Old Cascade Tunnel: Notes from WH

- Location: Stevens Pass, adjacent to Highway 2, Washington State, and the Stevens Pass ski facilities. Highway 2 is the second most heavily used highway across the Cascades. The pass elevation is approximately 4000'. There are significant facilities at the pass because of the skiing. (On the accompanying diagram the Old Cascade Tunnel (OCT) is labeled "Original Cascade Tunnel" and begins at the end of the Iron Goat Trail, marked in green.)
- Current use: none. The OCT was not considered for DUSEL due to NSF requirements on depth.
- Legal status: At the time of the DUSEL studies, two-thirds of the site was owned by US Forest Service, and one third privately owned, but transfer to the USFS via the Mountaineers was in progress. A recent records check indicated that the current ownership is entirely USFS. The area is within a recently established federal energy corridor through which Bonneville and other transmission lines pass from Columbia River to Seattle.
- Maximum vertical depth: approximately 650m – similar to Japanese site at Torchibora that was selected to be the HyperK site. An integration over the mountain overburden yielded a depth of 1.43 kmwe (defined with respect to a flat site) near the tunnel midpoint. This is very similar to WIPP.
- Physical parameters: 4.23 km in length, fully concrete lined, approximately 16 ft (wide) by 21 ft (high).
- Floors: gravel, track has been removed.
- Gradient: 1.6%, increasing to east.
- Power: Beverly transmission line (Chelan County PUD, Puget Sound Energy) runs over both portals.
- Road access: there are roads to both portals, but the east portal access is much superior, with a natural area for parking and close proximity to Highway 2. The west entrance (see below) is the terminus of the Iron Goat Trail. The distance from the east portal to Highway 2 is a few hundred yards. It is likely the USFS would develop the east entrance and create a parking lot, in return for excavated rock. There is a major rail line nearby (Burlington Northern's "northern line" that connects Seattle's port to Chicago).
- Previous scientific use: The OCT was operated as a scientific lab for the University of Washington and Boeing in the 1970s, under a use permit with USFS. The simplicity of the site should again allow some entity like a university to work with the USFS to establish long-term access through a use permit.
- Water quality: USFS analyses at the time of acquisition showed the drainage met all relevant state and federal requirements. No hydrocarbons were detected. Further testing was done by Phil Long of PNNL during the DUSEL process, as the OCT was a surrogate for the Pioneer Tunnel that was the focus of DUSEL interest. All EPA standards were met, including various trace metals.
- Rock: Mt. Stuart batholith granodiorite. Tests at similar depths in the nearby Pioneer Tunnel (which penetrates the same batholith) yielded rock properties in the excellent category – average RQD of 94%, average RMR 89%, with unsupported spans of up to 10m observed to be stable after 75 years. The rock quality appears to be considerably better than that of the HyperK site. It would be good to repeat measurements explicitly for the OCT site, as part of a scoping process, including corings at the deepest point to evaluate the stress field in the location where the DIANA cavity might be excavated. Fracturing could differ from the Pioneer Tunnel as there is a 300m depth difference.
- Maintenance issues: inspected in early 2006, where a list of needed repairs were identified. One tunnel weak point was identified for immediate repair in the western end of the tunnel, in the portal structure where the tunnel exits the granodiorite and enters soil. One year later (winter 2007) this location - approximately 180m from the west entrance – was the site of a burst in the tunnel back. The Shannon & Wilson estimate to put the tunnel in good order now is $\sim$ \$6-8M. S&W is responsible for Burlington Northern tunnel maintenance nationally.
- About 1 hour and 15 minutes from University of Washington, 1.5 hours from SeaTac airport.
- Potential interests: I envision the site as a location for specialized efforts that need modest overburden and would benefit from horizontal access, and where co-location at some multi-disciplinary lab would be impractical for reasons of compatibility, incremental cost, etc. It is also a candidate for a project needing a dedicated site where the dual non-mechanized access and ease of gas purging would be a safety advantage.

