

CNGS - Status Report

> Aim of CNGS - ν - oscillation

> > Main components - layout
CNGS as SPS facility - names

© Recent changes / hot topics

¥ Status of works - planning

> > > Summary



A sincere "THANK YOU!"

- for all the work done (and to come!)
- for your patience with the project leader...
- special thanks: Jean-Luc Caron (AC-DI-MultiMedia)

My Apologies

- for not mentioning, in this presentation,
your particular efforts or your work

What are Neutrinos (ν) ?

- ⇒ elementary particles
- ⇒ come in three flavors
(pistachio, chocolate, vanilla)
- ⇒ electric charge: zero !
- ⇒ **mass**: very small **zero?**
- ⇒ interaction with matter: "very weak"



" the elusive particle "

<u>Leptons</u>	
particle	electric charge
e	-1
ν_e	0

μ	-1
ν_μ	0

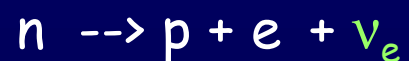
τ	-1
ν_τ	0

+ antiparticles

Where are the Neutrinos ?

⇒ “all around us”

-> radioactive decay of atomic nuclei (e.g. in granite)



-> nuclear reactors

-> from the sun

-> at accelerators... (high energy neutrinos)

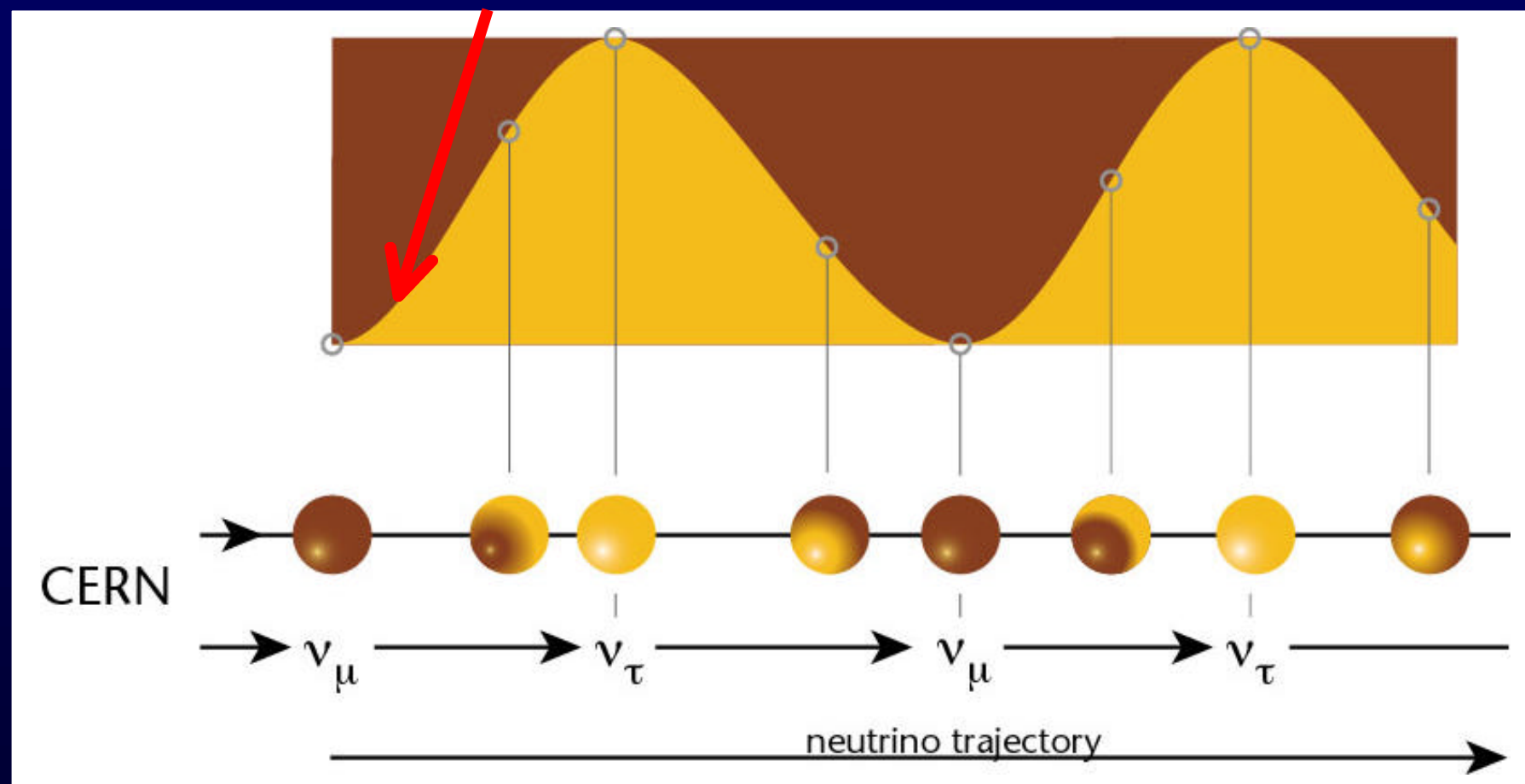


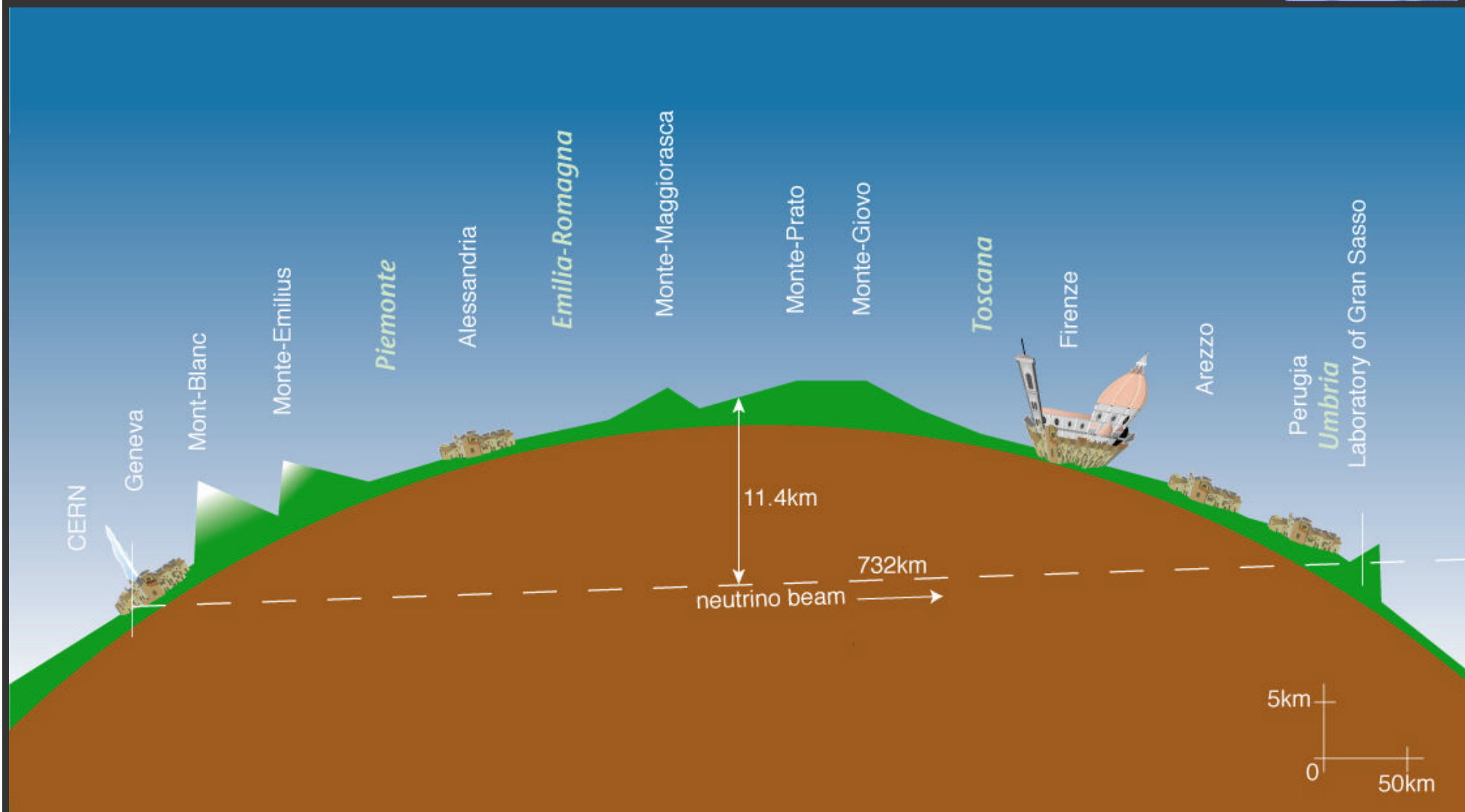
-> from reactions of cosmic rays in the atmosphere

....

Aim of CNGS: detect $\nu_{\mu} \rightarrow \nu_{\tau}$ "oscillation"
 ("long base-line experiment")

Gran Sasso



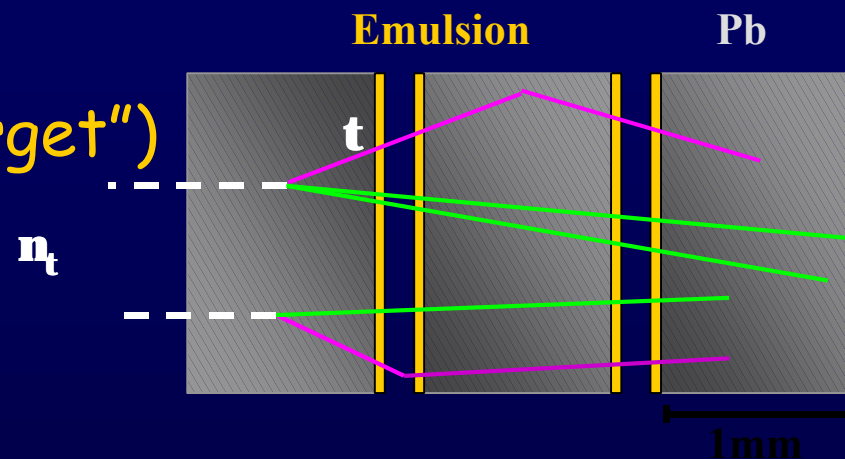


At Gran Sasso:

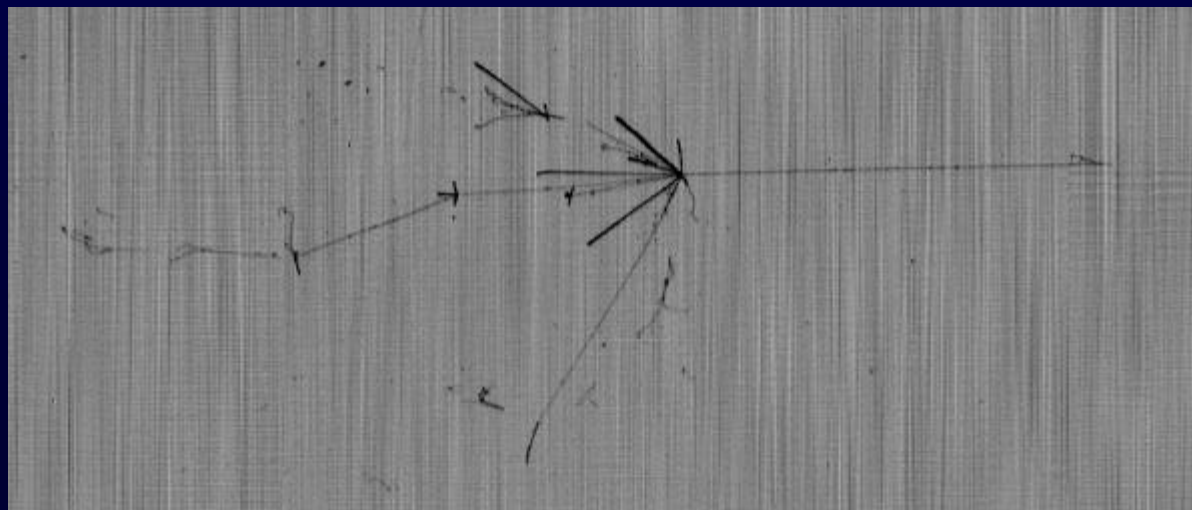


- existing Underground Laboratory - **LNGS**
- two experiments in preparation:

1) OPERA --> CNGS1
(> 1 kt emulsion "target")

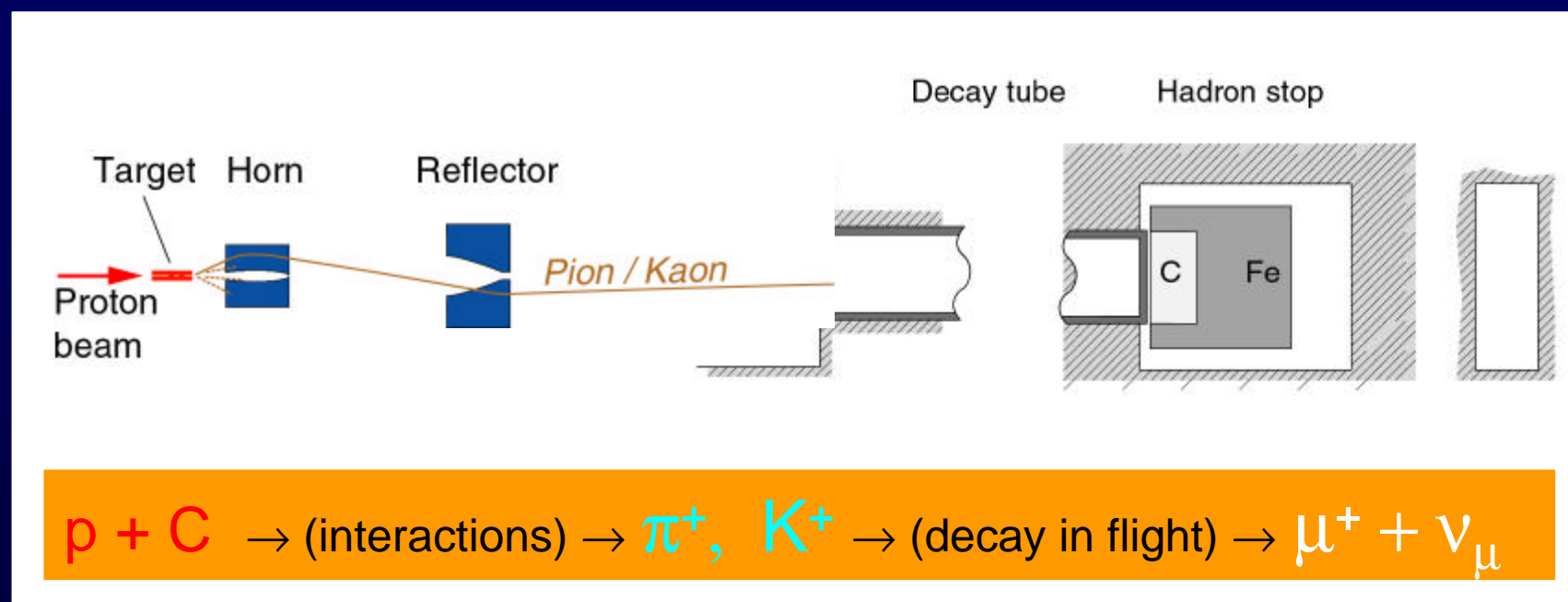


2) ICARUS --> ...
liquid argon TPC (example from 600 t module)



