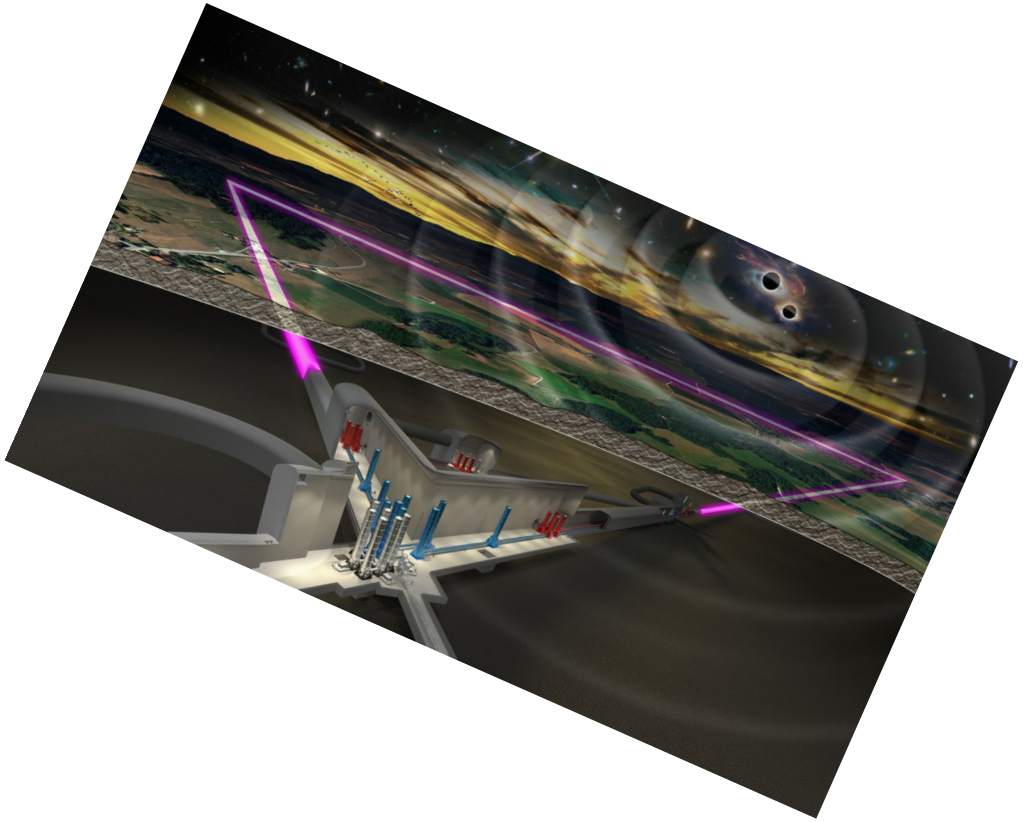
ETO: Engineering Department

In the process of creating



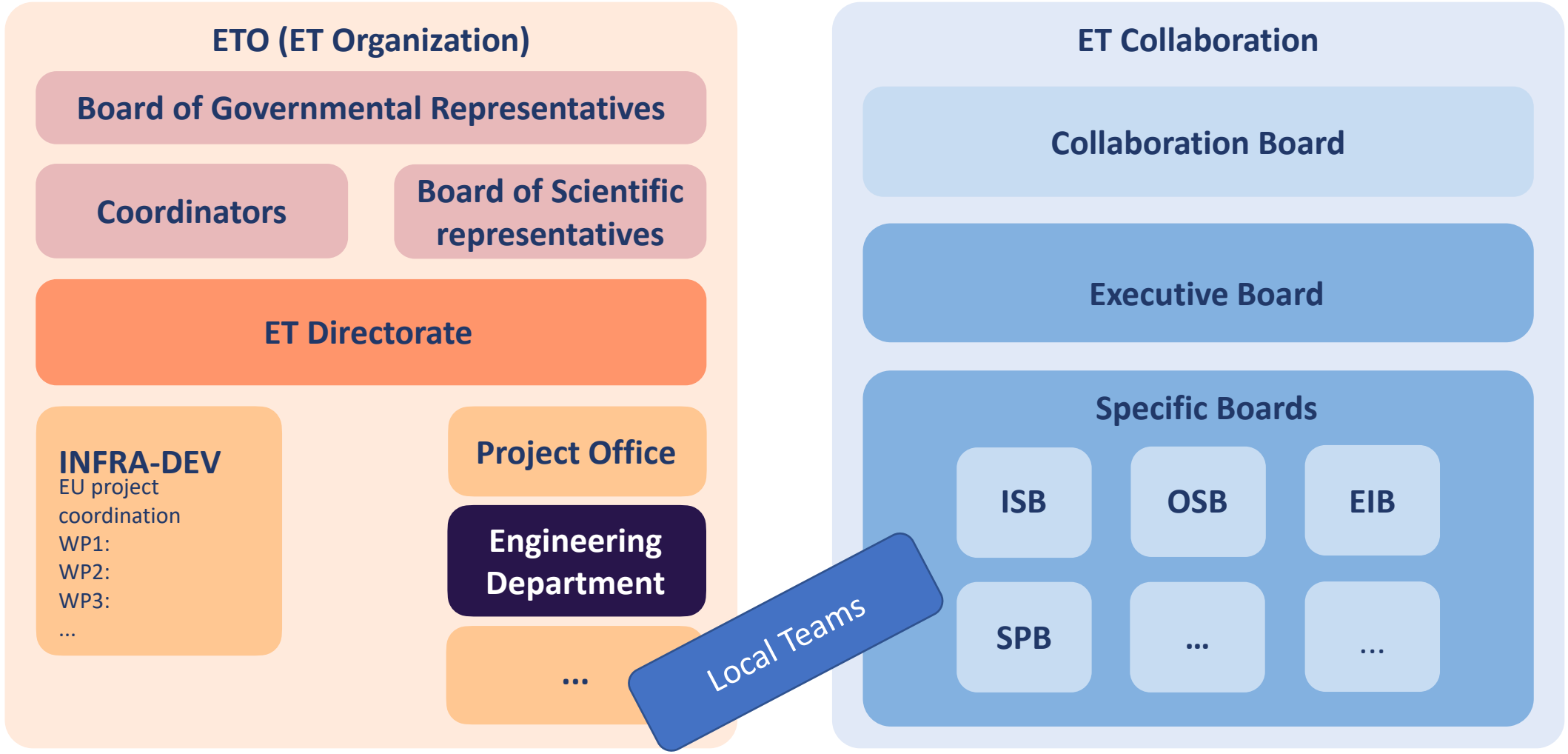
Patrick Werneke

XIII Einstein Telescope Symposium

12.05.2023

ET Dual Organizational Structure

1) project organization (towards legal entity) and 2) scientific collaboration



Engineering Department: mission

The Engineering Department will **design**, **procure, install, commission, operate, maintain and eventually, dismantle:**

1. **The special systems** (e.g. vacuum, cryo, monitor & survey) associated with the gravitational wave detector

and