  - Science near term: DIANA, the next-generation nuclear astrophysics accelerator, has modest depth requirements. This project is of interest to the DOE and NSF, and recently had a very favorable review. Key partners are JINA (Notre Dame, Chicago, Argonne, MSU), TRIUMF, and LBL. LBL would like to build and debug accelerator, operating it on the surface for two years, then moving it to its long-term underground location. This makes horizontal entrance and flatbed truck access attractive. DUSEL provided an estimate for creating space which the project's experimental leaders view as prohibitive, doubling project costs. DIANA's timeline requires site identification soon: as the engineering plan is already in place, the proponents would be in position to argue that this project should be a small- to mid-size priority in the expected 2013 Nuclear Physics Long Range Plan, given a definite site. The salt environment of WIPP is not suitable. Construction in Soudan would be challenging due hoist limitations: objects like the accelerator barrel cannot be taken underground intact. Similar issues exist at SNOLab. Kimbleton is a viable site, with the drawback there being the nightly blasting.
  - Science long-term: Location for a neutrino target. The FermiLab baseline is 2640 km, close to the bimagic baseline optimal for hierarchy tests and to the $\sim$ 3000 km baselines discussed for neutrino factories. The site's inexpensive hydroelectric power ($0.03/kilowatt-hr from the Chelan County PUD for projects of economic interest to the County) would be a major advantage for projects like an iron detector. The site is one of two on the globe that have magic baselines to both KEK and CERN of roughly 7400 km, should some far-far-future program want to utilize that aspect.
  - Public/USFS interest and the Iron Goat Trail coalition: historical preservation, public access. The Iron Goat Trail was established by a large coalition of environmental groups, railway historical groups, and the USFS who worked for over a decade, beginning in the early 1990s, to complete the trail. The effort was the subject of a PBS television documentary. The Old Cascade Tunnel is the most significant historical site on the trail and served as the trail's terminus (see accompanying photo). The portal collapse led to flooding that damage the area outside the west portal, forcing the USFS to place the area off limits to hikers due to dammed water. If S&W estimates are correct (see below), the necessary repairs and general rehabilitation of the tunnel could be done at low cost. This would allow the Iron Goat Trail coalition to restore their trail. Furthermore, if conditions are re-established in the tunnel to allow scientific use, significant new opportunities would arise. While the tunnel would be gated, tunnel tours could be given on a regular basis (e.g., twice a month). This would be important to the community, to the USFS, and to others interested in the trail as an anchor for tourism in the area.

- Needed: A scoping exercise by S&W to determine the cost of any needed tunnel rehabilitation; the quality of the rock; the cost of improving drainage and bringing power to tunnel interior; and the cost of the initial (DIANA) cavity. This would give the agencies a realistic estimate of what would be required to reopen this site, should they decide this is prudent. The envisioned technical work could be done by S&W and their partners, and the costing of the plan could be done by an industry estimator like Don Hilton, to ensure independence, or by a contractor. The tunnel may be unique in the US. If the break is not repaired, the tunnel will deteriorate over time due to exposure to water. Based on 2007 estimates by S&W, $400-500K would be needed to produce a detailed tunnel assessment and an engineering plan for tunnel rehabilitation and (DIANA) cavern excavation, and to complete an in-hole stress test at the proposed cavern location. A records check to establish any permitting needs beyond the USFS use permit would also be necessary. I envision a lab/university partnership, such as LBNL/Berkeley/UW/FermiLab, as the operator, as in the 1970s, to relieve agencies of responsibilities and to contain costs, perhaps modeled after Soudan. There are state economic development issues that make an out-of-state operator or operations partner very useful.

