NBI

TPC laser calibration system

Børge Svane Nielsen
Niels Bohr Institute

ALICE Technical Board, CERN, 18 February 2002

Table of Contents

System Goals

Use of laser calibration system:

– Electronics testing
– Sector alignment
– Drift velocity measurement
– Drift distortions: temperature effects, space charge and ExB effects

Goals for laser track layout and precision:

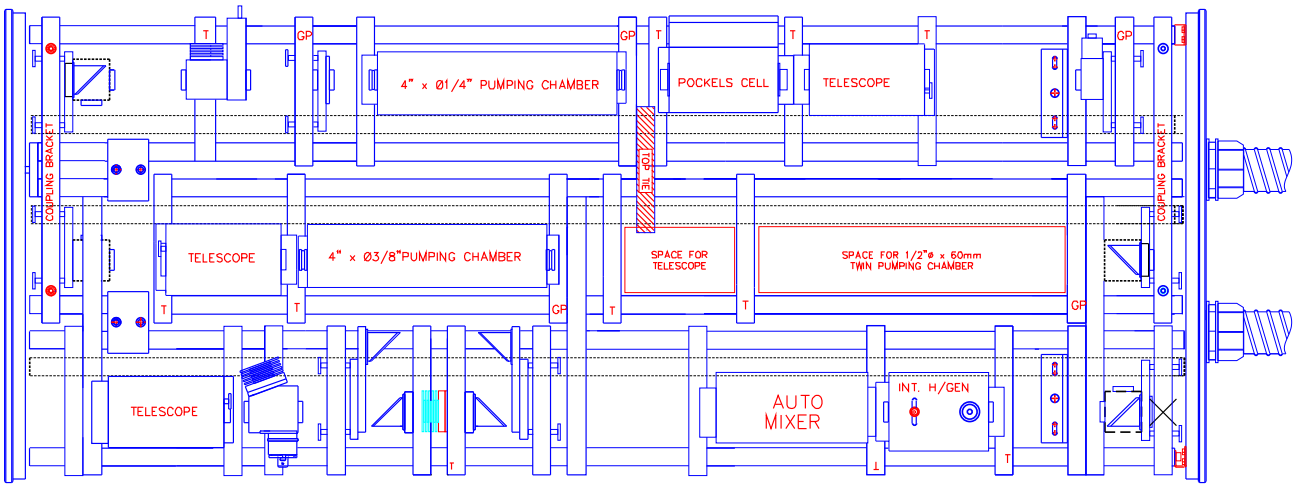
– 1 mm UV laser beams through most of TPC volume
– 1–5 mip equivalent ionization
– cross sector boundaries appropriately
– radial beams at different z and ϕ
– beam precision, production + installation: $\sim$ 10-20 mm @ 2-3 m
– beam precision, alignment: $\sim$ 200 μm

Technical principle:
– Wide laser beam ($\sim$ 25 mm) intersected by 1 mm mirrors inside TPC

Collaboration:
– Alexei Lebedev (STAR) can collaborate part-time
– micro-mirrors supplied from State Center Interphysica, Moscow

Design of laser system: from laser to narrow beams

Laser from Spectron Laser Systems.

