



GDE ACCELERATOR ADVISORY PANEL REVIEW

CONVENTIONAL FACILITIES AND SITING GROUP

Main Linac Tunnel Configuration Study

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Purpose

- *The Main Linac Tunnel Configuration study is a “Value Engineering” of the underground construction.*
 - *This is one of the CFS TD Phase 1 primary goals.*
- *This study will provide CFS cost data to Project Management to assess the overall value of various tunnel configurations.*
 - *Technical Considerations*
 - *Installation and Operations*

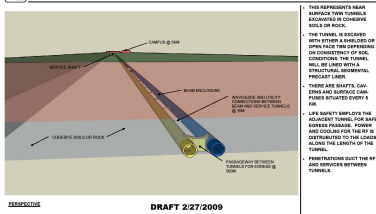
Tunnel Configurations

- **Development of study configurations**
 - ***The deep twin tunnel arrangement used in the RDR is used as the baseline for functional requirements. Adjustments are made to suit the configuration under study.***
 - ***Configurations have been adapted from the XFEL and Project X Collaborations. Additional configurations have been generated to optimize the requirements of alternative technical arrangements such as the KlyCluster.***
 - ***This study is evaluating both deep tunnel excavation and near surface solutions.***

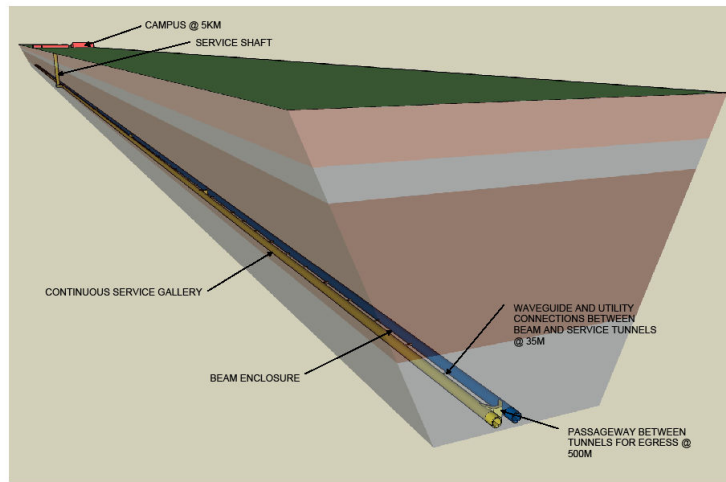


Configurations

TWIN NEAR SURFACE TUNNELS

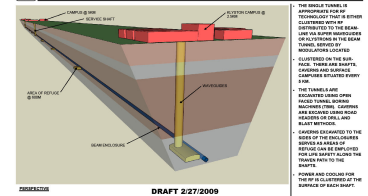


TWIN DEEP TUNNELS; VERTICAL ACCESS



- THIS IS THE RDR BASE-LINE PROFILE.
- THE TWIN TUNNEL IS APPROPRIATE FOR DISTRIBUTED RF.
- THERE ARE SHAFTS, CAVERNS AND SURFACE CAMPUSES SITUATED EVERY 5 KM.
- THE TUNNELS ARE EXCAVATED USING OPEN FACED TUNNEL BORING MACHINES (TBM). CAVERNS ARE EXCAVED USING ROAD HEADERS OR DRILL AND BLAST METHODS.
- LIFE SAFETY EMPLOY THE ADJACENT TUNNEL FOR SAFE EGRESS PASSAGE.
- POWER AND COOLING FOR THE RF IS DISTRIBUTED TO THE LOADS ALONG THE LENGTH OF THE TUNNEL. PENETRATIONS DUCT THE RF AND SERVICES BETWEEN TUNNELS.

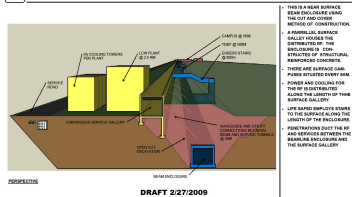
SINGLE DEEP TUNNEL; VERTICAL ACCESS



THIS REPRESENTS A SINGLE DEEP TUNNEL APPROXIMATE TO THE RDR BASE-LINE PROFILE.

