



Alternate Site and Tunnel Configuration Status Report KEK (2)

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Safety Aspects of SingleTunnel

Preliminary Study

as a part of tunnel configuration study



Background of the Prelim. Study

- Cost for underground civil construction takes large part in the total cost.
- In order to reduce it, alteration of tunnel configuration from twin to single have been seriously examined.
- As a part of the examination, a drawback on safety caused by change of tunnel configuration from twin to single must be examined.



Two Types of Single Tunnel for ILC

Type	Integrated Single Tunnel (Service & beam in one tunnel)	Beam only Tunnel (Clustered klystron)
Component	Klystrons, Racks, LCW Skid Power supply, Accelerator	Accelerator
Similar Tunnel	XFEL	CLIC (LHC)
Possible Fire Origin	High power transformers Distribution panels Switchboard Cable connections	Low power electronics
Potential combustibles or smoldering items	High power cables	Low power cables
Probability of fire	Low	Very low



Planning Approach

There will be no plan which is identical to all the sites, as many of safety elements are site dependant:

- Code, standard and permit procedure vary by the host country.
- Final plan is subject to approval of the relevant authority.

TDP, as well as RDR, will deal with “uniform measures” or “generic measures” which may be finalized in accordance with the specific requirements and discretion of the authorities in the host country.

Single tunnels will be able to achieve these safety measures ?

1. Fire Prevention/Localization
2. Fire Detection & Alarm
3. Evacuation Support
4. Evacuation
5. Smoke Control
6. Fire Suppression



1. Fire Prevention/Localization

- Flammable materials shall be eliminated.
- Oil shall be concealed in the hermetic containers.
- Cables shall be of fire retardant and sealed in the closed trays if practicable.
- Only instructed personnel is allowed to enter the underground areas.
- Taking flammable items into the underground areas is prohibited.
- Compartmentation is important, at least for shaft base caverns and experimental hall, which was not accomplished in RDR.

All achievable



2. Fire Detection & Alarm

- Smoke detectors
- Manual alarms

All achievable.

3. Evacuation Support

- Emergency lights
- Illuminated exit signs
- Public address system
- Security cameras

All achievable

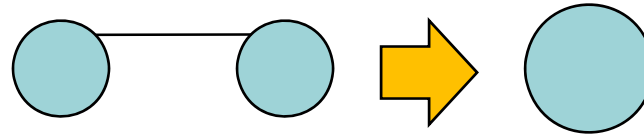
4. Evacuation: **challenging issue**

4.1 Basics

- Two way evacuation must be secured.
- Access to different fire compartments to be within 600 m.

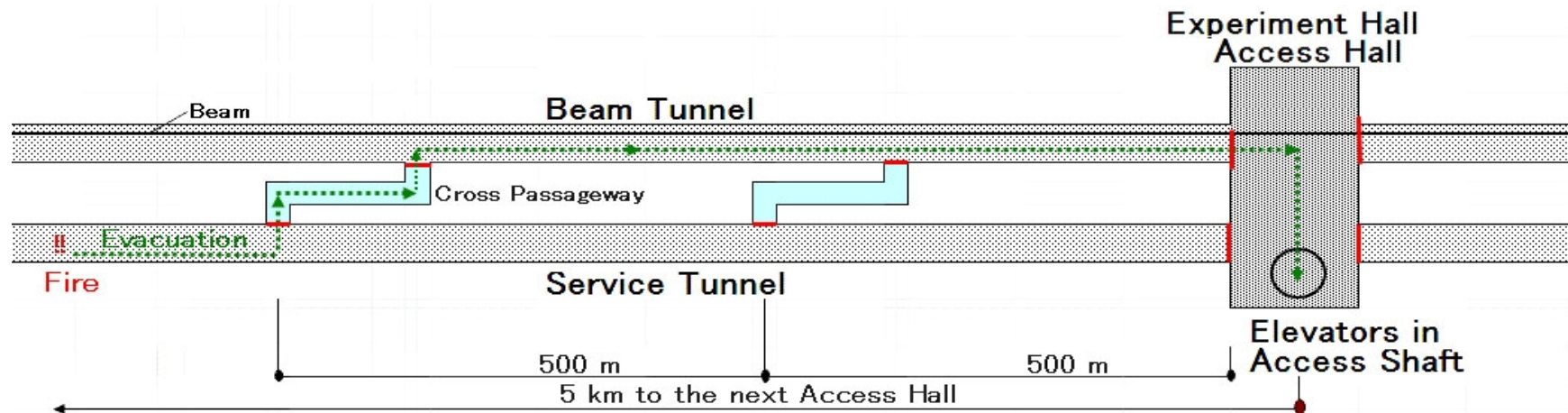
(tolerable time for evacuation is 10 min with walking speed of 1 m/sec.)