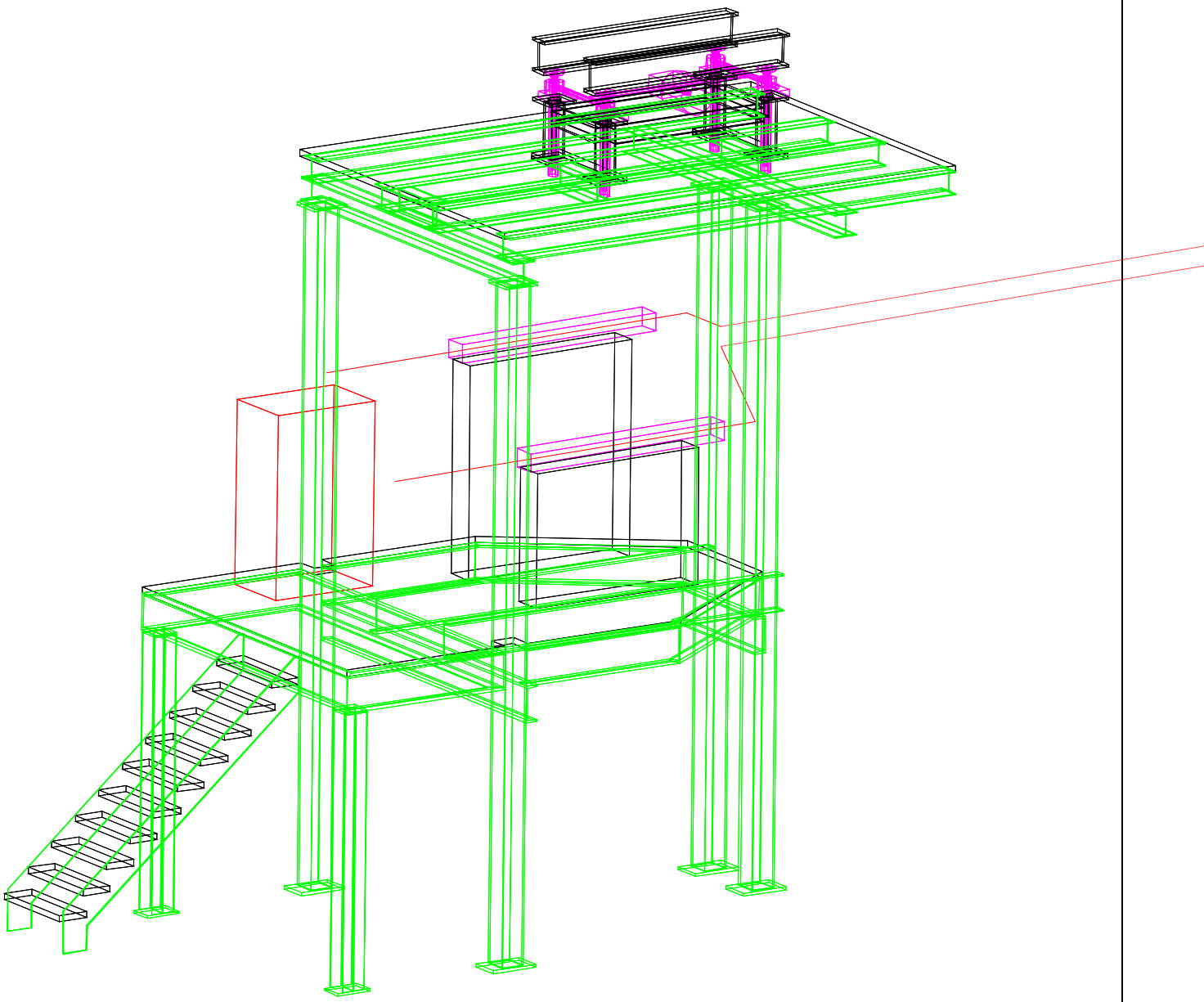


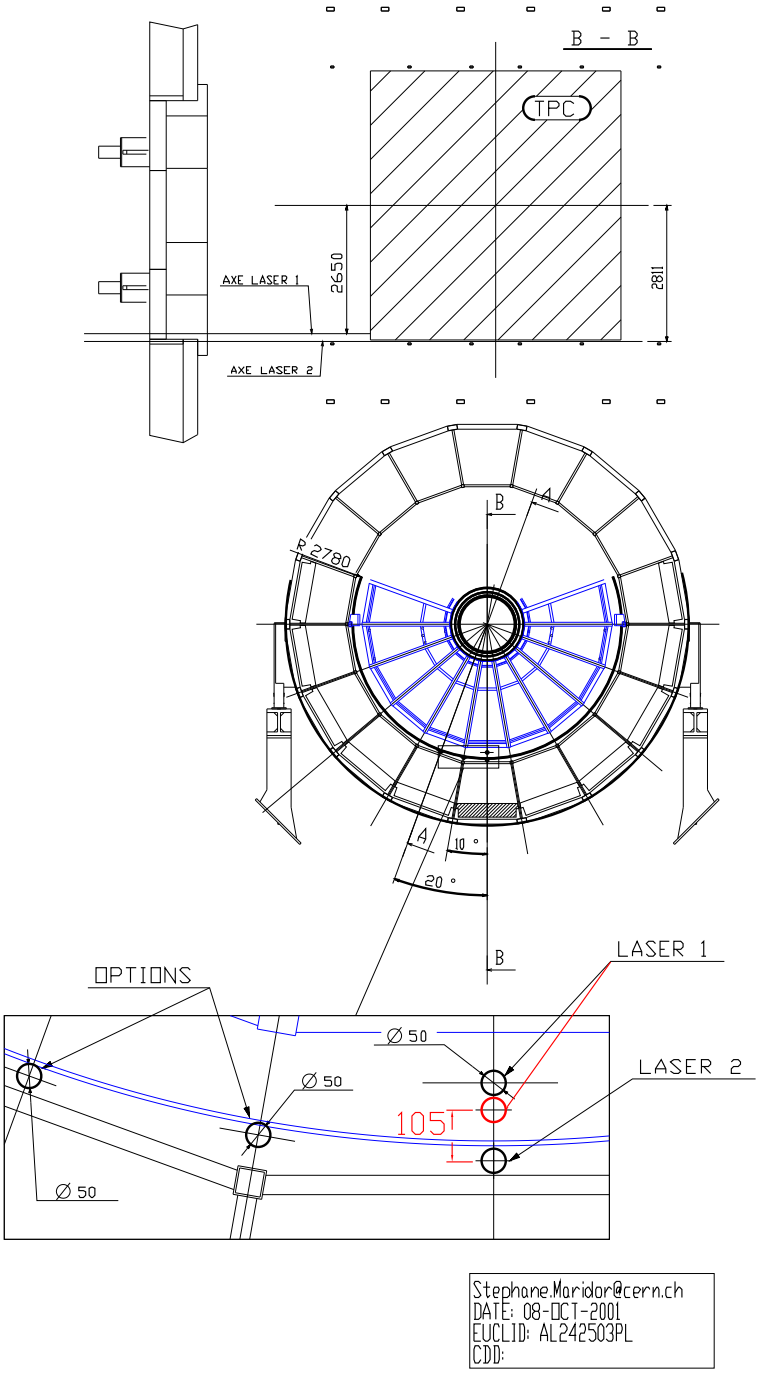
Special model: SL805-10-UPG

Pulsed UV laser (Nd:YAG)
energy per pulse: 100 mJ @ 266 nm, upgradable to 180 mJ
pulse width: 10 ns, repetition rate: max 10 Hz
'telescopic' resonator