- THE TUNNEL IS EXCAVATED AFTER THERE IS A PROPOSED OPEN FACE FOR APPROXIMATE TO CONVENTIONAL TUNNEL PROFILE.
- CONNECTIONS TO THE BEAM ENCLOSURE WILL BE MADE BY THE TUNNELS.
- PROTECT LINE.
- THERE ARE SERVICE CAVENS AND SURFACE CAMPUS SITUATED EVERY 5 KM.
- LIFE SAFETY EMPLOY THE ADJACENT TUNNEL FOR SAFE EGRESS PASSAGE.
- POWER AND COOLING FOR THE RF IS DISTRIBUTED TO THE LOADS ALONG THE LENGTH OF THE TUNNEL.
- PROVISIONS DUCT THE RF AND SERVICES BETWEEN THE TUNNELS.

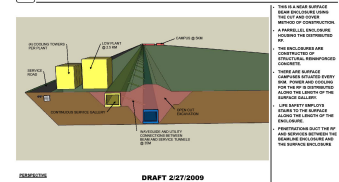
ENCLOSURE IN OPEN CUT EXCAVATION; CONTINUOUS SERVICE GALLERY



THIS IS A NEAR SURFACE TUNNEL APPROXIMATE TO CONVENTIONAL TUNNEL PROFILE.

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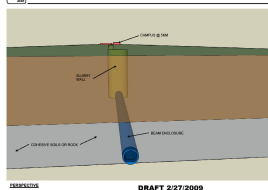
ENCLOSURE IN OPEN CUT EXCAVATION; CONTINUOUS AT SURFACE ENCLOSURE



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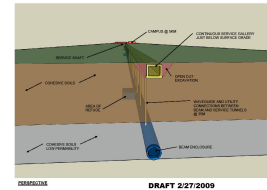
SINGLE NEAR SURFACE TUNNEL



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SINGLE NEAR SURFACE TUNNEL; CONTINUOUS AT SURFACE SERVICE GALLERY







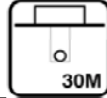
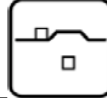

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[ftp://fess-](ftp://fess-ftp.fnal.gov/public/ilc/agenda/VE%20Efforts/MAIN%20LINAC%20TUNNEL%20CONFIGURATION%20STUDIES/ilc%20scheme%20%20Feb%2016%202009.pdf)

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Configuration Matrix

							
	DEEP		NEAR SURFACE				
	Twin Deep Tunnels	Single Deep Tunnel	Twin Near Surface Tunnels	Near Surface Tunnel, at Surface Gallery	Single near Surface Tunnel	Enclosure in Open Cut, Cont. Gallery	Enclosure & Cont. Gallery in Open Cut
EXCAVATION	TBM	TBM	TBM	TBM & OPEN CUT	TBM	OPEN CUT	OPEN CUT
No of TUNNELS	TWO-TUNNEL	ONE-TUNNEL	TWO-TUNNEL	TWO-TUNNELS	ONE-TUNNEL	ONE-TUNNEL	TWO-TUNNELS
SHAFT SOIL	VARIES	VARIES	VARIES	VARIES	SOFT / SLURRY	NA	NA
TUNNEL SOIL	ROCK	ROCK	COHESIVE SOIL or ROCK	COHESIVE SOIL -Low permeability	Saturated Sand & Gravel	SOILS VARIES	SOILS VARIES
SERVICE SPACE	SECOND TUNNEL	SURFACE BUILDINGS	SECOND TUNNEL	CONTINUOUS SERVICE GALLERY	AT CAMPUSES	CONTINUOUS SERVICE GALLERY	CONTINUOUS SERVICE GALLERY
ILC Technology	DISTRIBUTED RF	CLUSTERED RF	DISTRIBUTED RF	DISTRIBUTED RF	CLUSTERED RF	DISTRIBUTED RF	DISTRIBUTED RF
SIMILAR TO	RDR Sample Sites	RDR & CLIC	RDR	Dubna ILC	XFEL	Project X	Project X
ACCESS	Vertical Shaft	Vertical Shaft	Vertical Shaft	Vertical Shaft	Vertical Shaft	Hatch	Hatch

- **Electrical power levels remains constant. Clustered RF reduces electrical distribution.**



Cost Estimate Methodology

- Estimates are prepared in the same WBS format as the U.S. RDR estimate. This allows for line by line comparisons at the lowest WBS level.
 - The Estimate is color coded so that changes are clearly highlighted.
 - A description for each line in the cost estimate describes the basis for changes.
- Estimates done for the KlyCluster can be obtained from Cost Engineers.

