Input Data for Site Characterization/Feasibility Study

Important note:
In several obvious cases the data in this file has to be taken just as a guide-line since the file has been elaborated by physicists with limited knowledge on some of the Geo-technical issues involved. As part of the Feasibility Study it is expected from the Technical Companies corrections and/or optimizations to them when applicable.

Other Notes:

FS: Feasibility Study

PMT: Photomultiplier
FE: Front-End
DAQ: Data-Acquisition-System

- unless explicitly stated the data is for the final laboratory with the experiment running
- purple,s means that it is part of the work to obtain the corresponding data, and that it has to be done with the indicated company, institute etc. It deals mainly with the tank characteristics and construction
- red,s are yet to be defined by the physicists before the FS starts

Main Detector Cavern (MDC) I

	Water Cherenkov	Liquid Scintillator	Liquid Argon
Overburden FvF: keep AZ, LL, LM: remove	- the deeper is better to minimize cosmic-ray background > 4000 **LL:???** m.w.e preferred	- the deeper is better to minimize cosmic-ray background > 4000 m.w.e preferred	- the deeper is better to minimize cosmic-ray background > 600 m.w.e preferred
Number of Tanks	3 to 5	1	1 preferred (*)
Dimensions Tank	cylinder: 65m Ø x 65m height	SS cylinder of 30m Ø x105m height, inside a external Tank (e-tank) of ~ cylindrical shape (with Technodyne), of at least 34m Ø for water-buffer.	cylinder: 72,4m Ø x 26,5m height dome: 12,7m height x 144,8m Ø
Interaction Tank-Cavern	Initial approach: Self-supporting Tank with concrete backfilled against the rough-hewn stone walls. However this is to some extent part of the output of the FS. It has to be worked out with Technodyne considering the peculiarities of the site (stability, temperature, etc.)	Initial approach: Self-supporting e-Tank with concrete backfilled against the rough-hewn stone walls. However this is to some extent part of the output of the FS. It has to be worked out with Technodyne considering the peculiarities of the site (stability, temperature, etc.)	- Tank self-sustained - MDC base: reinforced concrete platform (*where the structure for supporting and thermal-isolating the Tank will sit*)
Dimensions cavern	Initial approach: 65m Ø x 70m height + dome (the same comments as in the previous item applies here)	It has to house the e-Tank fulfilling the conditions of the 2 previous items. The highest point of the dome at > 15 m from the Tank	cylinder: 75,1m Ø x 26,5m height + dome (With Technodyne)
Others			(*) if impossible take 2 caverns (tanks) of 53,1 (51,2)m Ø x 26,5m

Main Detector Cavern (MDC) II

	Water Cherenkov	Liquid Scintillator	Liquid Argon
Geomechanical Stability over 50 years	It should assure no deformations in the tank inducing micro holes/breaks, mainly at welding lines, (With Technodyne) where the water may leak at a rate larger than the capability of water diffusion in the rock	It should assure no deformation in the tank inducing micro holes/breaks,mainly at welding lines, With Technodyne, where the water may leak at a rate larger than the capability of water diffusion in the rock	Base platform stable [±With_ Technodyne cm]
Considerations in case of seismic activity	No collapse of Cavern/Tank under any circumstance The basic safety of the people should be assured under any circumstance (along the whole underground facility) *One output of the feasibility study should be the expected power spectrum for what it is estimated maximum probable seismic activity in the area*. The stability requirements indicated in the previous box should be fulfilled for quakes with that power spectrum.	No collapse of Cavern/Tank under any circumstance The basic safety of the people should be assured under any circumstance (along the whole underground facility) *One output of the feasibility study should be the expected power spectrum for what it is estimated maximum probable seismic activity in the area*. The stability requirements indicated in the previous box should be fulfilled for quakes with that power spectrum.	No collapse of cavern nor Tank under any circumstance The basic safety of the people should be assured under any circumstance (along the whole underground facility) *One output of the feasibility study should be the expected power spectrum for what it is estimated maximum probable seismic activity in the area*. The stability requirements indicated in the previous box should be fulfilled for quakes with that power spectrum.

