Basic assumptions for the Review of the ET Conceptual Design infrastructures @9th ET Symposium

G Losurdo and A Paoli

DISCLAIMER

This is not a technical report. It has to be intended as a brief note written down in a short time upon request of the ET steering committee to serve as a basis for a brainstorming, to be held on May 10th.

The work presented at the 9th ET symposium wasn't meant to be a design for the ET infrastructure/vacuum. It rather was an attempt of introducing some good practices in the ET concept design.

We started by the evidence of some issues in the concept design.

- Tunnel too crowded (slide 7): with the proposed configuration one should have a clear procedure for transportation of tube modules, assembly, welding, problem fixing.
- Superattenuators (slide 8): we believe that SA must lay on solid rock and two-story approach must be avoided. Moreover, a realistic tower footprint must be kept into account.
- Cavern shape (slide 9)

We then made a design which solves those issues. The assumptions there were mainly based on Virgo experience with SA and vacuum system. It is likely that with proper engineering studies some constraints could be relaxed.

The main questions is: how did we get a tunnel diameter of 11 m (main cost in the ET budget)?

1. *Avoid vertical overlap of the vacuum pipes*

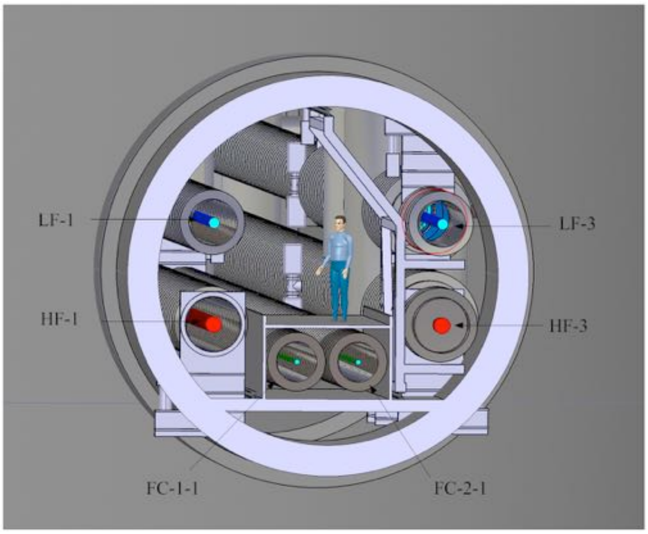
This is mainly driven by the requirement the all the SA are placed on solid ground. To relax this constraint a dedicated study with a realistic and well-engineered solution and simulations showing that the performance of the vibration isolator is not spoiled is necessary.

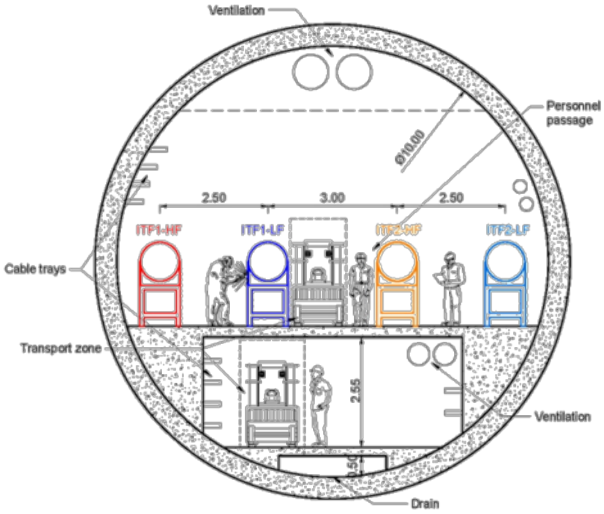
2. *Consider realistic Tower Bases →ø 4m HF; ø 5m LF (for cryogenic space issue);*

This is the choice with the largest impact on the tunnel diameter. We adopted a tower shape based on the Virgo experience. Other solutions might be possible, upon a proper study which guarantees that the necessary rigidity is achieved. On the other hand, **at the moment we don't know how the cryogenics of the LF test masses will be realized and what will be their footprint** and, at this stage, one has to be careful not to limit the technology design choices upon lack of space. In the following of this note the initial study of an alternative approach is presented.

