Estimates of the Vacuum pressure in the Beam Delivery System and Interaction Region

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- program VACCALC (SLAC)

  → calculates pressure profiles for given arrangement of pipes, pumps and gas sources

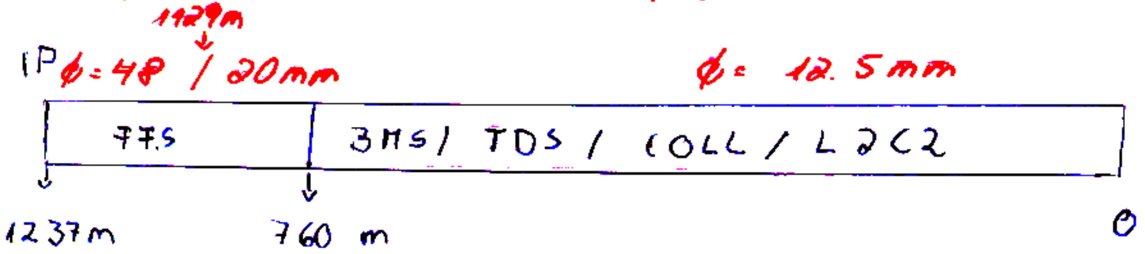
  input parameters:
  - conductance (geometry)
  - outgassing / gas load
  - pumping speed
  - length