Auxiliary Underground needs & Proposed Auxiliary Caverns (ACn)

Assumption for Tank Assembly (t.b.c. by Technodyne)	From bottom to top	From bottom to top	From bottom to top
Assump. for Detector Assembly	From bottom to top	From bottom to top	From bottom to top
Room1 (R1): Main Control	$80\ m^2 \otimes 240\ m^3$	$80\ m^2 \otimes 240\ m^3$	$80\ m^2 \otimes 240\ m^3$
R2: Office Space	$40\ m^2$	$40\ m^2$	$40\ m^2$
R3: Electronics et al.	$500\ m^2$ (in the dome)	$200\ m^2 \otimes 600\ m^3$	$100\ m^2 \otimes 300\ m^3$ (electronics on detector top)
R4: Liquid / gas handling	n/a	$200\ m^2 \otimes 600\ m^3$	$200\ m^2 \otimes 600\ m^3$?
R5: Clean Room (Certified)	n/a	$500\ m^2 \otimes 1500\ m^3$	$500\ m^2 \otimes 1500\ m^3$?
R6: Low Background Lab.	n/a	$100\ m^2 \otimes 400\ m^3$	$100\ m^2 \otimes 400\ m^3$?
R7: Clean Storage space	$500\ m^2 \otimes 1500\ m^3$ (PMT mod)	$200\ m^2$	$200\ m^2$
R8: Specific 1	[no. tanks]x[$500m^2 \otimes 3000m^3$] Water and Air Purification	$170\ m^2 \otimes 1700m^3$ Water Purification	? $m^2 \otimes$? m^3 Hot air production plant
R9: Power Transformation	From power needs (page 10)	From power needs (page 10)	From power needs (page 10)
Proposal for ACn,s	With Technodyne	With Technodyne	With Technodyne
AC0: for tank assembly	Rooms 1,2,7	Rooms 1,2,3,4,5,6,7	Rooms 1,2,3,7 ?
AC1	Room 8	Room 8	Room 8 ?
AC2	Room 9	Room 9	Room 9 ?
AC3			
MDC-AC0 relative positions	With Technodyne	With Technodyne	With Technodyne
MDC-AC1 relative positions	Floor of AC1 above top-level of water tank	Floor of AC1 above top-level of liquid tank	Floor of AC1 above highest level reachable by the LArg
AC1- AC2 relative positions	Same level	Same level	Same level
MDC-AC2 relative positions	As close as possible	As close as possible	As close as possible
Other considerations	Use the volume between the MDC dome and the tank for some of the Rn,s ?	Use the volume between the MDC dome and the tank for some of the Rn,s ?	

Initial Proposal for:

Access Tunnel (AT) [from main access shaft or tunnel]

Interconnection Tunnels (IT) [between caverns]

Ventilation Tunnels/Shafts (VT) [mostly safety reasons]

	Water Cherenkov	Liquid Scintillator	Liquid Argon
AT: minimum width x height AT: connecting to	With Technodyne (tank modules) All caverns	? ?	? ?
IT[AC0-MDC] characteristics IT[AC1-MDC] IT[AC2-MDC]	With Technodyne S-MS: Standard for transport of Mid-Sized equip. S-MS	With Technodyne S-MS S-MS	With Technodyne S-MS ?
VT[MDC, AC,s]	n/a	n/a	With Technodyne/WP3

Note: in Finland,(Pyhasalmi type) the optimum standard tunnel cross section is 4x4 m^2

Tank: Implications to the construction of the underground facility of procurement of parts + assembly + commissioning + ...

	Water Cherenkov	Liquid Scintillator	Liquid Argon

To be worked out between Geotechnic Company and Technodyne

Methods of filling the detector Tank to be considered

	Water Cherenkov	Liquid Scintillator	Liquid Argon
1	Natural nearby water springs filling rate desirable: 100 t / hour	Truck / Train Delivery to filling pipe filling rate: ~ 20 t / hour (all included)	Truck Delivery to filling pipe 7 trucks /day (150 tons/day) 7 days / week $\Rightarrow$ 2 years
2		Appropriateness of a distillation plant ?	Production Plant at Surface 150 tons/day x 7d/w $\Rightarrow$ 2 years

Main detector-related piping to be considered

	Water Cherenkov	Liquid Scintillator	Liquid Argon
1	In this case it is an output of the FS	1 x 1/2´´ *N-gas from Nitrogen Plant at surface to MDC*	1 x double-wall-vacuum-insulated *From LArg delivery place to MDC*
2		4 x 3 ´´ *From Liquid Scintillator delivery place to MDC*	?
3		4 x 3 ´´ *Water plant at surface to MDC*	?