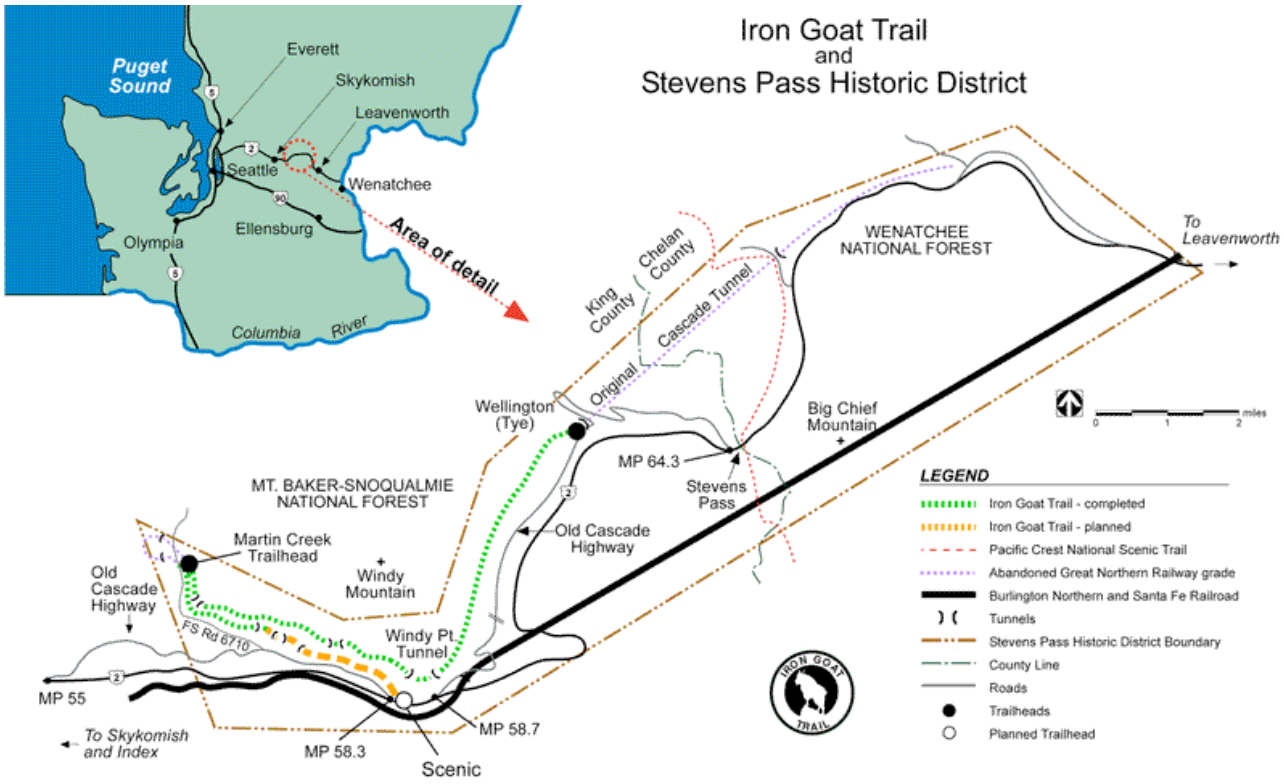
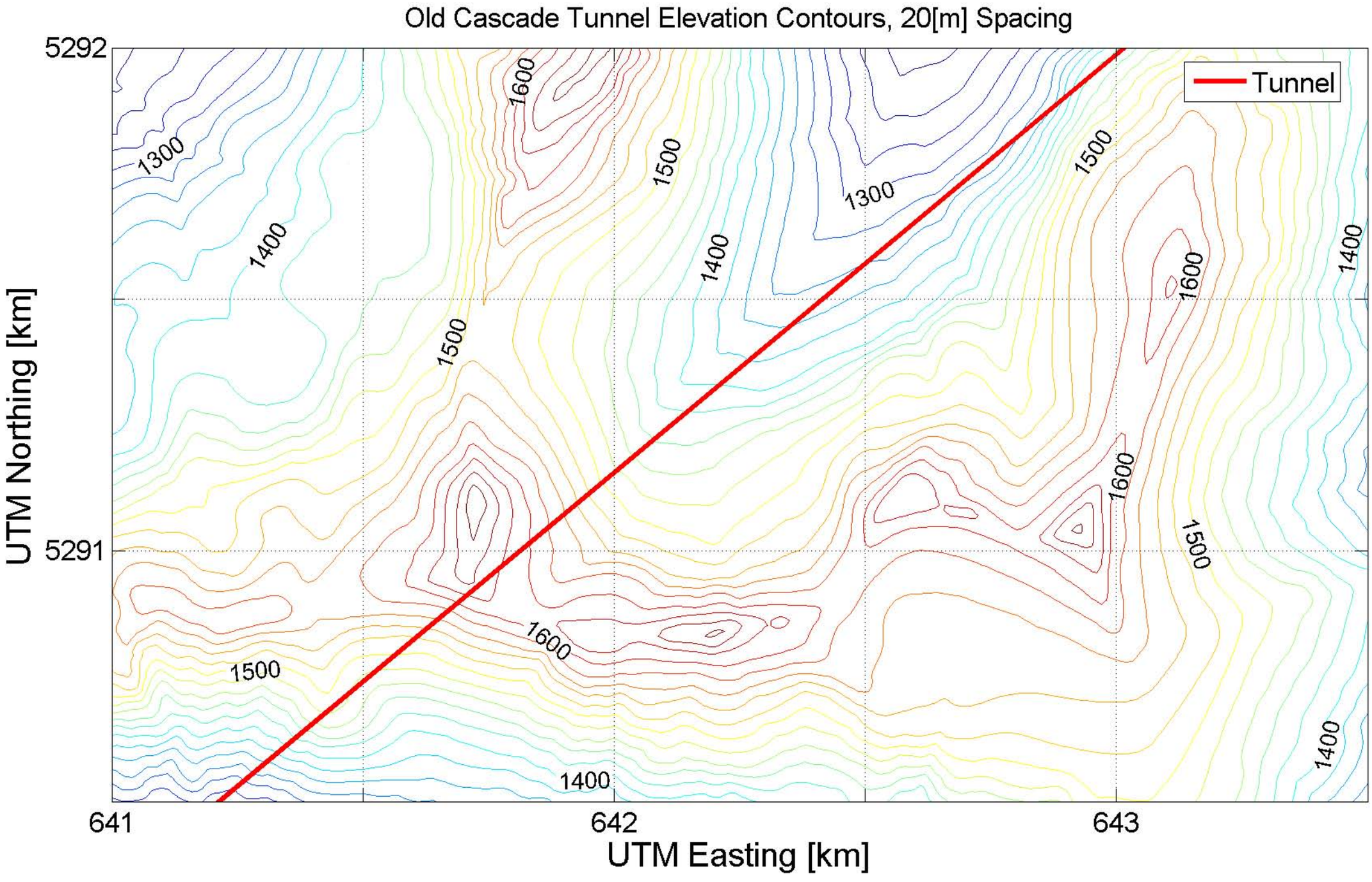


