Technical requirements for infrastructure from instrument

F. Sorrentino

Motivation and rationale

- Besides the space demands, technical requirements from detector may largely affect the cost of underground infrastructure
- The civil engineering working group in task force collected a list of relevant requirements
  - to be possibly attached to the baseline detector layout
  - to allow for a technical feasibility study on the ET infrastructure.
- For each requirement, the list identifies
  - name
  - quantitative values (range) & units
  - explanation/motivation
  - source of the requirement
  - status: initial guess, validated by task force experts, certified by ISB
- We should now discuss the list
  - try to move quantitative statements from initial guess to referenced values

Technical requirements - current list

Requirement #	requirement name	units	value/range	explanation	source	status
REQ_ENG_001	arm tunnel center inclination	mrad	<1.5	H/V coupling on TM, same order as minimum inclination from Earth curvature	SUSP, PAY (thermal noise)	initial guess
REQ_ENG_002	water tightness	m	>250	distance from TM: all caverns and part of arm cavity tunnel	Newtonian Noise	initial guess
REQ_ENG_003	humidity in tunnel	%	40÷60	lifetime of equipment	VAC, electronics, ENV sensors	initial guess
REQ_ENG_004	tunnel cleanliness	ISO	ISO 9	lifetime of equipment	VAC, electronics, ENV sensors	initial guess
REQ_ENG_005	cavern cleanliness	ISO	ISO 9 in general, ISO 7 and better in cleanrooms as specified in detector layout	vacuum contamination, stray light from dust, monolithic suspension failure from dust	VAC + SLC + PAY	initial guess
REQ_ENG_006	temperature stability in tunnels	deg	natural underground stability is sufficient		VAC, electronics, ENV sensors	initial guess
REQ_ENG_007	temperature stability in caverns	deg	0.1/hr, 0.2/day, 0.3/month	actuation range for suspensions, misalignment of in-air optical systems, and many other	SUSP + OPT + INJ + other	initial guess

Technical requirements - current list

Requirement #	reqirement name	units	value/range	explanation	source	status
REQ_ENG_007	temperature stability in caverns	deg	0.1/hr, 0.2/day, 0.3/month	actuation range for suspensions, misalignment of in-air optical systems, and many other	SUSP + OPT + INJ + other	initial guess
REQ_ENG_008	humidity stability in caverns	%	+/-5 within 40÷60	in-air optics, maybe other equipment	Virgo experience	initial guess
REQ_ENG_009	ventilation	TBD	TBD	seismic noise, acoustic noise, NN	SUSP, NN	initial guess
REQ_ENG_010	logistics	m	as specified in detector layout	main building blocks, i.e. cryostat and pipe sections	CRYO, VAC	initial guess
REQ_ENG_011	recesses in tunnels	#, m^3, m^2	TBD	safety/escape routes, gate valves	CE, VAC	initial guess
REQ_ENG_012	expected lifetime	year	>50	infrastructure lifetime of at least 50 years		
REQ_ENG_013	allowable main arm tunnel deformation	mm, mm/yr	TBD	Maintaining optical axis alignment.		
REQ_ENG	allowable differential deformation	mm	TBD; per 20m beampipe segment	To limit stress on welding lips (a few mm of differential motion per 15m segment is the limit for Virgo)	VAC, Virgo experience	

Technical requirements - additional items

vibration	e,g, from vacuum units, clean room filter units, cryogene units, drainage pumps, water dripping on protection structures ...
cranes in clean rooms	Are they required? Which dimensions?
additional cranes outside clean rooms	Are they required? Which dimensions?
noise rooms required?	Inside or outside of clean rooms? At all required? Dimensions?
clearance requirements to bypass clean rooms	Is 5 m confirmed?
filter units for clean rooms require additional profile clearance in cavern cross section?	We assume they do not require additional clearance and are positioned along the cavern axis aoutside of the cleanroom space, not e.g. on top of the clean room or at the side.
(emergency) ventilation required, e.g. for smoke extraction, cryogene leakage?	

energy release rate from facility infrastructure (vacuum pumps, cryogene units, ...), and how the heat should come to the surface (by cooling water pipes, by ventilation?).

Technical requirements - additional items

Ventilation	Are persons in the tunnel active when the detector is in use? (Important for the Ventilation design.)
Power supply	What is the expected electrical load of the cryogenic installation for the towers? Is every tower (with mirror) provided of a cryogenic installation? In case of power failure, does this installation need a kind of back-up power to avoid damages of the cryogenic installations?
Power supply	What is the expected eletric load of the lasers. How many will be installed in each corner of the ET-triangle? In case of power failure does this installation need a kind of back-up power to avoid damages of the equipment? (f.e. cooling system)
Power supply	What will be the coëfficiënt of sumultanieity of the vaccum pumps in the pipe pumping rooms of the tunnel. We calculated 2x 2500l/s for the first stage of creating the vacuum per pipe and only 1 pipe will be brought to vaccuum levels untill that level is reached. At that time the 2nd set of HV-pumps will start on the 2nd pipe and the 2x 300l/s UHV-pumps will start the second stage to go to ultra high vacuum on the first pipe. These UHV-pumps will be the only ones working occasionally to maintain the level of UHV. Is this assumption correct?
Power supply	What will be the coëfficiënt of sumultanieity of the baking of the pipes in the pumping rooms of the tunnel. We assume that only 1 part of 500m will be baked at any moment in construction phase. Once the test and commisioning has started, the baking will not be necessary anymore. Is this assumption correct?
Power supply	What will be the coëfficiënt of sumultanieity of the vaccum pumps in the towers. We calculated 2 segments in the tower which each have a 2500l/s-vaccuum pump for the first stage of creating the vacuum in the tower and all towers will be brought to basic vaccuum levels at the same time untill that level is reached. At that time the 2x 300l/s HV-pumps per tower will start the second stage to go to high vacuum. These HV-pumps will be the only ones working constantly to maintain the level of HV. Is this assumption correct?