- arrangement and size of pumps

  for given pipe diameter and average pressure

  ⇒ optimized combination of pumping speed and distance

- geometry - layout of beam pipe



collimators @ 805 / 897 m
989 / 1083 m

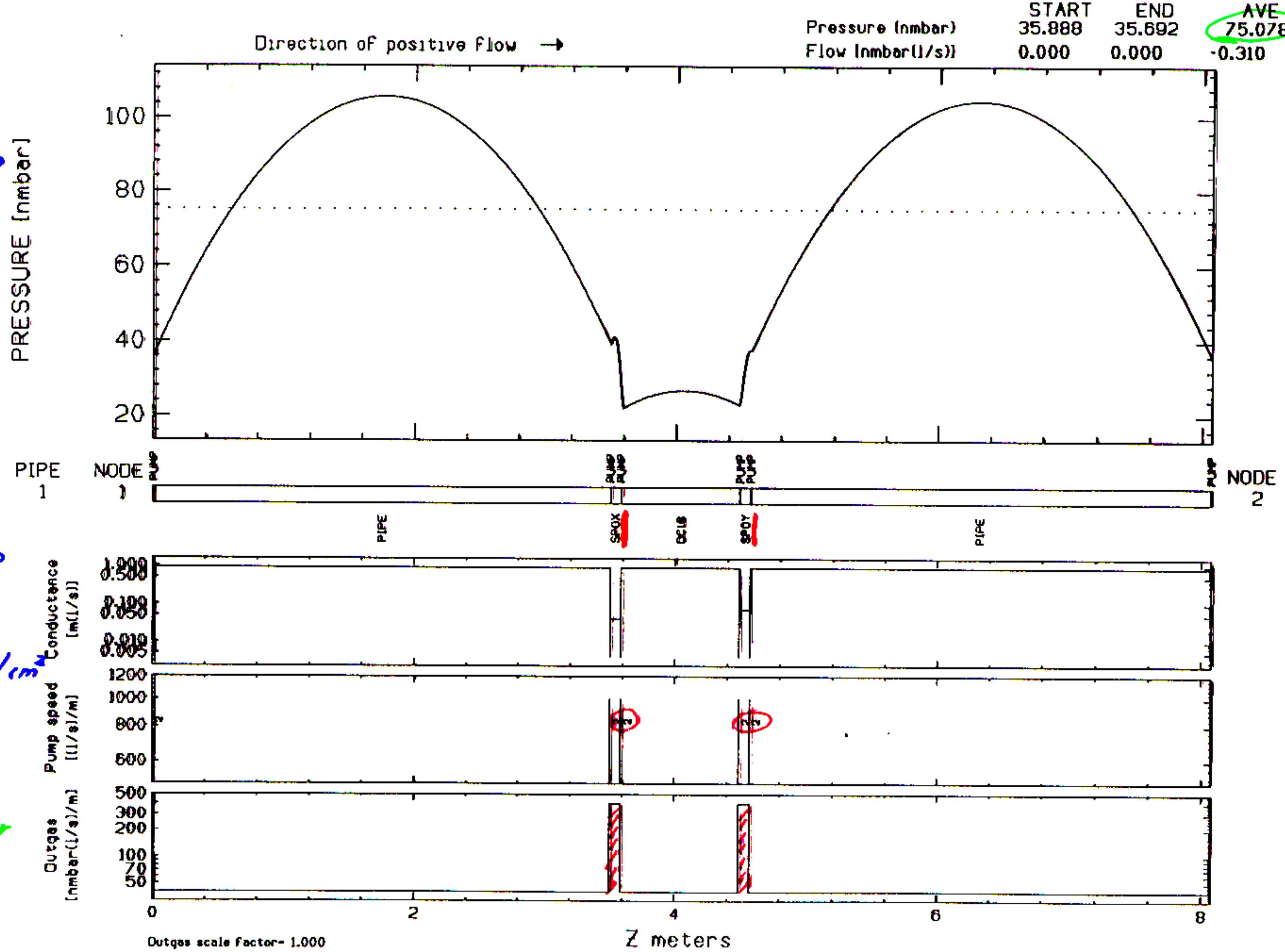
Spoilers @ 74m
169m
278m
373m

+ last 3 collimators
100 m
80 m from IP
20 m

Spoilers in collimator section

Model of TESLALC Beam Delivery System, LC2C COLL

TESLALC Beam Delivery System, COLL (Press. H2)



beam pipe

ϕ = 12.5 mm

pumps

2 l/s

SPOX

x = 1.7 mm

SPOY

y = 2.3 mm

l = 80 mm

gas load in Spoilers:

10^{-9} mbar l/s/cm^2

$\bar{p} \leq 10^{-7}$ mbar

• Beam Delivery System

goal: $\bar{p} \leq 10^{-7}$ mbar

assumptione: outgassing of beam pipe
$Q = 10^{-10}$ mbar l/s/cm² H_2

spoilers/collimators
$Q = 10^{-9}$ mbar l/s/cm² H_2
(γ's hitting walls)