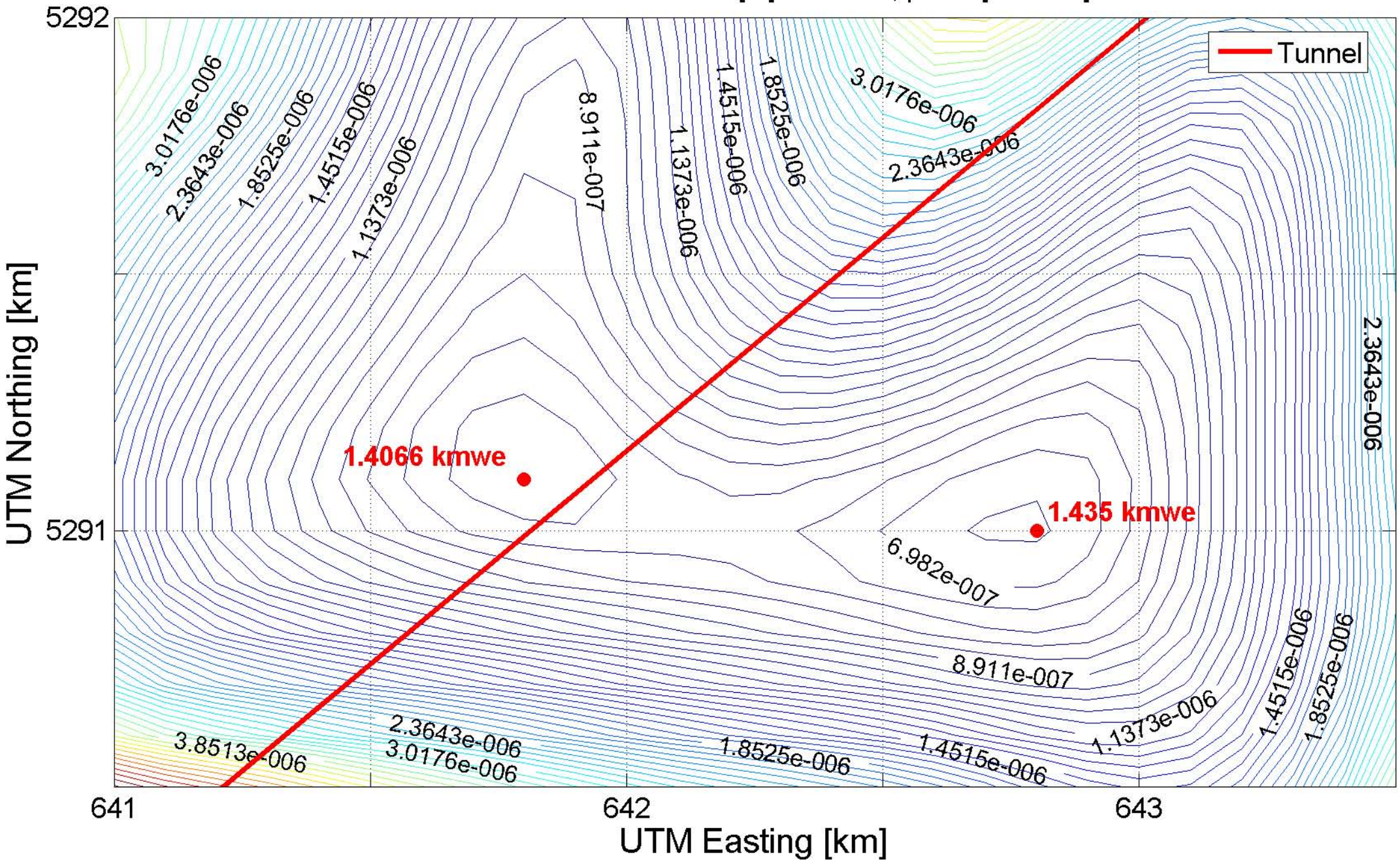
FIG. 1: Location of the Old Cascade Tunnel, immediately north of Stevens Pass.

