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RADIATION PROTECTION FOR WANF AND CNGS

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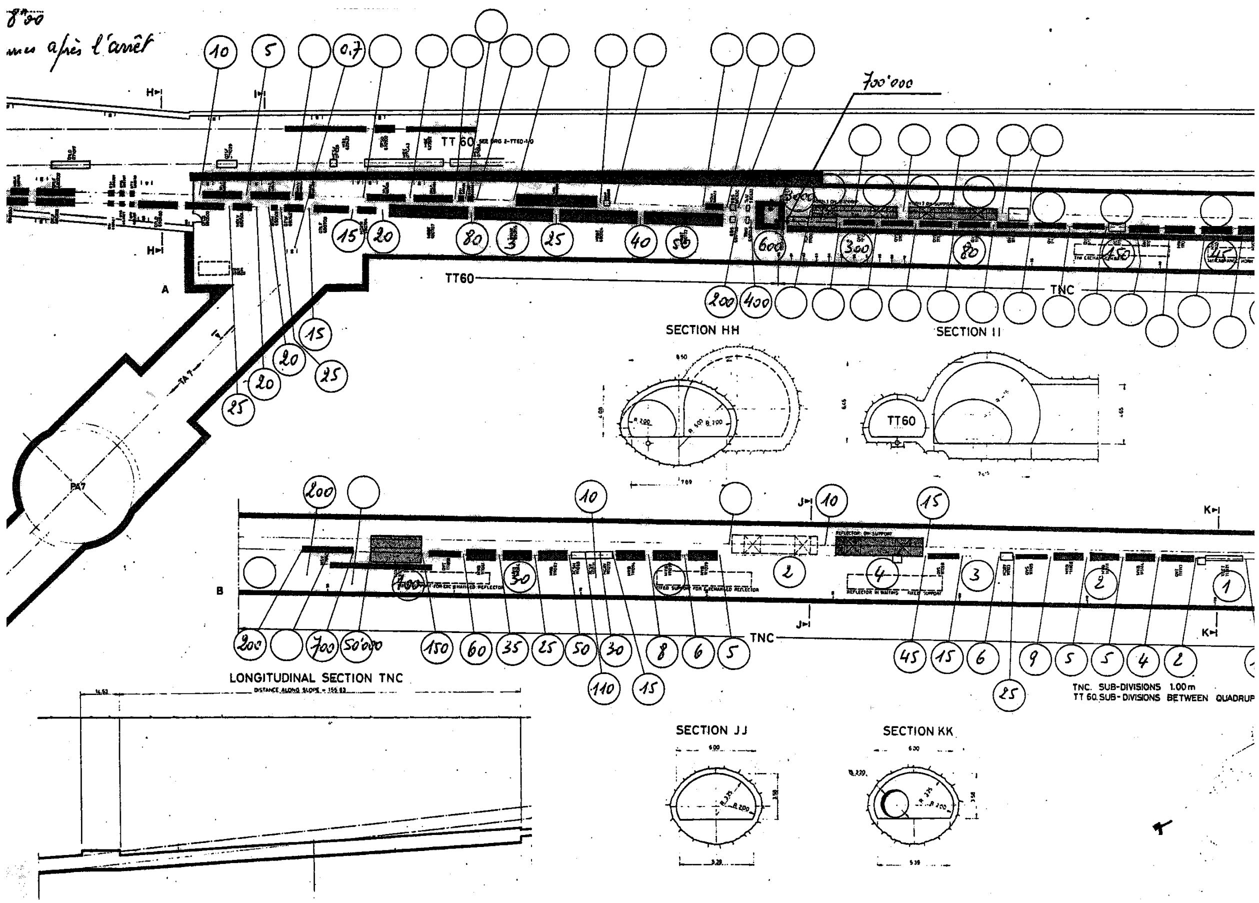
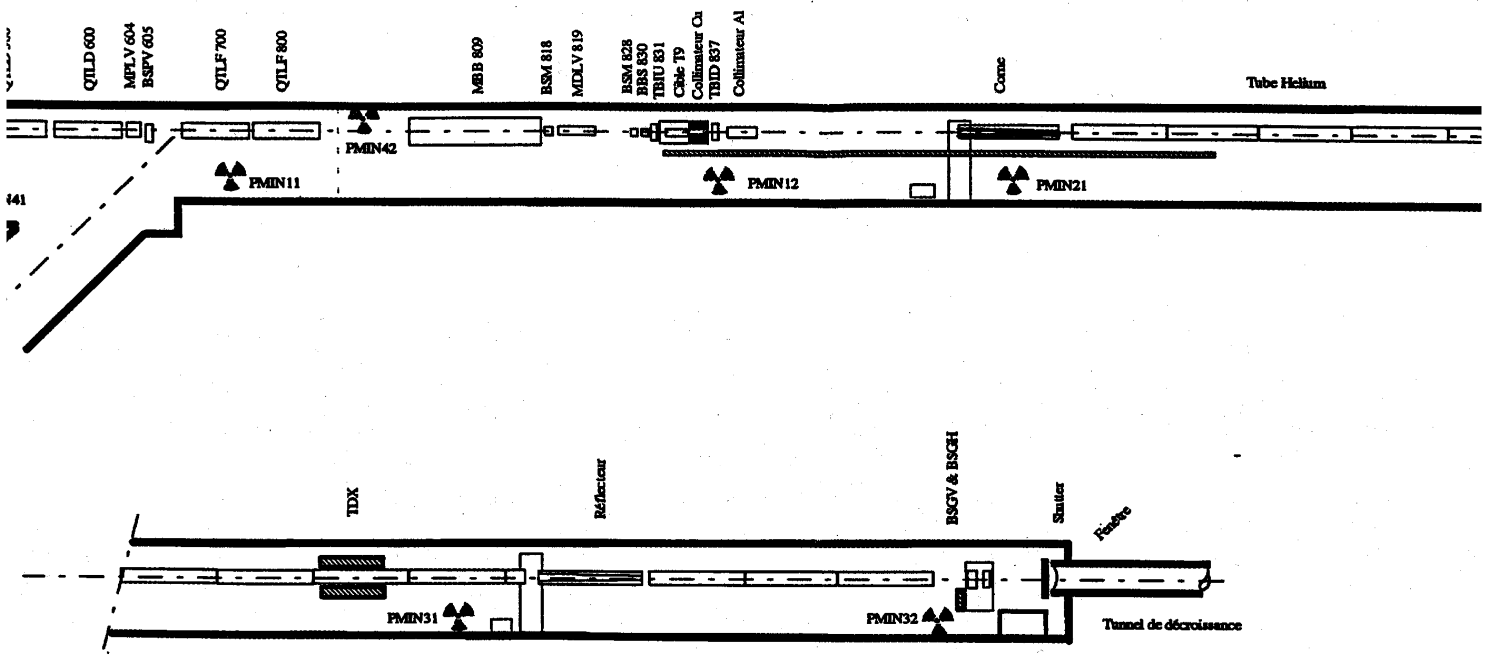
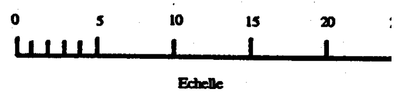
WANF 1975

