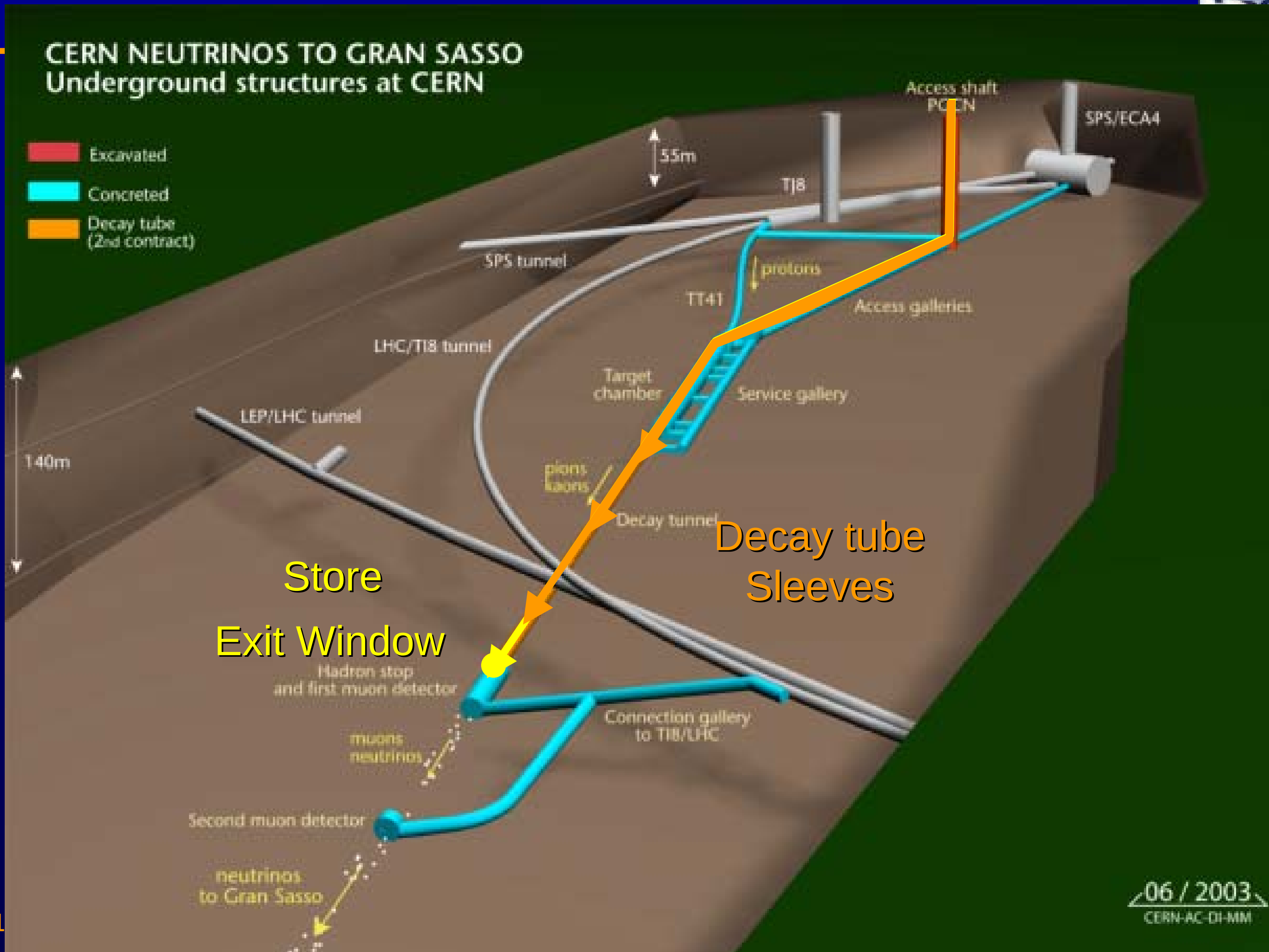
Decay Tube & Windows

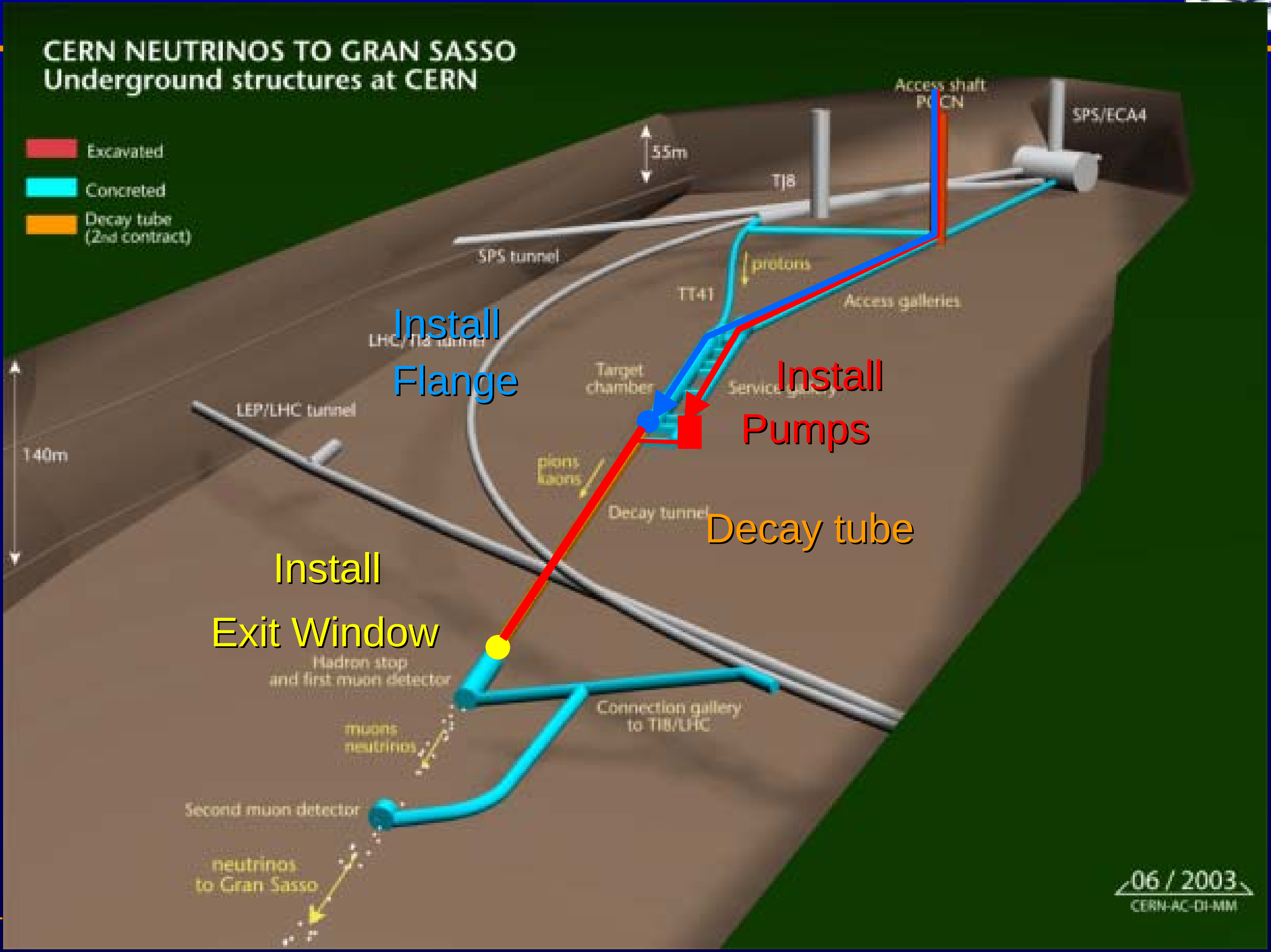
- Introduction

  (Location, Planning)
- Decay Tube
- Entrance Window
- Exit Window
- Vacuum System

