CNGS Reference Parameter List
updated 3 October 2005

Proton Beam: TT41

• Minimum repetition time (dedicated operation at 400 GeV/c)	6 s
• Maximum proton beam momentum (design)	450 GeV/c
• Proton beam momentum (assumed for operation)	400 GeV/c
• Proton beam normalised emittance (1σ)	H=12π mm mrad / V=8π mm mrad
• Proton beam emittance (1σ)	H=0.028 μm / V=0.016 μm
• Minimum repetition time (at 400 GeV/c)	6 s
• β^* at focal point	H=10 m / V=20 m
• Beam size at focal point	σ_x=0.53 mm / σ_y=0.53 mm
• Beam divergence at focal point	σ'_x=0.053 mrad / σ'_y=0.03 mrad
• Minimum repetition time (at 400 GeV/c)	6 s
• Time between bursts	50ms
• Proton intensity per extraction	2.4×10^{13}
• Proton intensity per cycle	4.8×10^{13}
• Proton intensity (hadron stop considerations)	8×10^{12} protons/second 200days/year
• Proton intensity (for environmental considerations)	7.6×10^{19} protons/year
• Expected integrated number of protons at 400 GeV/c	4.5×10^{19} protons/year

---

Proton beam exit window

• Elements	2 discs
Disc 1 (upstream)	
• Material	C-C
• Diameter	68.5 mm
• Thickness	2.5 mm
Disc 2 (downstream)	
• Material	Beryllium
• Diameter	60 mm
• Thickness	0.254 mm

Target Chamber: TCC4 (as built)
https://edms.cern.ch/document/310296/12

• Length of target chamber	115 m
• Diameter of target chamber	6.5 m
• Floor width of target chamber	5.6 m
• Enlargement at target (optional)	7.4 m
• Crane capacity	main host=7.5t / auxiliary host = 5t
• Free height under crane hook	3.6 m (7.5t) / 3.4 m (5t)

- Beam height in target chamber 1.56 m
- Diameter of service gallery TSG4 3.4 m
- Distance of service gallery from cavern 6.0 m
- Distance of proton focus to entrance of decay tunnel 100 m
- Distance of proton focus to entrance of decay tube 94 m

Target: T40

https://edms.cern.ch/document/597509/1

- Start coordinate target elements w.r.t. FP -0.5 m
- End coordinate target elements w.r.t. FP 1.5 m

Base-line target

- Material Graphite2020PT (Carbone Lorraine)
- Density 1.76 g/cm^3
- Target rod length 0.1 m
- Diameter of rods 5 mm first two rods, then 4 mm
- Number of rods 13
- Distance between rods for first 8 rods 9 cm
- Distance between last 5 rods 2 mm

- Target support material Carbon
- Dimension of target support 100/92 x 2040 mm^3
- Gas inside target support Helium
- Gas pressure 0.5 bar
- Upstream/downstream window material Beryllium
- Upstream window diameter 50 mm
- Upstream window thickness 0.381 mm
- Downstream window diameter 101.6 mm
- Downstream window thickness 0.645 mm

- Number of targets in the target magazine 5

TBID

- Upstream end of TBID w.r.t. FP 2.2 m
- window material Titanium
- Window thickness 250 μm
- Window diameter tbd
- Number of detector modules 2
- Number of planes/module 7
- Detector plane material Titanium
- Detector plane thickness 12 μm
- Vacuum < 10^{-4} bar

Horn and Reflector

- Upstream end of **horn** area w.r.t. FP 1.7 m
- Downstream end of horn area w.r.t. FP 11.015 m
- Upstream end of inner conductor w.r.t. FP 2.7 m
- Downstream end of inner conductor w.r.t. FP 9.35 m
- Diameter 0.716 m
- Magnetic length of horn 6.65 m
- Peak current in horn 150 kA

- Upstream end of **reflector** area w.r.t. FP 42.565 m
- Downstream end of reflector area w.r.t. FP 52.18 m
- Upstream end of inner conductor w.r.t. FP 43.35 m
- Downstream end of inner conductor w.r.t. FP 50 m
- Diameter 1.116 m
- Magnetic length of reflector 6.65 m
- Peak current in reflector 180 kA