beam expander 9 mm $\rightarrow$ 25 mm
divergence < 8 mrad, pointing stability < 0.1 mrad (1 mm at 10 m)
autotracking of 266 nm separator for temperature stability
remote controllable

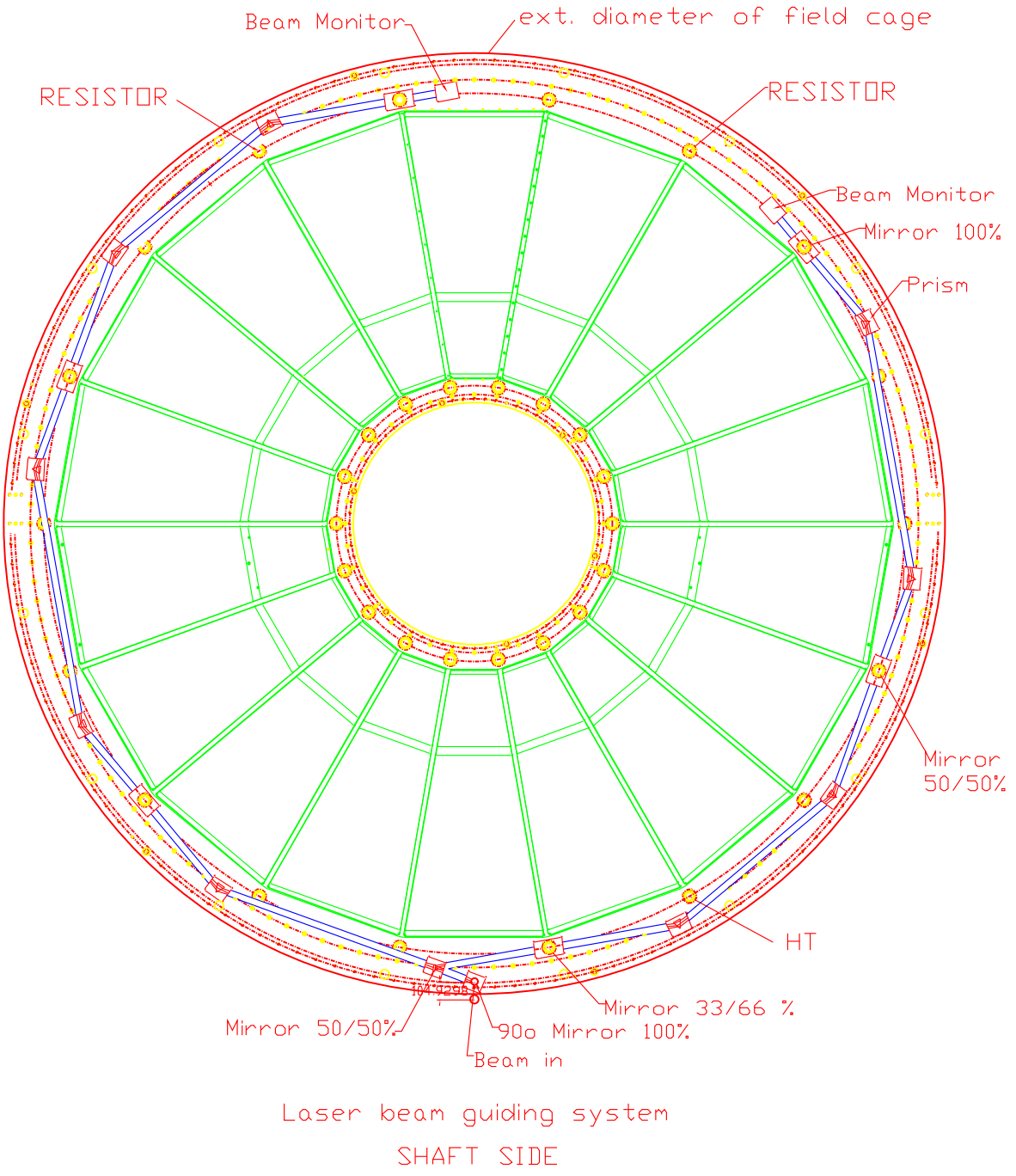
Running at NBI.