- L2C2, COLL, TDS, BMS

  ϕ = 12.5 mm

  small pumps (2 l/s) every 3.5 m ⇒ $\bar{p} = 10^{-7}$ mbar

- ~~collimators~~ spoiler in COLL

  x = 1.7 mm / y = 2.3 mm at separate locations

  l = 80 mm

  small pumps (2 l/s) around spoilers ⇒ $\bar{p} < 10^{-7}$ mbar in spoilers

- FFS

  ϕ = 20 mm : pumps (20 l/s) every 7 m $\bar{p} = 10^{-7}$ mbar

  ϕ = 48 mm : pumps (30 l/s) every 10 m $\bar{p} < 10^{-7}$ mbar

- collimators in FFS

  → 805/997/1083 m : x = 4 mm / y = 4.4 mm separated; l = 1 m

  pumps (20 l/s) around collimators $\bar{p} = 10^{-7}$ mbar

  → 80/100 m : ϕ = 40 mm ; l = 4 m

  pumps (400 l/s) around collimators $\bar{p} < 10^{-7}$ mbar

  → 20 m : ϕ = 14 mm l = 1 m : pumps (30 l/s) $p < 10^{-7}$ mbar

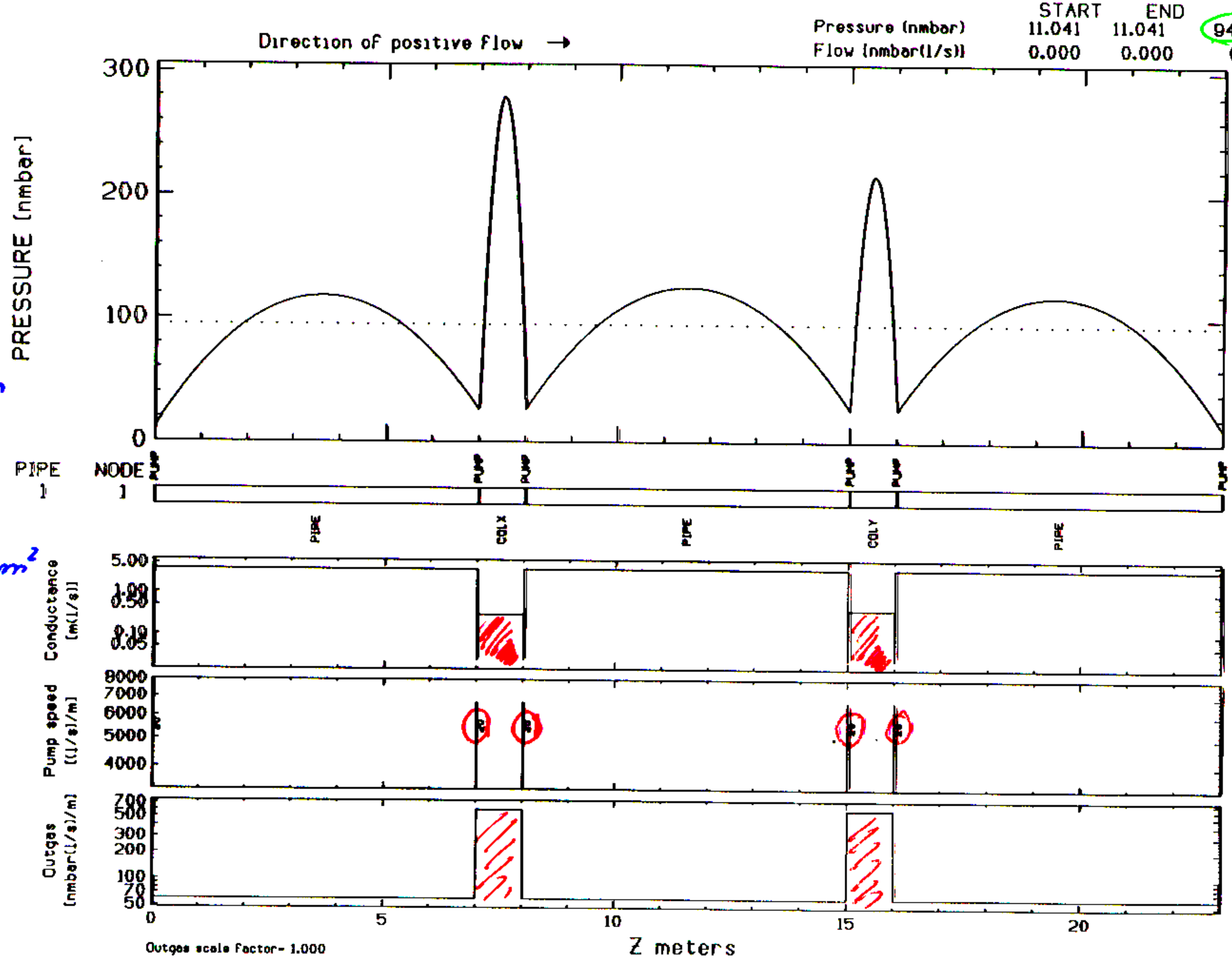
Model of TESLALC Beam Delivery System, FFS

TESLALC Beam Delivery System, FFS (Press. H2)

collimators at 805 m, 997 m, 1083 m from start of BeamDS

beam pipe
ϕ = 20 mm
pumps 20 l/s
COLX x = 4mm
COLY y = 4.4mm
l = 1m
gas load collimators
10^{-9} mbar l/s/cm²

$\bar{p} = 10^{-7}$ mbar



Collimators at ~~80~~ 100m from IP

Model of TESLALC Beam Delivery System, FFS

TESLALC Beam Delivery System, FFS (Press. H2)

	START	END	AVE
Pressure (nmbar)	24.271	24.271	44.798 ✓
Flow [nmbar(l/s)]	0.000	0.000	0.000