- The **West Area Neutrino Facility** (**WANF**) of the CERN SPS was commissioned along with the SPS accelerator itself in 1976.
- Until the early 1980's there were two neutrino production lines: a wide-band and a narrow-band beam line, produced from two separate proton lines incident on two adjacent targets in the same target housing.
- The narrow-band line was de-commisioned and the wide-band beam-line ran until a major re-design of the area in the early 1990s.



WANF 1995





- A new wide-band beam was installed in the early 1990s.
- There was a new target housing and the area was stripped out and rebuilt
- This wide-band beam operated until the area was shut down in 2000.

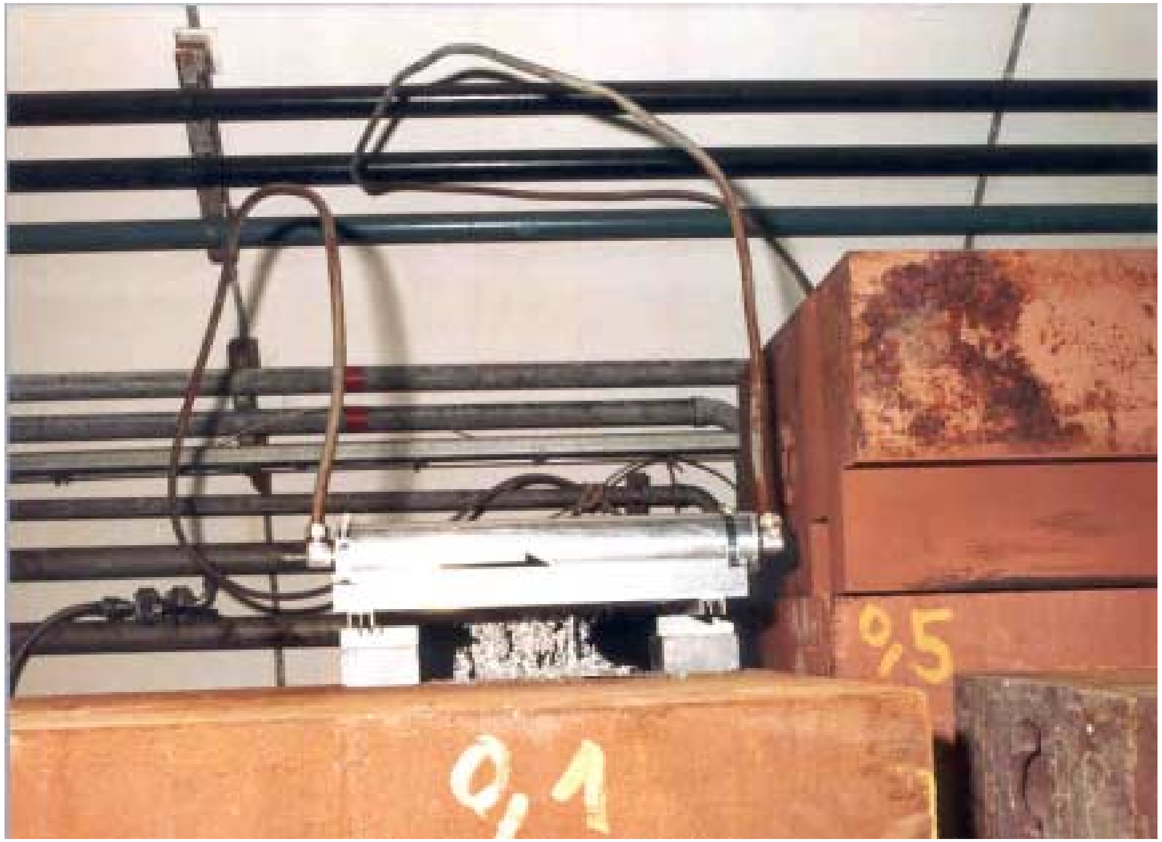
The WANF Robot

In the Tunnel

On the Surface

Pirate Neutrino Experiment

- A lead block was used to counterbalance a heavy metal target placed in the secondary pions down-stream of the WANF tar-get.
- Unfortunately the block was placed directly in the beam of protons passing through the neutrino tar-get.
- A manipulator was needed to cut apart the experiment and clean up the mess.