Location


CERN NEUTRINOS TO GRAN SASSO
Underground structures at CERN
Excavated
Concreted
Decay tube
(2nd contract)
Access shaft
PGCN
SPS/ECA4
55m
TJ8
SPS tunnel
protons
TT41
Access galleries
LHC/TI8 tunnel
Target
chamber
Service gallery
LEP/LHC tunnel
140m
pions
kaons
Decay tunnel
Decay tube
Sleeves
Store
Exit Window
Hadron stop
and first muon detector
Connection gallery
to TI8/LHC
muons
neutrinos
Second muon detector
neutrinos
to Gran Sasso
06 / 2003
CERN-AC-DI-MM

Location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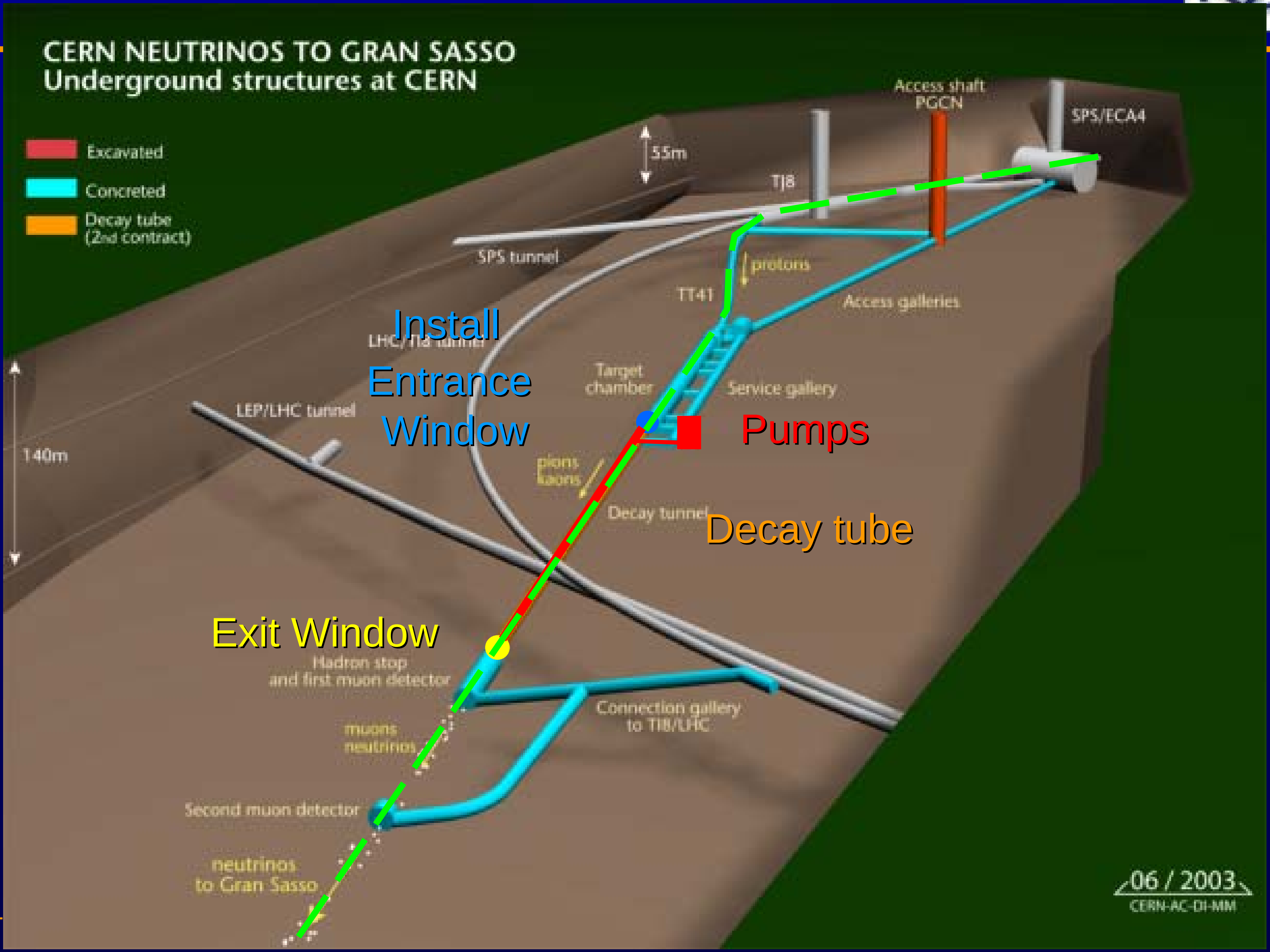
06 / 2003
CERN-AC-DI-MM
Install
Flange
Install
Pumps
Decay tube
Install
Exit Window

Location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CERN-AC-DI-MM

Planning

October

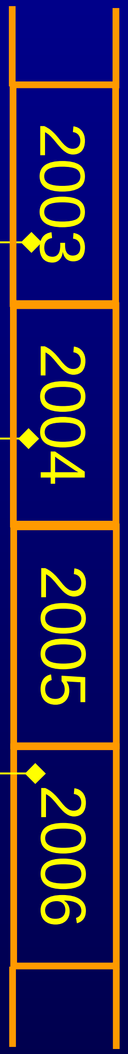
Transport Exit Window
& Storage in Hadron Stop
Install Decay Tube (November 2003 -May 2004)

August

Install Vacuum Pumps
Install Exit Window
Install Temporary Entrance Flange
Bring Decay Tube to Vacuum

January

Vent Decay Tube
Install Entrance
Window & Flanges
Bring back to vacuum



Decay Tube

Decay Tunnel:

- Internal diameter of 3.5m, 992m long, slope of 5.6%
- Supported by shotcrete

Decay Tube:

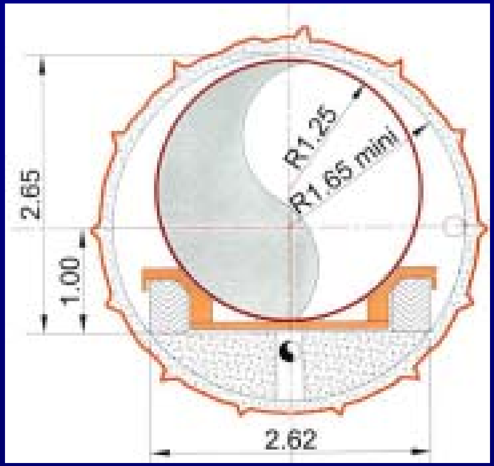
- Internal diameter of 2.45m, 998m long, 18mm thick
- Made of carbon steel
- Vacuum 1 mbar

Decay Tube Sleeves:

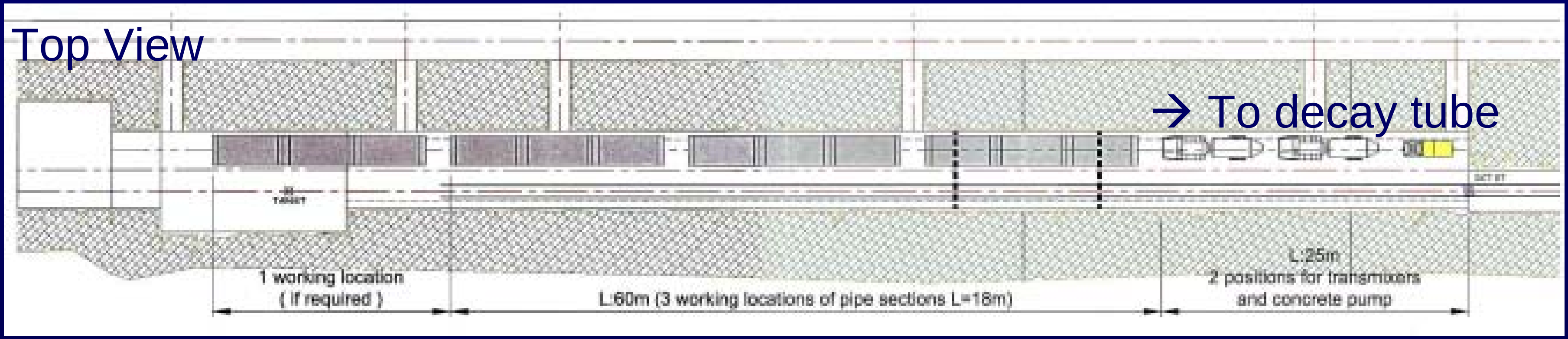
- 6m long (2x3m, welded)
- Will be combined to 18m long sleeves in target cavern

Decay Tube: Transport

Transported from surface to target cavern



Mechanical workshop in target cavern



3x6m sleeves welded → 18m

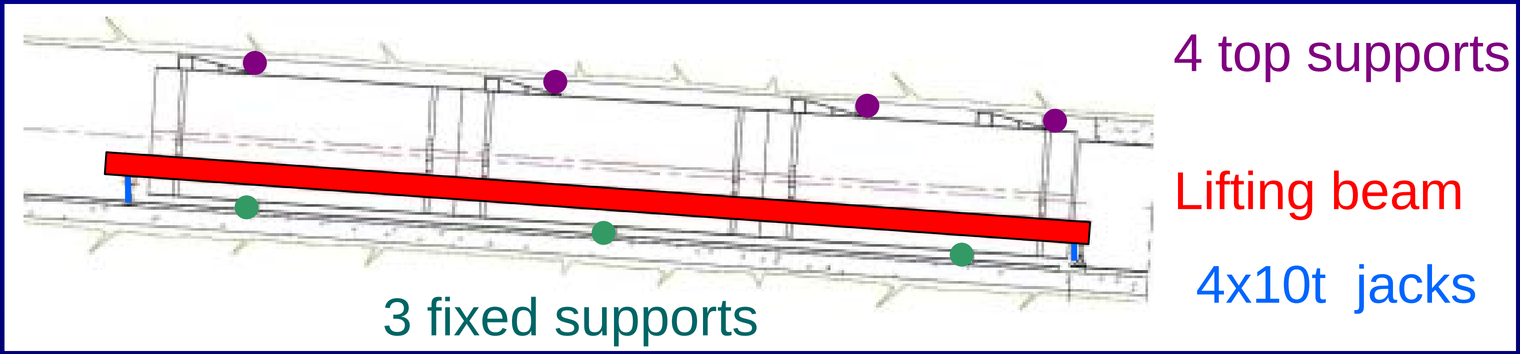
Decay Tube

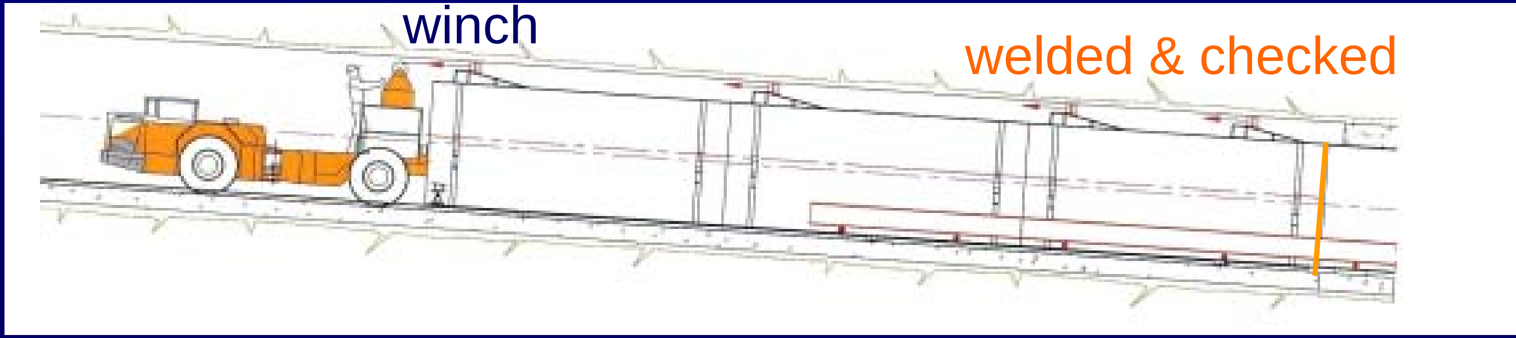
3 x 6m-sleeves on surface

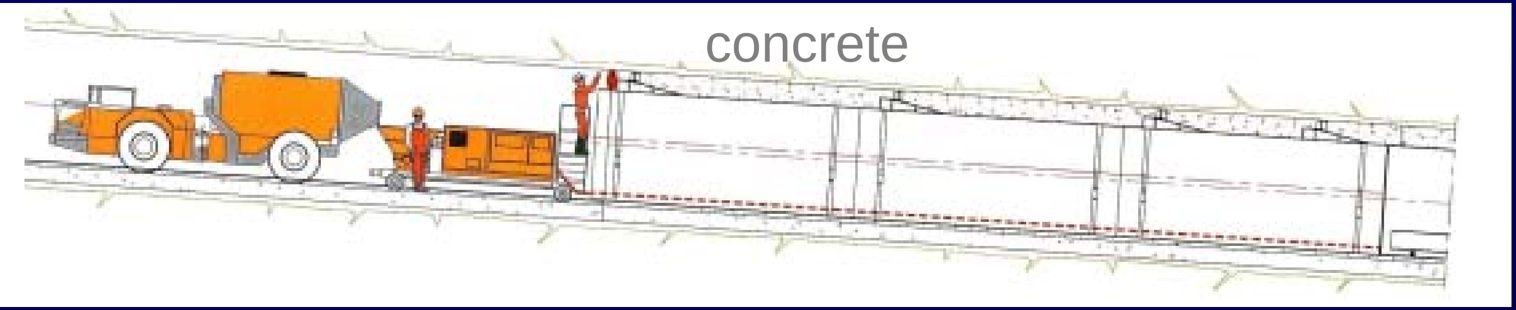
3 x 6m-sleeves in target chamber

1x18m-sleeve in target chamber

Decay Tube: Installation







Decay Tube: Quality Control

Contractor - Independent Control Agency - CERN

Plates / Pipes	
Dimensions, chemical analysis, mech. characteristics	100%
Ultrasonic test	20%

Welds	Workshop *	Decay Tunnel *
Visual Inspection	100%	100%
Ultrasonic test	85%	100%
Dye-Penetrant	100%	100%
X-Rays	15%**	---