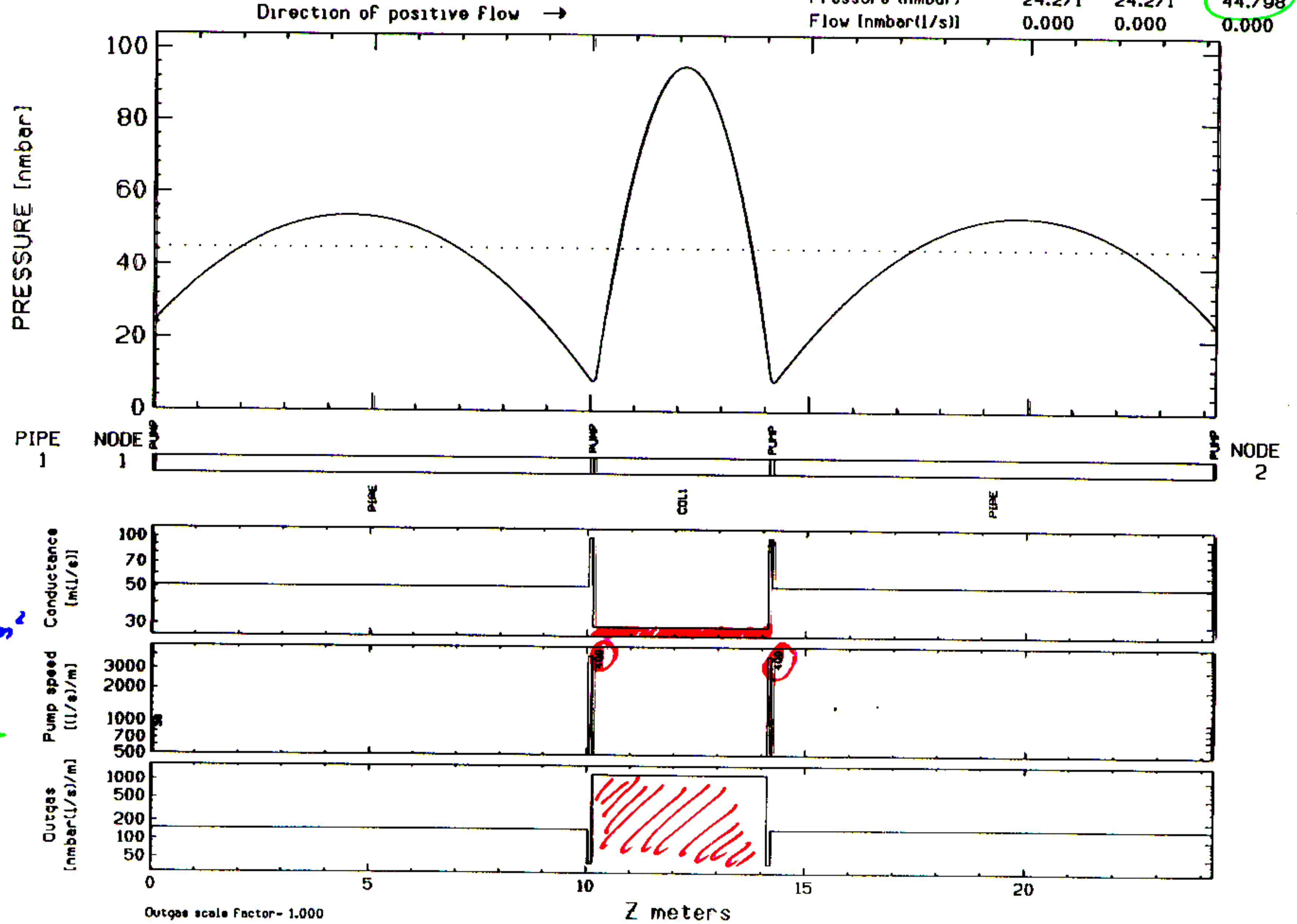
beam pipe
ϕ = 40 mm

pumps
30 l/s
400 l/s

collimator
ϕ = 40 mm
l = 4 m

gas load in collimator
10^{-9} mbar l/s/cm²