Principal problems in WANF – 1

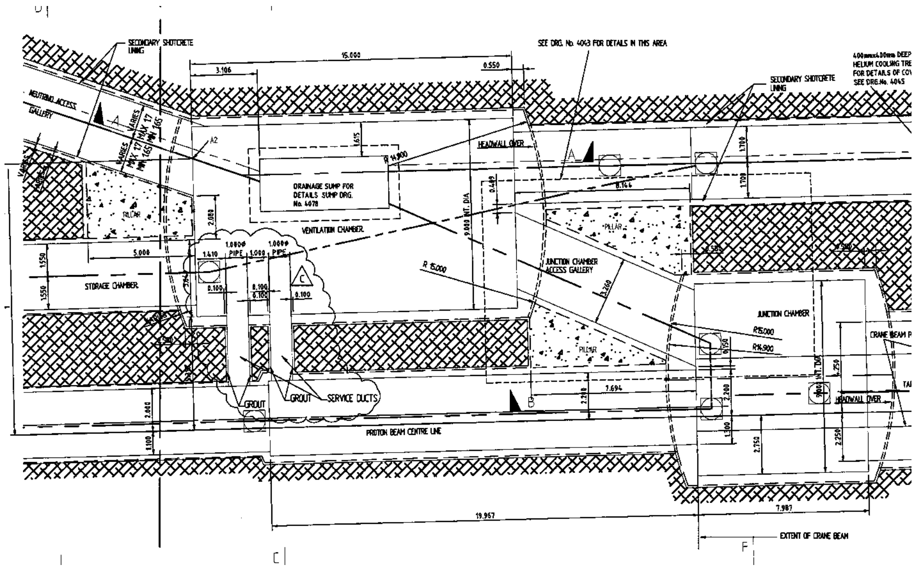
- Blocking of the vacuum shutter mechanism because of the degradation of the travel-limiter switches or thickening of grease due to radiation.
- Nozzles blocked in the water-distribution circuit of the magnetic horn due to build-up of deposits in the water in spite of the use of de-mineralized water.
- There was a continued inability to provide a correct closed-circuit ventilation system.
- Because of this, the decision was taken to stop the air circulation during operation. This caused strong rusting due to the build-up of humidity and ozone.

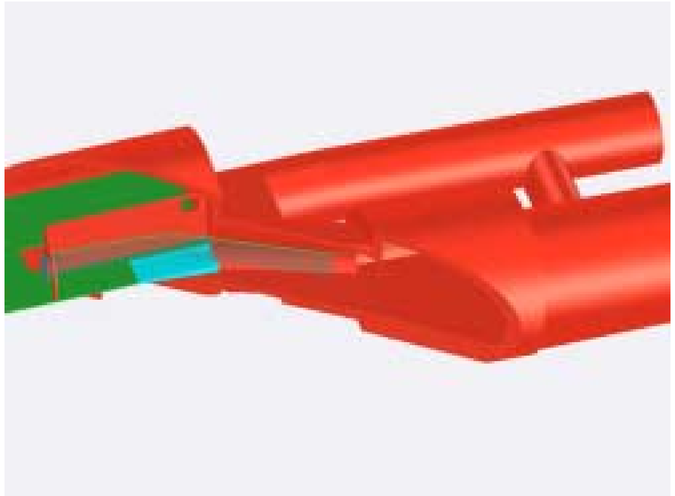
Principal problems in WANF – 2

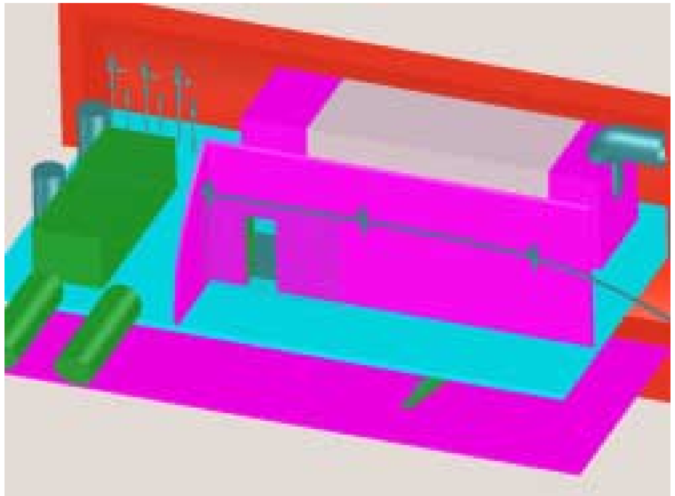
- The air distribution holes from the ventilation ducts were directed towards the crane rails, thus causing dispersion of this contaminated rust.
- Part of the gear mechanism for the crane was made out of teflon.
- O'rings in pumps and motors were not specified to be radiation resistant.
- Magnet supports for the proton beam line were badly conceived and were intermingled with cable trays, which meant that unnecessary dose was received during a major dismantling.
- Absence of a technical gallery.