2. **The technical infrastructure systems needed to operate the interferometer** (e.g. civil engineering, technical Infrastructures (power distribution, cooling & ventilation, …)

Engineering Department

The **activities** of the Engineering Department are in the following fields:

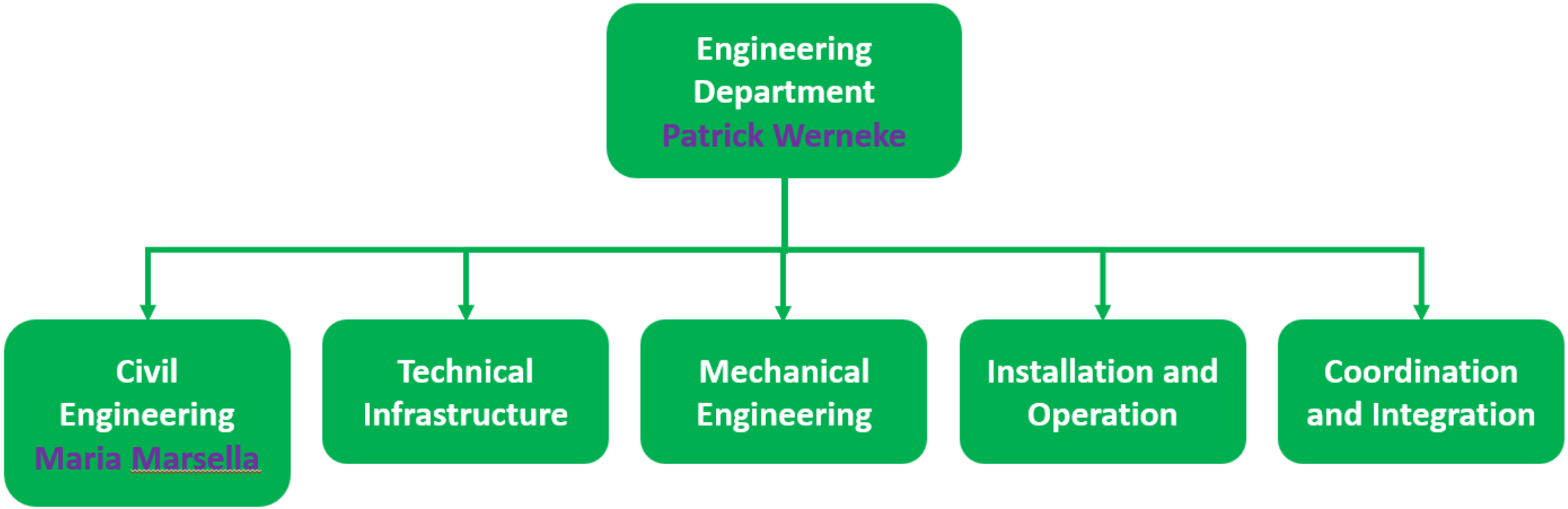
- **Civil Engineering:**
  - Underground shafts, decenderies, caverns and tunnels
  - Surface buildings, roads, ….
- **Technical Infrastructure:**
  - Cooling & ventilation, electricity, access and alarms, water management, …. ;
- **Mechanical Engineering:**
  - The technical systems associated with the gravitational wave detector: vacuum, cryogenics and survey;