Helium tubes

Helium tube I
- Start coordinate w.r.t. FP 11.4 m
- End coordinate w.r.t. FP 42.2 m
- Tube length 30.8 m
- Diameter first 6.8 m 0.80 m
- Diameter remaining length 1.20 m

Helium tube entrance window
- Material Titanium
- Diameter 0.80 m
- Thickness 0.3 mm

Helium tube exit window
- Material Titanium
- Diameter 1.2 m
- Thickness 1 mm

Helium tube II
- Start coordinate w.r.t. FP 51.70 m
- End coordinate w.r.t. FP 92.7 m
- Tube length 41 m
- Diameter 1.2 m

Helium tube entrance window
- Material Titanium
- Diameter 1.2 m
- Thickness 1 mm

Helium tube exit window
- Material Titanium
- Diameter 1.2 m
- Thickness 1 mm

Decay Tunnel TND4

- Upstream end of decay tunnel w.r.t. FP — 100 m
- Length of decay tunnel — 989.5 m
- Diameter of decay tunnel — 3.5 m

- Upstream end of decay pipe w.r.t. FP — 94.5 m
- Length of decay pipe — 998 m
- Diameter (inner) of decay pipe — 2.45 m
- Wall thickness decay pipe — 18 mm
- Material of decay pipe — steel
- Concrete filling around pipe — 50 cm

- Material of **protecting shutter** — steel
- Diameter of protecting shutter — 1.445 m
- Thickness of protecting shutter — 3 cm

- Material of **entrance window** of the decay pipe — Titanium G2
- Diameter of window — 1.40 m
- Thickness of window — 3 mm

- Material of **exit window** of the decay pipe — steel
- Diameter of window — 2.45 m
- Thickness of window — 5 cm

- Pressure in decay pipe — 1 mbar
- Pumping down time (max.) — 2 days

Hadron Stop (TNB4) and Muon Chambers (TNM41, TNM42)

https://edms.cern.ch/document/364662/2

- Upstream end of hadron stop cavern w.r.t. FP — 100 m + 989.5 m
- Length between upstream hadron stop cavern and decay tube end window — 3 m
- Length between decay tube end window and upstream end of hadron stop — 1.5 m
- Length between downstream end of hadron stop to wall — 0.28 m
- Length of hadron stop cavern — 26 m
- Diameter of hadron stop cavern — 6 m
- Floor width of hadron stop cavern — 4.4 m
- Length of hadron stop — 17.6 m
- Cross-section of hadron stop — 4 x 4 m^2
- Length of graphite insert — 3.2 m
- Cross-section of graphite insert — 2.4 x 2.8 m^2
- Material of cooling modules — Aluminium
- Length of cooling modules above/below graphite — 4.8 m
- Cross-section of cooling modules — 2.4 x 0.2 m^2

- Material of wall between hadron stop & first muon chamber — concrete

- Thickness 40 cm

- Length of first muon chamber TNM41 5 m
- Length of molasses ‘muon filter’ 67 m
- Length of second muon chamber TNM42 5 m

Muon detector support

https://edms.cern.ch/document/479515/0

- Material Aluminium/stainless steel (tbc)
- Width 4.178 m
- Height 4.117 m
- Length 1.1m
- Downstream end of support w.r.t. downstream chamber wall 1 m (TBD)

Muon detector

- Material of cylindrical body stainless steel
- Material of parallel electrodes Aluminium
- Cylinder thickness 2 mm
- External length 491 mm (without connectors)
- Internal length1 (inner body of monitor) 375.5 mm
- Internal length2 (ionization volume) 345 mm
- External diameter 88.9 mm
- Disc diameter 75 mm
- Ionization volume ~1.465 dm3
- Thickness of electrodes 0.5 mm
- Number of electrodes 61 (60 cells)
- Length between 2 electrodes 5.75 mm (+ 0.5 mm electrode)
- Gas Nitrogen 99.9%
- Pressure 1-1.1 bar