Jean-Claude Gaborit and Gérard Grobon

CNGS Ventilation Chamber

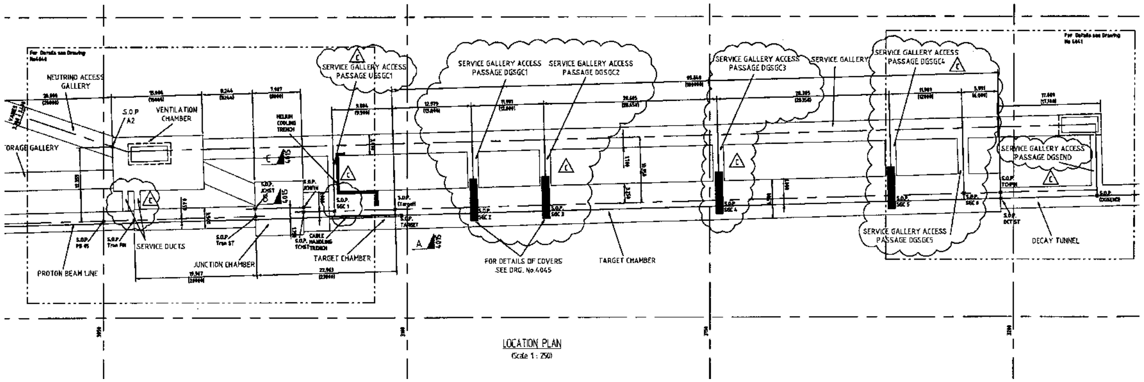


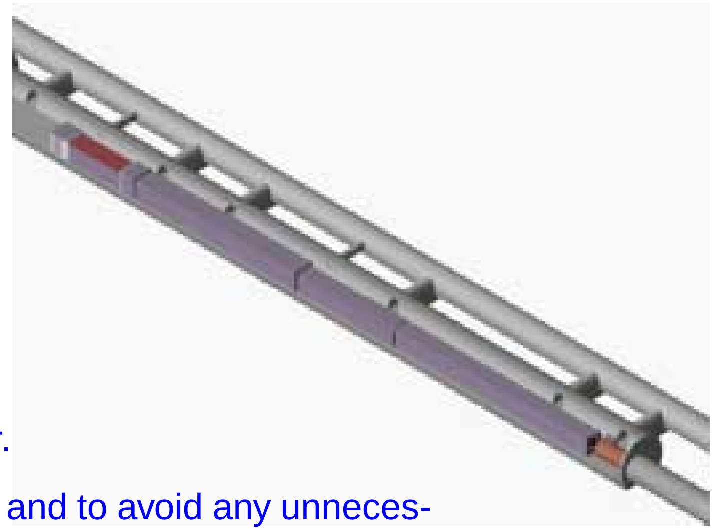




- There will be a large access cross-over chamber which will house the ventilation systems on an upper floor.
- The ventilation system will be separate for the target chamber/service gallery, the proton beam-line tunnel and the access gallery.
- Part of the upper floor will also house the crane cable when the crane is in its parked position.
- There will be a special stub tunnel to serve as a radioactive storage area.