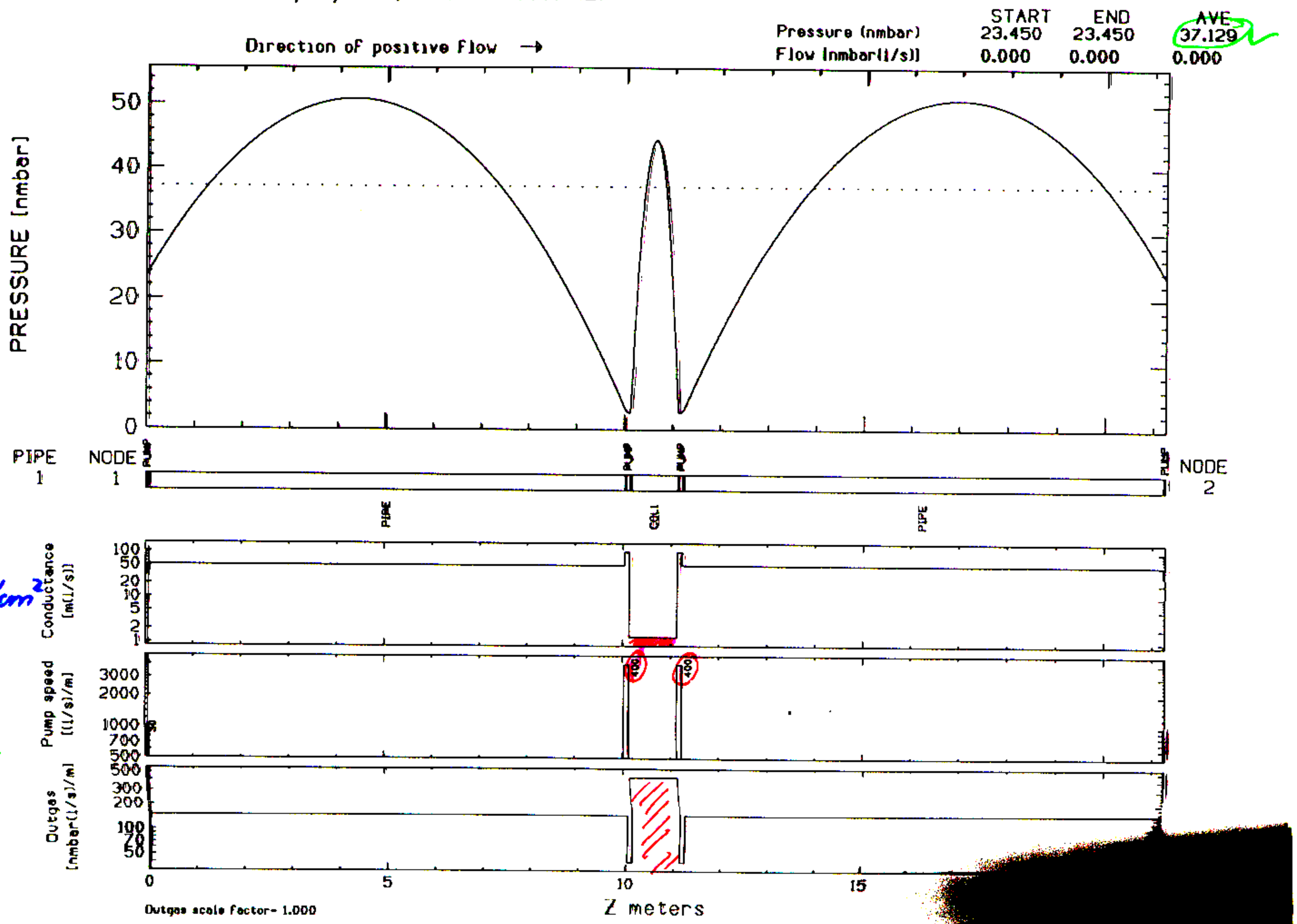
$\bar{p} < 10^{-7}$ mbar



collimator at 20m from IP

Model of TESLALC Beam Delivery System, FFS

TESLALC Beam Delivery System, FFS (Press. H2)