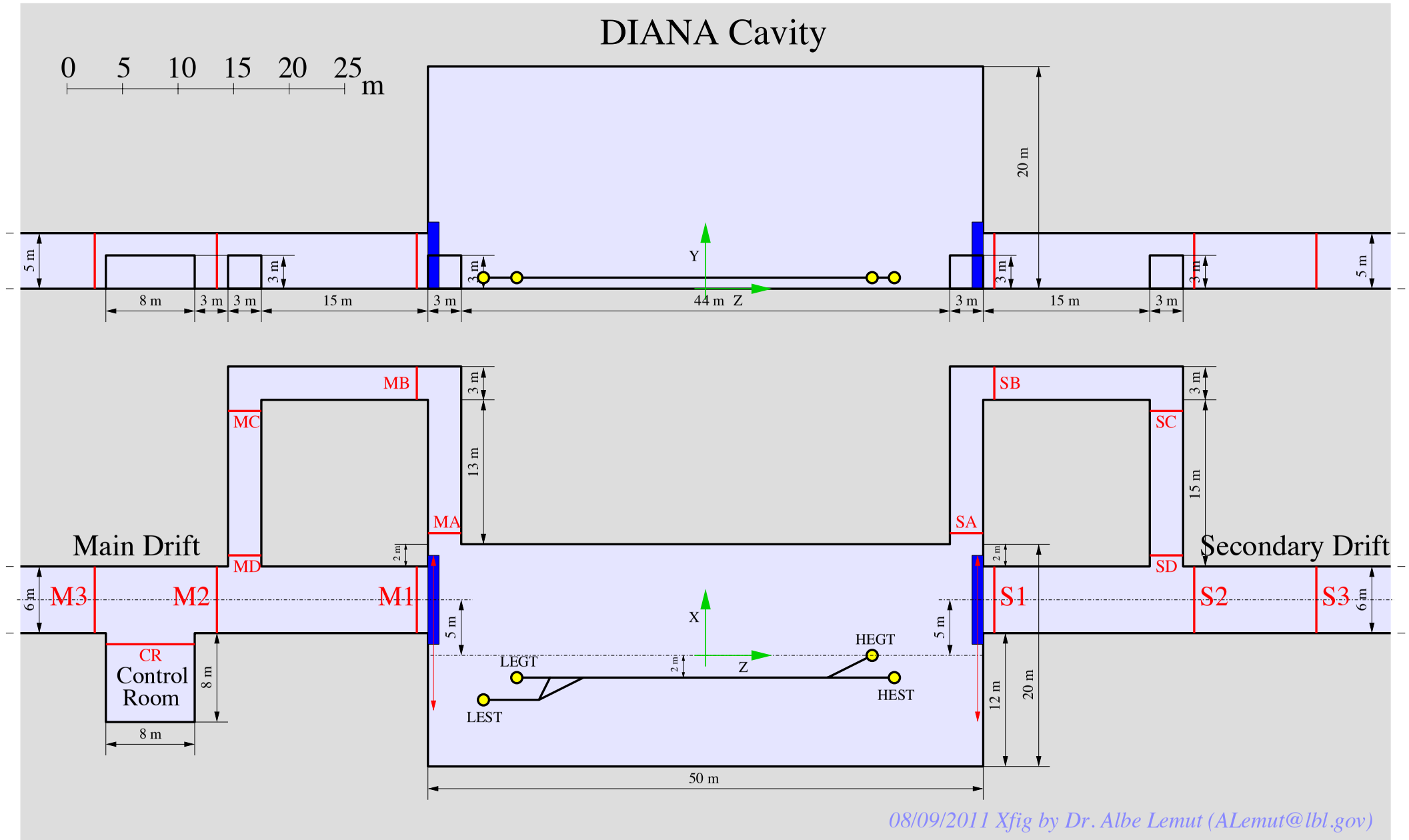
FIG. 2: West portal of the Old Cascade Tunnel.