Surface needs; Buildings to house them

	Water Cherenkov	Liquid Scintillator	Liquid Argon
R0:	Radon-Hut: [air purification system +ventilation + humidity control + air condition] for MDC+AC,s+IC,s	Radon-Hut: [air purification syst. +ventilation +humidity control+ air condition] for MDC+AC,s+IC,s	Radon-Hut: [air purification syst. +ventilation+humidity control+air condition] for MDC+AC,s+IC,s
R1: Main Control	80 m^2	80 m^2	80 m^2
R2: Offices+Meeting +workshops+etc.	145 m^2	1000 m^2	1000 m^2
R3: Storage Area	1000 m^2 $\otimes$ 6000 m^3	1000 m^2 $\otimes$ 6000 m^3	1000 m^2 $\otimes$ 6000 m^3
R4: Specific 1	100 m^2 + 200m^2 *Storage+Assem. PMT*	200 m^2 $\otimes$ 1600 m^3 *Water Station*	? m^2 $\otimes$? m^3 *LAr production plant*
R5: Specific 2	?	100 m^2 $\otimes$ 300 m^3 *Liquid Nitrogen Plant*	? m^2 $\otimes$? m^3 *Cryogenics*
Proposed Buildings			
B0	R0	R0	R0
B1	R1+R2+R3+R4	R1+R2+R3	R1+R2+R3
B2	?	R4+R5	R4+R5

Regular Operation of the Underground Facility

	Water Cherenkov	Liquid Scintillator	Liquid Argon
Typical / max. no. people Exceptional situations with more people than the above (visitors, emergencies ..)	3 / 20 With WP3	4 / 20 With WP3	3 / 20 With WP3
Temperature of liquid Temperature gradient	12(in)-14(out) ^{o}C < 2 x10^{-4} ^{o}C / cm	8 - 18^{o}C; lower preferred < 1 x10^{-4} ^{o}C / cm	83 ^{o}K
Temperature of caverns	MDC (dome): 22 ± 1 ^{o}C AC1: 22 ± 1 ^{o}C AC2: 22 ± 1 ^{o}C	MDC: ? ± ? ^{o}C AC1: 22 ± 1 ^{o}C ?	MDC: ? ± ? ^{o}C AC1: 22 ± 1 ^{o}C ?
Thermal stabilization of MDC	This possibility is site-dependent, and therefore an output of the FS	no ?	by hot-air forced flow
radon at MDC+AC,s+relevant IT,s radon at rest of facility (AT,s+other IT,s) radon in air inside the Tank Ventilation: Time to change 1 volume of air MDC+AC,s +relevant IT,s 1 volume air rest facility (AT,s+other IT,s)	< 40 Bq/m^3 <100 Bq/m^3 0.3 mBq/m^3 output of the FS output of the FS	< 40 Bq/m^3 ~ ? Bq/m^3 ? output of the FS output of the FS	< 40 Bq/m^3 ~ ? Bq/m^3 ? output of the FS output of the FS
Crane needs	With Technodyne	?	?
Own-power-generation	Human safety (w/ WP3) + basic instrument care (see page 10)	Human safety (w/ WP3) + basic instrument care (see page 10)	Human safety (with WP3) + basic instrument care (see page 10)
Specific 1 Specific 2	? ?	? ?	Hot air forced flow [? m^3/h] between MDC' walls and tank Availability of hot air flow [? m^3/h] following the risk analysis (with WP3)

Regular Operation of the Experiment (underground)

	Water Cherenkov	Liquid Scintillator	Liquid Argon
Power needed:			
Related to Detector	no. of tanks x 500 kW (HV PMTs and FE-Electronics)	5 kW	? kW
External Electronics	? kW	100 kW	? kW
- Specific 1	? kW [water and air purification]	? kW [water purification]	? [Larg purification]
- Specific 2	n/a	n/a	? [Hot Air production plant]
Own-power-generation	? kW [Basic care of instrumentation in case of power failure] for ACQ	? kW [Basic care of instru-mentation if power failure]	? kW [Basic care of instru-mentation if power failure]
Heat dissipation: - tank + ancillary in MDC - Electronics et al. Hut - Specific 1 - Specific 2	≈ Power needed (previous box) + heat from the rock (which is an output of the FS)	≈ Power needed (previous box) + heat from the rock (which is an output of the FS)	-60 + ? kW ≈ power needed (prev. box) + heat from the rock (which is an output of the FS)
Flow of liquids (pumping capacity) at pipes	- Water: 100 m^3/h	- Liq. N pipe: 20 m^3/h - Liq. scintil.: 20 m^3/h - Water: 20 m^3/h	- LAr filling: 6 m^3/h - LAr recirculation: 36 m^3/h

Note: general information of the PMTs

	How Many	Cost	Weight	Typical Dimension
Water Cherenkov	no. tanks x [76000 / 5000]			12'' Ø / 8'' Ø
Liquid Scintillator	15000		5kg/unit	