CNGS: the main components (1)

(based on CERN experience: PS / SPS neutrino beams \rightarrow WANF)

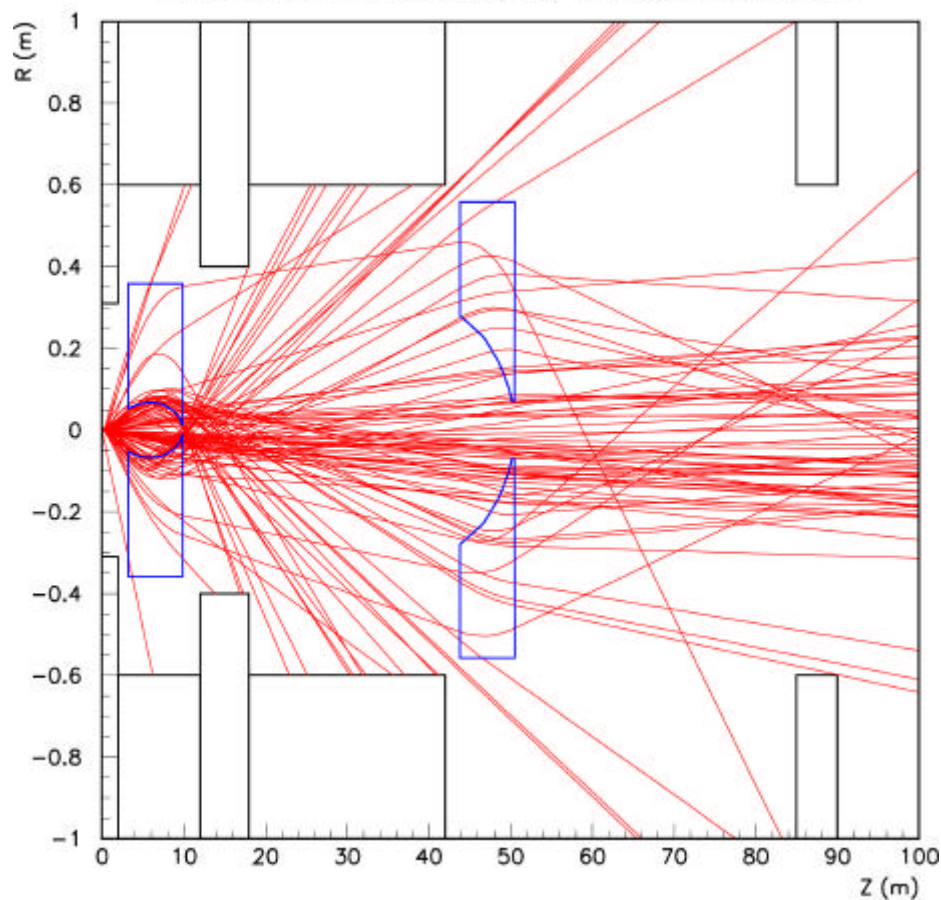


protons from SPS: 400 GeV/c, beam-size $\sigma = 0.5\text{mm}$

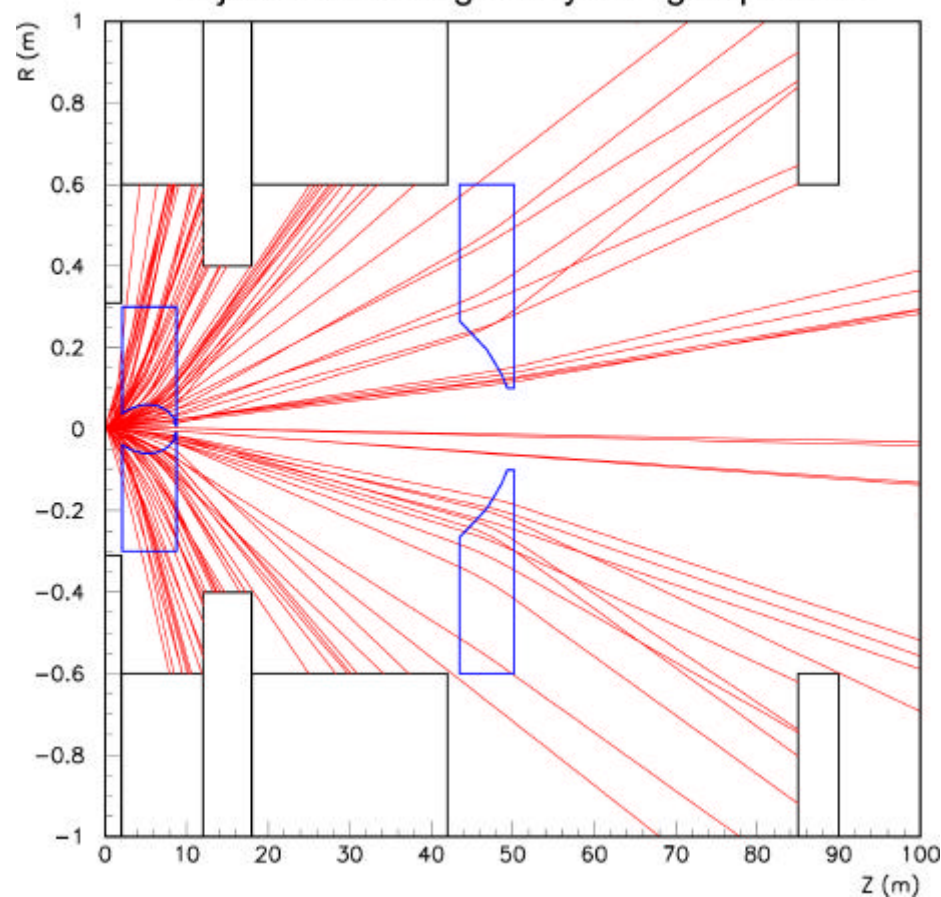
Horn / Reflector: secondary beam focusing



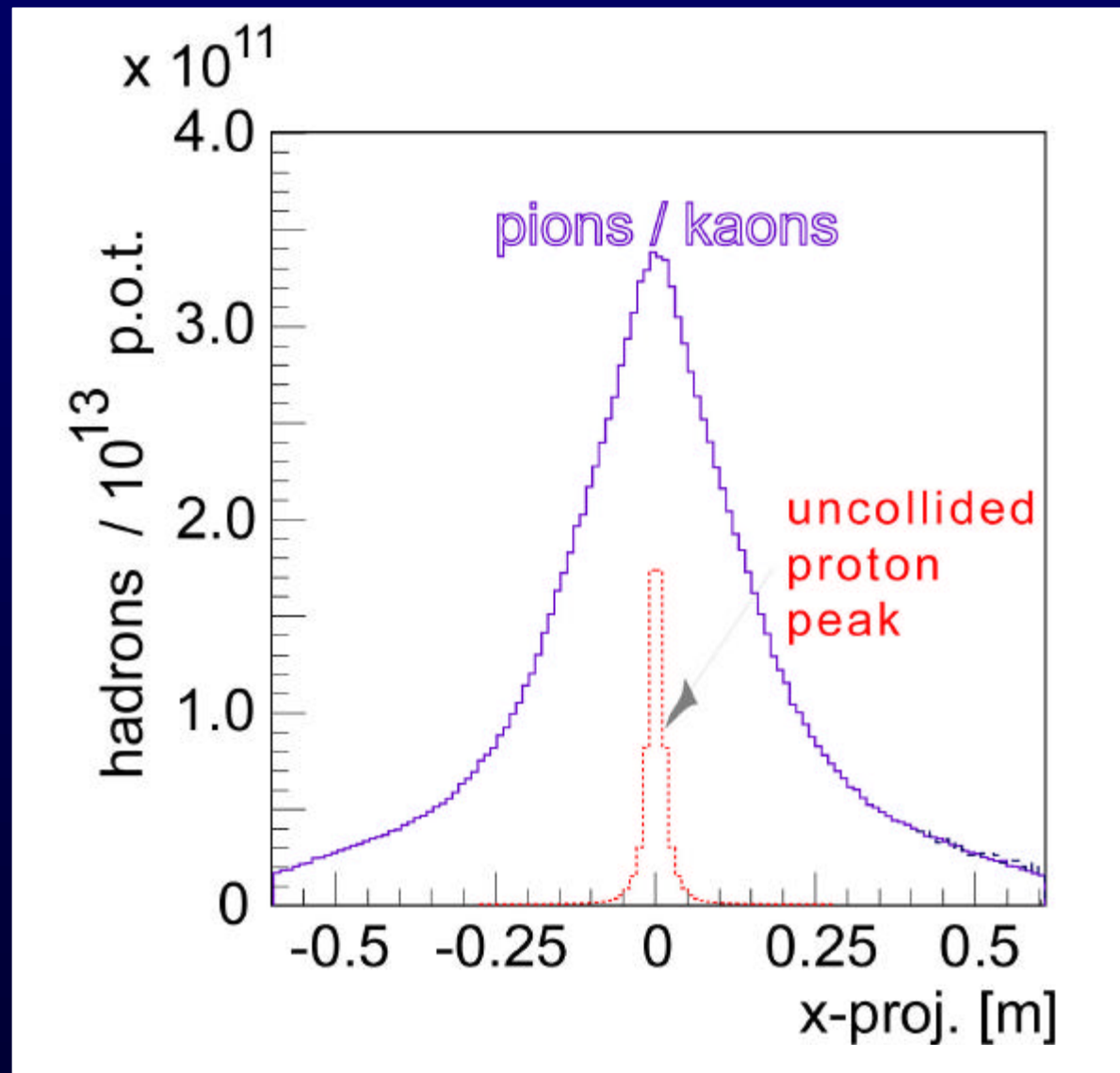
trajectories of positively charged particles



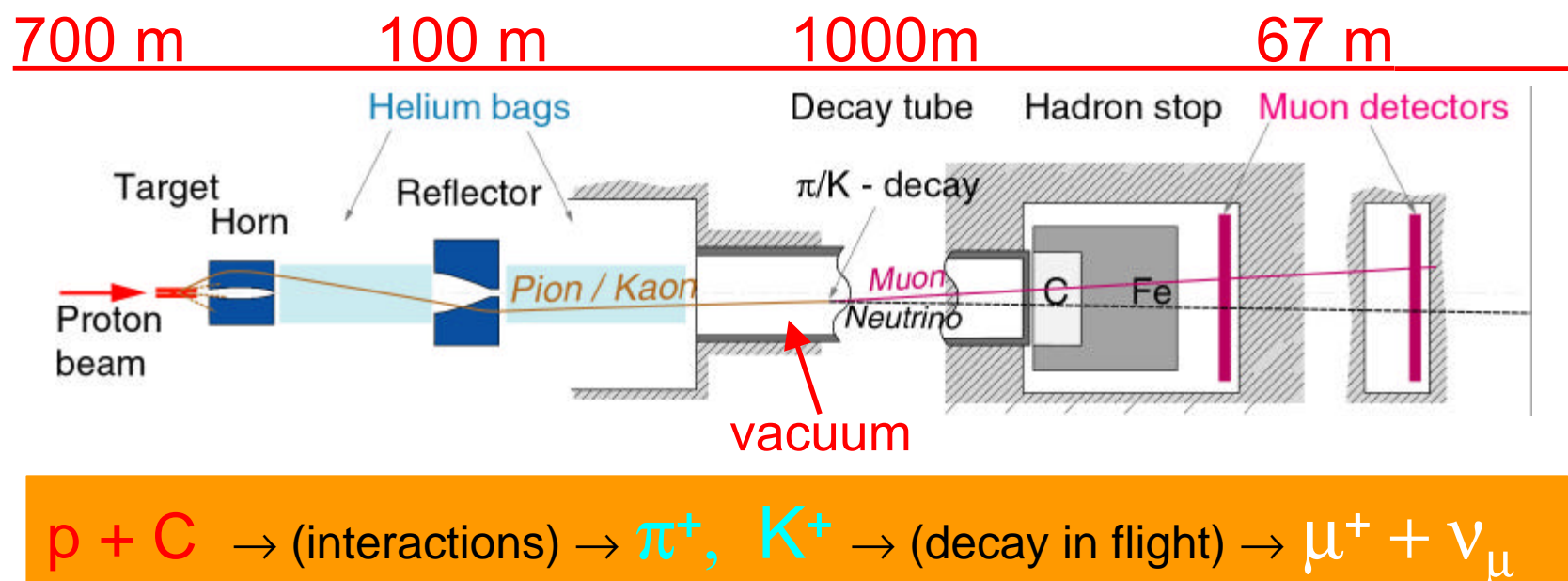
trajectories of negatively charged particles