3. *Service space between vacuum pipes for installation and maintenance*

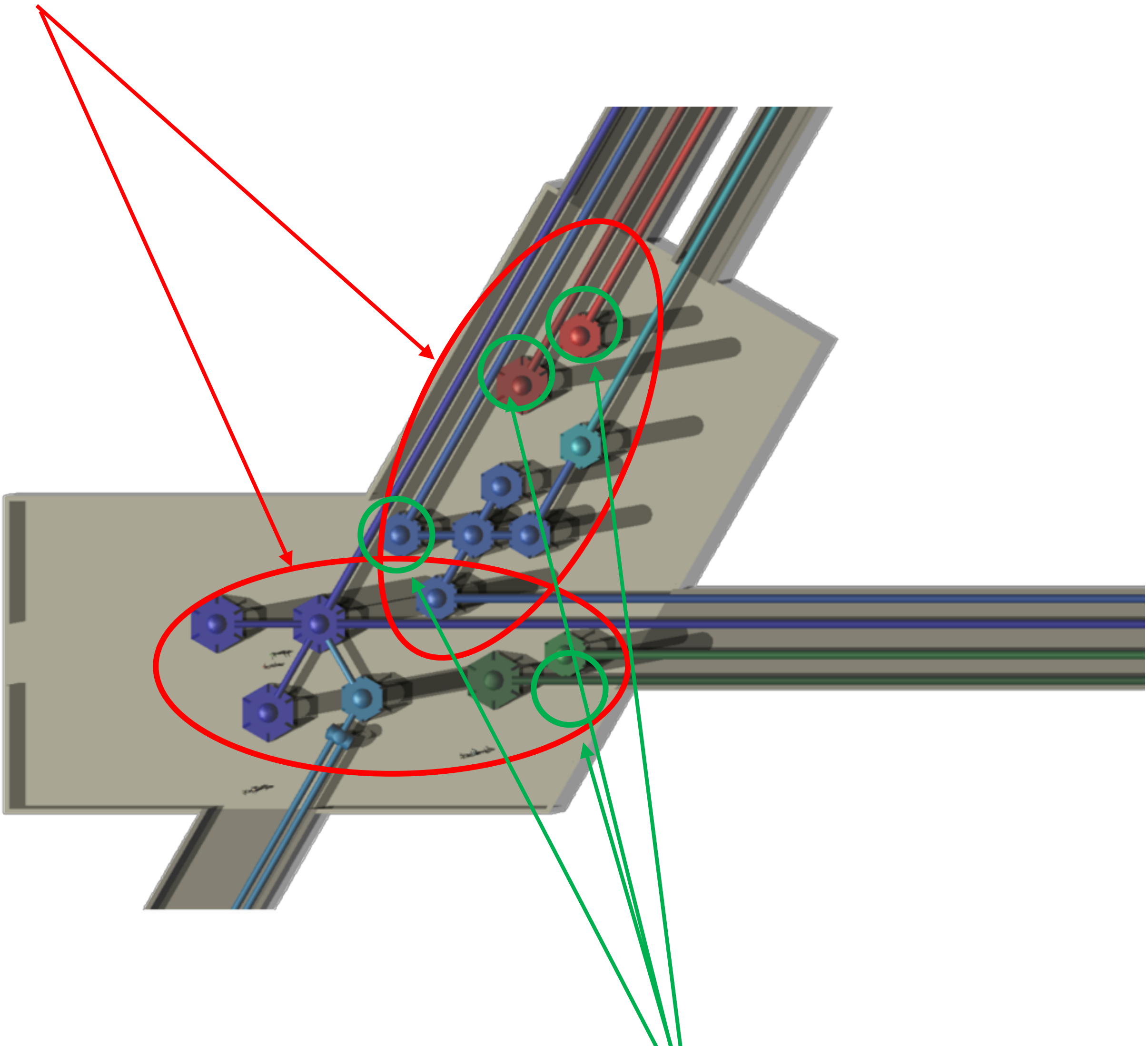
The large tunnels guarantees a low risk operation of the vacuum system: module transportation and assembly, welding, fixing in case of troubles. Hopefully, new ideas and design will succeed in reducing the tunnel diameter we must be sure that we have a procedure for all the necessary operations.