The image shows two side-by-side spreadsheets. The left spreadsheet is titled 'CONVENTIONAL FACILITIES & SITING - Americas Region' and dated '9/4/08'. It lists various engineering and construction items with associated costs. The right spreadsheet is titled 'Kly Cluster Estimate' and also dated '9/4/08'. It shows a similar breakdown of costs for a different project, with some cells highlighted in red to indicate changes.

LEGEND (AUG 21 2008)

Changes in RDR amount or quantities for the KLY cluster scheme

New line item added for the KLY cluster scheme

Still to be corrected in RDR

LEGEND (RDR Dec 2006)

Main CFS WBS level (1.7)

Second level of WBS (1.7.1 to 1.7.8)

Third level of WBS

Fourth level of WBS detail

Conventional Facilities

Notes on the cost analysis for the KLYCluster Estimate dated 9-4-08

DRAFT 9-11-08

Code	Description	Cost	Change
Code	Description	Cost	Change
1.7	CIVIL ENGINEERING		
1.7.1.1	Engineering study work and documentation		
1.7.1.1.1	In-house Engineering		
1.7.1.1.2	Outsourced Consultancy Services		
1.7.1.2	Outsourced Facilities		
1.7.1.2.1	Shafts		
1.7.1.2.1.1	1x 14" dia. Shafts @ 100' (1.7.1.2.1.1.1)		
1.7.1.2.1.2	1x 16" dia. Shafts @ 100' (1.7.1.2.1.2.1)		
1.7.1.2.1.3	1x 18" dia. Shafts @ 100' (1.7.1.2.1.3.1)		
1.7.1.2.1.4	1x 20" dia. Shafts @ 100' (1.7.1.2.1.4.1)		
1.7.1.2.1.5	1x 24" dia. Shafts @ 100' (1.7.1.2.1.5.1)		
1.7.1.2.1.6	1x 28" dia. Shafts @ 100' (1.7.1.2.1.6.1)		
1.7.1.2.1.7	1x 32" dia. Shafts @ 100' (1.7.1.2.1.7.1)		
1.7.1.2.1.8	1x 36" dia. Shafts @ 100' (1.7.1.2.1.8.1)		
1.7.1.2.1.9	1x 40" dia. Shafts @ 100' (1.7.1.2.1.9.1)		
1.7.1.2.1.10	1x 44" dia. Shafts @ 100' (1.7.1.2.1.10.1)		
1.7.1.2.1.11	1x 48" dia. Shafts @ 100' (1.7.1.2.1.11.1)		
1.7.1.2.1.12	1x 52" dia. Shafts @ 100' (1.7.1.2.1.12.1)		
1.7.1.2.1.13	1x 56" dia. Shafts @ 100' (1.7.1.2.1.13.1)		
1.7.1.2.1.14	1x 60" dia. Shafts @ 100' (1.7.1.2.1.14.1)		
1.7.1.2.1.15	1x 64" dia. Shafts @ 100' (1.7.1.2.1.15.1)		
1.7.1.2.1.16	1x 68" dia. Shafts @ 100' (1.7.1.2.1.16.1)		
1.7.1.2.1.17	1x 72" dia. Shafts @ 100' (1.7.1.2.1.17.1)		
1.7.1.2.1.18	1x 76" dia. Shafts @ 100' (1.7.1.2.1.18.1)		
1.7.1.2.1.19	1x 80" dia. Shafts @ 100' (1.7.1.2.1.19.1)		
1.7.1.2.1.20	1x 84" dia. Shafts @ 100' (1.7.1.2.1.20.1)		
1.7.1.2.1.21	1x 88" dia. Shafts @ 100' (1.7.1.2.1.21.1)		
1.7.1.2.1.22	1x 92" dia. Shafts @ 100' (1.7.1.2.1.22.1)		
1.7.1.2.1.23	1x 96" dia. Shafts @ 100' (1.7.1.2.1.23.1)		
1.7.1.2.1.24	1x 100" dia. Shafts @ 100' (1.7.1.2.1.24.1)		
1.7.1.2.1.25	1x 104" dia. Shafts @ 100' (1.7.1.2.1.25.1)		
1.7.1.2.1.26	1x 108" dia. Shafts @ 100' (1.7.1.2.1.26.1)		