- Ultimately reachable to the final safety area (refuge area) which is pressurized and equipped with the staircase and the elevator(s) to reach to the ground.

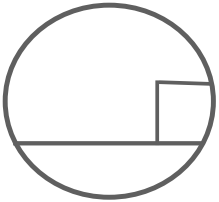
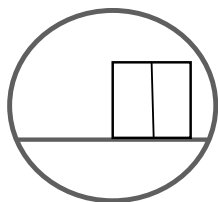
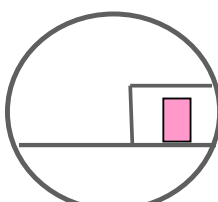
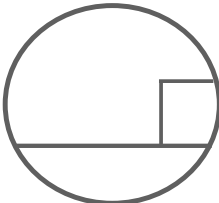
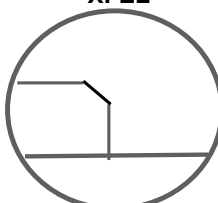
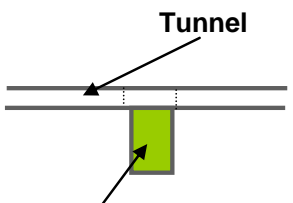


From twin tunnel to single tunnel

- For twin tunnel configuration, a presence of the second tunnel solves the fire hazard.
- One can escape to the other tunnel through the connecting passage way located at interval of ~500 m within 8 minutes,