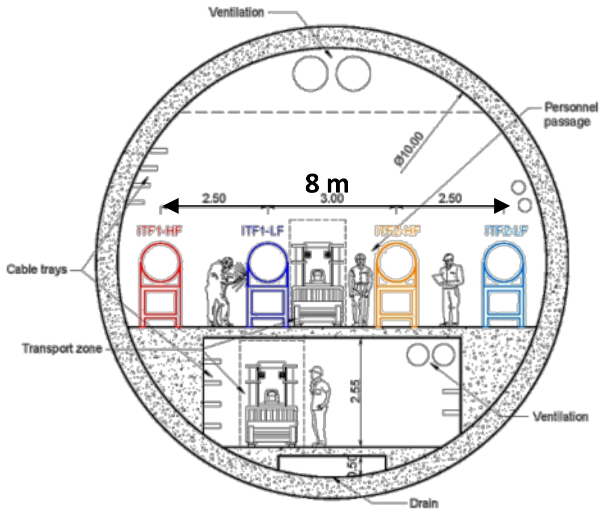
→ Horizontal positioning

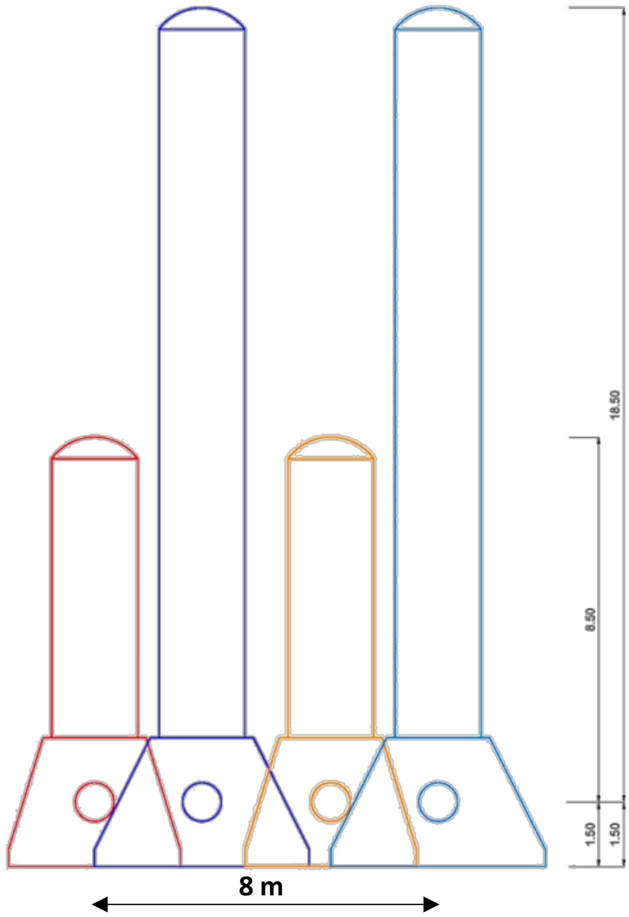
→ Accommodate realistic Tower Bases in the Experimental Halls



→ Interferences between Base Tower and vacuum pipes

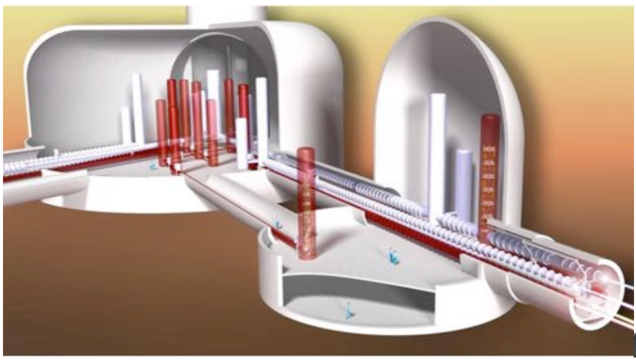
→ This drives to a Tunnel inner diameter of 10 m