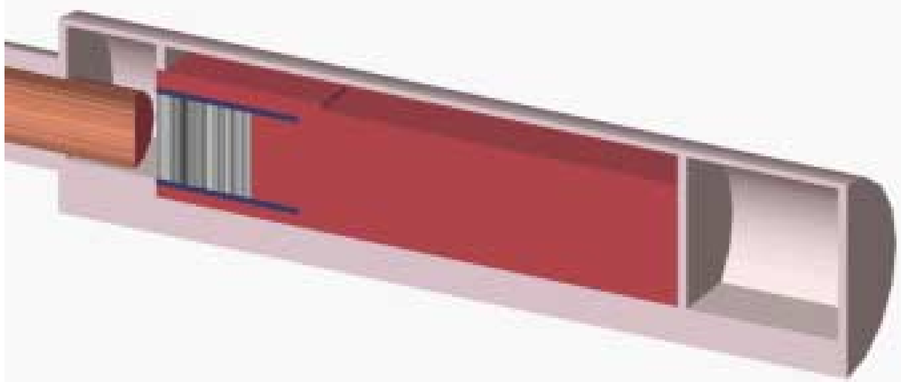
CNGS Target Chamber

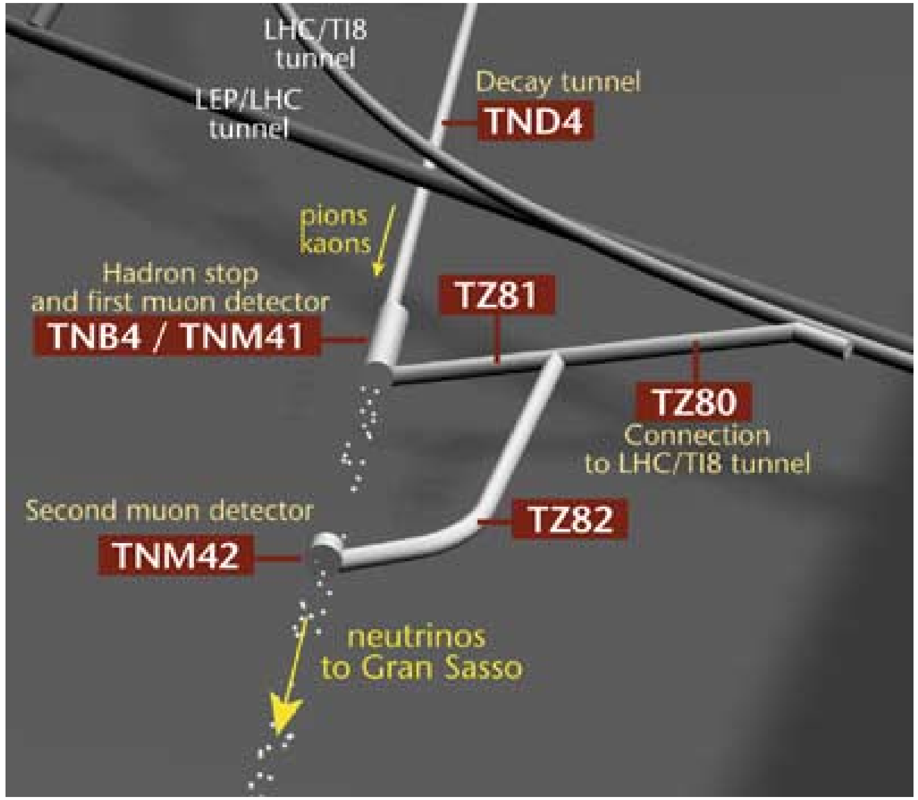




- Service and cross galleries minimise occupancy of the target chamber.
- Helium bags will be installed in the beam line to minimise air activation and to avoid any unnecessary reduction in the pion and kaon flux – and hence in the neutrino flux.
- Marble will be installed around the target shield to reduce the remanent dose rates during interventions close to the target.
- Marble will be installed on the inner faces of the shield around the horn to minimise dose rates during horn exchanges.
- Concrete will be installed everywhere around the beam-line downstream of the target to minimise air and rock activation.