- Other material in the detector 2 alumina discs
- Diameter 84 mm
- Thickness 15 mm

Shielding around target

Collimator: https://edms.cern.ch/document/463575/0
Fixed target shielding: https://edms.cern.ch/document/458191/0
Mobile target roof shielding: https://edms.cern.ch/document/458199/0

- Elements: 0.6 m collimator shielding, 2.6 m long side shielding

Collimator shielding
- Material: iron
- Height: 1.73 m
- Width: 1.2 m
- Height of centre of collimator: 1.22 m

Collimator
- Material: hexagonal Boron Nitride (hBN)
- Outer diameter: 0.128 m (0.12 m)
- Inner diameter: 0.014 m
- Length: 1 m

Target shielding
- Start coordinate w.r.t. FP: -1.5 m
- End coordinate w.r.t. FP: 1.7 m
- Material: iron
- Length: 3.2 m
- Left/right wall distance to axis: 0.4 m
- Side wall thickness: 0.8 m
- Side wall height: 1.93 m
- Movable roof height: 0.85 m
- Movable roof length: 3.76 m

Additional side shielding at passage side
- Material: marble
- Height: 2.0 m
- Width: 0.4 m
- Length: 3.2 m

Shielding around horn

https://edms.cern.ch/document/584730/1

- Upstream end of shielding area w.r.t. FP: 1.7 m
- Downstream end of shielding area w.r.t. FP: 11.015 m
- Shielding elements: 0.4 m long wall, 5 x 1.8 m long shielding

Wall
- Material: marble
- Width: 3 m
- Height: 2.9 m
- Width of opening: 0.8 m
- Height of opening: 1 m

Side walls
- Material: 30cm marble/20cm iron/30cm concrete

- Thickness 0.8 m
- Height of walls 2.4 m
- Left/right wall distance to axis 0.7 m

- Total shielding height (roof included) 2.8 m
- Roof shielding thickness 0.3 m (tbc)

Shielding around reflector

https://edms.cern.ch/document/584738/1

- Upstream end of shielding area w.r.t. FP 42.565 m
- Downstream end of shielding area w.r.t. FP 52.18 m
- Shielding elements 4 x 2.4 m long
- Material concrete

- Left/right wall distance to axis 0.9 m
- Side wall thickness 0.8 m
- Side wall height for 3 upstream elements 2.6 m
- Roof thickness for 3 upstream elements 0.4 m
- Side wall height of last element 2.24 m
- Roof thickness in last element 0.6 m for 0.8 m length
  0.4 m for 1.6 m length

Shielding around helium tube I

https://edms.cern.ch/document/584732/1

- Upstream end of shielding area w.r.t. FP 11.015 m
- Downstream end of shielding area w.r.t. FP 42.565 m
- Shielding elements 0.3 m long wall
  2.4 m long collimator
  12 x 2.4 m long shielding

Wall

- Material marble
- Height 2.9 m
- Width 3 m
- Width of opening 0.8 m
- Height of opening 1 m

Collimator

Outer part

- Material concrete
- Height 2.8 m
- Width 3 m
- Thickness 0.4 m

Inner part

- Material iron
- Height 2 m
- Width 2.2 m
- Thickness 0.4 m

- Opening 1 x 1 m^2

Shielding
- Material concrete
- Height of shielding underneath helium tube 0.6 m
- Left/right wall distance to axis 0.7 m
- Side wall thickness 0.8 m
- Side wall height 2.2 m
- Roof thickness 0.6 m

Shielding around helium tube II

https://edms.cern.ch/document/584747/1

- Upstream end of shielding area w.r.t. FP 52.18 m
- Downstream end of shielding area w.r.t. FP 93.045 m
- Shielding elements 17 x 2.4 m long
- Material concrete

- Height of shielding underneath helium tube 0.6 m
- Left/right wall distance to axis 0.7 m
- Side wall thickness 0.8 m
- Side wall height 2.2 m

- Roof thickness for first 3 upstream elements 0.6 m
- Roof thickness for other elements 0.4 m