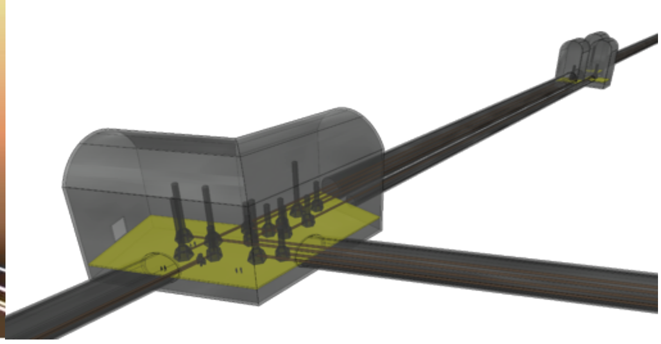


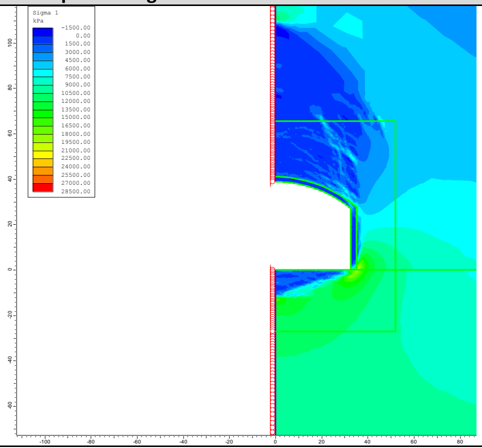
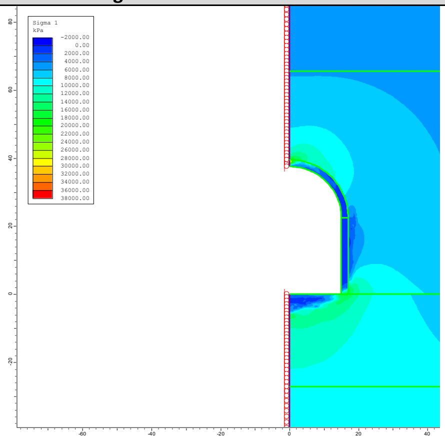


4. *__Cavern shape is critical__*

The shape of the caverns has been re-designed in order to reduce the excavated volume and improve the stability and the stress conditions.

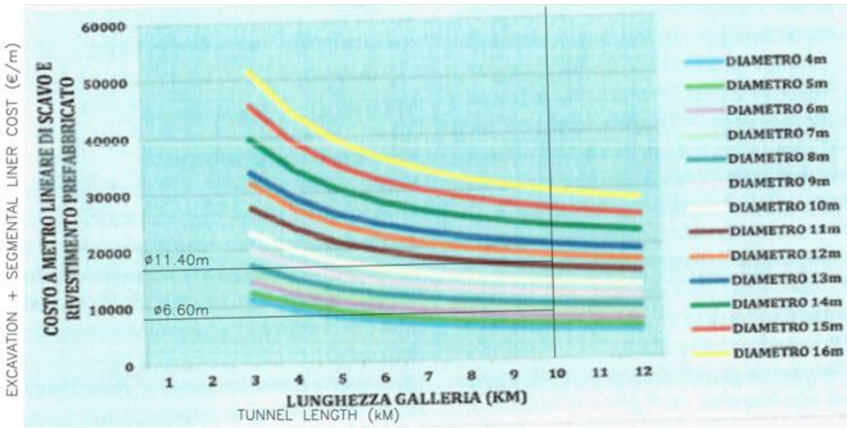




Parameter	Conceptual design scheme	Review design scheme
Max. Principal Tension S11		