CNGS Hadron-stop Area





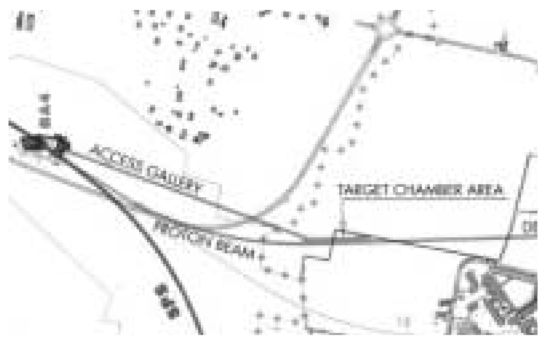
- A graphite core stops hadronic back-splash and hence rock activation
- No extra radiological impact allowed for LHC so no release allowed of radioactive air and closed circuits required for radioactive water.
- There are two concrete transverse walls to isolate active air.
- No concrete alongside the hadron-stop which allows easier dismantling.
- There is a sump for any water spills.

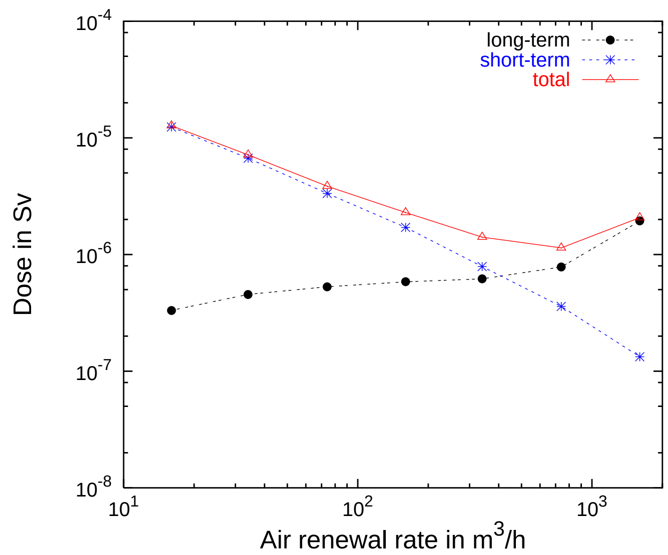
The 1999 Dilemma

- In an early stage of the CNGS project, it was intended that the air in the target cavern, the cross-galleries and the service gallery would be contained in a closed circuit during proton operation.
- When access to the target chamber was required, fresh air would be circulated from the outside via a duct through the access gallery and mixed with the air in the target cavern before being extracted via the access gallery itself.
- The radionuclides of concern are long-lived beta/gamma emitters (^{7}Be, ^{22}Na, ^{32}P, ^{33}P).
- The expected releases were 90% of the annual limit based on reference release values determined from long-term release dose conversion coefficients.
- However, the radioactivity is released over a period of only a few hours and so should be compared to reference values for short-term releases which are an order of magnitude more restrictive.
- Judged this way CNGS releases of radioactive air would be unacceptable.