1.7.1.2.1.27	1x 112" dia. Shafts @ 100' (1.7.1.2.1.27.1)		
1.7.1.2.1.28	1x 116" dia. Shafts @ 100' (1.7.1.2.1.28.1)		
1.7.1.2.1.29	1x 120" dia. Shafts @ 100' (1.7.1.2.1.29.1)		
1.7.1.2.1.30	1x 124" dia. Shafts @ 100' (1.7.1.2.1.30.1)		
1.7.1.2.1.31	1x 128" dia. Shafts @ 100' (1.7.1.2.1.31.1)		
1.7.1.2.1.32	1x 132" dia. Shafts @ 100' (1.7.1.2.1.32.1)		
1.7.1.2.1.33	1x 136" dia. Shafts @ 100' (1.7.1.2.1.33.1)		
1.7.1.2.1.34	1x 140" dia. Shafts @ 100' (1.7.1.2.1.34.1)		
1.7.1.2.1.35	1x 144" dia. Shafts @ 100' (1.7.1.2.1.35.1)		
1.7.1.2.1.36	1x 148" dia. Shafts @ 100' (1.7.1.2.1.36.1)		
1.7.1.2.1.37	1x 152" dia. Shafts @ 100' (1.7.1.2.1.37.1)		
1.7.1.2.1.38	1x 156" dia. Shafts @ 100' (1.7.1.2.1.38.1)		
1.7.1.2.1.39	1x 160" dia. Shafts @ 100' (1.7.1.2.1.39.1)		
1.7.1.2.1.40	1x 164" dia. Shafts @ 100' (1.7.1.2.1.40.1)		
1.7.1.2.1.41	1x 168" dia. Shafts @ 100' (1.7.1.2.1.41.1)		
1.7.1.2.1.42	1x 172" dia. Shafts @ 100' (1.7.1.2.1.42.1)		
1.7.1.2.1.43	1x 176" dia. Shafts @ 100' (1.7.1.2.1.43.1)		
1.7.1.2.1.44	1x 180" dia. Shafts @ 100' (1.7.1.2.1.44.1)		
1.7.1.2.1.45	1x 184" dia. Shafts @ 100' (1.7.1.2.1.45.1)		
1.7.1.2.1.46	1x 188" dia. Shafts @ 100' (1.7.1.2.1.46.1)		
1.7.1.2.1.47	1x 192" dia. Shafts @ 100' (1.7.1.2.1.47.1)		
1.7.1.2.1.48	1x 196" dia. Shafts @ 100' (1.7.1.2.1.48.1)		
1.7.1.2.1.49	1x 200" dia. Shafts @ 100' (1.7.1.2.1.49.1)		
1.7.1.2.1.50	1x 204" dia. Shafts @ 100' (1.7.1.2.1.50.1)		
1.7.1.2.1.51	1x 208" dia. Shafts @ 100' (1.7.1.2.1.51.1)		
1.7.1.2.1.52	1x 212" dia. Shafts @ 100' (1.7.1.2.1.52.1)		
1.7.1.2.1.53	1x 216" dia. Shafts @ 100' (1.7.1.2.1.53.1)		
1.7.1.2.1.54	1x 220" dia. Shafts @ 100' (1.7.1.2.1.54.1)		
1.7.1.2.1.55	1x 224" dia. Shafts @ 100' (1.7.1.2.1.55.1)		
1.7.1.2.1.56	1x 228" dia. Shafts @ 100' (1.7.1.2.1.56.1)		
1.7.1.2.1.57	1x 232" dia. Shafts @ 100' (1.7.1.2.1.57.1)		
1.7.1.2.1.58	1x 236" dia. Shafts @ 100' (1.7.1.2.1.58.1)		
1.7.1.2.1.59	1x 240" dia. Shafts @ 100' (1.7.1.2.1.59.1)		
1.7.1.2.1.60	1x 244" dia. Shafts @ 100' (1.7.1.2.1.60.1)		
1.7.1.2.1.61	1x 248" dia. Shafts @ 100' (1.7.1.2.1.61.1)		
1.7.1.2.1.62	1x 252" dia. Shafts @ 100' (1.7.1.2.1.62.1)		
1.7.1.2.1.63	1x 256" dia. Shafts @ 100' (1.7.1.2.1.63.1)		
1.7.1.2.1.64	1x 260" dia. Shafts @ 100' (1.7.1.2.1.64.1)		
1.7.1.2.1.65	1x 264" dia. Shafts @ 100' (1.7.1.2.1.65.1)		
1.7.1.2.1.66	1x 268" dia. Shafts @ 100' (1.7.1.2.1.66.1)		
1.7.1.2.1.67	1x 272" dia. Shafts @ 100' (1.7.1.2.1.67.1)		
1.7.1.2.1.68	1x 276" dia. Shafts @ 100' (1.7.1.2.1.68.1)		
1.7.1.2.1.69	1x 280" dia. Shafts @ 100' (1.7.1.2.1.69.1)		