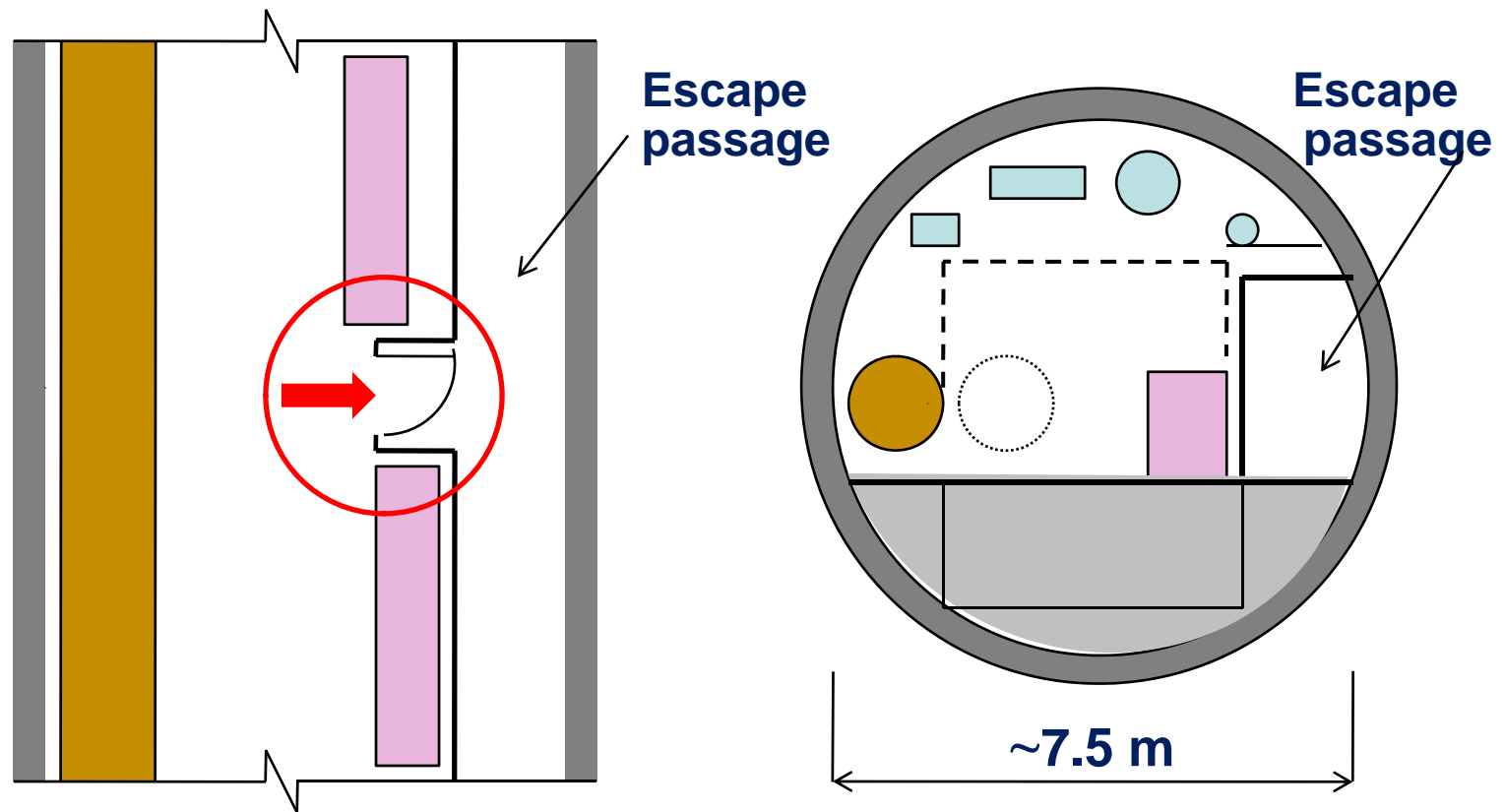


4.2 Four evacuation methods conceived now

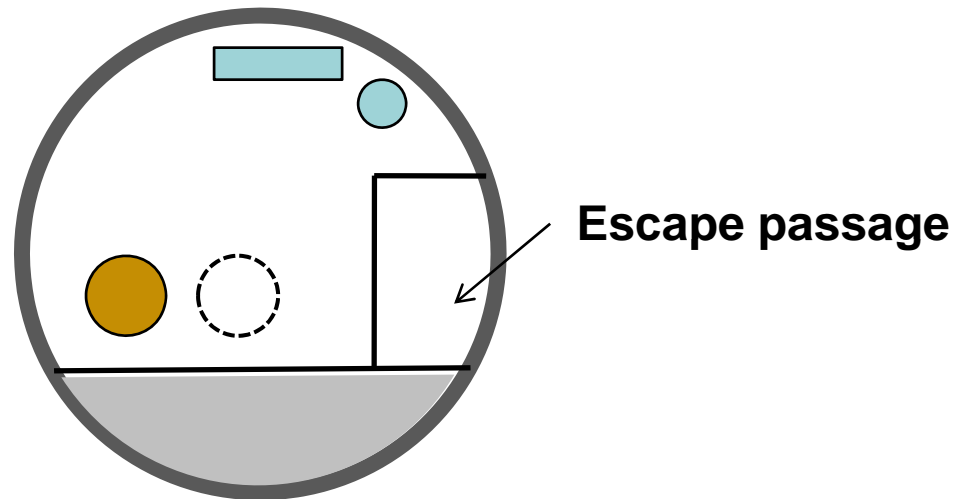
	1	2	3	4
	Enclosed escape passage in tunnel	Compartmentation @ 500 m	Shielded RF units	Refuge alcove @2.5 km
Integrated single tunnel (service & beam in one tunnel)		CLIC 		
Beam only tunnel (cluster klystron scheme)		or XFEL 		