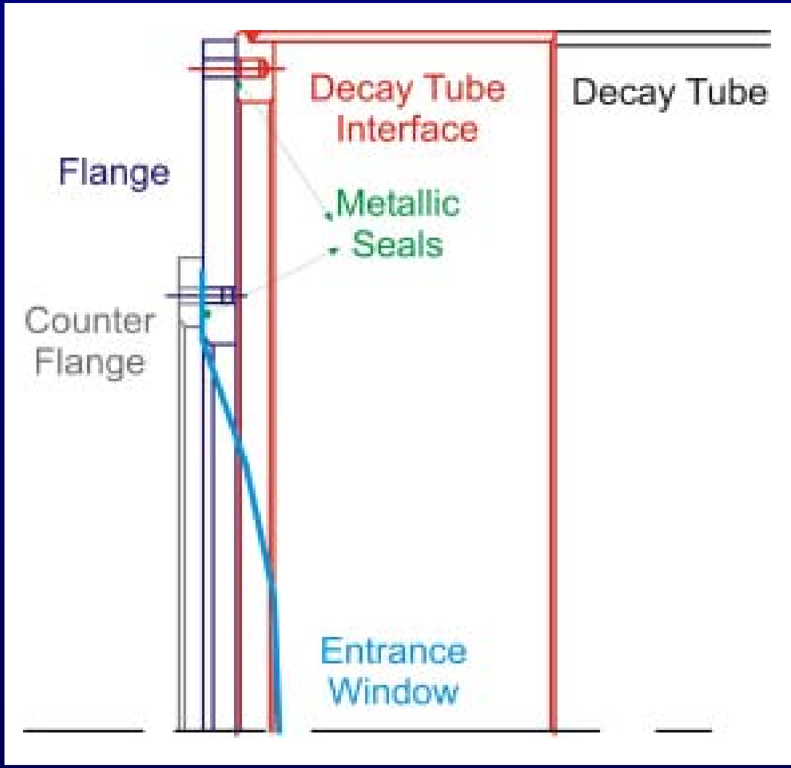
Tightness test of Decay tube - At the end of the works

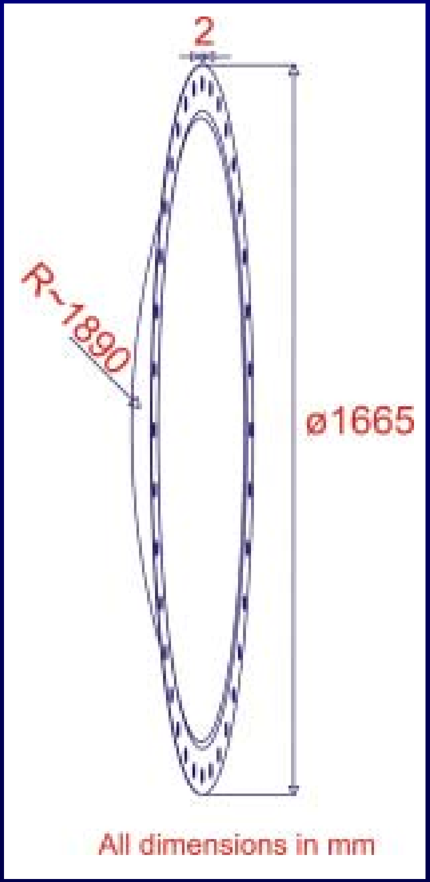
* %=percentage of weld length checked
**X-rays check all welds not checked by ultrasound

Entrance Window

Minimize particle loss → Thin

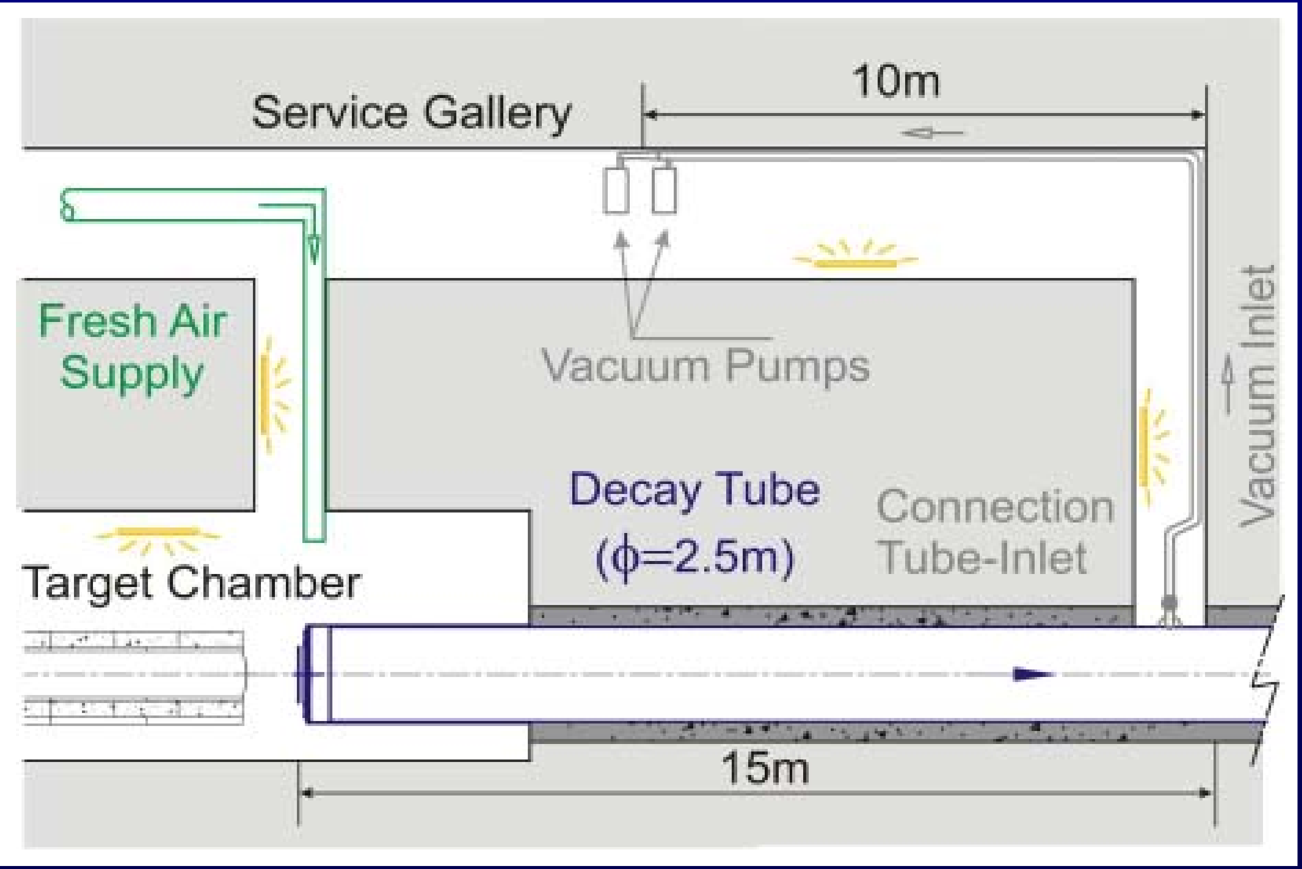
- 2mm Titanium window





Entrance Window: Safety

FE calculations → ok, no active cooling needed
X-ray & pressure test 3 bar → ok



Rupture?