p / K profile at entrance to decay tunnel

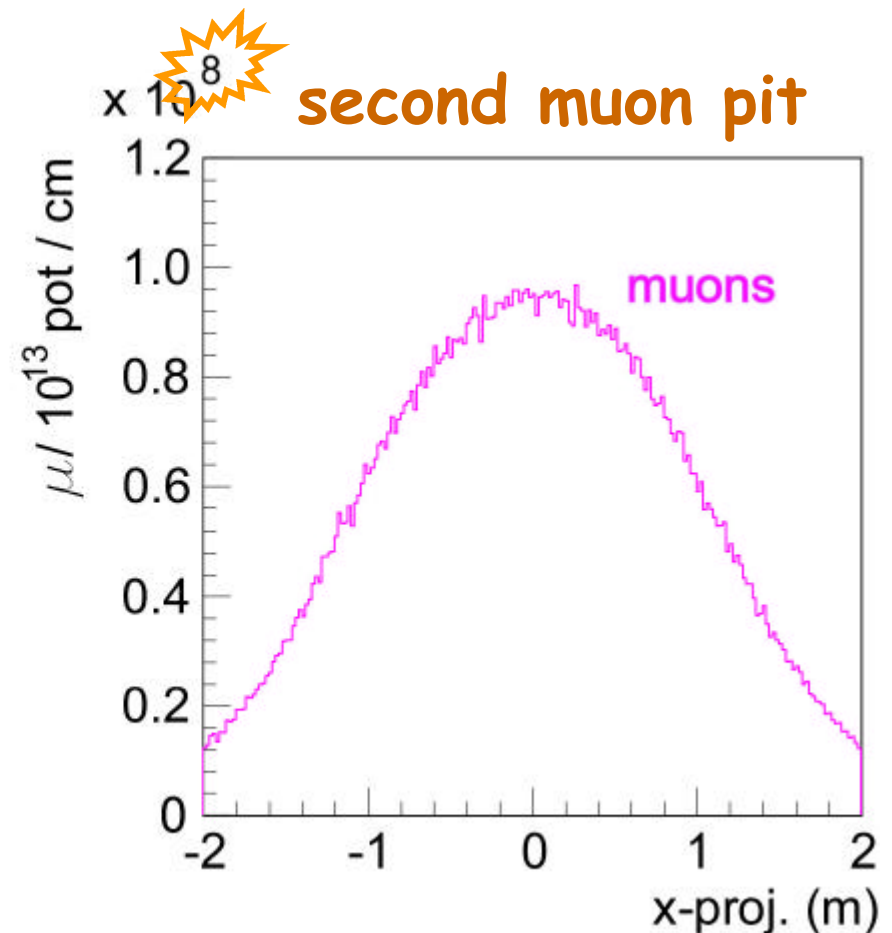
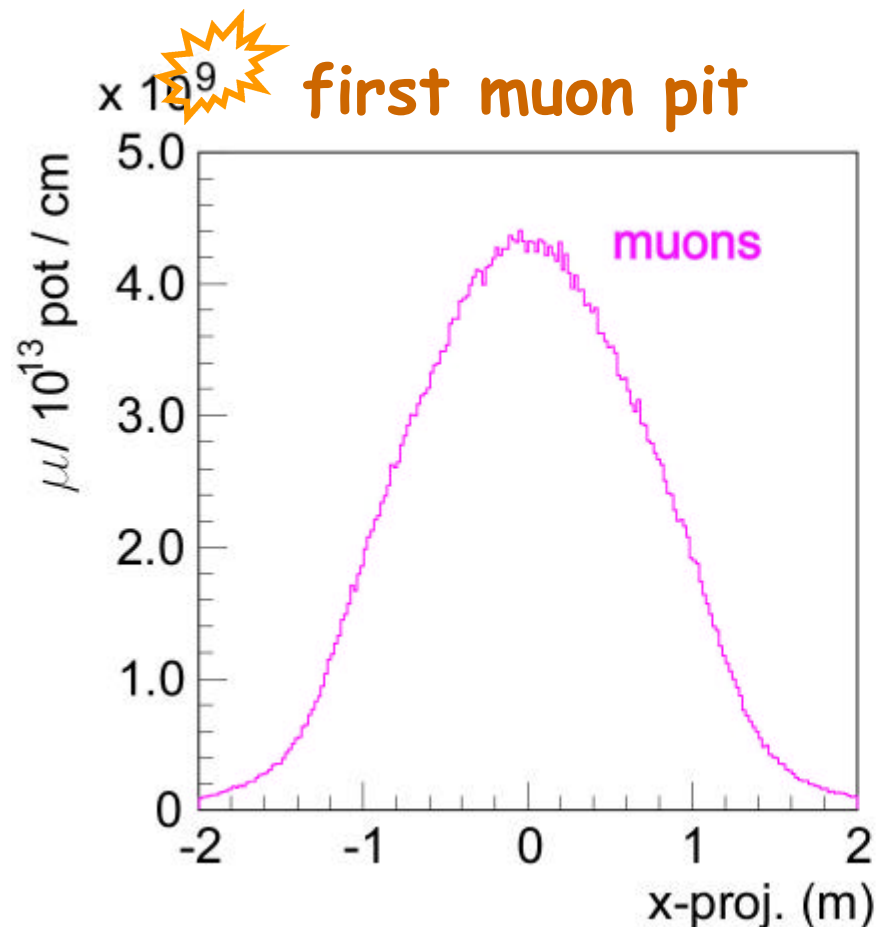


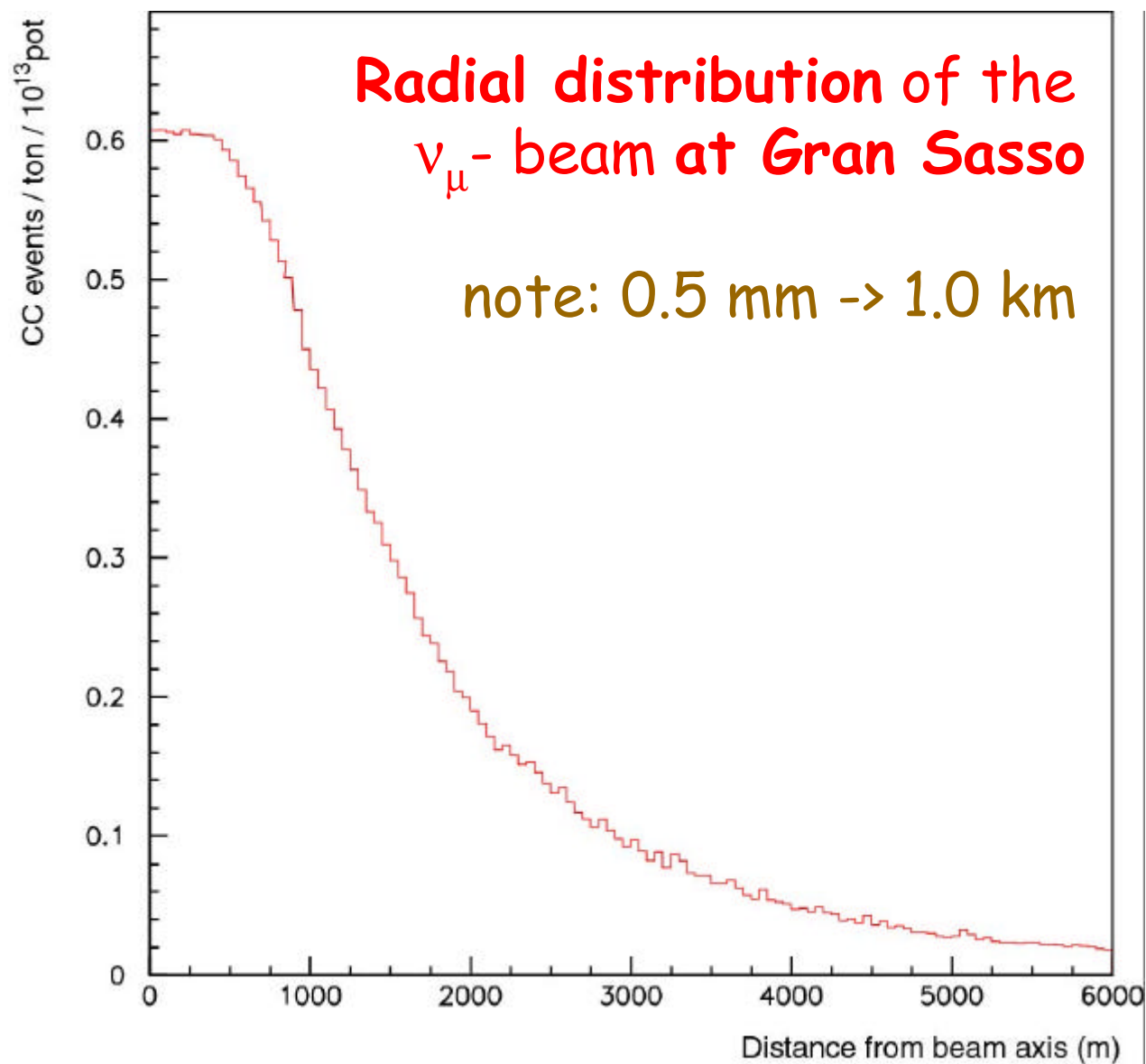
CNGS: the main components (2)



$$\pi^+ \text{ ® } \mu^+ + \nu_\mu$$

expected CNGS muon profiles





Number of particles expected per year:



For 1 year of CNGS operation, we expect:

(4.8×10^{13} protons in SPS, 55% efficiency -- 1997(?))

protons on target 4.5×10^{19}

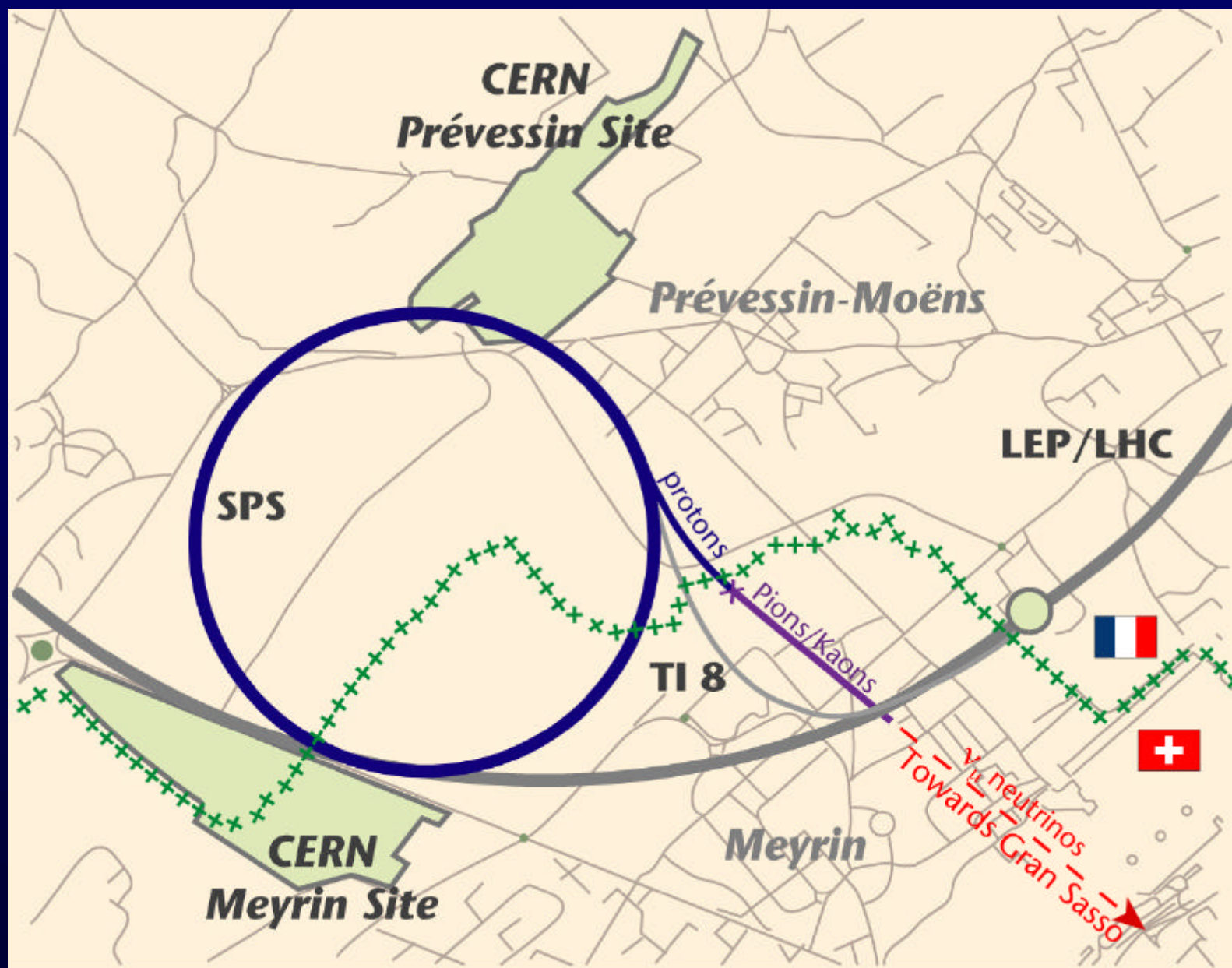
pions / kaons at entrance to decay tunnel 5.8×10^{19}

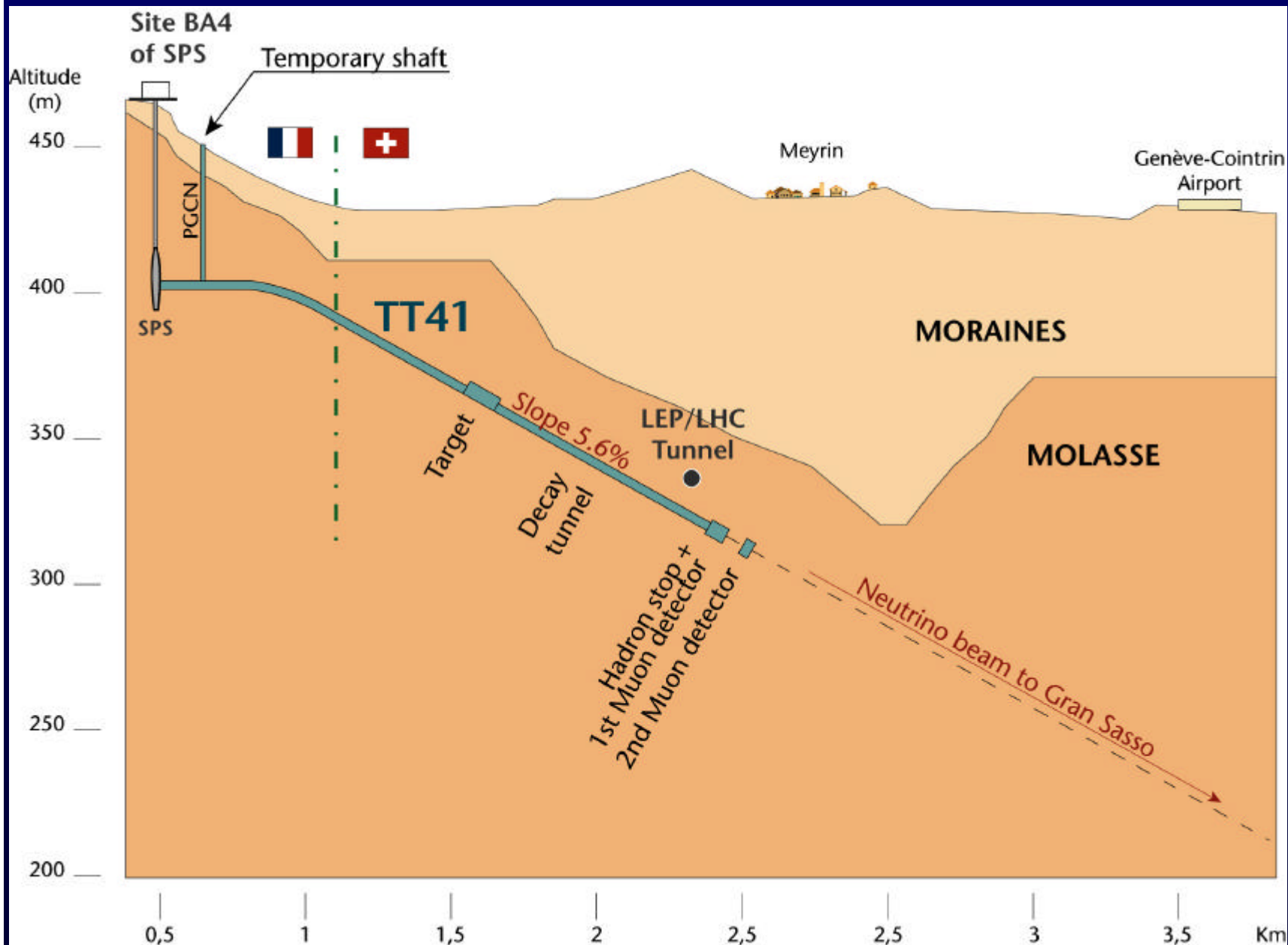
muons in first / second muon pit $3.6 \times 10^{18} / 1.1 \times 10^{17}$