Engineering Department

The **activities** of the Engineering Department are in the following fields:

- **Installation and operation:**
  - Logistics, transport, handling and lifting
  - Responsible for clean operations
- **Coordination and integration (In close collaboration with the Project Office):**
  - Coordination of the activities for installation, interventions and changes
  - Integration studies and maintenance of the engineering documentation
  - Coordination of safety in the field
  - Organization and scheduling of the installation and interventions
- **Giving technical support to the ET collaboration and local teams**

Engineering Department



Collaboration with CERN

- We have an MOU with CERN for their support on technical topics. The MOU was setup with INFN and Nikhef. Recently IFAE has joined as a fourth partner. **More partners are welcome.**

- The MOU so far covers the work for the ET beampipe. The CERN vacuum team has the responsibility to deliver the **technical design for the ET beampipe** at the end of a three year project. MOU partners will provide financial support for related CERN fellowships.
  - **Coordinate the efforts** of the institutes that work for the ET beampipes;
  - Ensure **the link with** the vacuum community of the **CE**.
  - **Propose less expensive** technical **solutions** that fulfil the requirements
  - Leading to a **pilot sector** and a **TDR** by end of **2025.**

- A second MOU appendix has been agreed on and is now being formalized: CERN will provide **support** towards the **technical design for the underground structure** (civil engineering)

Engineering Department

- We are also in discussion with other teams at CERN on other topics: **Safety and Health, Technical Infrastructure, Coordination of large projects, Logistics, Engineering Information Management.**

- So far we see a huge benefit for ET from the work at CERN for the beampipe:
  - Large team with different expertise working on the beampipe
  - See “Beampipes for Gravitational Wave Telescopes 2023” workshop, at CERN from 27 to 29 of March 2023 – see Carlo’s presenation.

Engineering Department: ET Phases

ET is currently in Phase I of a **Design and Preparation Phase**, which ends with the **selection of a site** for ET.
Deliverables for:

- Preliminary TDR
- Costing overview
- Risk assessment

2. Prepatory Phase 2: this phase will end with the final TDR, costing overview and risk assessment;
3. Implementation Phase: this phase will end with the Einstein Telescope commissioned;
4. Operation Phase
5. Termination Phase

Engineering Department: ET Phases

Preliminary TDR:

The first version of the TDR containing the information needed for **costing** and **risk** assessment of the ET Civil engineering and Technical Infrastructure.

For Phase 1:

- Separate underground Civil Engineering from underground Technical Infrastructure
  - Get results faster, not an optimized design.
- Separate underground Civil Engineering from surface Civil Engineering

Phase 2:

- Integration of all the Civil and Technical systems

Engineering Department – Civil Engineering

Phase 1 for **Civil Engineering** studies:

- Deliverables: Preliminary TDR & Cost and Risk assessment

Technical Design :

- Different options are identified and developed with enough technical and commercial detail to allow for thorough comparison and evaluation
  - Δ is the baseline
  - Logistics for installation, maintenance and upgrades
  - Safety assessments
- Civil engineering studies carried out with the help of an external consultant
  - Include information from site investigation works

Engineering Department – Civil Engineering

Phase 1 for **Civil Engineering** studies:

- Deliverables: Preliminary TDR & Cost and Risk assessment

Technical Design:

- Single design option is selected (for Δ – 2L is compared as a change to the Δ)
- Cost estimate, risk assessment and conceptual schedule are prepared
- Preliminary TDR completed

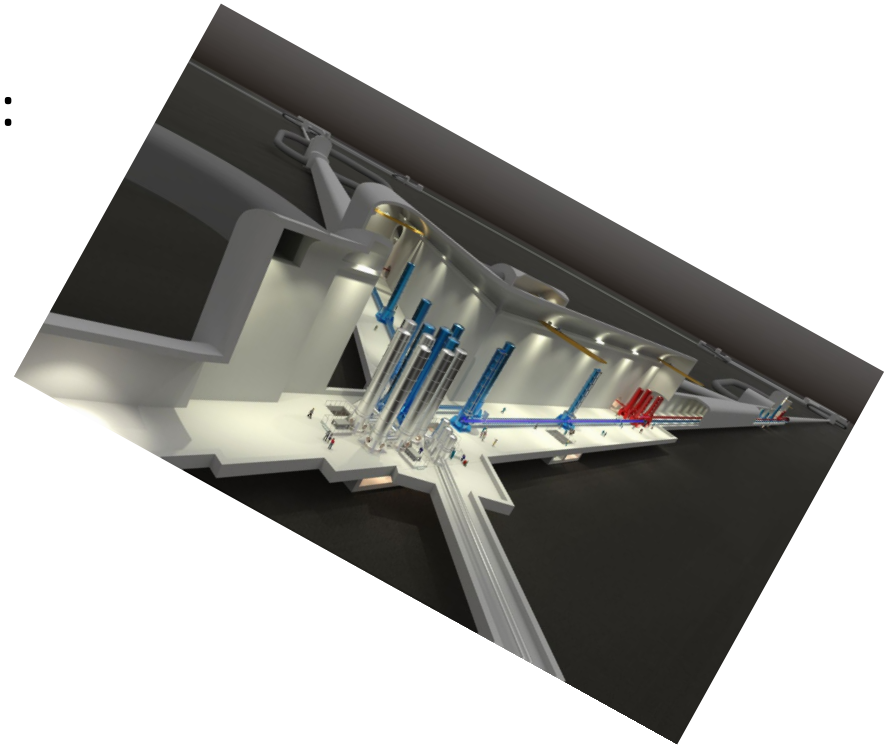
Engineering Department – Civil Engineering