Laser hut and beam transport to TPC end-plates.

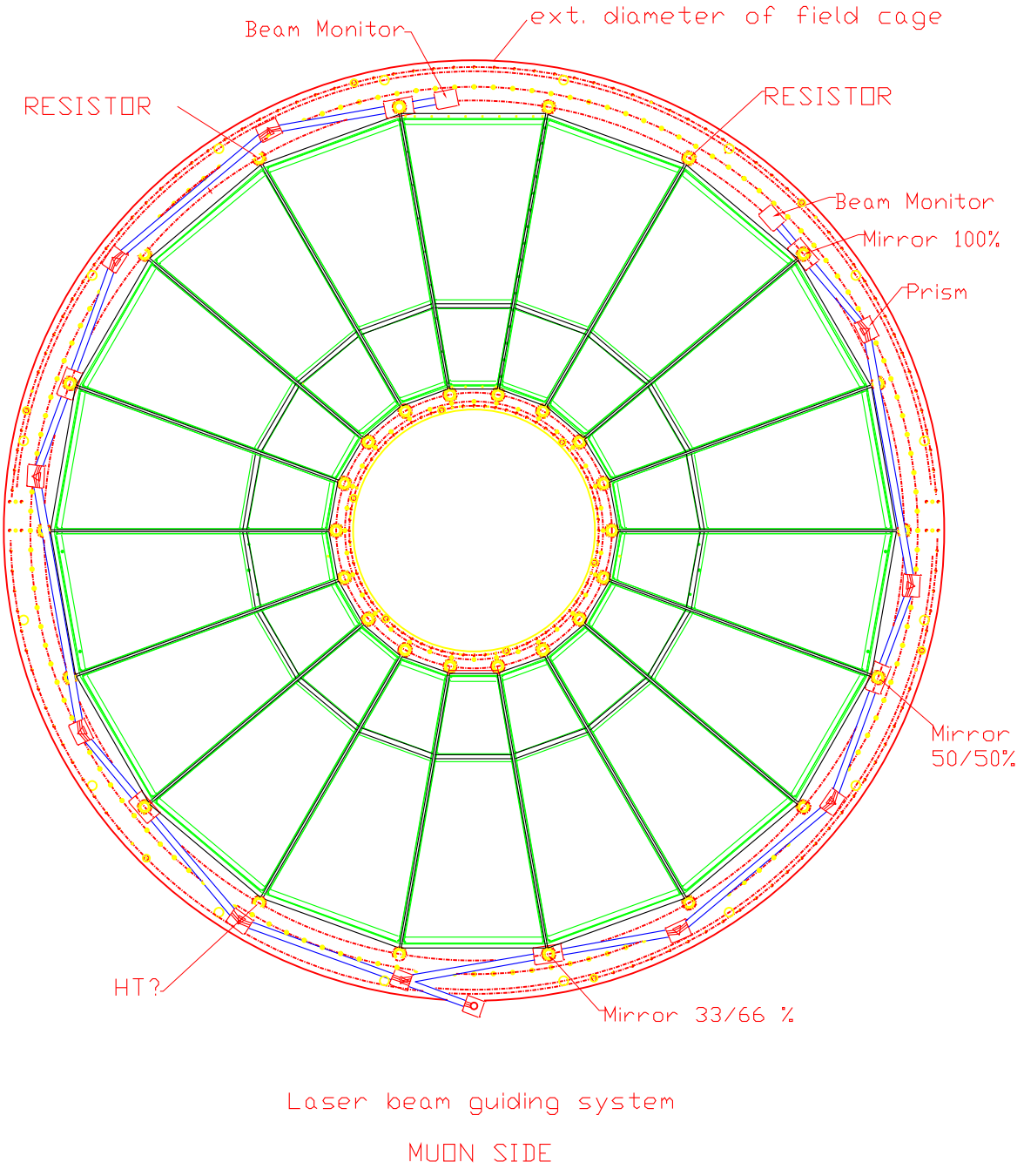



B - B
TPC
AXE LASER 1
AXE LASER 2
2650
2811
R 2780
A
B
10 °
20 °
OPTIONS
LASER 1
LASER 2