ν_{μ} in 100 m² at Gran Sasso 3.5×10^{12}

ν_{μ} "charged current" events per 1000 t ≈ 2500
($\nu + N \rightarrow N' + \mu$)

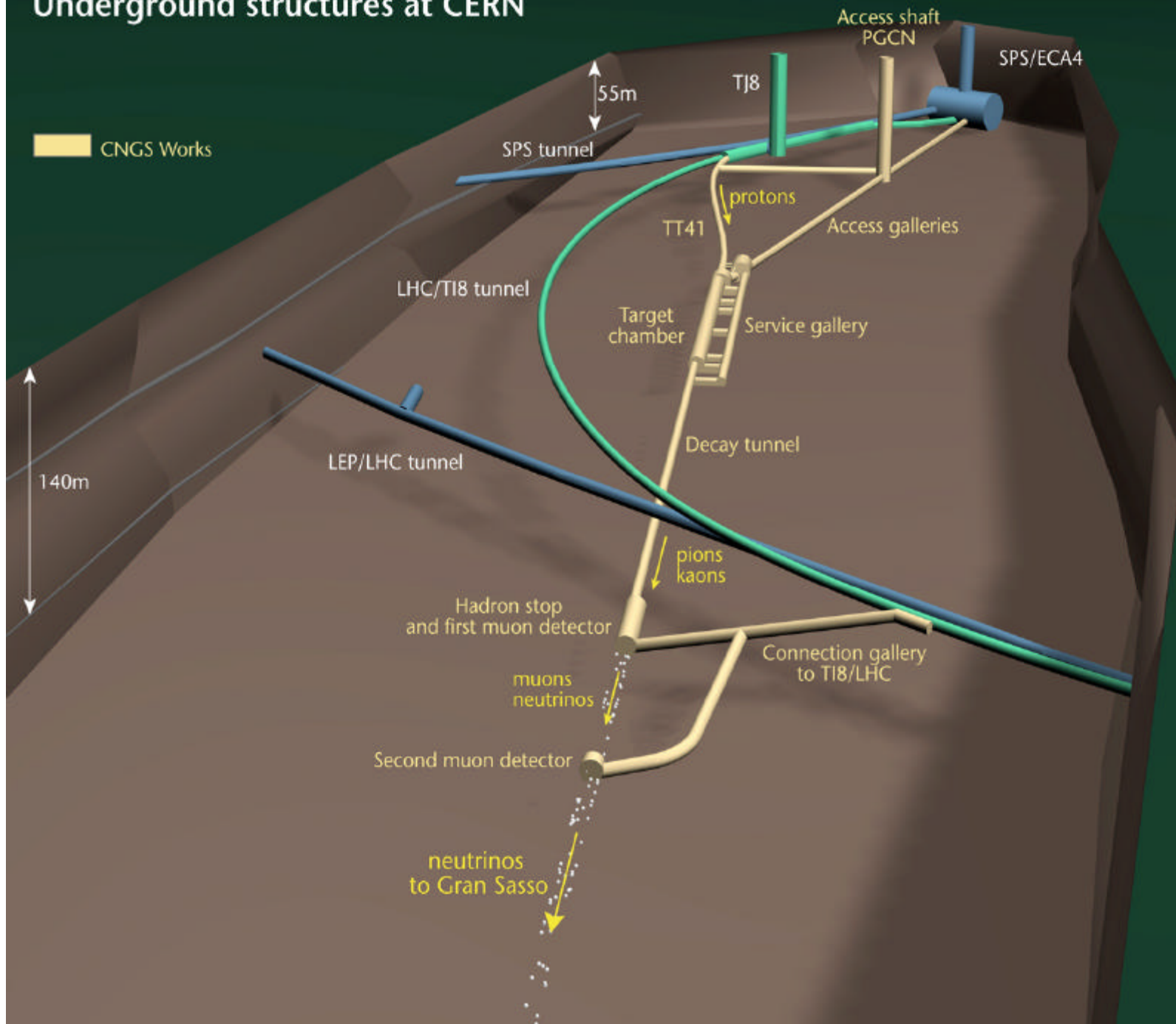
ν_{τ} events (from oscillation) ≈ 20 "detectable"





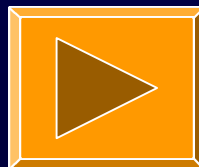
CERN NEUTRINOS TO GRAN SASSO

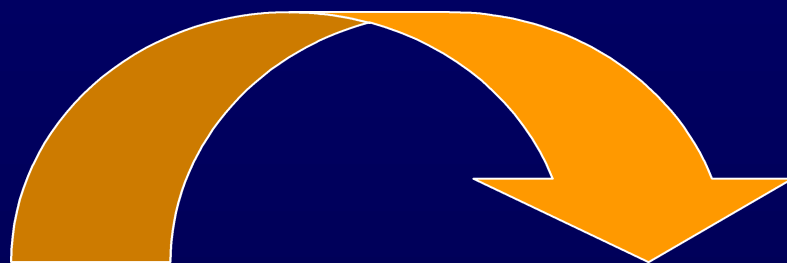
Underground structures at CERN



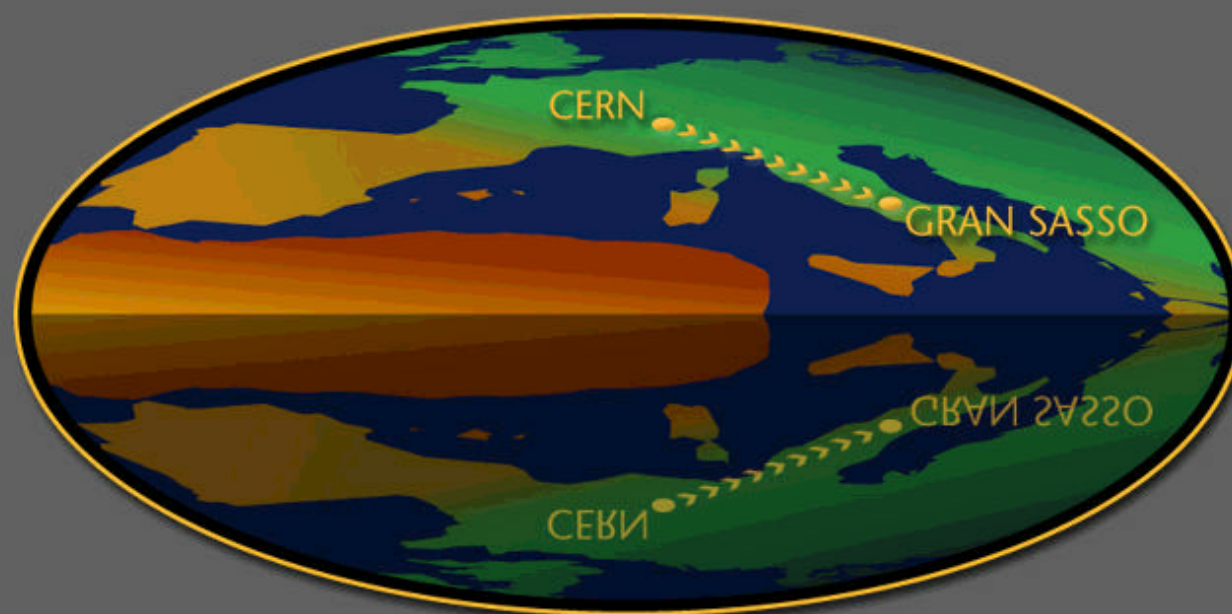
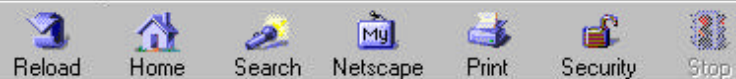
N.B. CNGS is an SPS facility

- SPS naming conventions for tunnels, caverns, equipment, etc.
- exception: civil engineering drawings (for historic reasons)
- examples





CNGS web pages



CERN NEUTRINOS TO GRAN SASSO
ENTER



Baptisme of the Tunnel Boring Machine for CNGS 26/06/2001

Events

Project Overview

Beam Performance

Civil Engineering

Naming Conventions

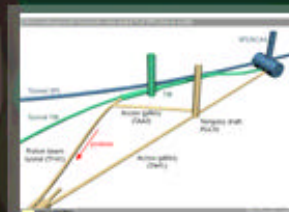
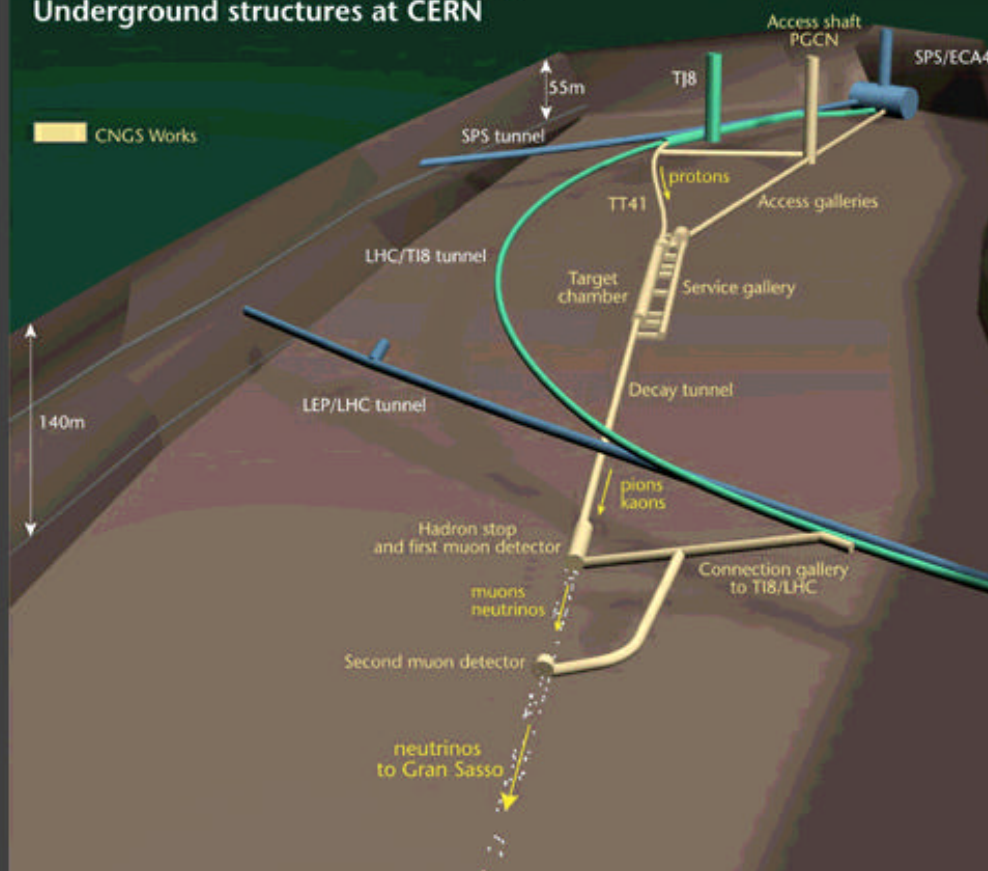
Publications/Talks

Download Pictures

Links

Technical Page (EDMS)

CERN NEUTRINOS TO GRAN SASSO Underground structures at CERN



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Naming conventions

CNGS being a project of the SL Division entirely linked to the SPS accelerator, it has been agreed that for the CNGS equipment, the official [SPS equipment codes](#) should be used throughout the facility. The names of the [CNGS underground structures](#) are also defined following the SPS naming convention for buildings, tunnels and caverns. The names are shown in two graphs, for the target and the hadron stop area. The names of the surface buildings at point 4 of the SPS are defined on the [CERN map](#).



SPS Equipment Codes

[\[html\]](#)



Names of caverns and tunnels:

Target area



Hadron stop area



CNGS Logo

[\[html\]](#)

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Download Pictures

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SPS Equipment Codes and People Responsible for Naming

[back](#)

Code	Equipment Description	Responsible	Group
A	Acceleration Cavities + RF Equipment	T. Linnecar	SL-HRF
B	Beam Monitoring Devices	H. Schmickler	SL-BI
C	Communications +	R. Parker	IT-CS
	Controls Equipment	G. Coianiz	SL-CO
D	unused	-	-
E	Electrical Supply + Distribution Equip.	J. Pedersen	ST-EL
F	Fluid Distribution	M. Wilhelmsson	ST-CV
G	Girders + Supports	M. Mathieu	EST-ESM
H	Handling Devices + Special Equipment	I. Ruehl	ST-HM
I	LEP Transfer Equipment	-	-
J	unused	-	-
K	Kicker Equipment (magnets use 'MK')	L. Ducimetiere	SL-BT
L	Lenses other than Quadrupoles +	W. Kalbreier	SL-MS
	Layouts	J. Ramillon	EST-ESM
M	Magnetic Deflection Devices	W. Kalbreier	SL-MS
N	unused	-	-
O	unused	-	-
P	Personnel Safety (Radiation)	D. Forkel-Wirth	TIS-RP
Q	Quadrupoles	W. Kalbreier	SL-MS
R	Racks + other Enclosures	to be named	-
S	Power Supply Equipment	R. Genand	-
	(Power Converters follow magnet name)	M. Royer	SL-PO
T	Targets, Dumps, Collimators, etc.	S. Peraire	SL-BT
U	Ventilation & Air Handling	M. Wilhelmsson	ST-CV
V	Vacuum Equipment	P. Strubin	LHC-VAC
W	unused	-	-
X	Experimental Area Equipment	M. Clement	SL-EA
Y	Access+Miscellaneous Equipment	E. Cennini	ST-AA
Z	Electrostatic Devices	B. Goddard	SL-BT

Recent changes to CNGS layout

(NB. Last SL seminar on CNGS: E. Weisse, Nov. 1997)



May 1999: CNGS beam optimised for ν_τ appearance at LNGS
(Nov 2000) (hard work for Secondary Beam Working Group)

--> change of focussing (target / horn / reflector layout)

--> reduction of material in horn and reflector

--> increase current in horn and reflector

(WANF: 100 kA --> CNGS 1998: 120 kA

--> 1999: 150 kA

--> 2000: 180 kA)

Dec. 1999: CNGS project approved by CERN Council

Recent changes to CNGS layout



1) Civil Engineering Layout:

- connection to LHC
- new tunnel: TA42

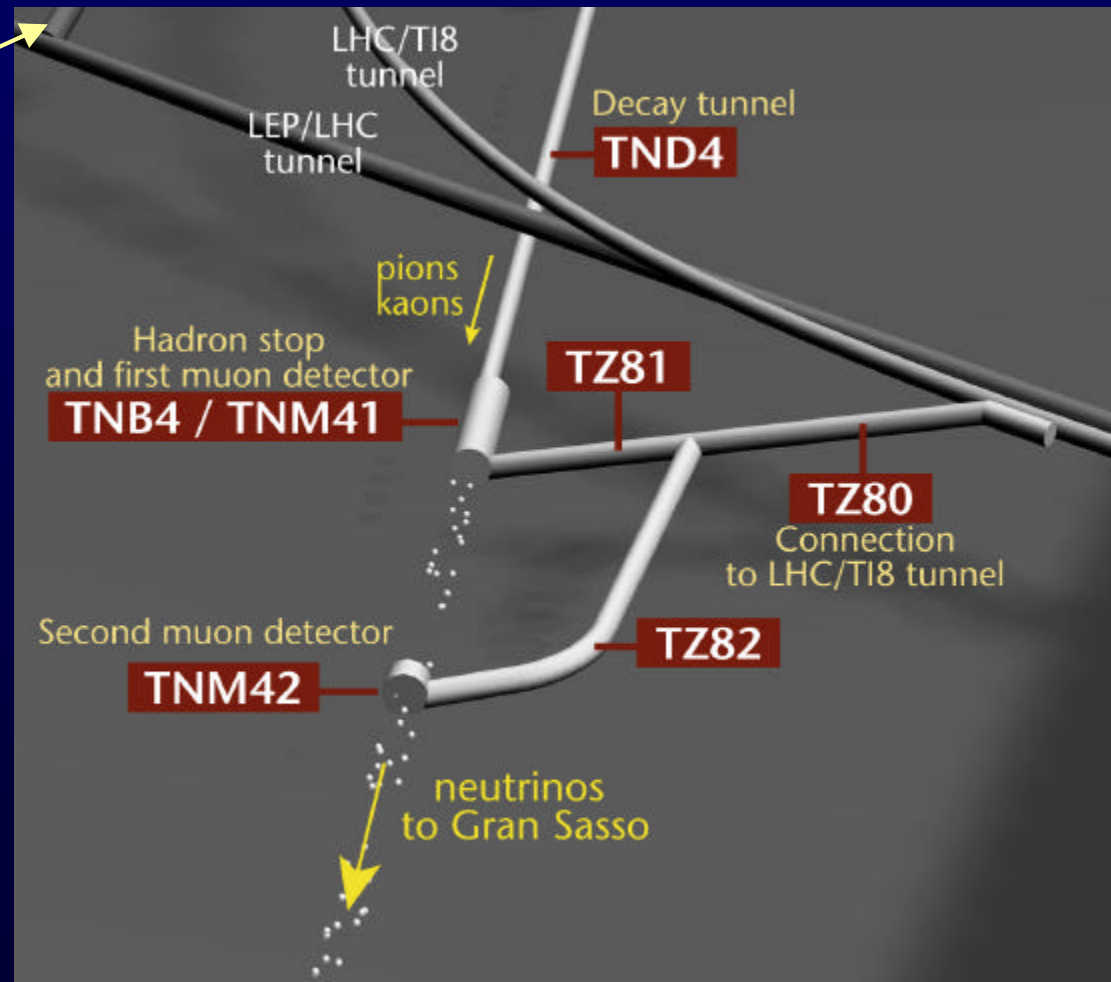
Connection of CNGS (μ -detectors) to LHC



Original project: connect to LHC directly (at RE88 alcove)
(problems of space / passage / safety)

Present project: connect via TI8 tunnel to LHC (and SPS)

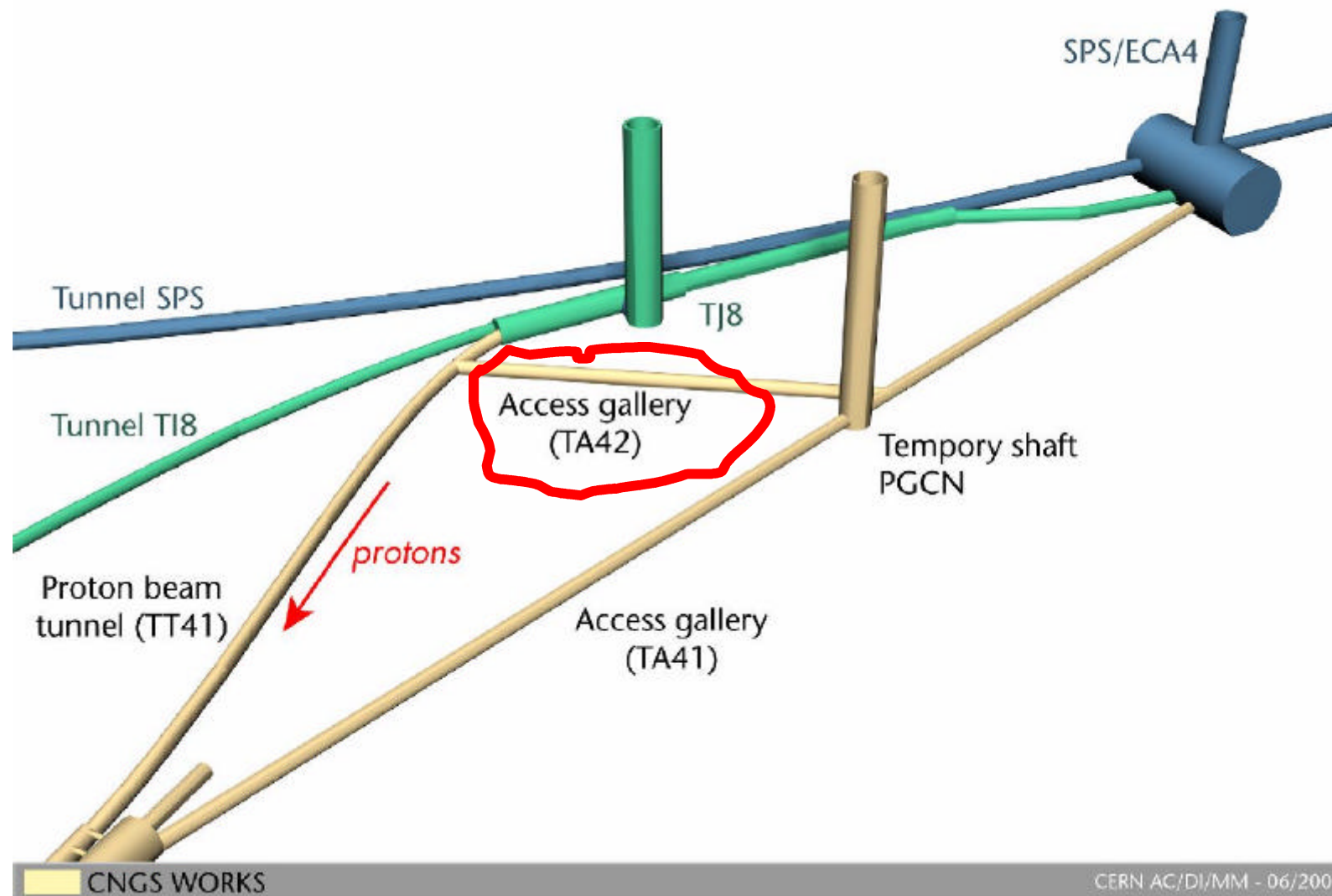
RE88



New tunnel: access gallery "TA42" (L=116 m)

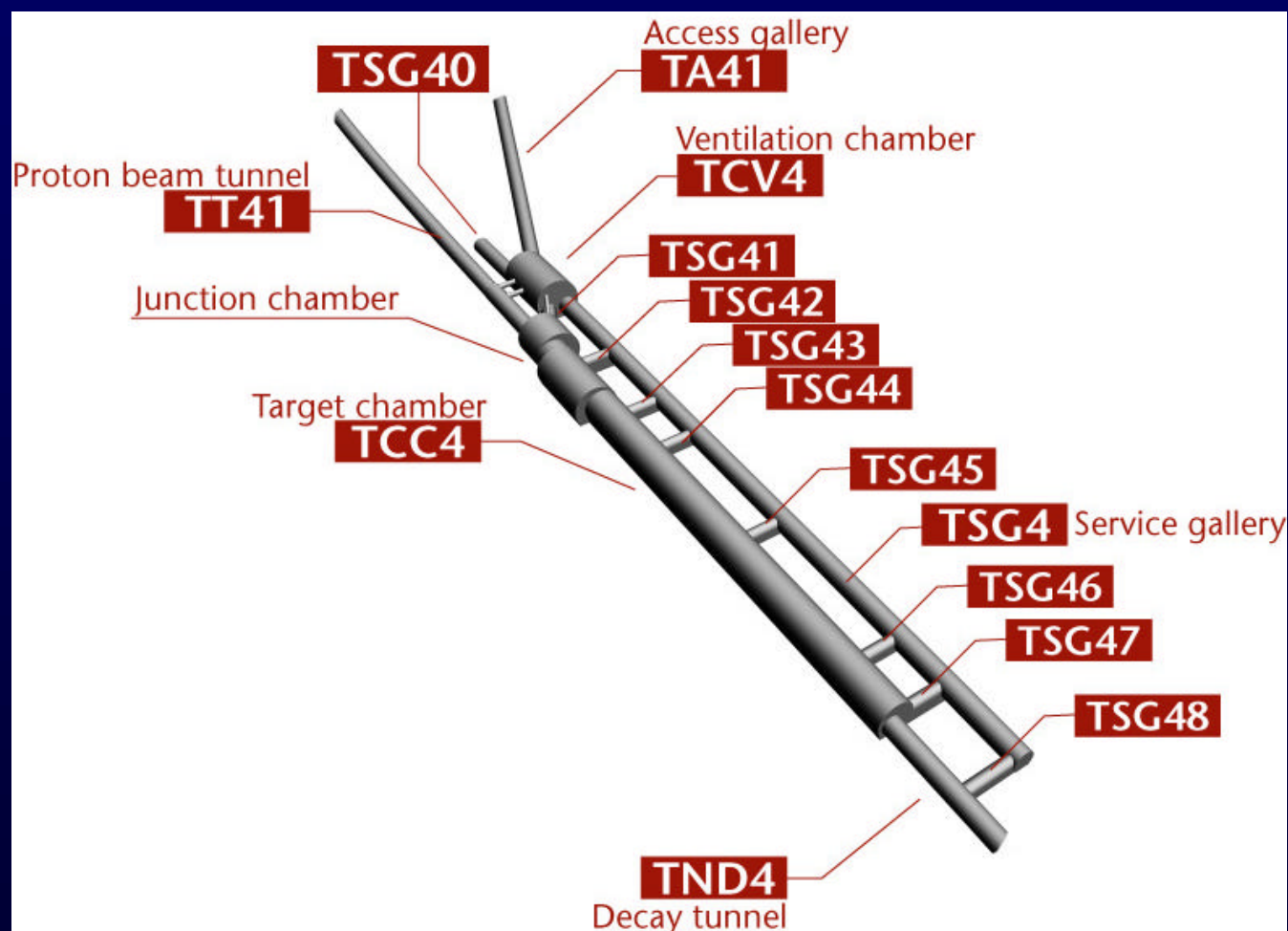


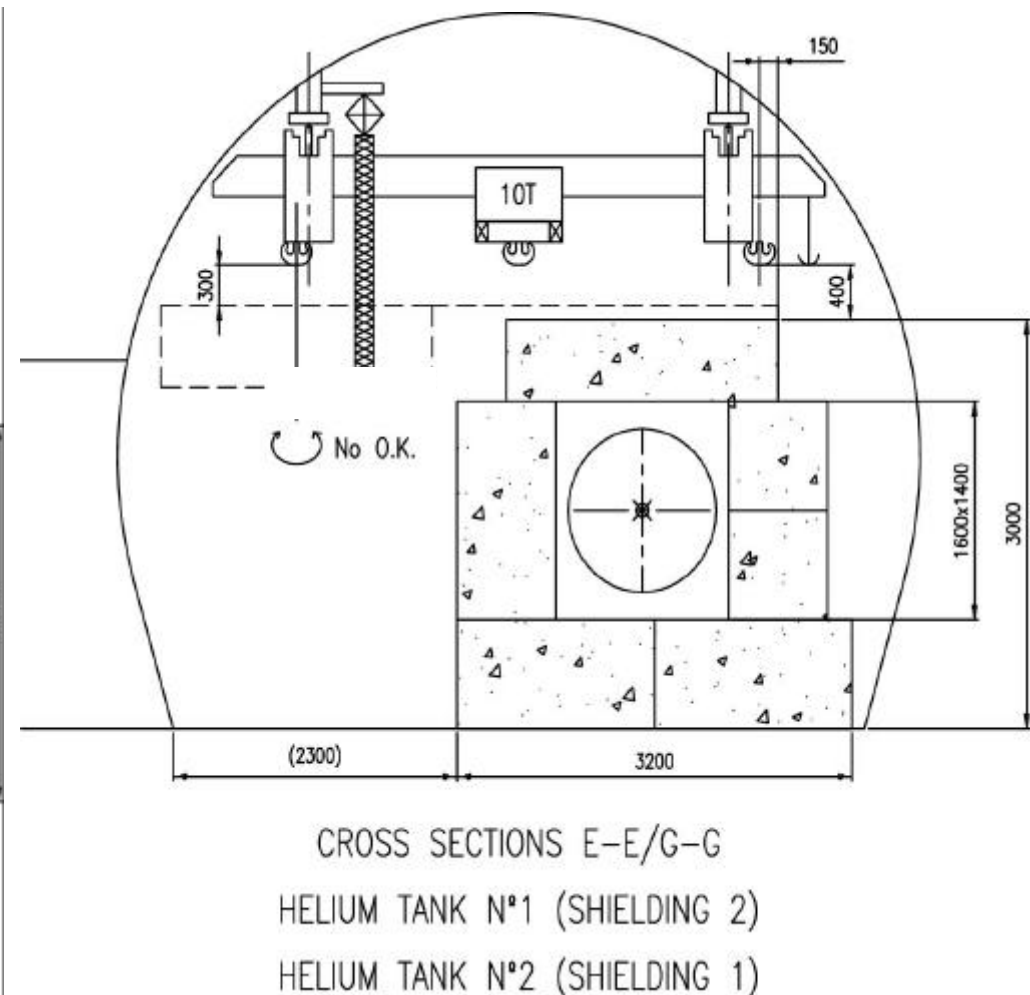
CNGS underground structures near point 4 of SPS (not to scale)



Recent changes to layout

2) Layout in Target Chamber TCC4 (target - horn - reflector)





Cooling Target Chamber - VERY preliminary !