Phase 1 for **Civil Engineering** studies:

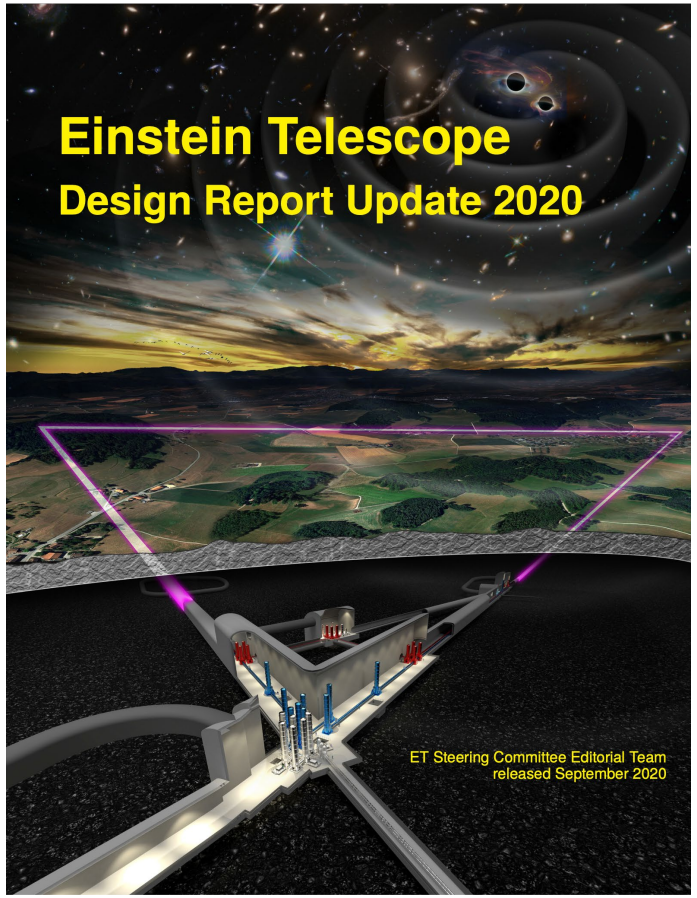
- Deliverable: Preliminary TDR & Cost and Risk assessment

➢ What do we need to **start** the Technical Design:

- Functional Layout
- Project requirements



Functional layout and project requirements



- The Design Report Update 2020 is a good starting point for finding layouts and requirements, however they are not complete and subject to change.

- A PBS (Product Breakdown Structure) was created:
  - Provide input for the costing and naming
  - Provide the backbone for the WBS that will define the **project schedule.**
  - Provide the backbone for **requirements** breakdown and hierarchy.
  - See: Thematic workshop (ETO: Configuration kick-off and optical/functional layout)

Functional layout and project requirements

Start with Design Report files and will follow up on the open issues: “hot topics”

- Especially for ones related to Civil Engineering

✓ Beampipe diameter is baselined

➢ Towers: access from below or lateral (space required)?

➢ Ability to move Towers around - by how much?

➢ Space needed for Cryogenics for LF and HF / routing of pipes to surface

➢ Height of the Superattentuators

➢ Telescope design thoughts and questions to be answered

➢ Logistics for installation, maintenance and upgrades

➢ And probably some more issues

Engineering Department – Technical Infrastructure

Phase 1 for **Technical Infrastructure** studies:

- Power Distribution
- Optical Fiber Infrastructure
- Signal Distribution
- Lighting and Emergency Infrastructure
- Cooling and Ventilation
- Dewatering systems
- Infrastructure sensors

➢ Could use help with studies from the Collaboration

Engineering Department

Resources:

- In the process of completing the initial team with in-kind contributions from the participating national institutes.
- The recruitment process of the INFRA-DEV resources is ongoing
  - Difficulties with finding Civil Engineer and Integration and Infrastructure Engineer

- To fulfill our tasks for Phase 1 more resources are needed:
  - We are in the process of establishing how much resources we need