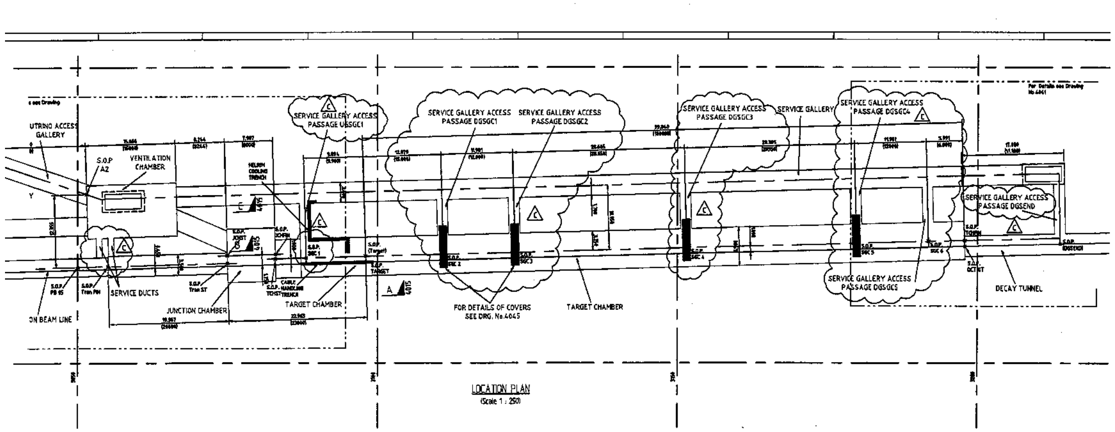
Change the Ventilation Regime

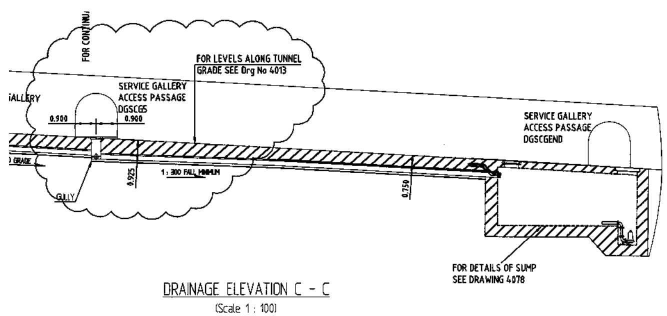
- The total quantity of long-lived radioactivity released will not be affected to a significant extent by whether the air is vented continuously or over a very short period.
- However by releasing the air from the target chamber over a long period of time, one can make use of the averaging effects over the year of atmospheric conditions, wind-speed and wind-direction.
- The renewal rate must be slow enough not to give rise to problems with short-lived radioactivity and fast enough to remove a significant fraction of the long-lived activity in a continuous long-term mode.
- The dose at 200 m from the stack, short-term, long-term and total, for a single operational period for the worst meteorological conditions was calculated as a function of renewal rate.
- There is a broad minimum in the total dose at a renewal rate of about 5% of the final flushing rate before access *i.e.* at around 800 m^3/h.
- The maximum dose received would then be about 1 μSv per operational period of 67 days, which means that the maximum annual dose could easily be considered as acceptable.

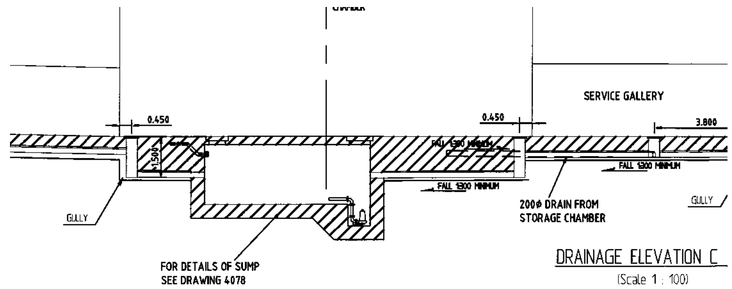




Radioactive Drain-water







- In both the target and hadron-stop areas, special sumps are planned to collect any water leaking or accidentally spilt in the areas together with any ground-water infiltrating into them.
- These sumps will not be connected to the drains directly nor to the sumps collecting non-radioactive drain-water, but there will be a means of emptying the sumps into special containers (in the ventilation junction area for example).
- These containers will then be transported to the surface where tests will be made of the pH and radioactivity levels before any decisions are taken as to discharge of the water via the normal drains.
- This operation is not expected to take place more than once per year.

Radiological Considerations

Radiological Concern	Current Solution
Reduction of activity in air and rock	Concrete beam-line shielding
Reduction of remanent dose rates	Marble shielding
Strip-line connection	Specialised robot
Avoiding “hot” objects on surface	Mortuary close to TCC4
Reduction of activity in rock around hadron-stop	Graphite core
No radioactive air from hadron-stop	Double concrete wall around stopper
Eventual removal of stopper	No surrounding concrete
Eventual removal of decay tube	To be seen
Access sas for clothing changes	To be seen
A check of air quality BEFORE entering the cave	To be seen
Keep emergency access ways clear	To be seen