment that runs through Fermi Lab. This also avoids the potential of encountering hydrogen sulphide gas that is potentially present in the top of the Galena-Platteville. By keeping the tunnel an average of 50 feet below the top of the Galena-Platteville the tunnel will also avoid encountering the Maquoketa shale and the bedrock valleys at the north and south ends of the alignment. Conversely, for northern Illinois the laser straight places detector hall(s) of rock tunnel solution in the Galena formation with a substantial cover of galena formation. The Galena formation has better structural properties for large roof spans, compared to the overlaying shale layers. The importance of this will increase as the roof span requirements increase.
	4F	The CERN site can accommodate either laser straight or earth curvature profiles.
	4G	The DESY site would be better off with the earth curvature profile as the water pressure might possibly be too high in the central part with the laser straight profile.
	4H	Conversely to item 4C above, for northern Illinois the laser straight places detector hall(s) of rock tunnel solution in the Galena formation with a substantial cover of galena formation. The Galena formation has better structural properties for large roof spans, compared to the overlaying shale layers. The importance of this will increase as the roof span requirements increase.
	4J	Apart from an impact on cost (linked to actual depth), a deep experimental hall is neither a problem for the CERN site (LHC wide span experimental caverns in deep molasse rock) nor for the DESY site (to be excavated full section from surface).
	4K	The hard bed-rock in the Asian sites are good for construction of big underground halls. (For example, a big underground hall of 34m wide, 220m long and 54m high, constructed 520m deep in a hard bed-rock, has neither concrete supporting wall nor pillars.)
5		**1 or 2 IRs, if two, run interleaved?**
	5A	A solution that functions like the Fermilab CDF or D0 hall arrangement, but mirrored about the beam line would allow for a cost effective way of employing two detectors. The practicality of such a solution must consider shielding requirements and not substantially increasing the roof span. The obvious savings include the elimination of a second final focus, beam dumps, and a reduction of hall utilities.
6		**1 or 2 Tunnel**
	6A	Maintenance for components (this is addressing the conventional components such as fans, pumps and dehumidifiers) breaking in 1 tunnel maybe difficult & problematic, in 2 tunnel, some work on equipment breakdown located on the service tunnel can minimize overall downtime. In addition redundant and backup systems can be installed to minimize shutdowns required for convention components. With two tunnels the beam tunnel can drain to the klystron tunnel. With two tunnels the beam tunnel can drain radioactive water to the klystron tunnel.
	6B	HVAC ductwork will be more in 2 tunnel than 1, but the cost difference will be minimal. Possibility to use tunnel(s) as air ducts should be assessed.
	6C	Vibration from LCW pump/motors located in the beam tunnel (deep tunnel solution) may be an issue for the 1-tunnel solution, as compared to the 2 tunnel where most of this pump/motors will be located in the service tunnel (depending of the type of motors foreseen).

	6D	The Life Safety for a two (2) tunnel scheme is based on a transit tunnel system, similar to the English Channel, whereas the two tunnels run parallel with each other. Cross passageways are located throughout the length of the tunnel system. In the event of a fire in one of the tunnels, the other tunnel preserves as a safe haven facilitating emergency personnel and life safety egress. The distance between two consecutive cross escape/service passageways needs to be addressed. It may vary from one site to the other due to local legislation (under investigation). The Asian team is studying cross passageways every 1 km, which is kinked for radiation shielding purpose without heavy shielding doors.
	6E	The Life Safety for a one (1) tunnel scheme would utilize refuge areas (niches) located throughout the length of the tunnel. These refuge areas will be constructed in lieu of the cross passageways and parallel tunnel; thereby, creating a safe haven facilitating life safety egress after the fire event is controlled by the responding emergency personnel. The two (2) tunnel cross passageways and the one (1) tunnel solutions will both require refuge areas which will require air ventilation, fire wall separation, fire suppression system, and emergency communication system. Other considerations may include the mitigation of an accidental cryogenic spill. The acceptance of a Life Safety egress mitigations needs to be checked (in particular in case of the two tunnels alternative) as it depends on local legislation.
	6F	With two tunnels the beam tunnel can drain radioactive water to the klystron tunnel.
7		**DR size and shape**
	7A	The length of additional tunnel (in excess of the main linac) required to house the damping rings is directly proportional to the cost for the damping ring tunnel.
	7B	None of the various damping ring configurations, seen to date, presents constructability issues that would make one configuration substantially better than another. The present three types of damping ring can be excavated with a TBM.
	7C	Damping ring shape, the larger the diameter the more difficult draining will be. Pumps may be required here as an invert drain from a large DR may need to be lower than the drain at the tunnel. However the possibility of inserting the DR into tilted planes should be investigated, as it may avoid the necessity of pumping.
	7D	As Damping Ring gets longer, issues regarding laser straight vs. curvature will also need to be taken into consideration. Smaller damping rings are controlled by constructability issues such as TBM turning radius.
8		**e+ source type conv/undulator/compton**
9		**Is there an e+ pre damping ring**
10		**Damping Ring Location**
	10A	There was a diagram that showed the damping ring located at the middle of the linac, to allow for the construction of the 1Tev linac in the future while the linac is running. Obviously, there will be a large cost savings in the first cost of the tunneling for this scenario, but there might be an issue with vibration during the upgrade and a more technical question whether it is possible with regard to the technical components. It also seems that there will be the need for additional beam transfer lines to be added to phase 2 equipments.