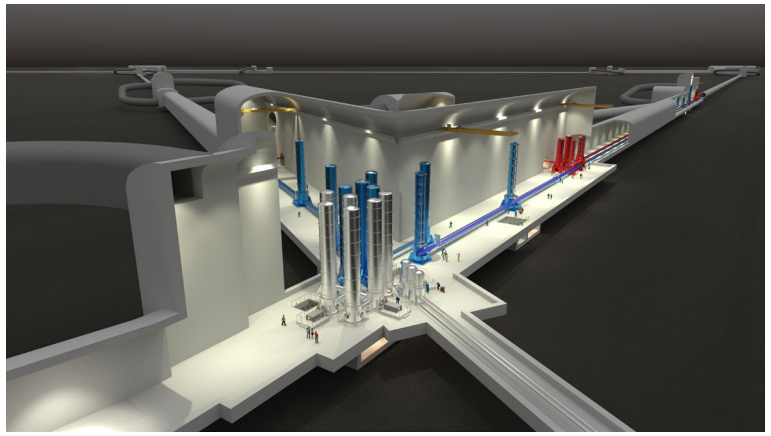
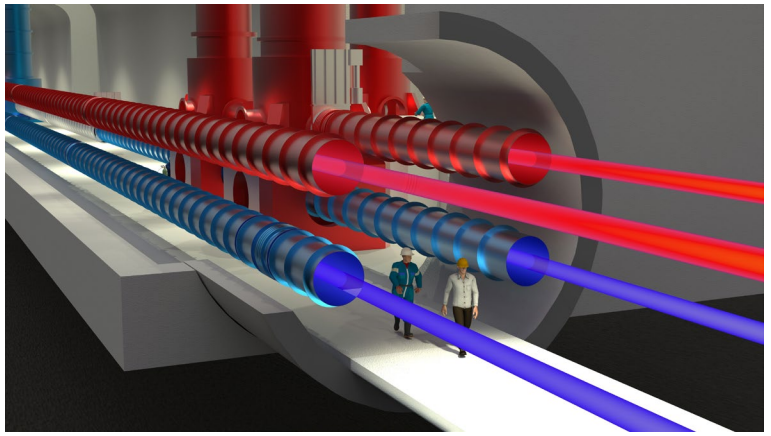
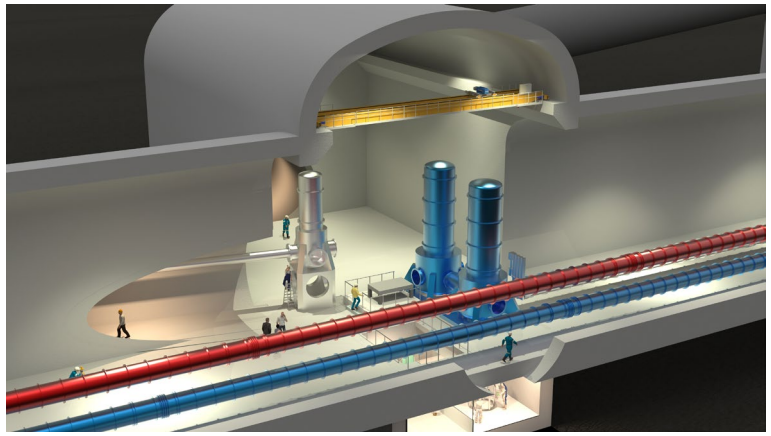
Engineering Department

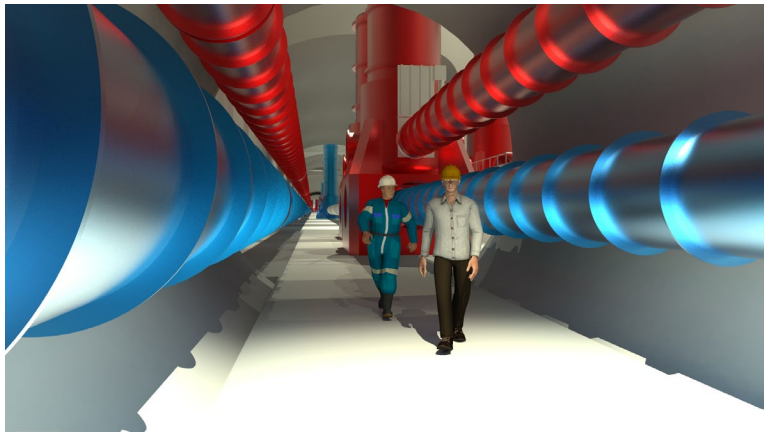
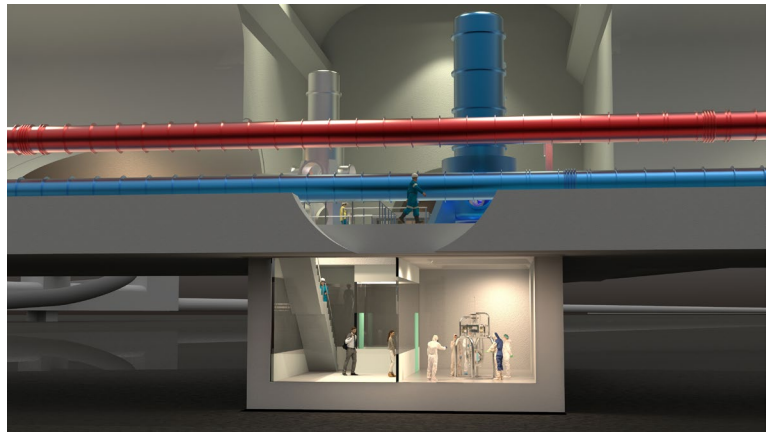
Resources:

- Several resource contributions (In-kind and INFRA-DEV) to CERN for the beampipe development:
  - The MOU with CERN for the beampipe is ending with pilot sector and a TDR by end of **2025.**

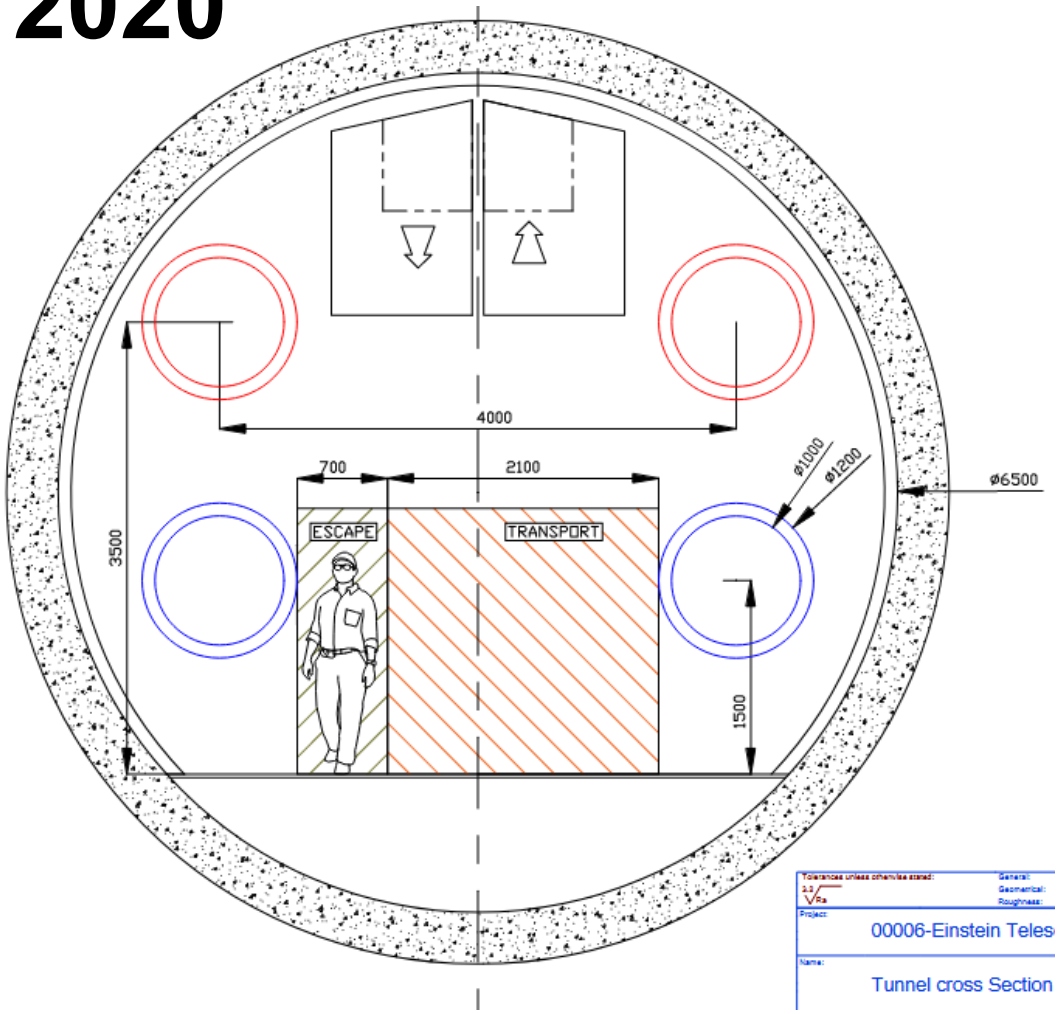
- More engineering help would be very welcome. If you are interested to contribute contact me.