FIG. 3: Old Cascade Tunnel cross section.

FIG. 4: Tunnel interior.


Old Cascade Tunnel Elevation Contours, 20[m] Spacing
Tunnel
UTM Northing [km]
UTM Easting [km]
5292
5291
641
642
643
1300
1400
1500
1600


Old Cascade Tunnel 1000[m] elevation, μ flux [cm^{-2} s^{-1}]
Tunnel
1.4066 kmwe
1.435 kmwe
3.0176e-006
2.3643e-006
1.8525e-006
1.4515e-006
1.1373e-006
8.911e-007
6.982e-007
3.8513e-006
UTM Northing [km]
UTM Easting [km]
5292
5291
641
642
643


DIANA Cavity
0 5 10 15 20 25 m
20 m
5 m
3 m
8 m
3 m
3 m
15 m
3 m
Y
44 m Z
3 m
15 m
3 m
MB
MC
13 m
MA
SB
SC
15 m
SA
Main Drift
MD
Secondary Drift
SD
M3
M2
M1
S1
S2
S3
6 m
CR
Control
Room
8 m
8 m
2 m
5 m
X
Z
LEGT
LEST
HEGT
HEST
2 m
5 m
12 m
20 m
50 m
08/09/2011 Xfig by Dr. Albe Lemut (ALemut@lbl.gov)
Rock
Air
Water Door
Fluence Ref. Point