Ø 50
Ø 50
Ø 50
105°
Stephane.Maridor@cern.ch
DATE: 08-OCT-2001
EUCLID: AL242503PL
CDD:

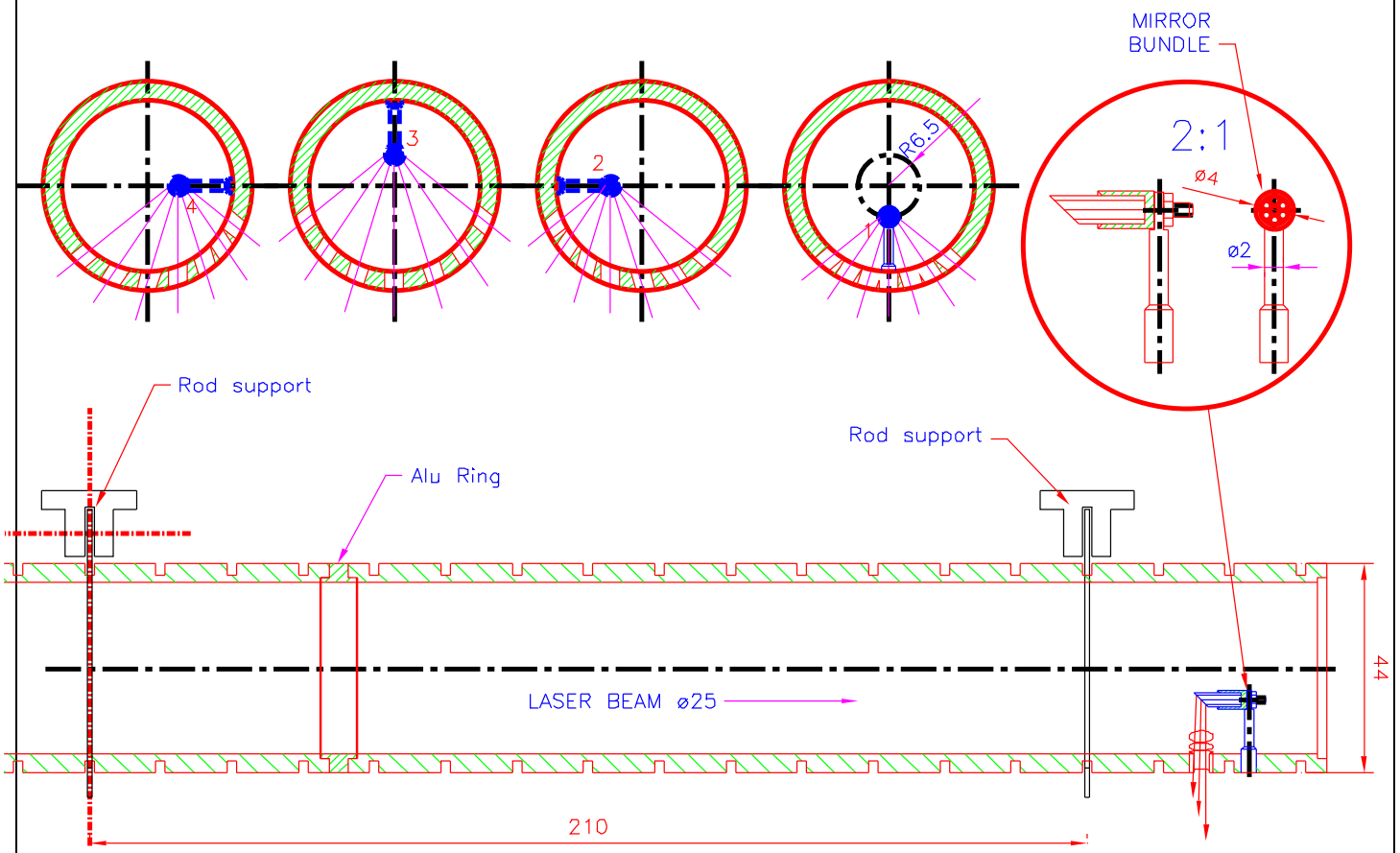
Beam transport on TPC end-plates, Shaft side