Installation

Temporary Flange

Shut Down

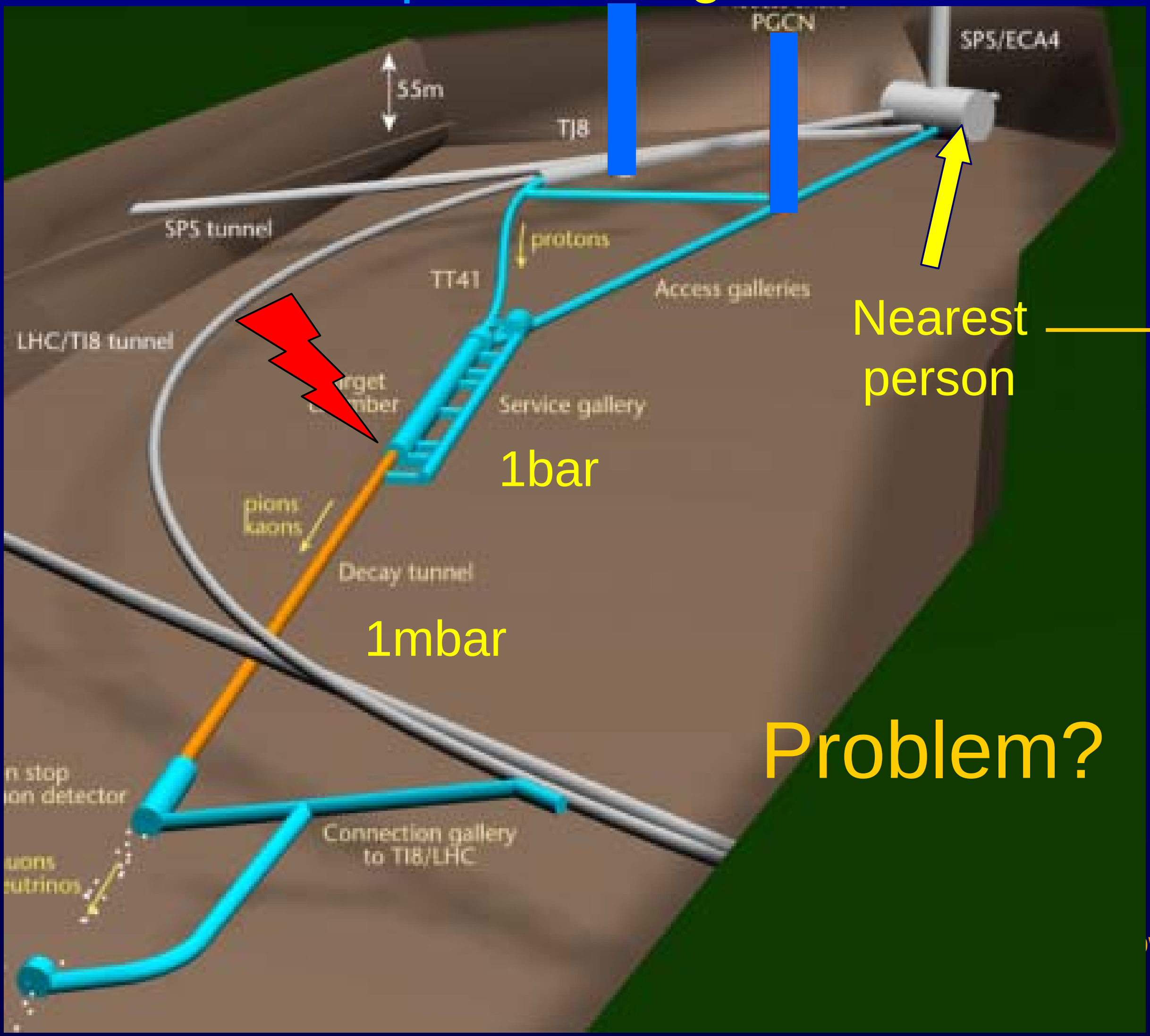
Window + Shutter

↓

Safety
during access
(vent if doubt)

Entrance Window: Safety

But what if rupture during beam?



Safety

- Pressure drop <0.5bar
- Wind speed <<5m/s

FE-Model

- Rupture D=1.7m (full)
- Rupture D=0.5m
- Reduced X-sections
- Pits as buffer

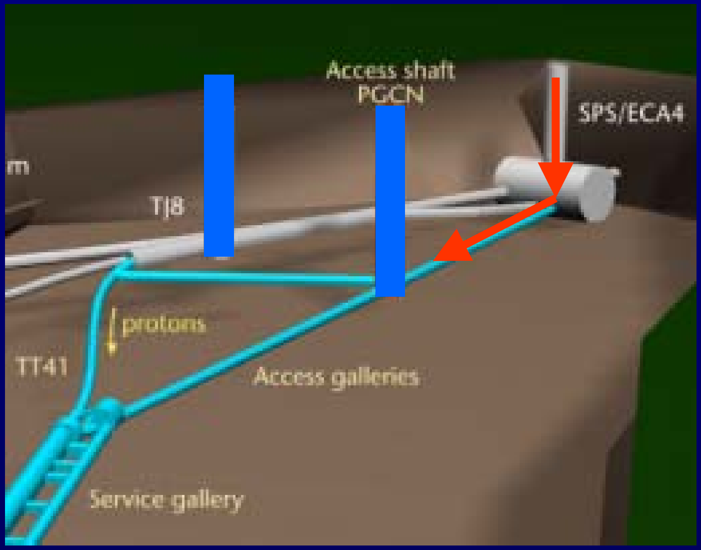
Results

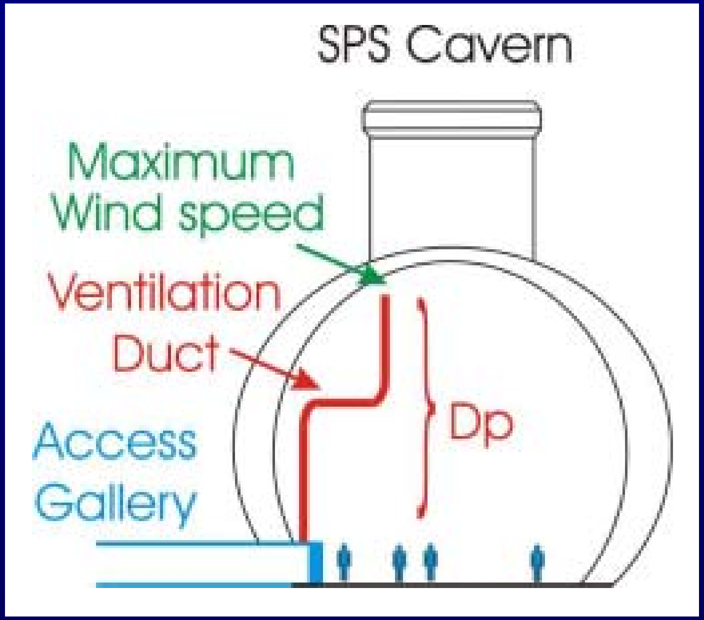
- Pressure drop: 2200Pa / 200Pa
- Windspeed: 36m/s / 10m/s

Entrance Window: Safety

Solution…

Use ventilation to balance pressure (pressure losses in ducts)