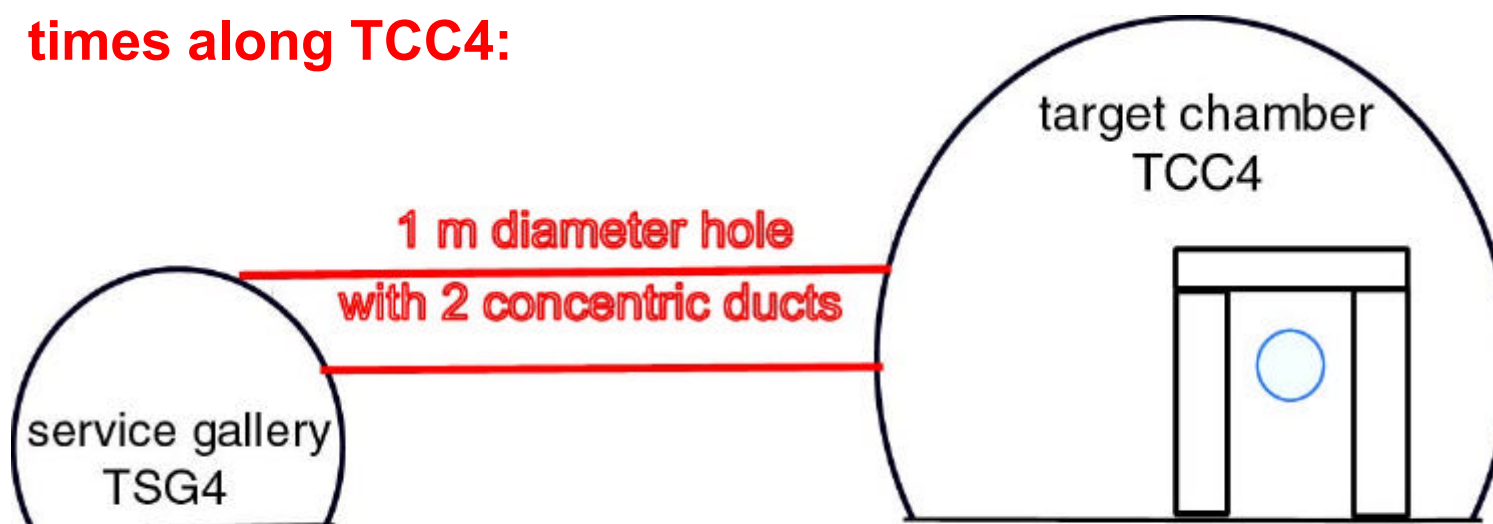
"Problem": prepare for higher SPS proton beam intensities
(average of 8×10^{12} vs. 2.6×10^{12} p.o.t. per second)

-> proton beam power **500 kW**

-> particles produced and lost in target chamber: **250 kW**

Solution (?): cooling (5×50 kW from local air conditioning units)

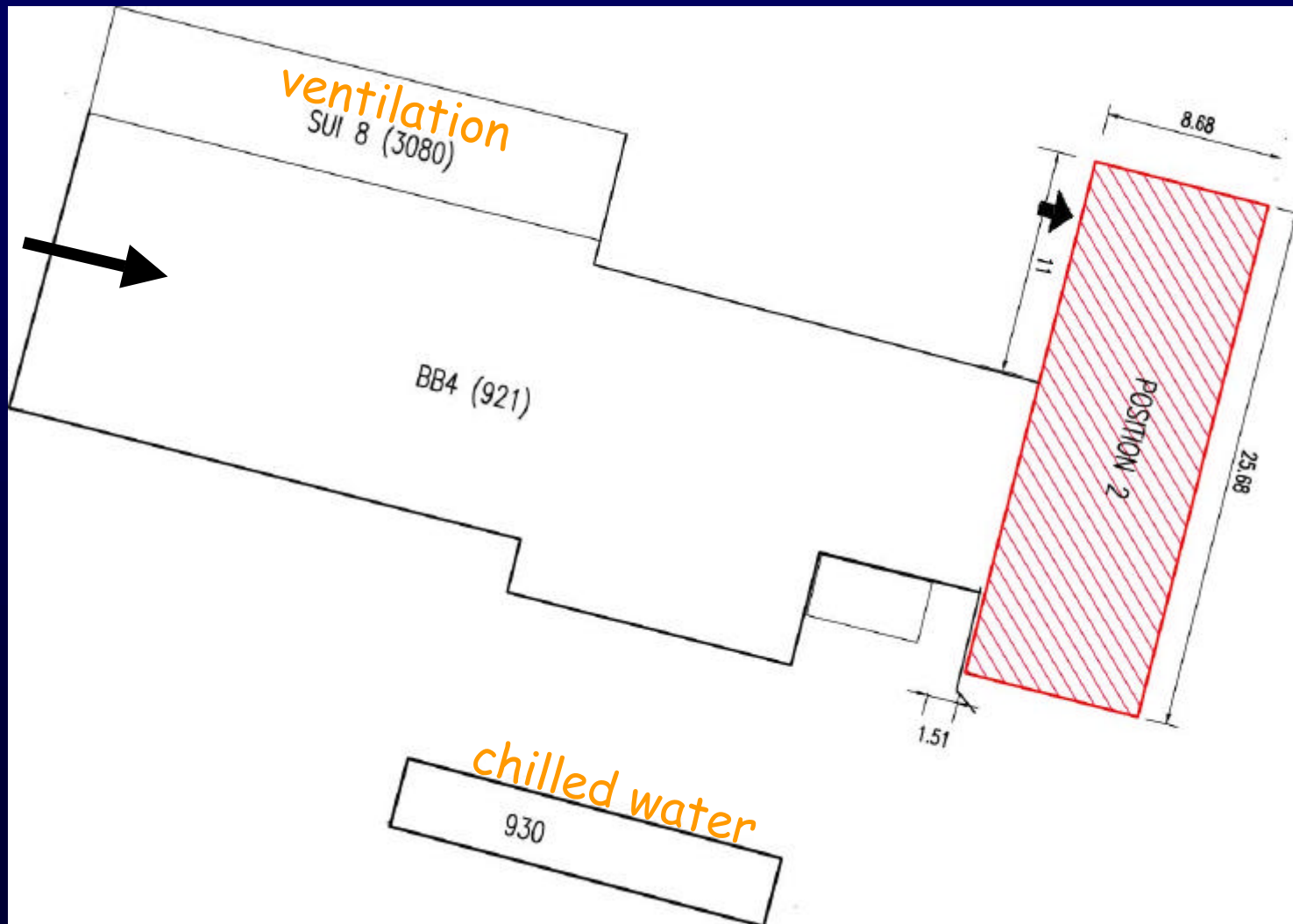
5 times along TCC4:



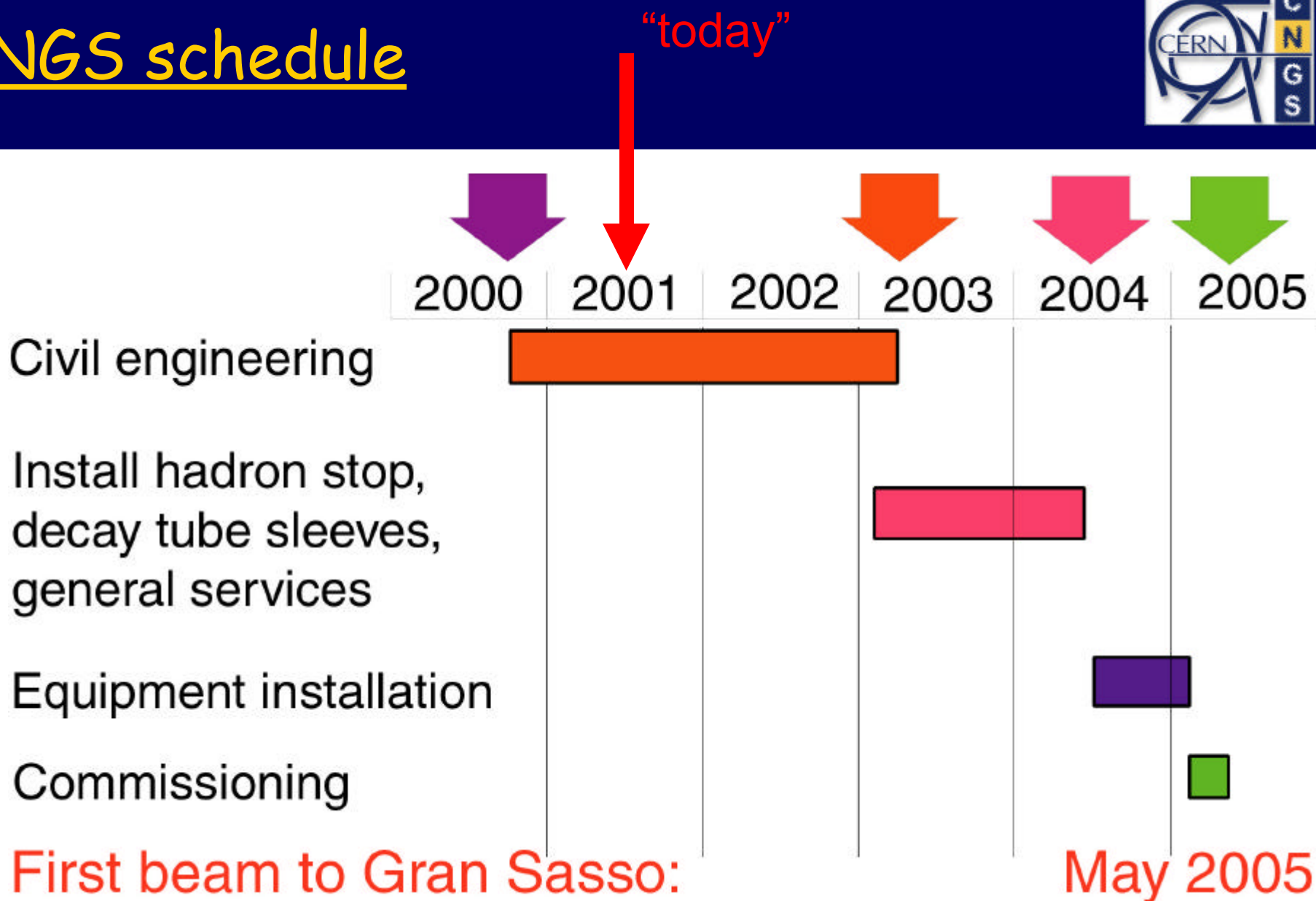
Recent changes to layout



3) Annex to BB4 (proposed !) (to house powering equipment for horn / reflector)



CNGS schedule



CNGS status -- Civil Engineering (1)



- ◆ ground breaking ceremony:
12 October 2000



12 July 2001

CNGS status -- Civil Engineering (2)



"baptism" of the Tunnel Boring Machine: 26 June 2001



12 July 2001

CNGS status -- Civil Engineering (3)



"baptism" of the Tunnel Boring Machine: 26 June 2001



12 July 2001

CNGS status -- Civil Engineering (4)



- ◆ excavation proceeds "on schedule"
- ◆ connection to ECA4: 4 July 2001

watch
progress
of TBM



12 July 2001

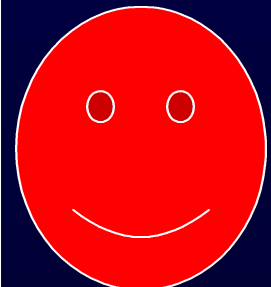
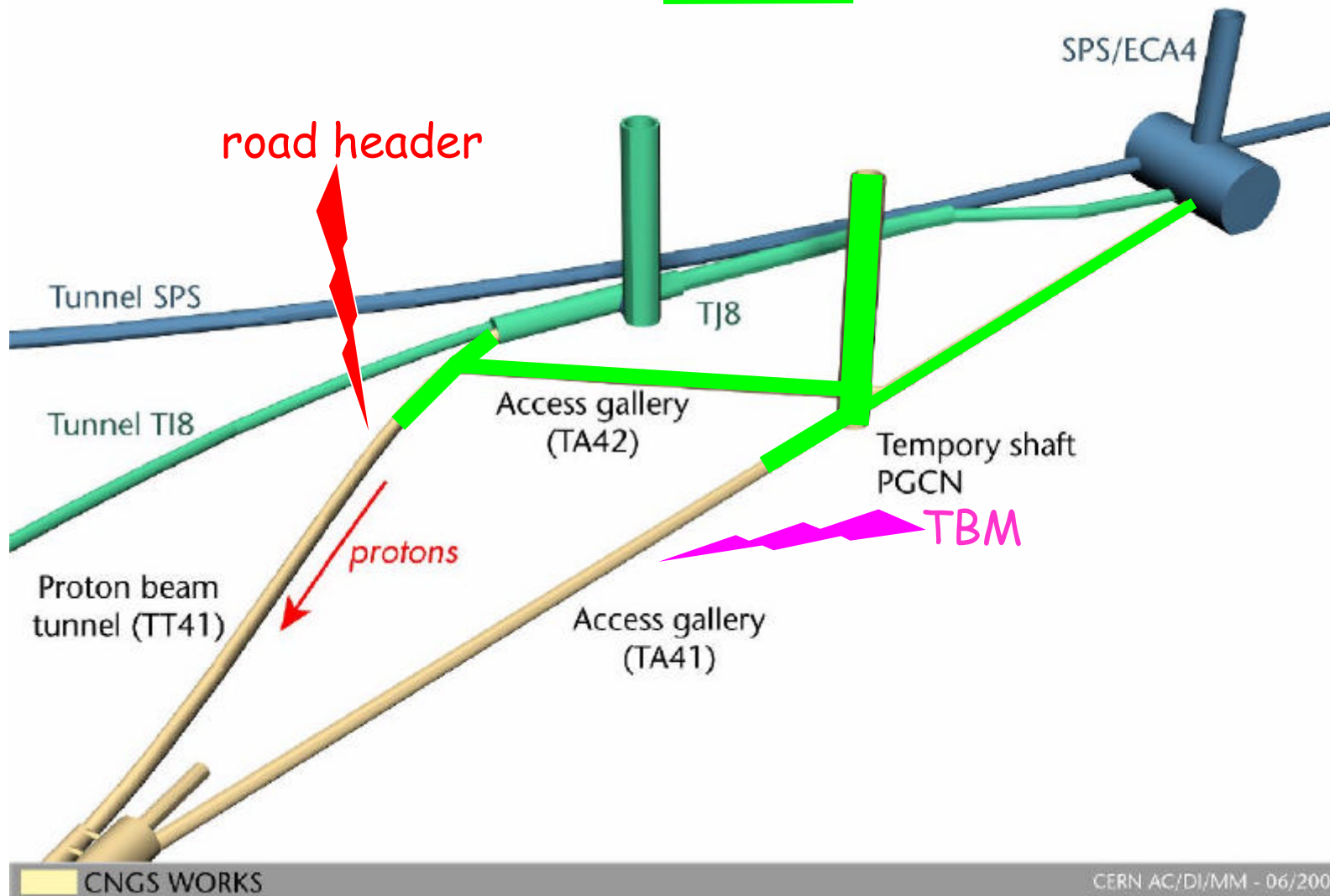
CNGS status report
SL seminar by K. Elsener

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CNGS status -- Civil Engineering (5)



CNGS underground structures near point 4 of SPS (not to scale)



12 July 2001

CNGS status report
SL seminar by K. Elsener

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CNGS status -- Infrastructure



"le monde ST"