4.2.1 Enclosed Escape Passage in Tunnel

Case of integrated single tunnel

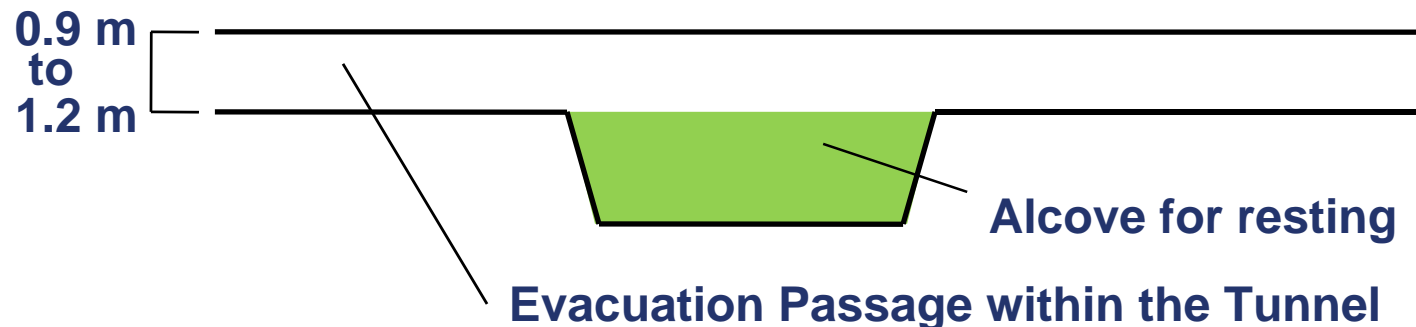


Case of beam only single tunnel (with clustered klystrons on the surface)



Diameter of RDR beam tunnel is 4.5 m. With the escape passage, it may be increased to ~5.7 m

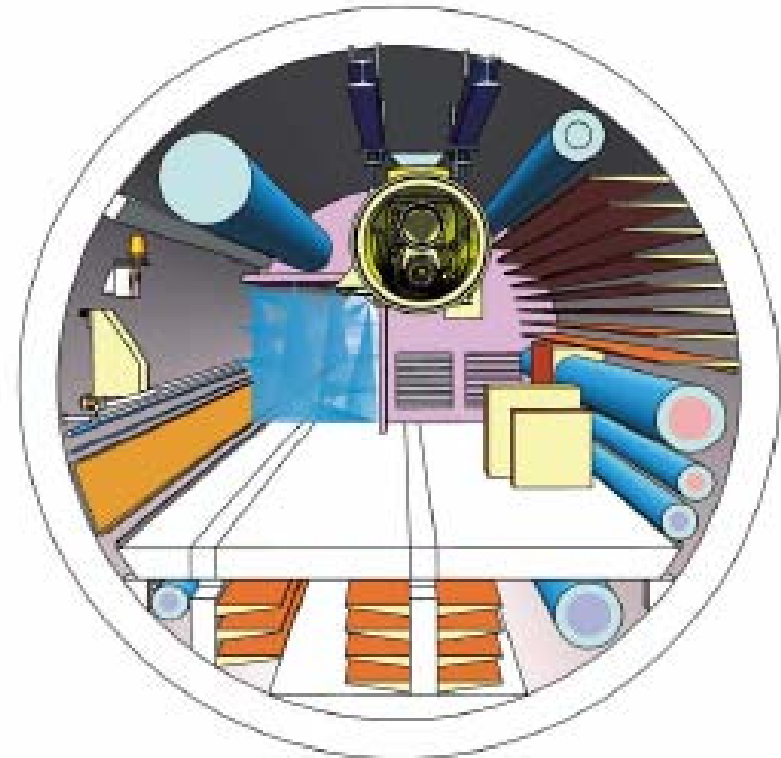
- Size of the tunnel will become 7.5 m for integrated tunnel and 5.7 m for beam only tunnel.
- Passage is unusual and inhuman space with a width of 0.9 ~ 1.2 m and a length of 5 km. It might give psychological effect to the refugees.
- Alcoves @ interval of 250 ~ 500 m in the escape passage for fatigued people to take breath, and to let the people behind him pass on may solve this problem.



4.2.2 Compartmentation Method

XFEL solution

- Tunnel is divided into **segments** of ~600 m by fire walls.
- **Short tunnel** pass thru bulkhead for escape of personnel and transport of goods
- **Pressurized mist** curtains in short tunnel to prevent fire & smoke from spreading



(by STUVA e.V.)