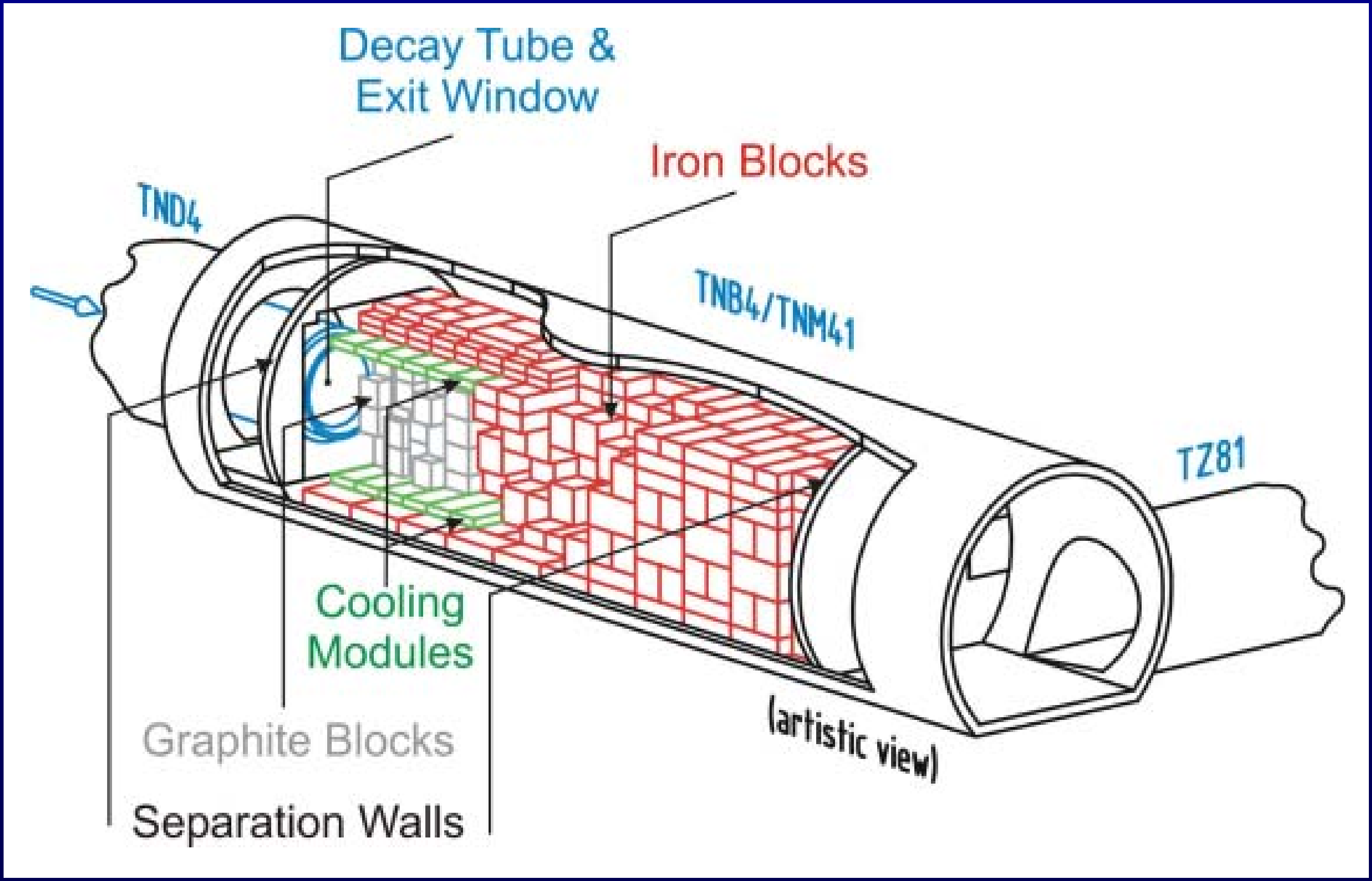
Sufficient?

→ More calculations
→ Other ideas

→ High-velocity zone moved

e.g. 2200Pa, allow 50m/s
→ Duct of D=0.45m, takes 10 mins

Exit Window Location



Exit Window

Lower energy particles → Thick

- 50mm Carbon Steel

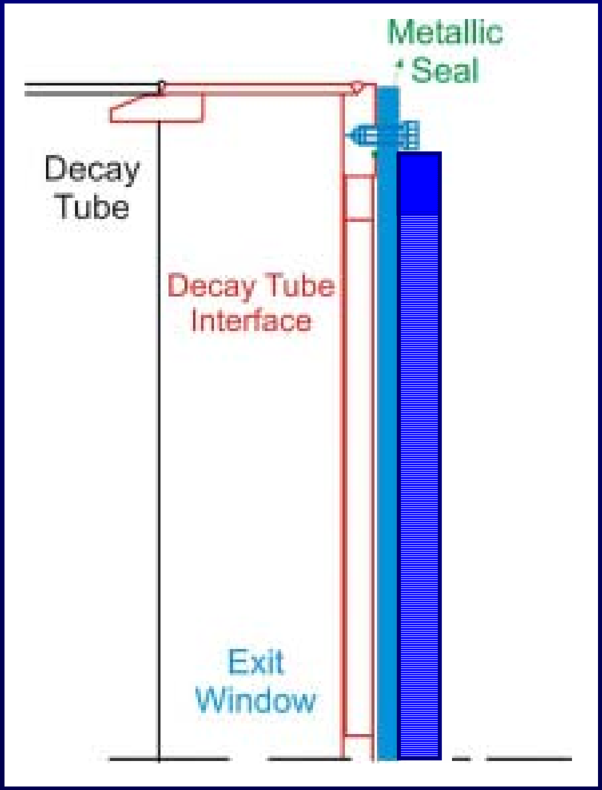
- Avoid high temperatures

  (beam dump: uncontrolled area, no access)