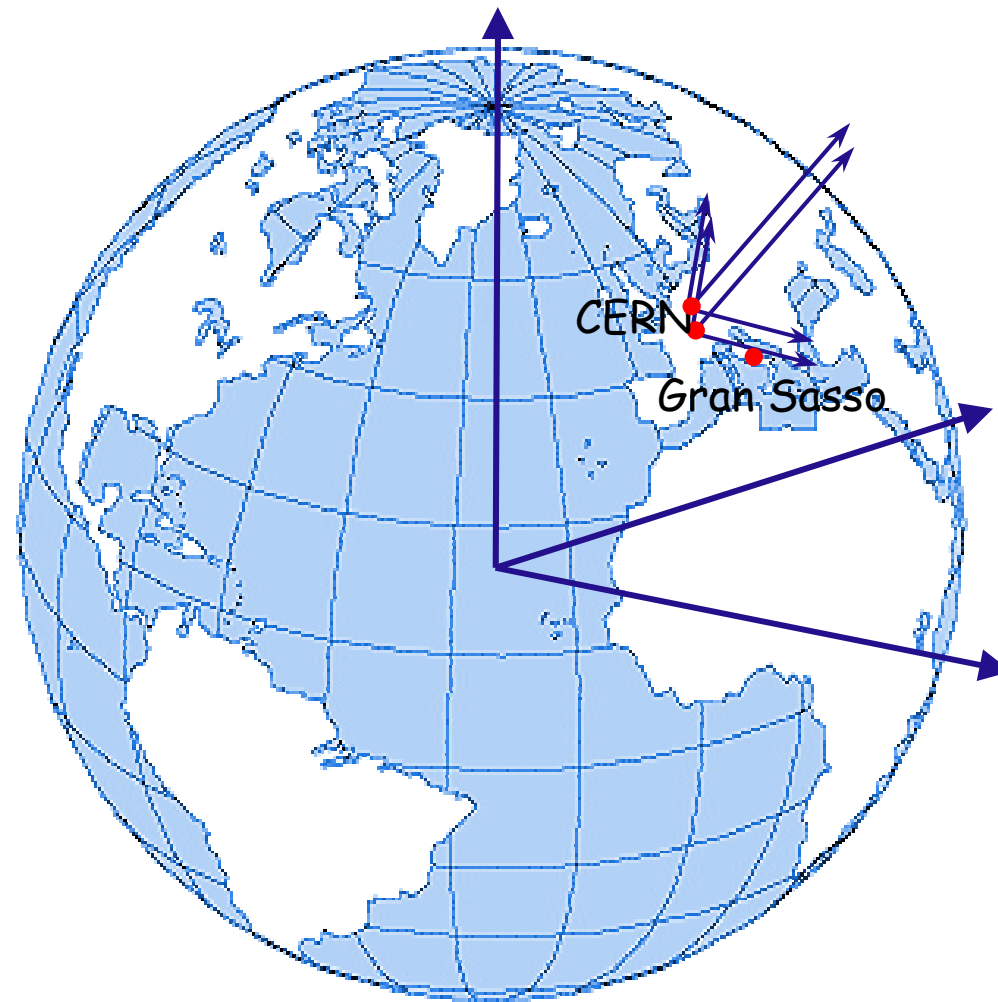
- ◆ most conceptual and much detailed design work already done
 - progress on cross sections, layout,
(market survey / tendering has started...)
- ... and much work is still ahead ...
 - cooling TCC4, cooling decay tube (?) etc.
 - equipment for TA42 ...
- ◆ **crane** in the target chamber TCC4
- ◆ help from ST/CV (layout, decay tube, etc.)
- ◆ **Planning for installation: in progress**



CNGS status -- Survey / Geodesy (1)

- × difficult, challenging work to reach a precision of 30 metres at detectors in Gran Sasso, 732 km away
 - × final co-ordinates for beam at CERN determined
- > "all is under control" !

Le Problème de Positionnement





CNGS status -- Survey / Geodesy (1)

... remain to be done:

- definition of alignment of all the elements
- longterm stability (definition of fixed points)
- definition of alignment control in highly radioactive environment (ie. target chamber TCC4)
- ...

CNGS status -- Proton beam TT41 (1)



Proton
beam
→



12 July 2001

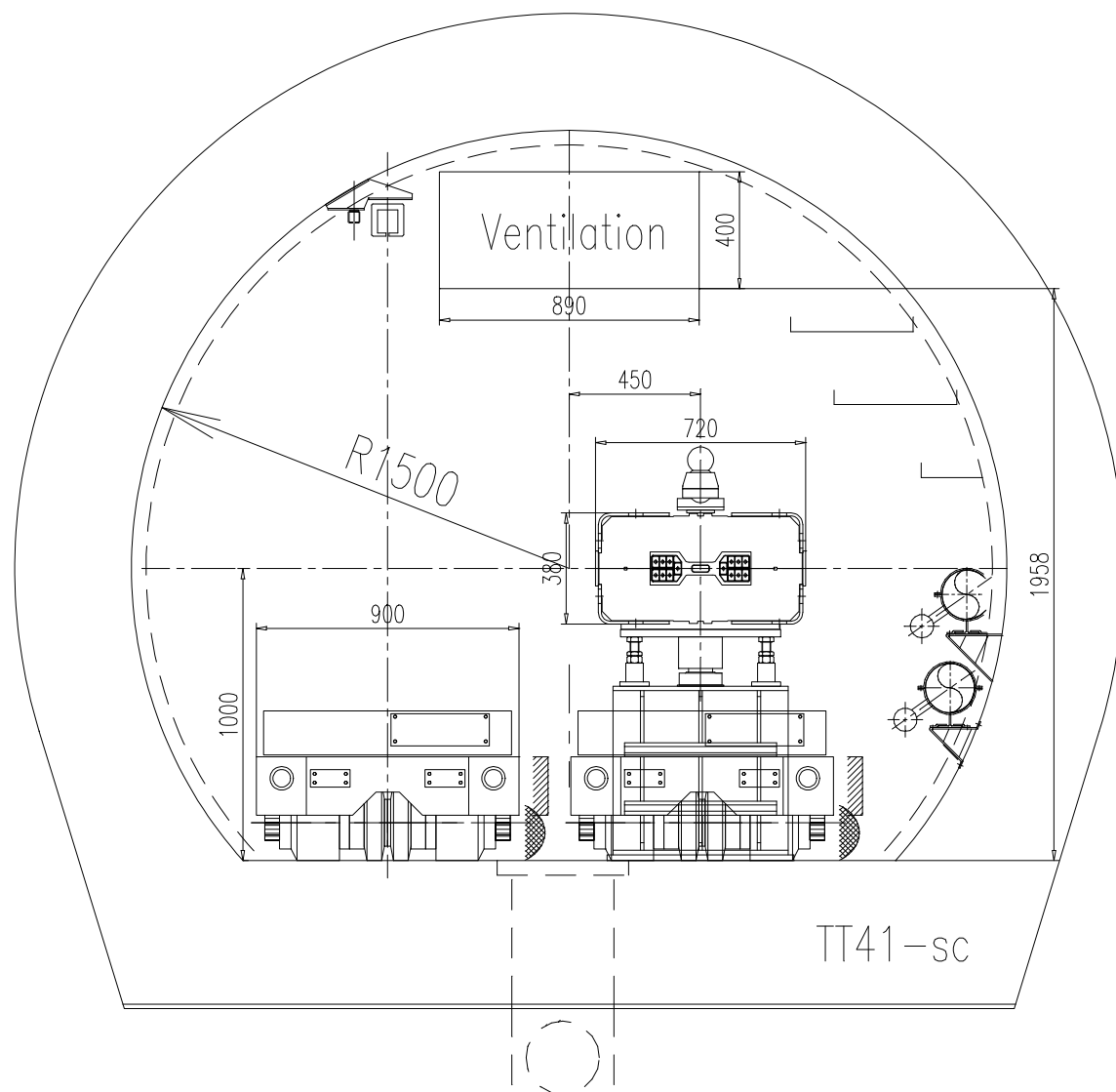
CNGS status report
SL seminar by K. Elsener

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CNGS status -- Proton beam TT41 (2)



- 400 GeV/c protons, fast extracted from SPS in point 4
(extraction has to cope with LHC and CNGS beam structure)
- extraction elements: design in work
(SLI project: first extraction tests / TT40 in 2003)
- TT41 (700 m of transfer line): conceptual design/layout **finished**
- MBG deflection magnet design: **finished** (EDMS /CDD)
- QTG quadrupole design: **finished**
--> BINP started **production of MBG and QTG prototypes**
- MDG correction elements: **design not yet started**



TT41 section -

"preliminary"

warning:
there is "no space"

CNGS status -- Proton beam TT41 (3)

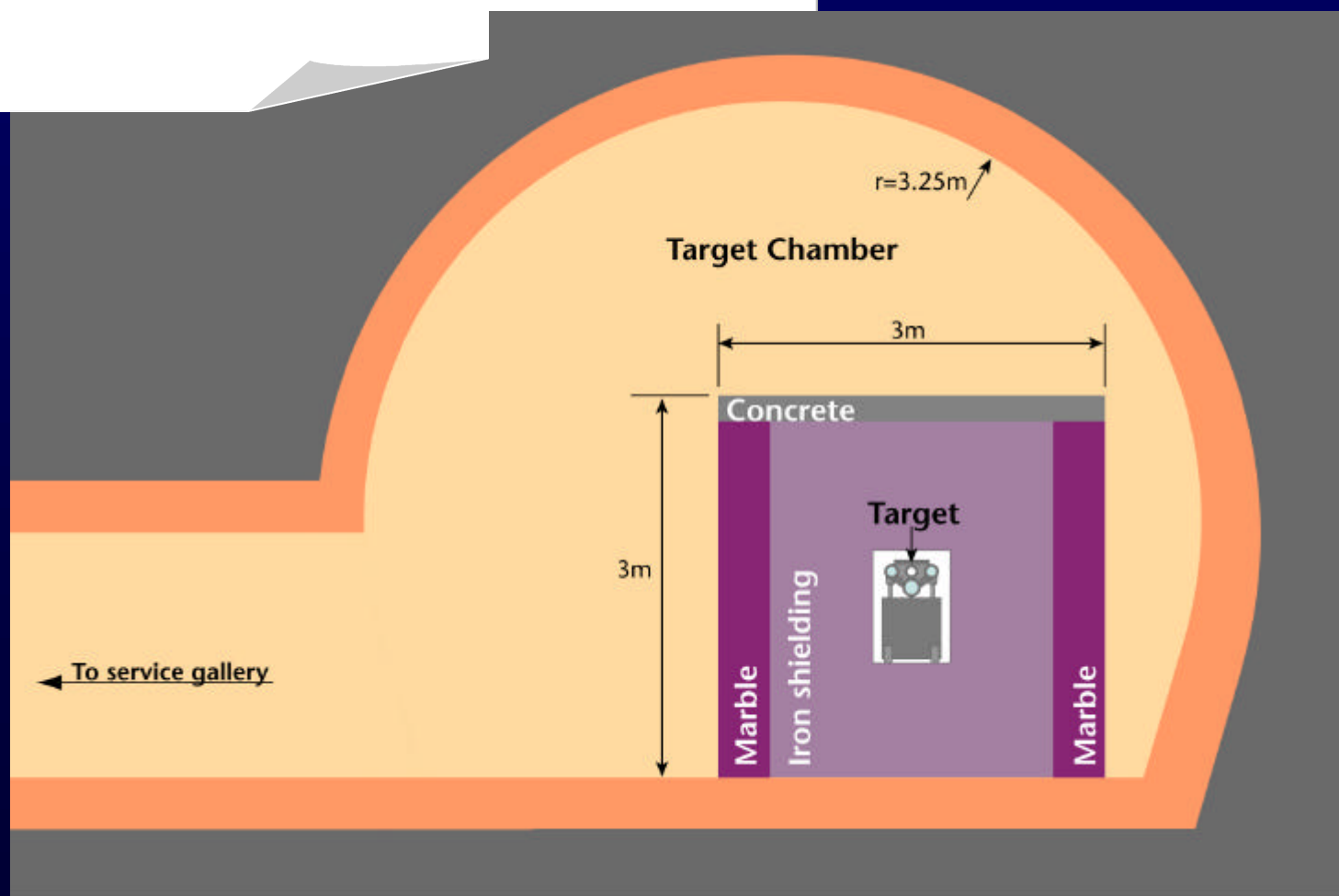


- power supplies (SL/PO): well under way
- vacuum: design well advanced (MBG / QTG done)
- beam instrumentation:
 - first design and cost estimate available
(BPM's, OTR's; SEM's around the target ?)
 - > presently under discussion (involving SL/OP)
- safety element (TBSE): well under way

CNGS status -- target station T40 (1)



Proton beam
Target

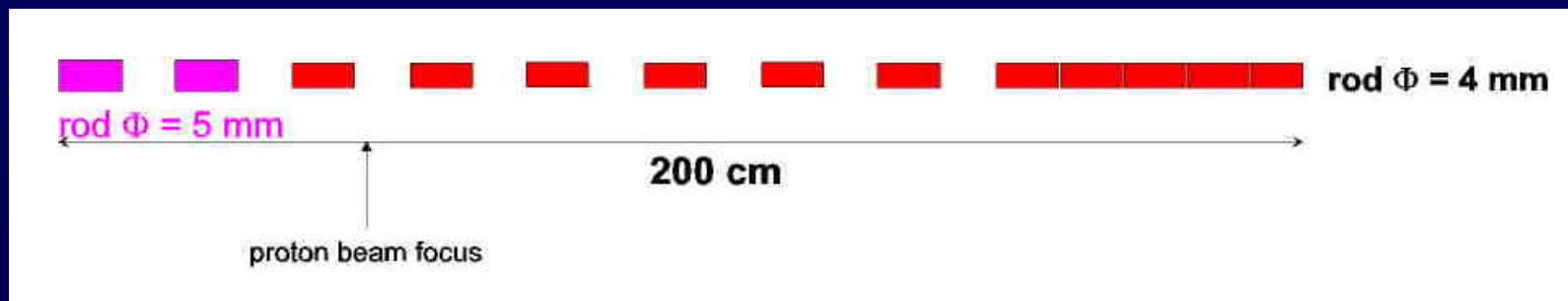


CNGS status -- target station T40 (2)



-> target rod optimisation:

- first step: symmetric beam impact - **done**
10 cm long graphite rods, $\varnothing = 5\text{ mm}$ and/or 4 mm
--> target o.k. even for CNGS-II, 3.5×10^{13} p.o.t / $10\mu\text{s}$



- second step: asymmetric beam impact - **not done yet**

NOTE: asymmetric beam impact might change the estimated lifetime of the target

--> influence on target design

--> influence on **beam instrumentation design !!**

(e.g.. 0.1 mm accuracy needed for every burst, average over 100 bursts?)

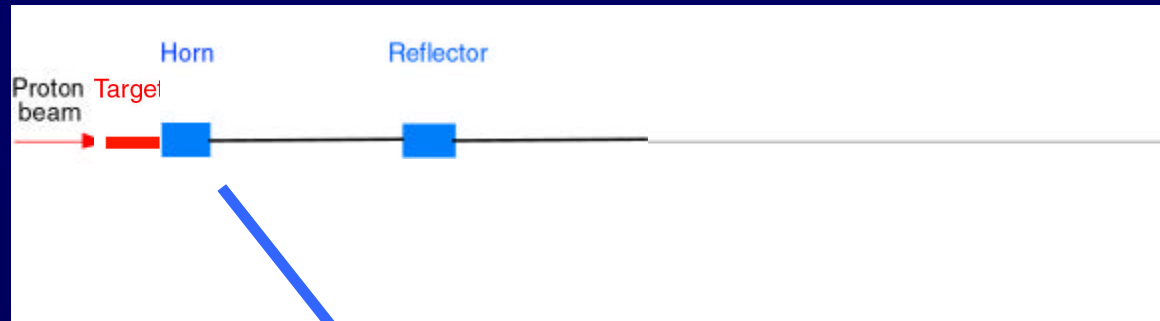
CNGS status -- target station T40 (3)

- + target box design (rod supports, etc.)
- + target box motorisation
- + target box helium cooling
- + target box removal/exchange mechanism
- + target station shielding design

Warning: interfaces with other equipment
--> layout!