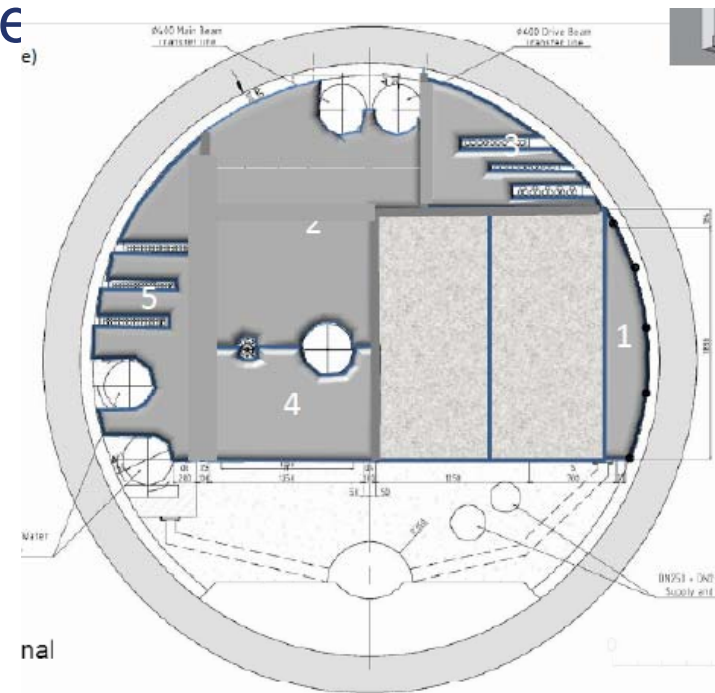


- Compartmentation of the space is very basic measure for fire safety. XFEL scheme is excellent and it secures high level of safety in this respect.
- We would like to learn more of its technical details
- Diameter of XFEL tunnel is 5.2 m with suspended accelerator module.
- If it is placed on the floor, tunnel size will become larger.
- As for the mist curtain, testing and accreditation by the authority may be required by the authority of the host country.

Case of CLIC

Same as XFEL, compartmentation is considered. Instead of pressurized mist curtain in XFEL, fire door is considered. Distance of the separation walls yet to be decided (500m?).

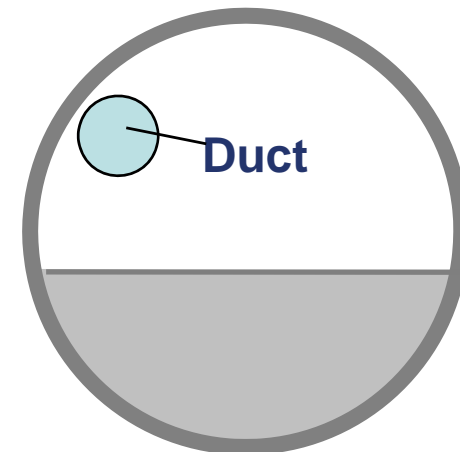
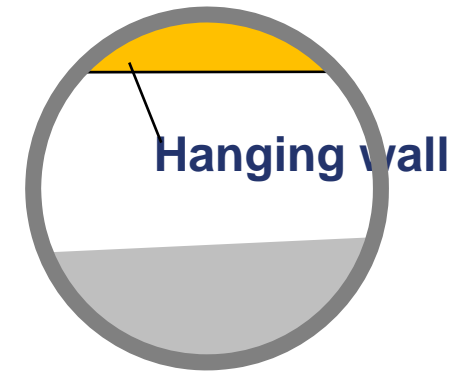
As this is highly safe solution, we would like to be kept Informed with its technical development.



(by F. Corsanego)

5. Smoke Control

- In RDR, for service tunnel of twin tunnel scheme, hanging wall is proposed in lieu of mechanical smoke extraction, partly because there is no space for duct in the tunnel.
- For single tunnel schemes, there will be a space for duct.
- For beam only single tunnel, necessity of smoke control must be carefully evaluated.



6. Fire Suppression

- In RDR, portable chemical fire extinguishers are proposed as the uniform equipment, and
- use of water was not considered to avoid damages to technical components by water.
- However, the authority of the host country might request to equip automatic sprinkler system and fire hydrant too.

Closing Remarks

It will be possible to prevent a drawback on safety caused by single tunnel configuration. Safety of personnel can be secured in some way or other.

Safety Planning @ next phase

Technical system, machine layout, tunnel cross section design and safety measures are correlated. Safety plan and cost impact should be performed in the next phase in a close coordination among the disciplines, as well as taking the outcomes of the collaboration with CLIC and XFEL into consideration.