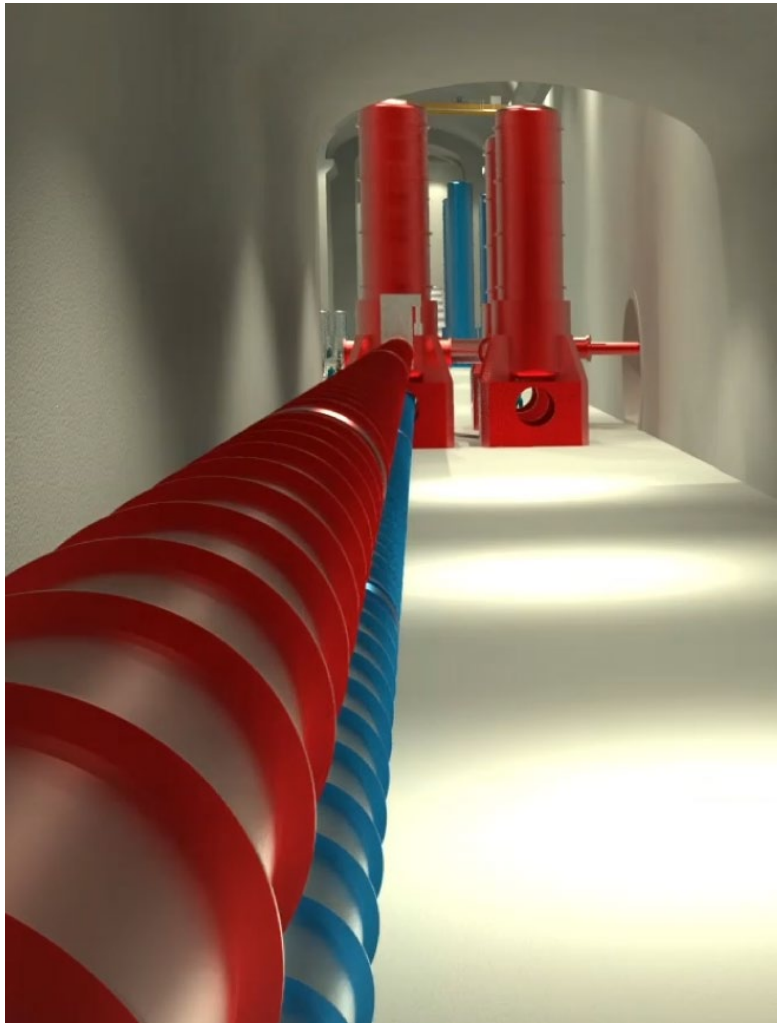
End

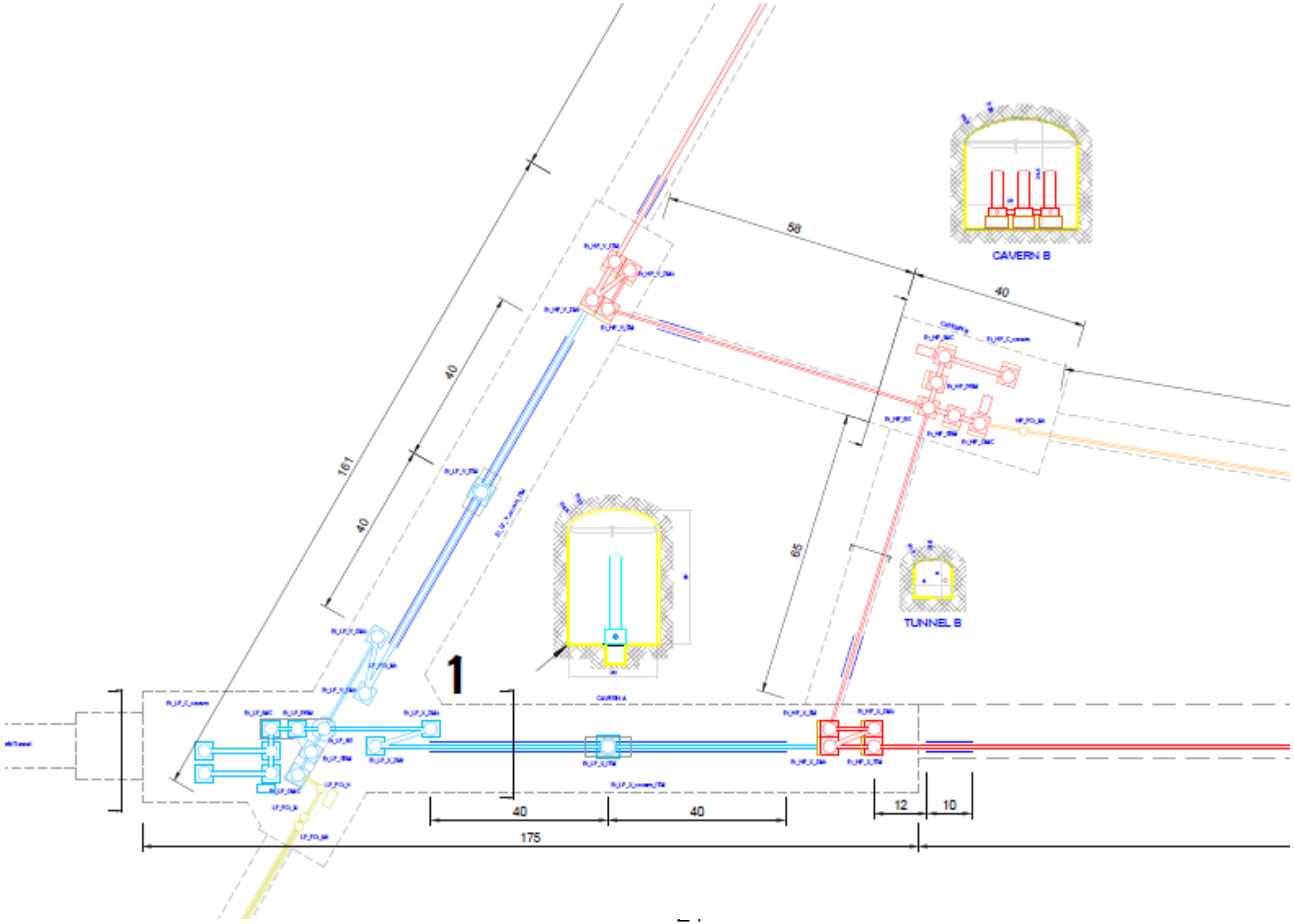




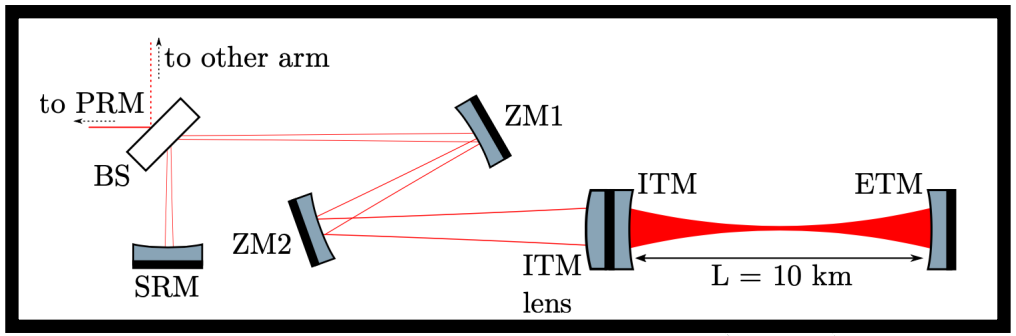
Tunnel layout from Design Report Update 2020

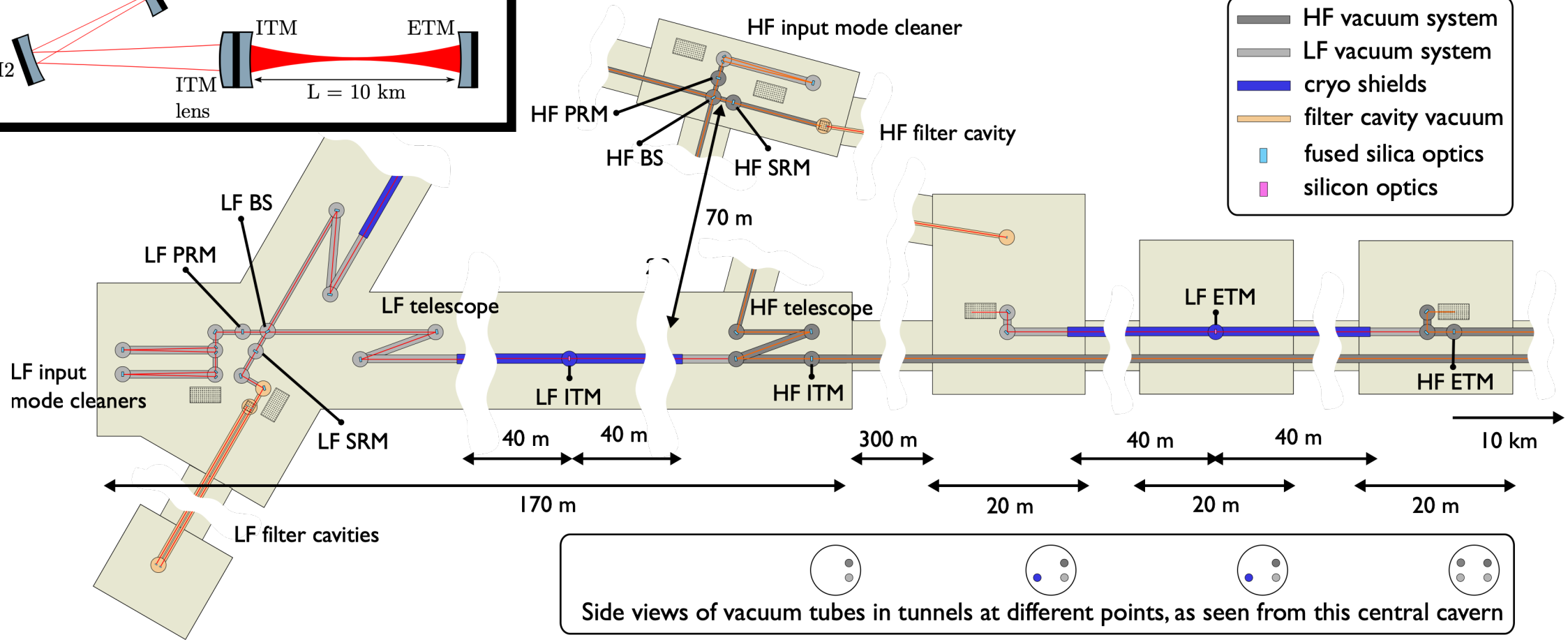





CAVERN B
TUNNEL B
CAVERN A
1
58
40
40
161
40
65
40
40
12
10
175

Optical layout





S. Rowlinson: Feasibility study of beam-expanding telescopes in the interferometer arms for the Einstein Telescope https://arxiv.org/abs/2011.02983