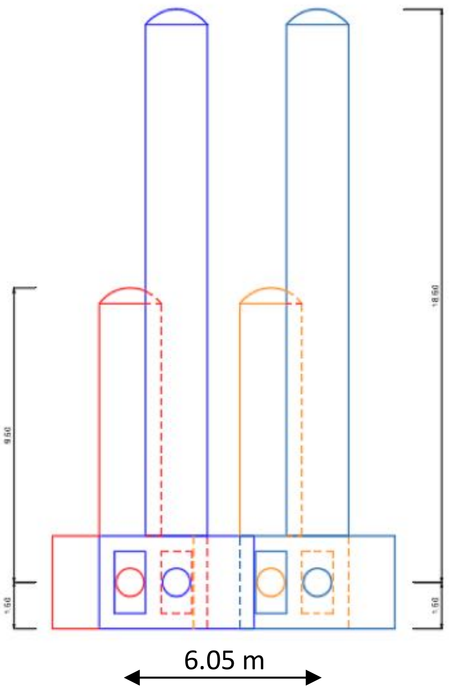
Further considerations

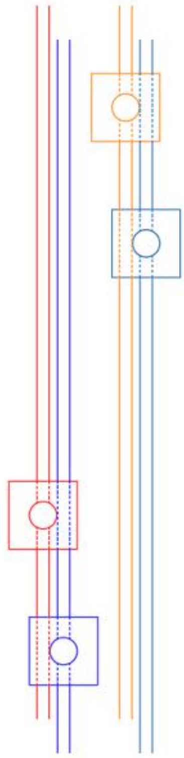
Here we present some further considerations on the point 2 (footprint of tower bases). For Virgo, the tower bases were conceived to guarantee stability of the towers and to serve as “ovens” for their bakeout. This matter must be studied anew for ET and it is likely that a completely different solution may be viable. In the following sketch an alternative basic design is proposed, which allows to reduce the tunnel internal diameter from 10 to 8 m. This might drive a saving of 120-150 M€, taking into account of the reference costs for mechanized excavation tunnels.

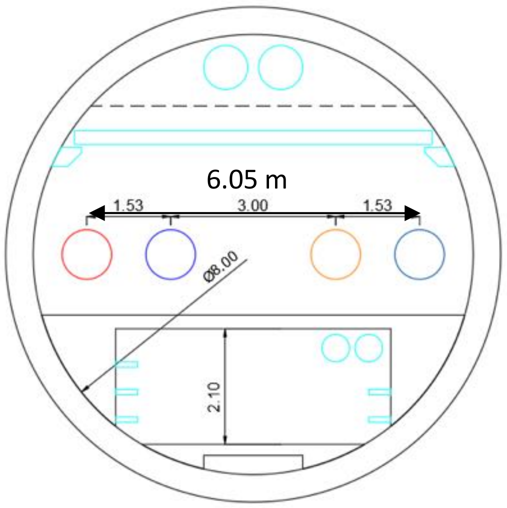


However, to proceed in this direction one must first clarify:

- The space needed by the cryogenic setup inside the tower and around the towers;
- The space-interference between the tower base and the adjacent vacuum pipe crossing through;
- The feasibility of the non-symmetric tower base;
- The requirements for a correct assembly and operation of the vacuum tubes.







Ø int 8m

Concluding remarks

The proposed design was not meant to be "final", but rather a conservative design to be thought as a basis for a discussion. We believe that other options are possible but good practices must be followed:

- We want to realize the infrastructure for detectors that must stay at the frontier of the physics research for half a century: we cannot tie our hands sacrificing space at a stage when crucial design choices have not been made. We already did this mistake with the Virgo central building.
- We might decide to take some risks to save considerable amount of money, but this must be accompanied be a serious study providing an assessment of the risk and a risk mitigation strategy.

In order to understand if the tunnel diameter could be reduced we propose to proceed as follows:

- Study a quasi-engineered alternative solution for the tower bases, capable of reducing the inter-tower distances. This solution must guarantee the required rigidity, the space for cryogenics, the accessibility to the tower optical windows, …
- If the previous step is successful, the pipes in the tunnel will be closer. In this new configuration one has to study a quasi-engineered solution for the transportation, assembly, welding of the tubes and for the interventions to fix problems in case it is needed.

In other word, the tunnel diameter must be the outcome of a multi-disciplinary study, involving experts of suspensions, vacuum, cryogenics, infrastructure, ….

One additional comment: in the ET design the vacuum tube diameter has been reduced wrt Virgo. This might be sensible, but it is weird that a detector aiming to a factor 100 of better sensitivity wrt Virgo has a smaller tube. Probably this aspect is worth some further study.