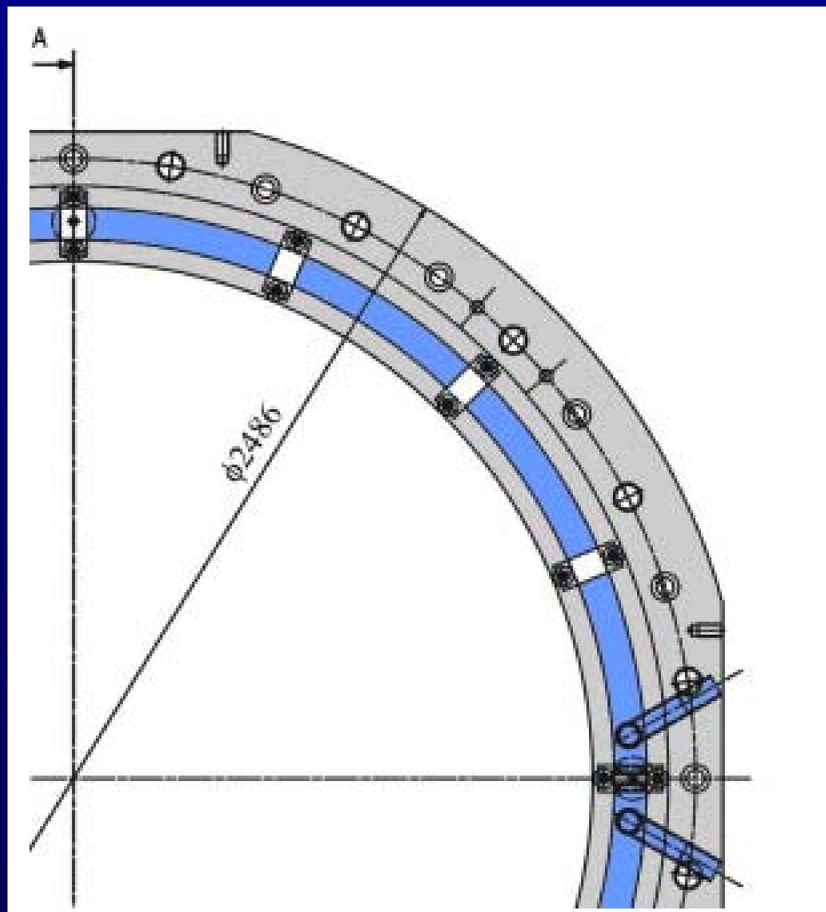
- FE calculations → not safe

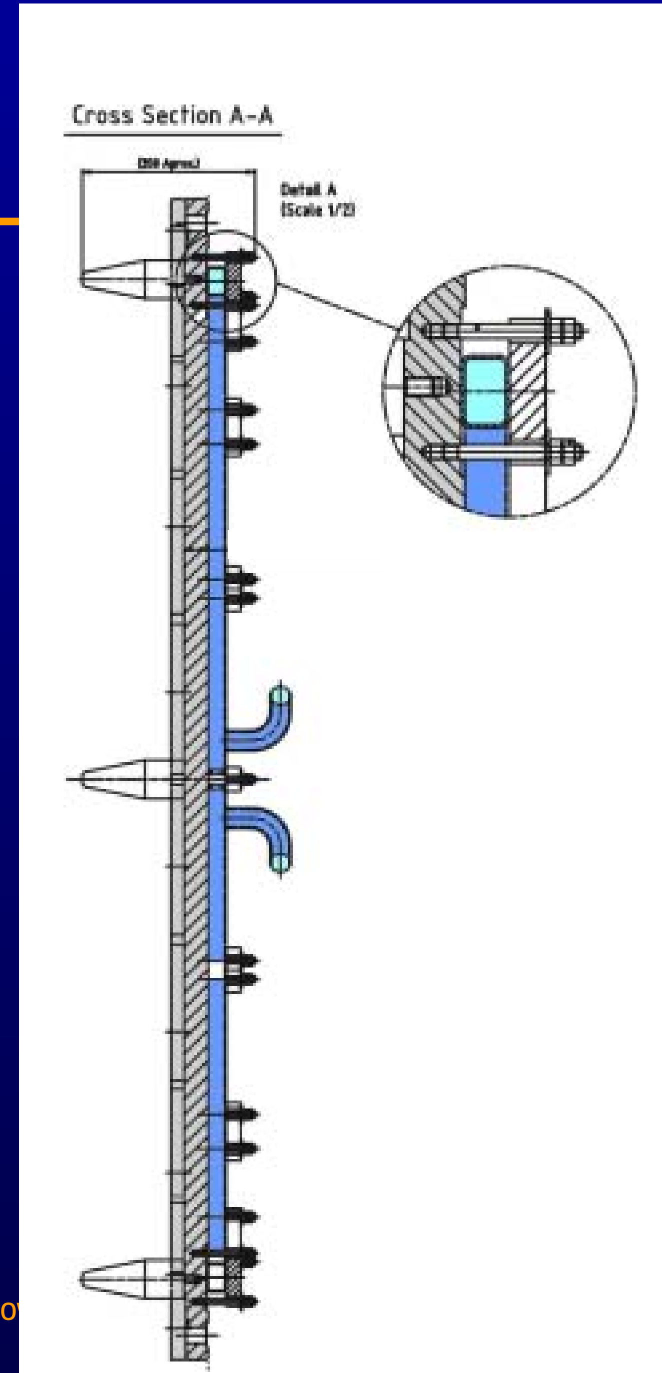
  (beam dump cooling: extra circuit easy to add)