	10B	Injectors and damping ring(s) located adjacent to the interaction point would allow most of the non-linear conventional construction to occur in one area at the geographic center of the project. For the north-south orientation through the Fermilab site it would allow for this construction to be within the existing Fermilab site boundary. The same applies to the CERN site. However this is not true for the DESY site, as the location of the experimental hall is about 16 km away from the existing site. Long transport line from the damping ring to the far end of the linac is necessary even at the first stage. This scheme has to be studied carefully from the view point of beam dynamics and cost impact.
15		**Crossing angle**
	15A	Crossing angles of the order of magnitude of what was discussed at Snowmass (20 mrad) can be accommodated the Sites under consideration in all regions. (in a "close to horizontal" plane).
19		**Tunnel Depth**
	19A	Deep tunnel will have more piping, pump head. Deep tunnel may require additional heat exchanger to minimize overpressure. The cost impact will be minimal. The environment impact of the deep tunnel for accelerator application is not well understood in America. Thus, a thorough investigation/ study of this matter is required tor the American sample site.
	19B	Deep tunnel will have more ductwork, but cost overall impact should be in the noise
	19C	Fee simple land acquisition at shafts only for a deep tunnel solution is anticipated to be less costly than procuring surface land rights required for a cut and cover solution.
	19D	A cut and cover type solution is applicable to none of the European Sites anyway for environmental reasons.
	19E	There will be more construction disruption in cut-cover construction compared to deep tunneling
	19F	Deep tunnel rock is more stable than near surface/cut cover (one of the main reasons why it has been decided that the CERN site tunnel would be deep). Asia and America agree.
	19G	In a deep twin tunnel, the relationship of the service tunnel to the beam tunnel is fairly constant, therefore the distribution (piping and waveguide) is repeated, as compared to the cut-cover, where this distribution will not be uniform.
	19H	Near surface will still need to have a service tunnel on some portion of the along the length of the tunnel, which means support tunnel arrangement similar as shown in Site C, near Fermilab Site.
23		**Linac Power Sources (Klystron)**
	23A	The required supply water temperature for Klystron was noted as 30C (86F) to 40C(104F) in Tesla. Using the upper temperatures in this range provides for certain cost savings over using the 86F, especially for sites with high design wet bulb temperatures. The savings will be for eliminating or limiting the need for chillers and allows higher temperature approach heat exchangers. This needs to be checked with Klystrons experts.
	23B	Asian group is planning to use dry cooling towers in order to avoid water consumption. In case of dry cooling towers, the higher cooling water temperature is preferable in order to make summer (if in the summer) shutdown time shorter, especially in south area. But temperature of cooling water has to be determined from the view point of Klystron operation.
	23C	Klystron expert should provide guide for maximum klystron waveguide length, and if uniformity of waveguide distribution is a criteria. A cut-cover solution, due to varying surface depth, may cause an uneven waveguide distribution over the length of the machine. A one (or 1.5) tunnel solution will require waveguides to be routed to shaft if you are to maintain access to klystrons. In case of a twin tunnels solution, minimizing the wave guide length would bring some savings.
38		**Distance Between Cryo Plants**

	38A	The distance between Cryo plants is taken from Tesla at roughly 5 km. Adjustment in spacing will have an effect on the construction cost.
	38B	Agreed. This distance between consecutive shafts seems realistic also in term of civil engineering (TBM) constraints. However, a solution with distances of 9-10 km between shafts is under investigation with cryogenic, ventilation and civil engineering experts as it would present substantial advantages in terms of environmental impact.
	38C	Cryo plant spacing between refrigerators for ~0.5km cryo maintenance units is 2 x ~3km = ~6 km. BCD Decision #30.
48		**How Much Ground Motion Can be Tolerated at the site**
	48A	Ground motions in the form of settlement, both elastic and non-elastic can range from fractions of an inch to inches in soils. Motions resulting from the pumping of wells and seasonal water table fluctuations are an additional source of ground motion. These settlements can be minimized if the tunnel is placed in rock. Ground motions induced by other natural events such as earthquakes can be minimized by site selection. Cultural sources such as roads, trains, quarries, can initially be addressed by maintaining a distance to sources, but future development can not be controlled. The criteria for ground motion should come from the accelerator requirements in a quantitative format so that site selection can address this issue in the proper perspective. Some sites will reduce vibration due to better damping properties of the in situ materials.
	48B	Generally speaking, underground CE structures are not very sensitive to earthquakes (this is not necessarily true for the machine and experiments equipment).
	48C	In case of shallow tunnel in soils, continuous sinking of the tunnel has been observed at the speed of a few mm/year. This is thought to be caused by weight of buildings on the surface.
	48D	Ambient ground motion of a site plus imported vibration from all support equipment and all other vibration sources during the operation must be less than the beam stability requirement for the critical components of the machine with some safety margins. Thus, a noisier site reduces vibration budget considerably. A lesser vibration budget increases the cost of vibration mitigation substantially, thus, a thorough trade-off study for vibration mitigation of a sample site is required.
49		**Phased Civil engineering Project to accommodate funding**
	49A	The longer the time between phasing the more will be the overall cost due to escalation.
	49B	Overall costs with two phases will be far higher than the cost of structures constructed at one time (depending of time span up to 1.5 ?).