Beam transport on TPC end-plates, Muon side



Laser rods


MIRROR
BUNDLE
2:1
ø4
ø2
R6.5
4
3
2
1
Rod support
Alu Ring
Rod support
LASER BEAM ø25
44
210

Micro mirror bundle

On order from Moscow Engineering School, State Center Interphysica.

Specifications:

– 1 mm diam. quartz fibres, cut at 45°$\pm$ 0.3 mrad and coated for 266 nm

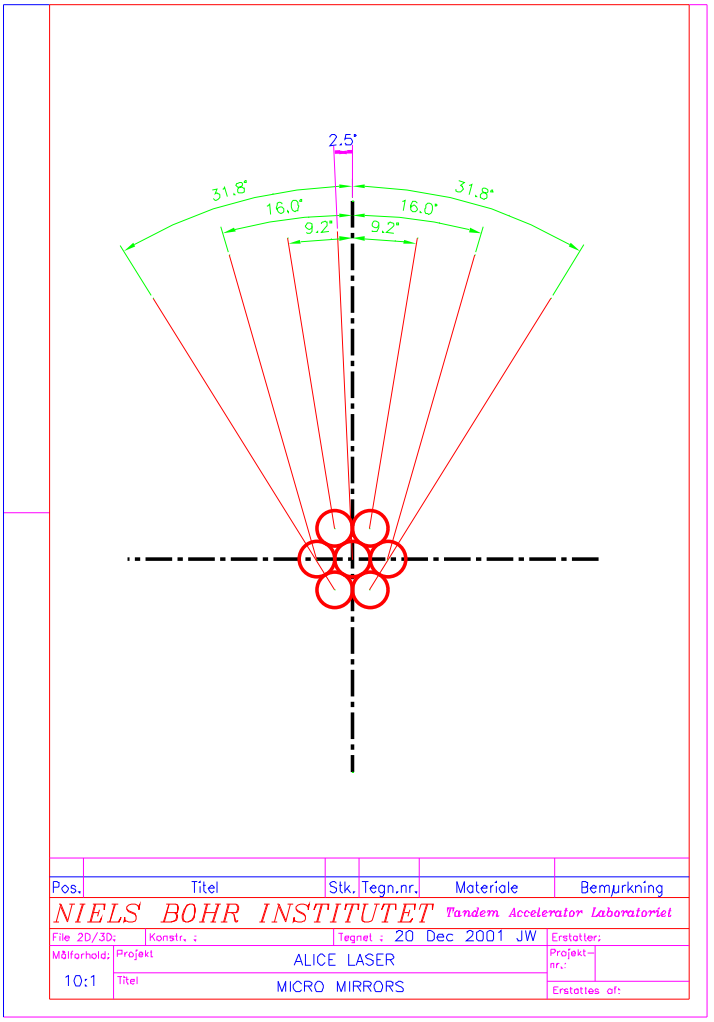
– bundles assembled of 7 micro-mirrors in cup, $\Delta\theta$, $\Delta\phi \leq 1°$

– all angles measured to $\Delta\theta$, $\Delta\phi \leq 0.05$ mrad.