  → Active cooling

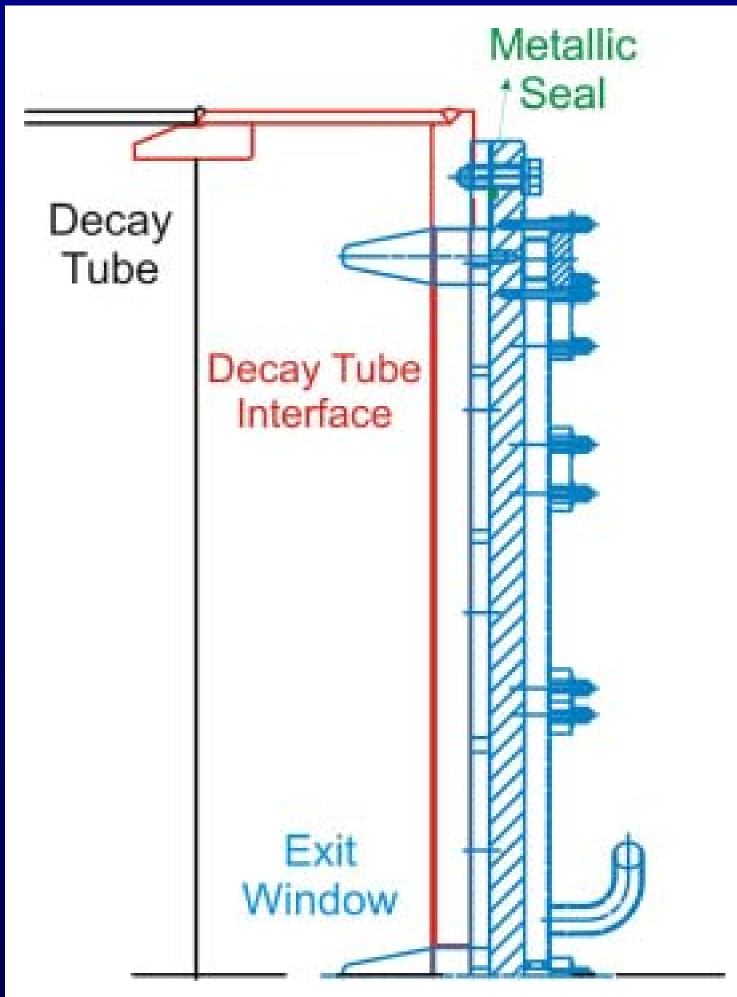


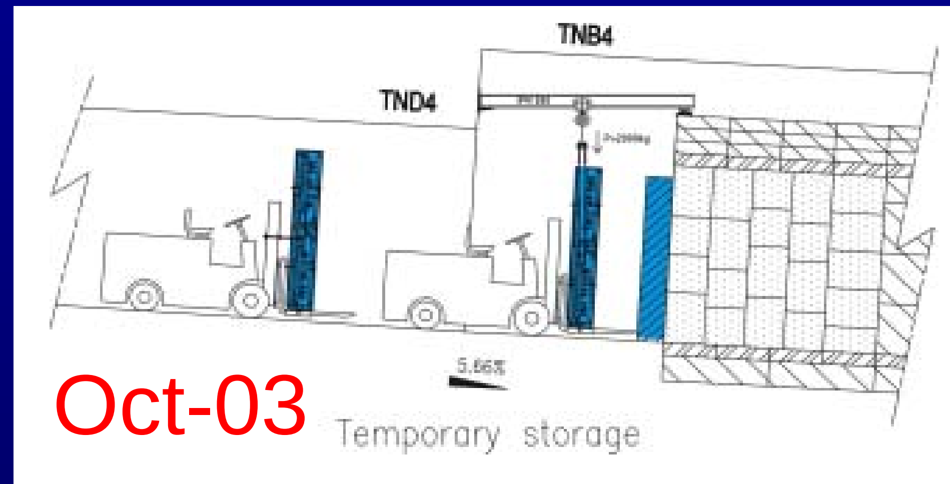
Exit Window

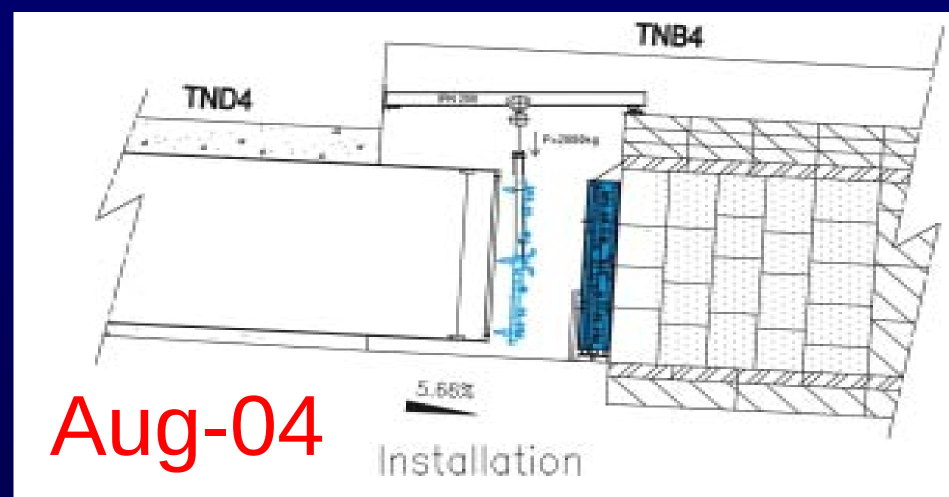




Exit Window: Installation





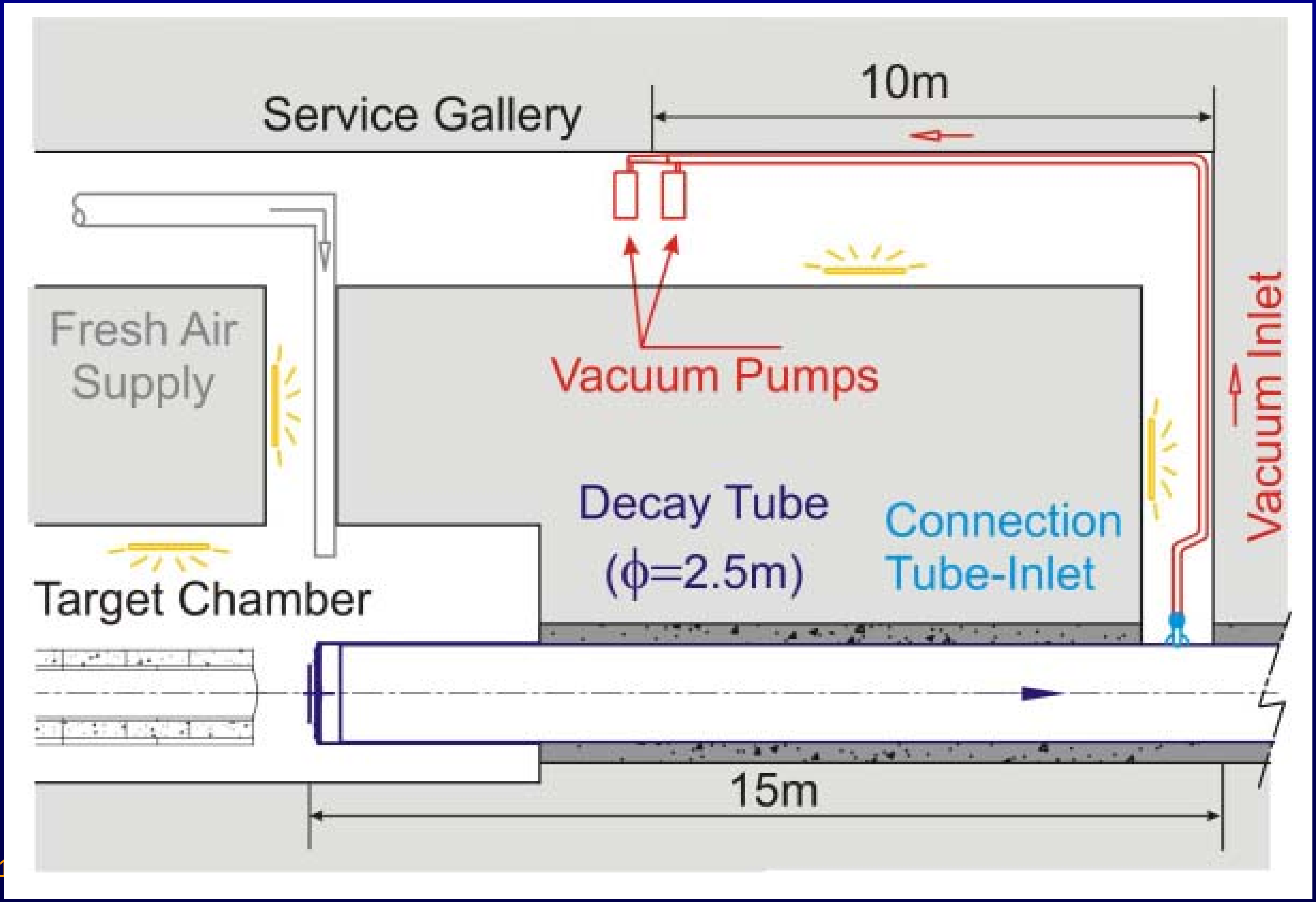


Exit Window: Installation





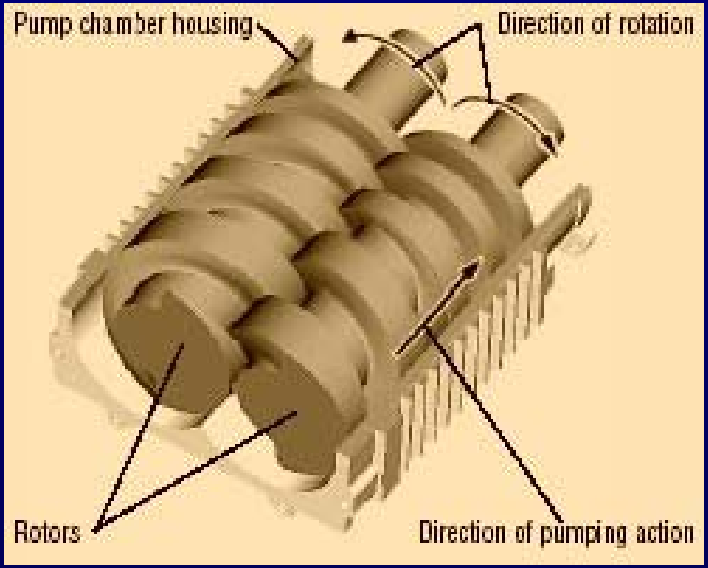

Vacuum System



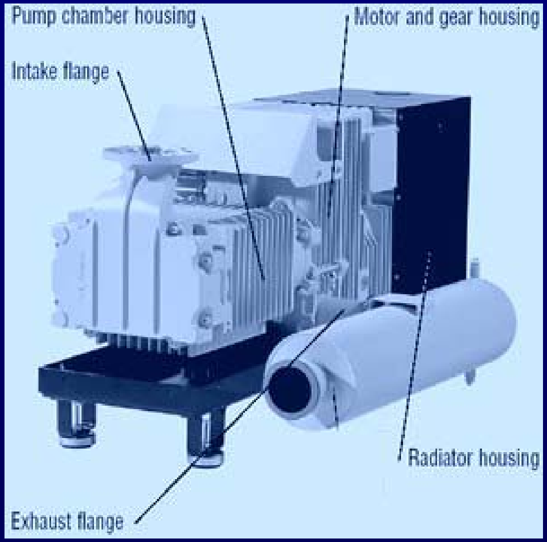
Vacuum System

Vacuum Pumps

- Pumps with air cooling or independent cooling circuit
- Dry pumps → no oil → no duct needed for exhaust



Principle of Dry Pump



2 identical pumps of 250m3/h

→ 3 days pumping to obtain 1mbar in decay tube