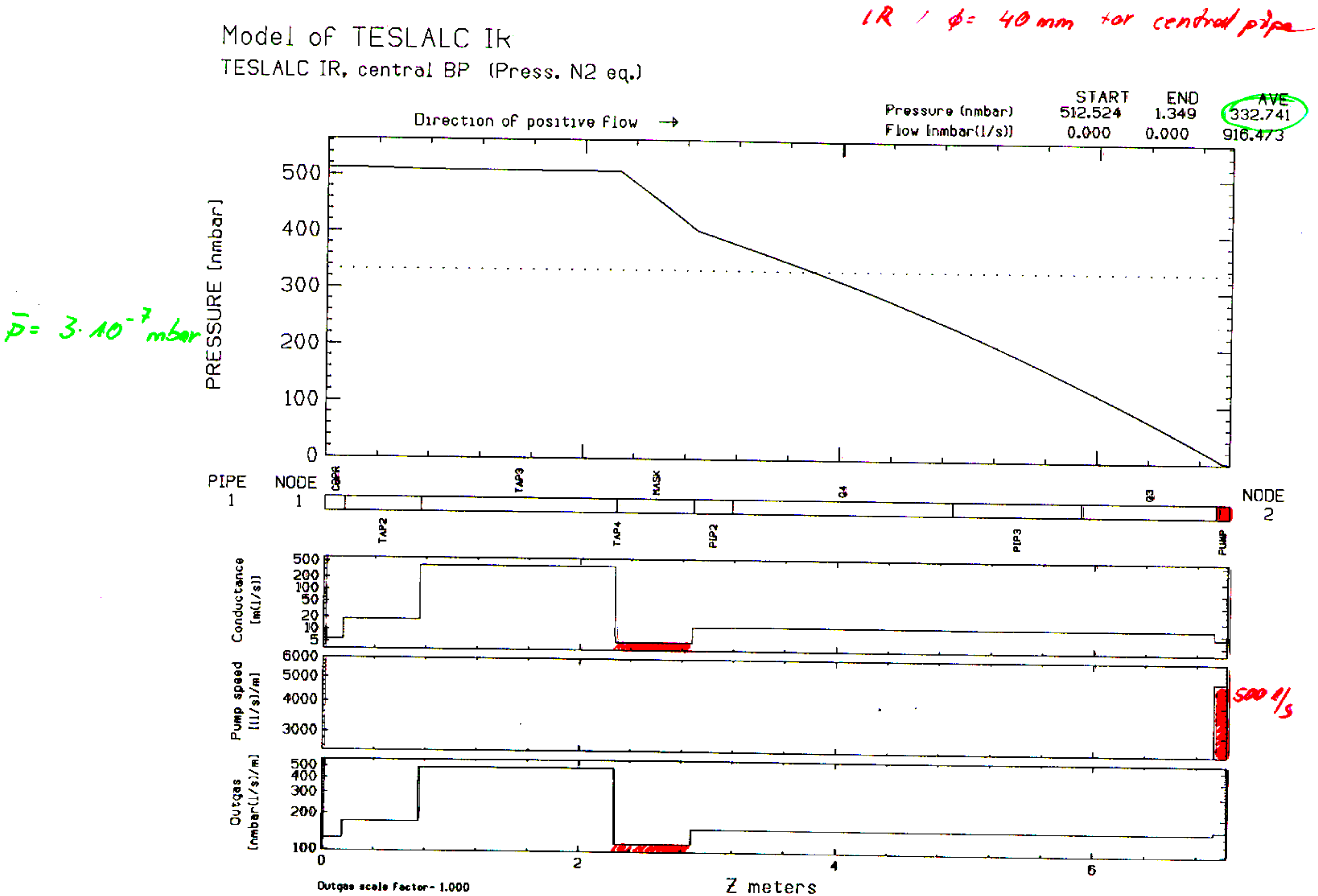
beam pipe
ϕ 48 mm

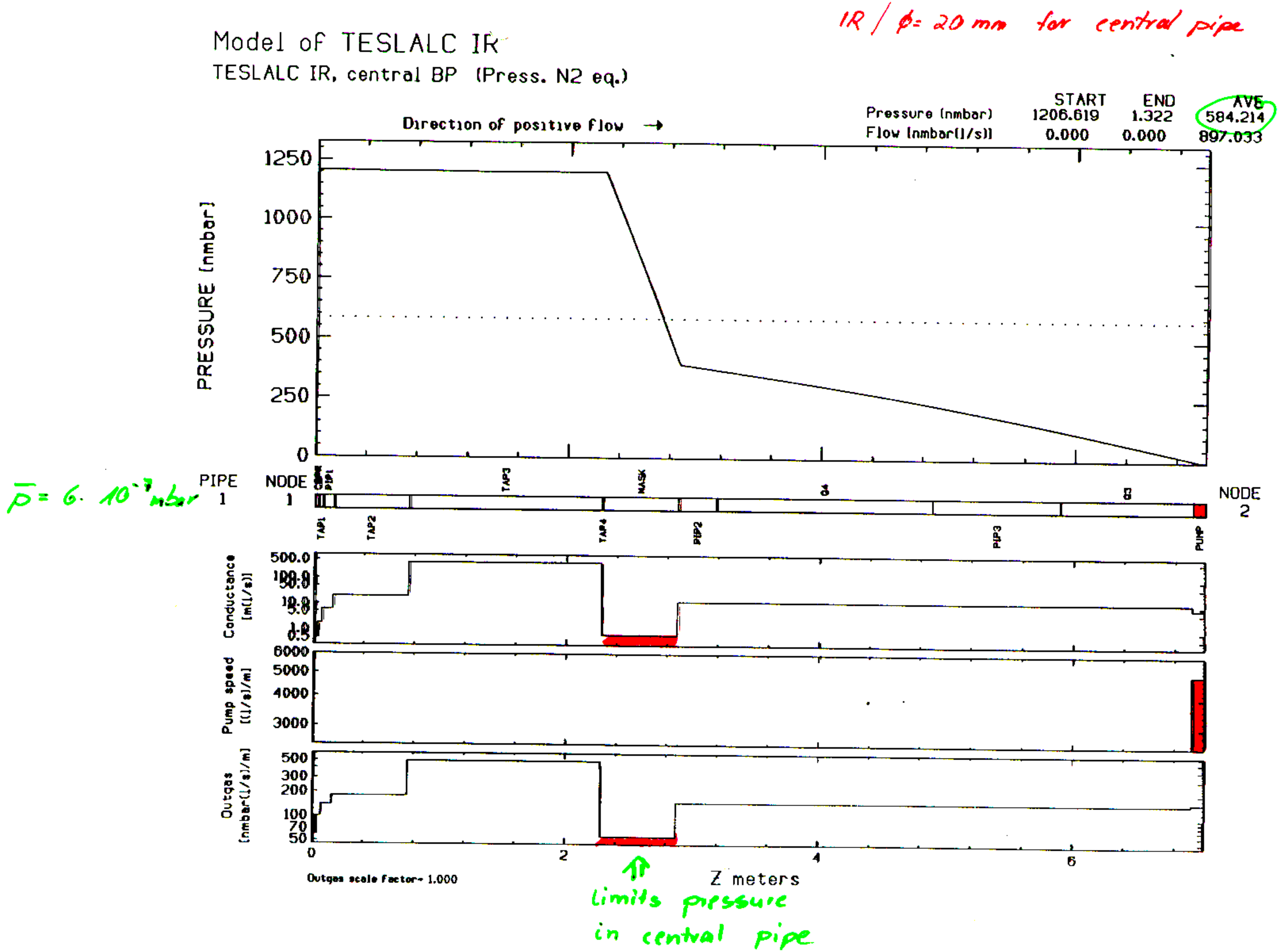
pumps
30 l/s
400 l/s

collimator
ϕ = 14 mm
l = 1 m

gas load in collimator
10^{-9} mbar l/s/cm^2

$\bar{p} < 10^{-7}$ mbar

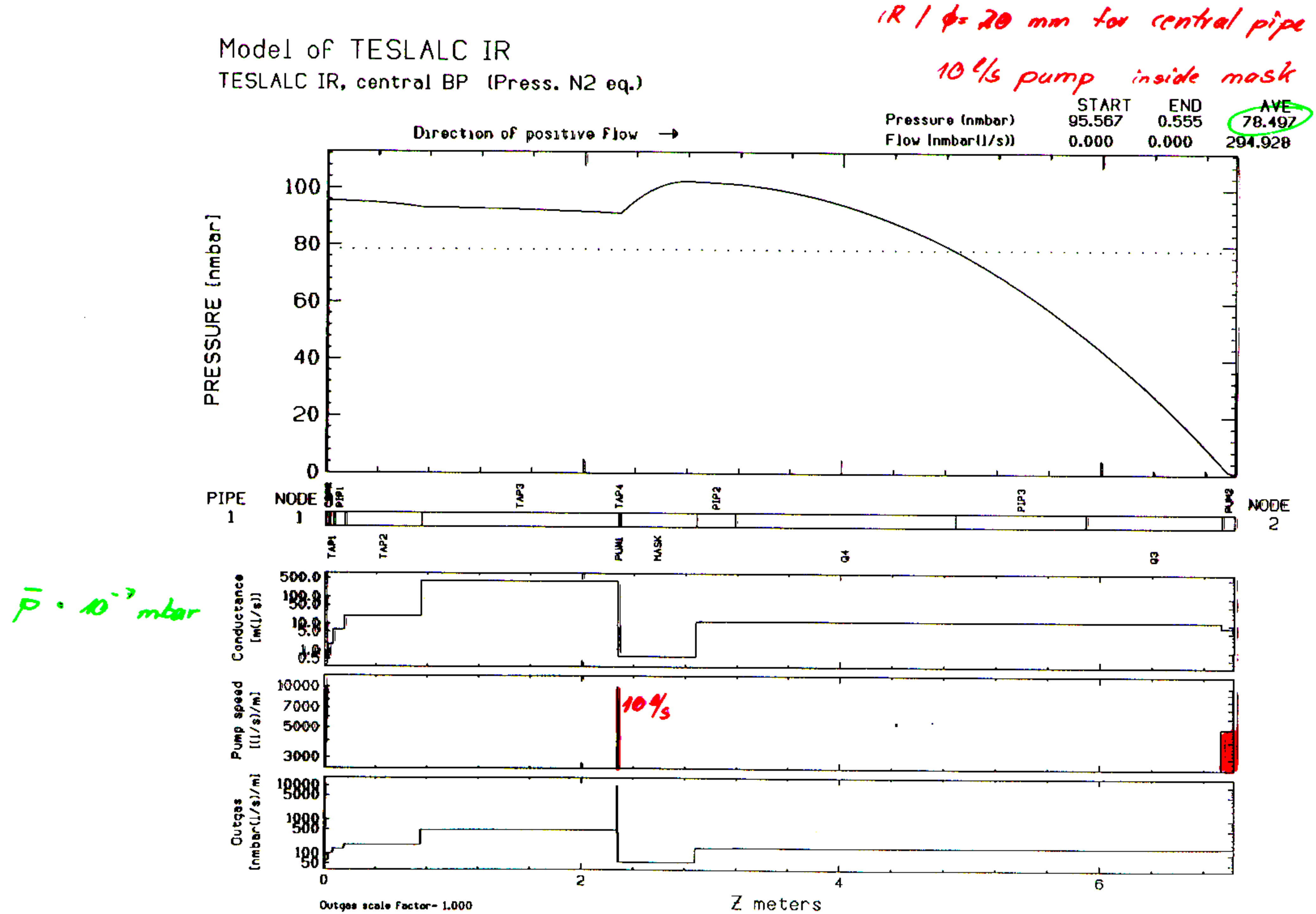

IR / ϕ= 40 mm for central pipe
Model of TESLALC Ik
TESLALC IR, central BP (Press. N2 eq.)
Direction of positive flow →
Pressure (nmbar)
Flow [nmbar(l/s)]
START
512.524
0.000
END
1.349
0.000
AVE
332.741
916.473
p̄= 3·10⁻⁷ mbar
PRESSURE [nmbar]
500
400
300
200
100
0
PIPE 1
NODE 1
NODE 2
CBPR
TAP2
TAP3
TAP4
MASK
PIP2
Q4
PIP3
Q3
PUMP
Conductance [m(l/s)]
Pump speed [(l/s)/m]
Outgas [nmbar(l/s)/m]
500 l/s
0
2
4
6
Z meters
Outgas scale factor- 1.000