Delivery:

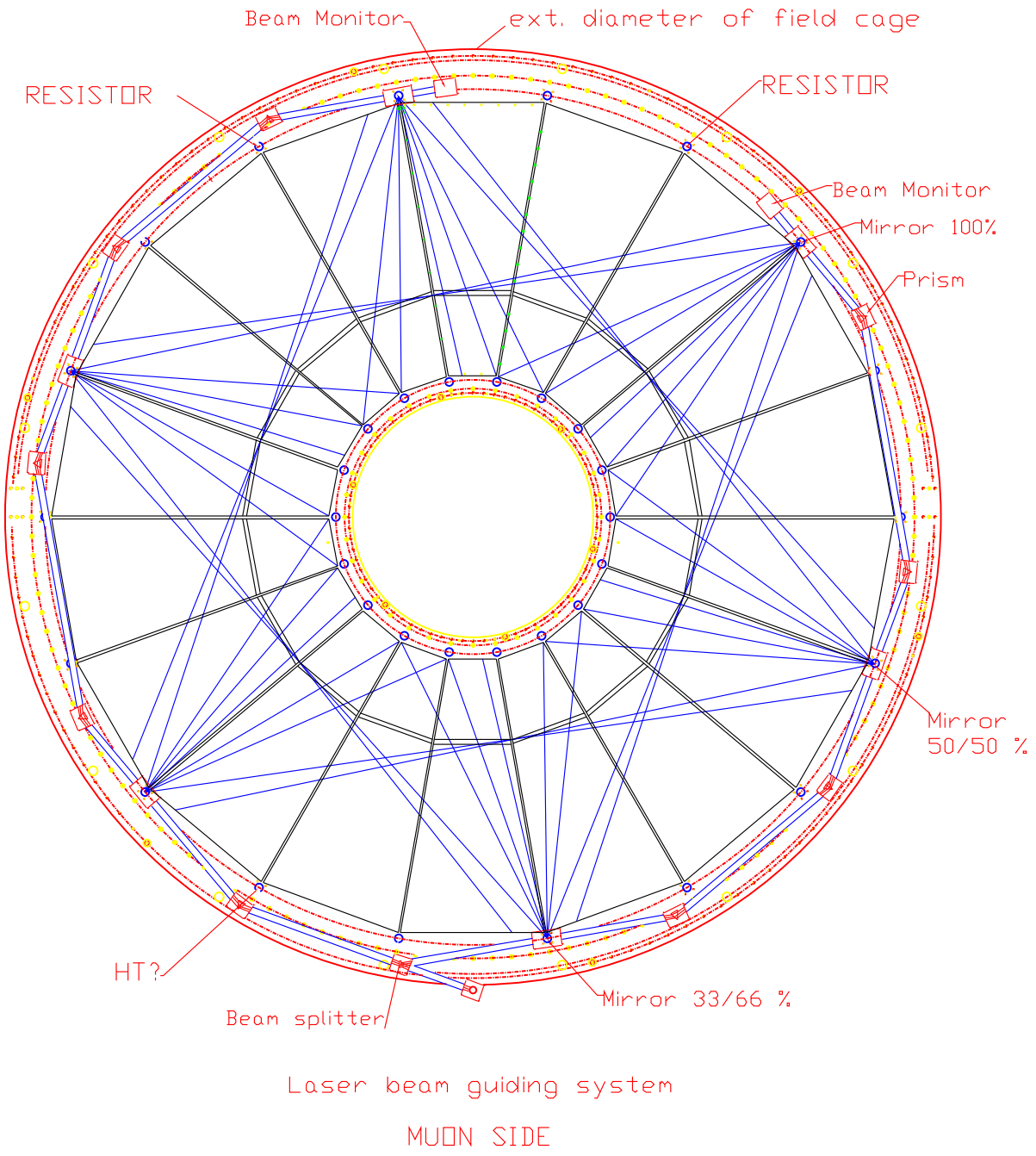
– half in May 2002

– half in June/July 2002



Beam pattern R-ϕ

Radial beams with strategic sector boundary crossings



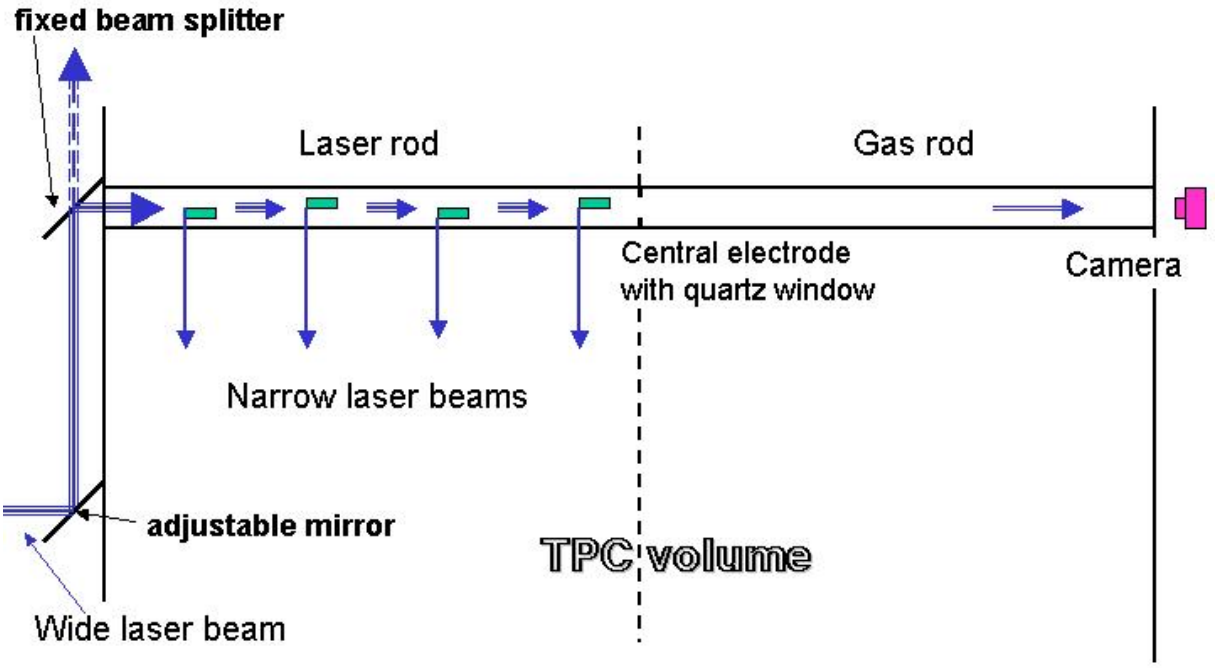
Beam pattern R-z

– 4 mirror positions in z

– Large span and uniform distribution in z

– Avoid crossing laser beams in TPC volume

$\Longrightarrow$ 2 or more sets of mirror z positions



Beam steering:

– Beam monitors (cameras) in: laser hut
entrance on TPC end-plate
far end of one or several laser rods

– Active beam steering (θ-ϕ): laser hut
entrance on TPC end-plate

Spacial and angular precision

Final alignment precision aim: 200–300 μm space points

Δx, Δy, Δz (mirrors) $\leq$ 200 μm

$\Delta\phi$, $\Delta\theta$ (track angles) $\leq$ 0.1 mrad

Sources of misalignment:

– Mirror bundle misalignment: Δx, Δy, Δz, $\Delta\phi$, $\Delta\theta$

– Laser beam angles: $\Delta\phi$, $\Delta\theta$

Other active/passive optics alignment is only to optimise the beam quality.

Error sources in mirror positions relative to nominal:

– Mirror bundle production

– Installation of mirror bundles in laser rods

– Installation of laser rods in TPC

Δx,Δy,Δz (mirrors) $\leq$ 200 μm

$\Delta\phi$,$\Delta\theta$ (mirrors) $\leq 1^\circ$

Error sources in measured mirror positions:

– Measurement of mirrors in bundles:

Δx,Δy,Δz $\leq$ 100 μm $\Delta\phi$,$\Delta\theta \leq$ 0.05 mrad

– Measurement of mirror bundles in rods:

Δx,Δy,Δz $\leq$ 100 μm $\Delta\phi$,$\Delta\theta \leq$ 0.05 mrad

– Measurements of assembled rods:

Δx,Δy,Δz $\leq$ 100 μm $\Delta\phi$,$\Delta\theta \leq$ 0.1 mrad

– Measurements of installed rods in TPC:

Δx,Δy,Δz $\leq$ 200 μm

$\Delta\theta \leq$ 0.1 mrad (OK – rods do not bend)

$\Delta\phi \leq$ 0.1 mrad (**tough!!**)

– Movements of outer cylinder, laser rods and mirror holders **?**

Production, installation and alignment

Micro-mirror and rod production:

– Micro-mirror production and measurement as for STAR (in Moscow)
– Assembly and measurement of rod pieces at NBI
– Full rod assembly and measurement at CERN

TPC assembly:

– Rod installation: assure ϕ mechanically to 1° or better
– Alignment measurements on assembled TPC:
look through rods from end-plate to end-plate
– Measure some spots from HeNe laser inside TPC before chambers

Optics and laser control and monitoring:

– Detailed design and production in parallel with rod production
– Production of optics components industrial
– Production of mechanics and assembly at NBI
– Installation and alignment on TPC end-plates
– Laser hut and beam transport in surface test area
– Laser hut and beam transport in ALICE