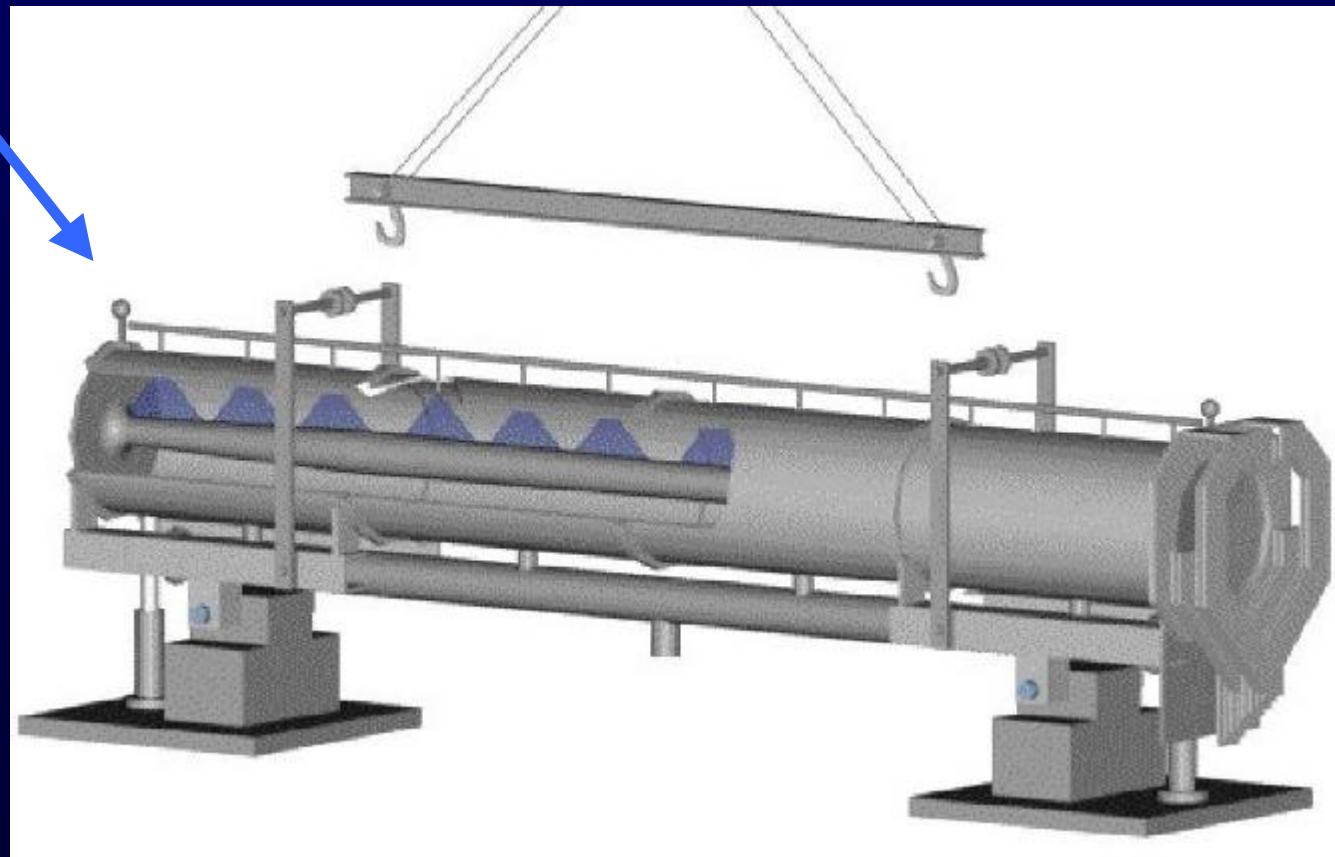
CNGS status -- focusing devices (1)



length: 6.5 m
diameter: 70 cm
weight: 1500 kg

Pulsed devices:
150kA / 180 kA, 1 ms

water-cooled:
distributed nozzles



CNGS status -- focusing devices (2)

(collaboration with IN2P3)



- horn inner conductor:
final design approved,
expected at CERN
in Nov. 2001
to start final tests in BA7
- mechanical construction
supports:
approval 31 August 2001
- water cooling:
design approaching final stage

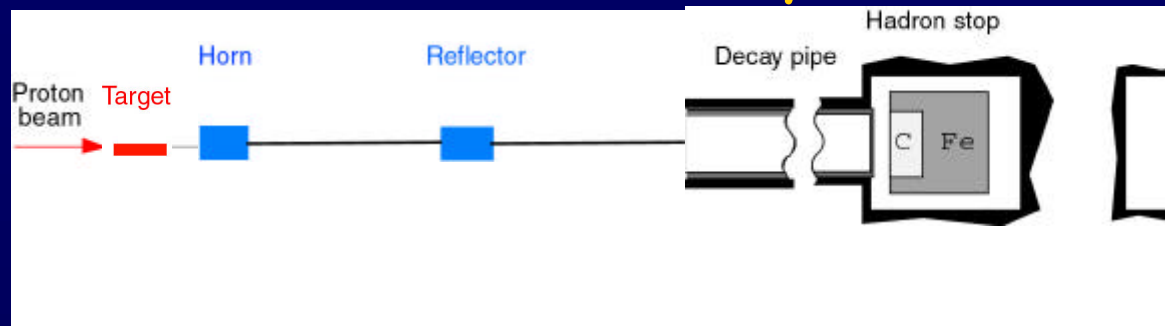
CNGS status -- focusing devices (3)



- electrical system:
 - pulse transformer: techn. spec. ready
 - 25% of modif. to power system done
- to be studied in detail:
 - striplines (incl. flexible elements)
 - robotised horn connections

Horn tests in BA7 (1.5 Mio pulses)

CNGS status -- decay tube



- detailed design "about to start" (consultant)

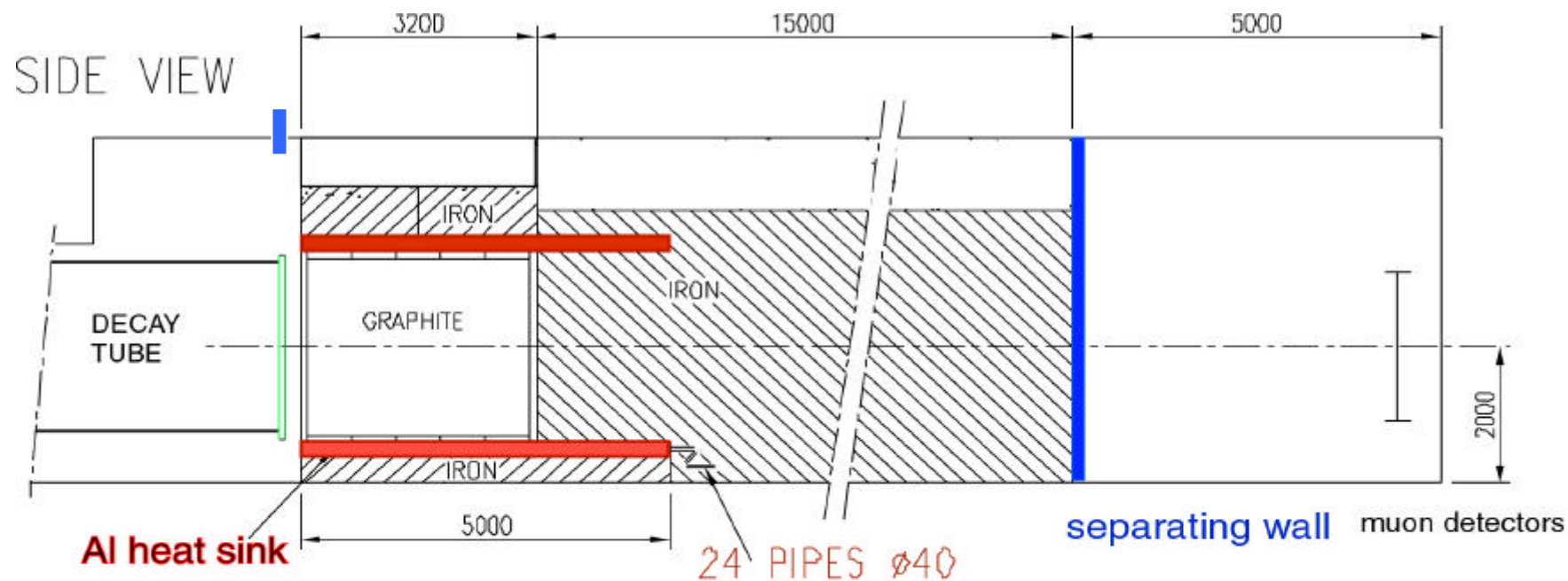
- 2.45 m diameter steel tubes, 6 m long each, 1 km total
- welded together in-situ
- vacuum: ~1 mbar
- tube embedded in concrete (?)

- ??? • problem (??):
heating by particles hitting the tube (150 kW)
- solution:
water cooling (???)

CNGS status -- decay tube windows

- decay tube entrance window: 2 mm Ti, 1.4 m diameter
 - design / mechanical / thermal studies well advanced
first results on "shock" (beam impact) -> "no problem"
 - test window in Nov. 2001 (**spare WANF window!**)
- safety issues** in case of a rupture of this window:
-> tech. Student starting study
- decay tube exit window: thick, steel
- detailed design under study**

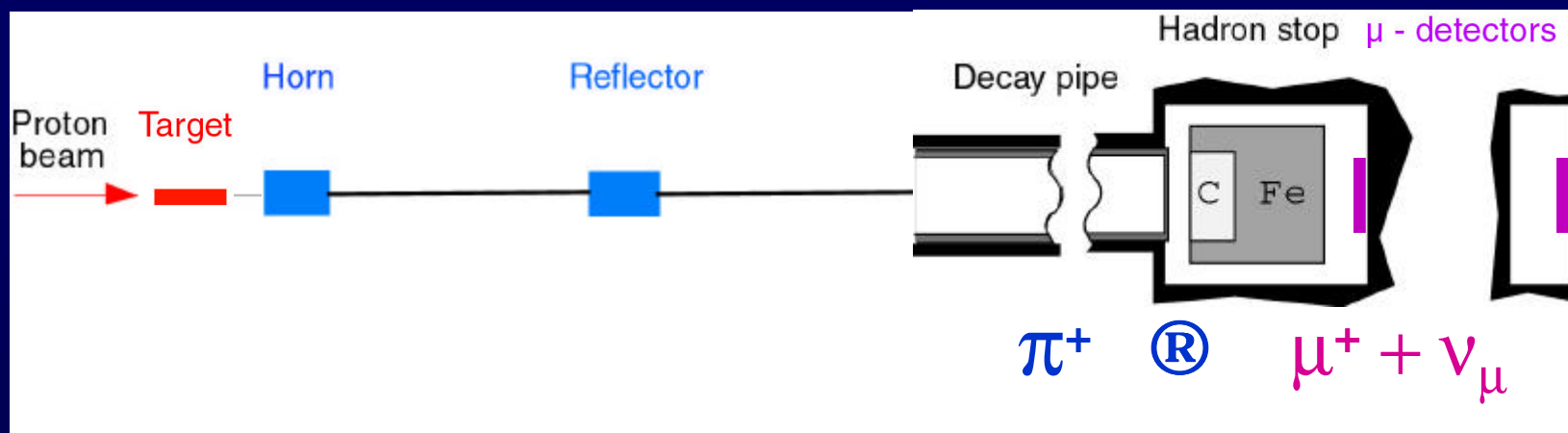
CNGS status -- hadron stop



detailed design: in work

- graphite insert (3.2 m), water cooling
- iron blocks from WANF --> start November 2001

CNGS status -- muon detectors (1)



Reminder: measure the **muons** \leftrightarrow measure the **ν_μ neutrinos**

- muon detector system at WANF neutrino beam:
array of Si detectors in each muon pit
- CNGS muon detectors: **not yet designed**
 - Si detectors one option ("base-line") \leftrightarrow WANF !
 - BLM ionisation chambers another option
 - ... other options...

NOTE: Access to muon detector stations very restricted



CNGS status -- apologies !!

- radiological issues / INB

important to note:

TCC4 (target chamber): "hot" area

TSG4 (service gallery): protected area

TT41 (proton beam tunnel): like SPS transfer lines

- controls (TT41, T40, secondary beam elements)

- timing ("Universal Time Stamp"

SPS extraction <--> Gran Sasso detectors)

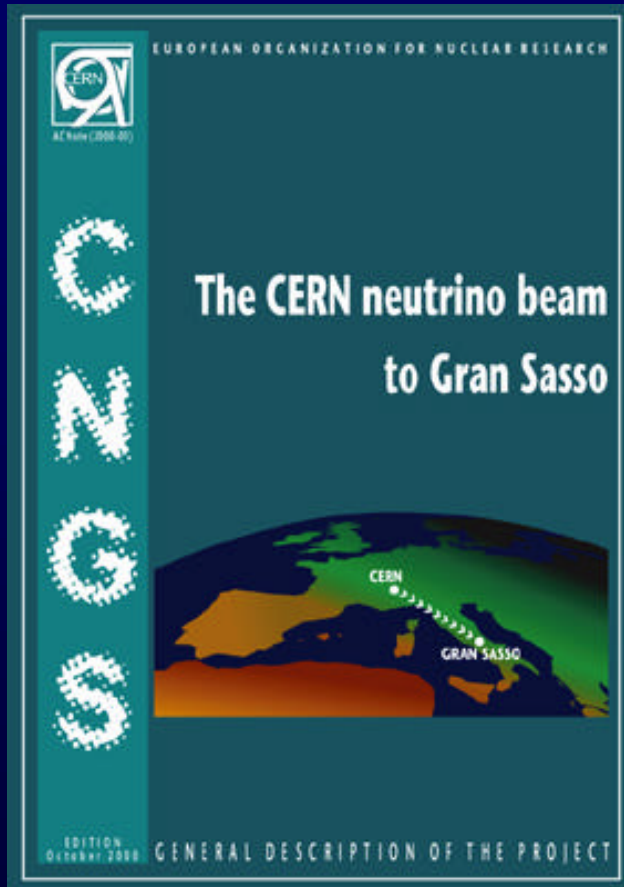
- ...

NB. voluntary contributions -> complex tendering proc.



SUMMARY ...

for more information:



CNGS general description

+

<http://proj-cngs.web.cern.ch/proj-cngs>