IR / ϕ= 20 mm for central pipe
Model of TESLALC IR
TESLALC IR, central BP (Press. N2 eq.)
Direction of positive flow →
Pressure [nmbar] START 1206.619 END 1.322 AVE 584.214
Flow [nmbar(l/s)] START 0.000 END 0.000 AVE 897.033
PRESSURE [nmbar]
1250
1000
750
500
250
0
PIPE 1
NODE 1
NODE 2
TAP1
TAP2
TAP3
TAP4
MASK
PIP1
PIP2
PIP3
PUMP
Conductance [m(l/s)]
Pump speed [(l/s)/m]
Outgas [nmbar(l/s)/m]
Z meters
Outgas scale factor= 1.000
p̄ = 6· 10⁻⁷ mbar
limits pressure in central pipe

Model of TESLALC IR

TESLALC IR, central BP (Press. N2 eq.)



- Interaction Region

goal: $\bar{p} \leq 10^{-7}$ mbar

assumptions: - outgassing of beam pipe
$Q = 10^{-10}$ mbar l/s/cm² $\underline{N_2}$
- warm beam pipe in superc. quads
- 1. pump left / right of sc. quads
- simplification of geometry
→ tapered pieces replaced by tubes with
$\phi = \frac{\phi_{min} + \phi_{max}}{2}$

results: • without pump within mask

$\phi = 20$ mm	$\phi = 40$ mm
$\bar{p} = 6 \cdot 10^{-7}$ mbar	$\bar{p} = 3 \cdot 10^{-7}$ mbar

! Faktor 2
mask is critical part

• 10 l/s pump within mask (pump channels in mask, coating, ...)

$\bar{p} < 10^{-7}$ mbar

more calculations needed (e.g. N_2 → H_2; modeling of geometry)

- Summary
- BDS → $\bar{p} = 10^{-7}$ mbar not critical
- IR → $\bar{p} = 10^{-7}$ mbar needs effort = pumping in inner part

→ important to include in design

? is $\bar{p} = 10^{-7}$ mbar sufficient ?