1.7.1.2.1.70	1x 284" dia. Shafts @ 100' (1.7.1.2.1.70.1)		
1.7.1.2.1.71	1x 288" dia. Shafts @ 100' (1.7.1.2.1.71.1)		
1.7.1.2.1.72	1x 292" dia. Shafts @ 100' (1.7.1.2.1.72.1)		
1.7.1.2.1.73	1x 296" dia. Shafts @ 100' (1.7.1.2.1.73.1)		
1.7.1.2.1.74	1x 300" dia. Shafts @ 100' (1.7.1.2.1.74.1)		
1.7.1.2.1.75	1x 304" dia. Shafts @ 100' (1.7.1.2.1.75.1)		
1.7.1.2.1.76	1x 308" dia. Shafts @ 100' (1.7.1.2.1.76.1)		
1.7.1.2.1.77	1x 312" dia. Shafts @ 100' (1.7.1.2.1.77.1)		
1.7.1.2.1.78	1x 316" dia. Shafts @ 100' (1.7.1.2.1.78.1)		
1.7.1.2.1.79	1x 320" dia. Shafts @ 100' (1.7.1.2.1.79.1)		
1.7.1.2.1.80	1x 324" dia. Shafts @ 100' (1.7.1.2.1.80.1)		
1.7.1.2.1.81	1x 328" dia. Shafts @ 100' (1.7.1.2.1.81.1)		
1.7.1.2.1.82	1x 332" dia. Shafts @ 100' (1.7.1.2.1.82.1)		
1.7.1.2.1.83	1x 336" dia. Shafts @ 100' (1.7.1.2.1.83.1)		
1.7.1.2.1.84	1x 340" dia. Shafts @ 100' (1.7.1.2.1.84.1)		
1.7.1.2.1.85	1x 344" dia. Shafts @ 100' (1.7.1.2.1.85.1)		
1.7.1.2.1.86	1x 348" dia. Shafts @ 100' (1.7.1.2.1.86.1)		
1.7.1.2.1.87	1x 352" dia. Shafts @ 100' (1.7.1.2.1.87.1)		
1.7.1.2.1.88	1x 356" dia. Shafts @ 100' (1.7.1.2.1.88.1)		
1.7.1.2.1.89	1x 360" dia. Shafts @ 100' (1.7.1.2.1.89.1)		
1.7.1.2.1.90	1x 364" dia. Shafts @ 100' (1.7.1.2.1.90.1)		
1.7.1.2.1.91	1x 368" dia. Shafts @ 100' (1.7.1.2.1.91.1)		
1.7.1.2.1.92	1x 372" dia. Shafts @ 100' (1.7.1.2.1.92.1)		
1.7.1.2.1.93	1x 376" dia. Shafts @ 100' (1.7.1.2.1.93.1)		
1.7.1.2.1.94	1x 380" dia. Shafts @ 100' (1.7.1.2.1.94.1)		
1.7.1.2.1.95	1x 384" dia. Shafts @ 100' (1.7.1.2.1.95.1)		
1.7.1.2.1.96	1x 388" dia. Shafts @ 100' (1.7.1.2.1.96.1)		
1.7.1.2.1.97	1x 392" dia. Shafts @ 100' (1.7.1.2.1.97.1)		
1.7.1.2.1.98	1x 396" dia. Shafts @ 100' (1.7.1.2.1.98.1)		
1.7.1.2.1.99	1x 400" dia. Shafts @ 100' (1.7.1.2.1.99.1)		
1.7.1.2.1.100	1x 404" dia. Shafts @ 100' (1.7.1.2.1.100.1)		



Unit Assembly Costs

- *Deep tunnels, caverns and shaft taken from RDR.*
- *Open cut excavations, enclosures and surface galleries from Project X.*
- *Near surface tunnels cost are being generated by consulting Engineer.*
- *Material costs, labor and equipment rates used are for the Midwest U.S.*
- *Estimate comparisons are made in common year dollars (2006).*



Summary

- **Hanson Professional Consulting Engineers:**
 - **Will complete unit costs.**
 - **Will assemble Main Linac Cost estimate for remaining five configurations**
- **Hughes Associates:**
 - **Perform Life Safety and Exiting Analysis for all configurations.**
- **Main Linac Tunnel Configuration study will be brought to completion and assembled into a final report to document the work done.**