Positron source beamline lattice

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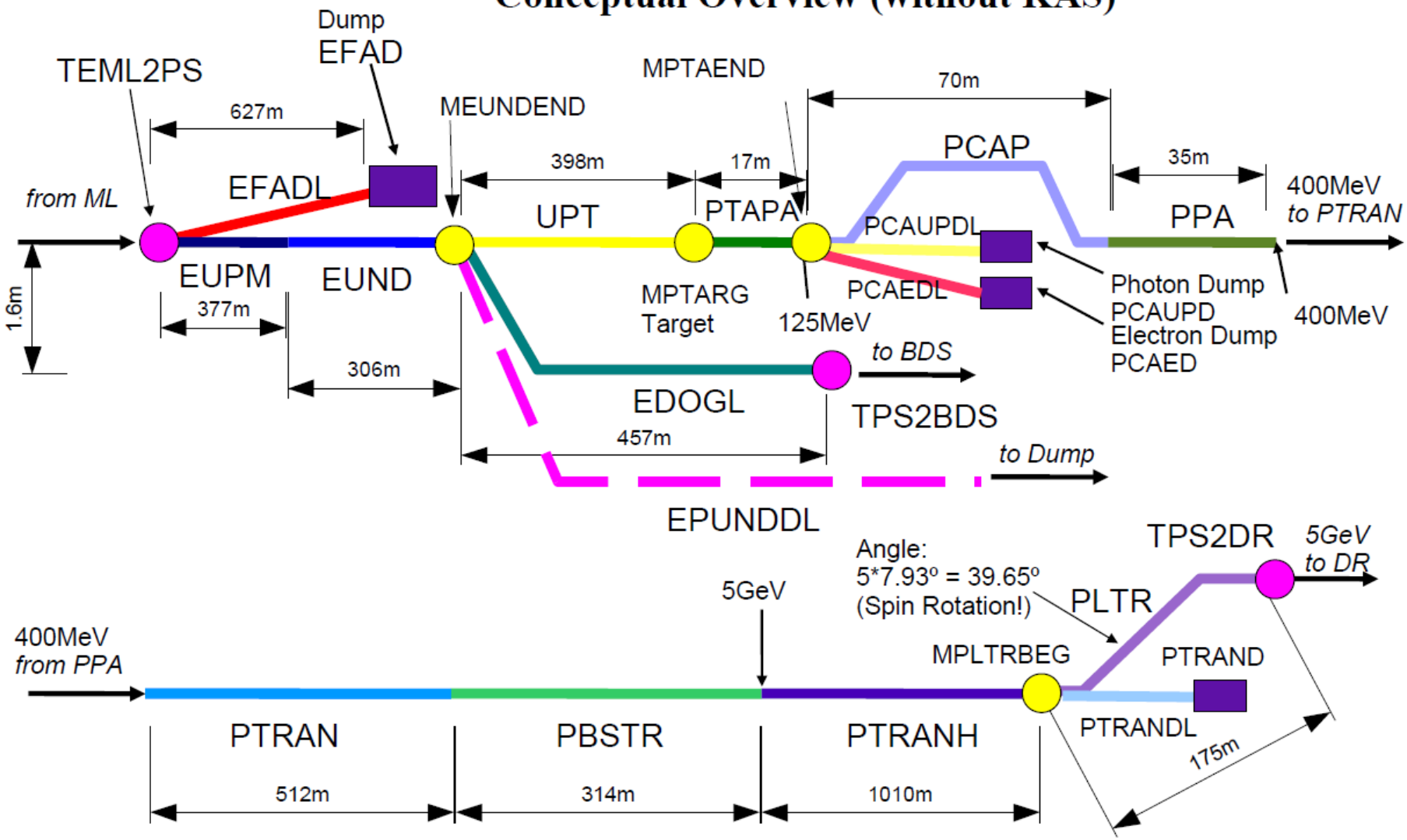
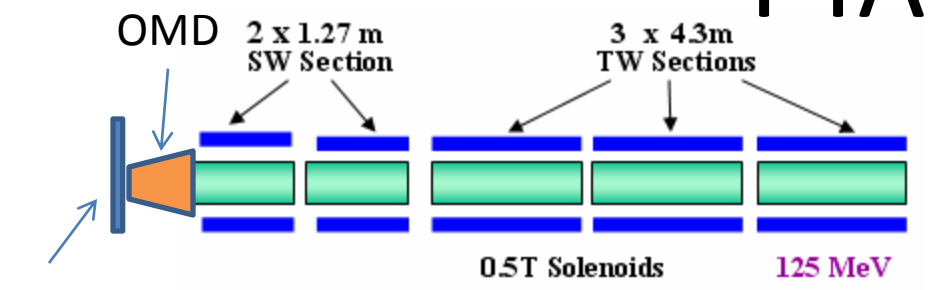
Positron Source Beamlines
Conceptual Overview (without KAS)



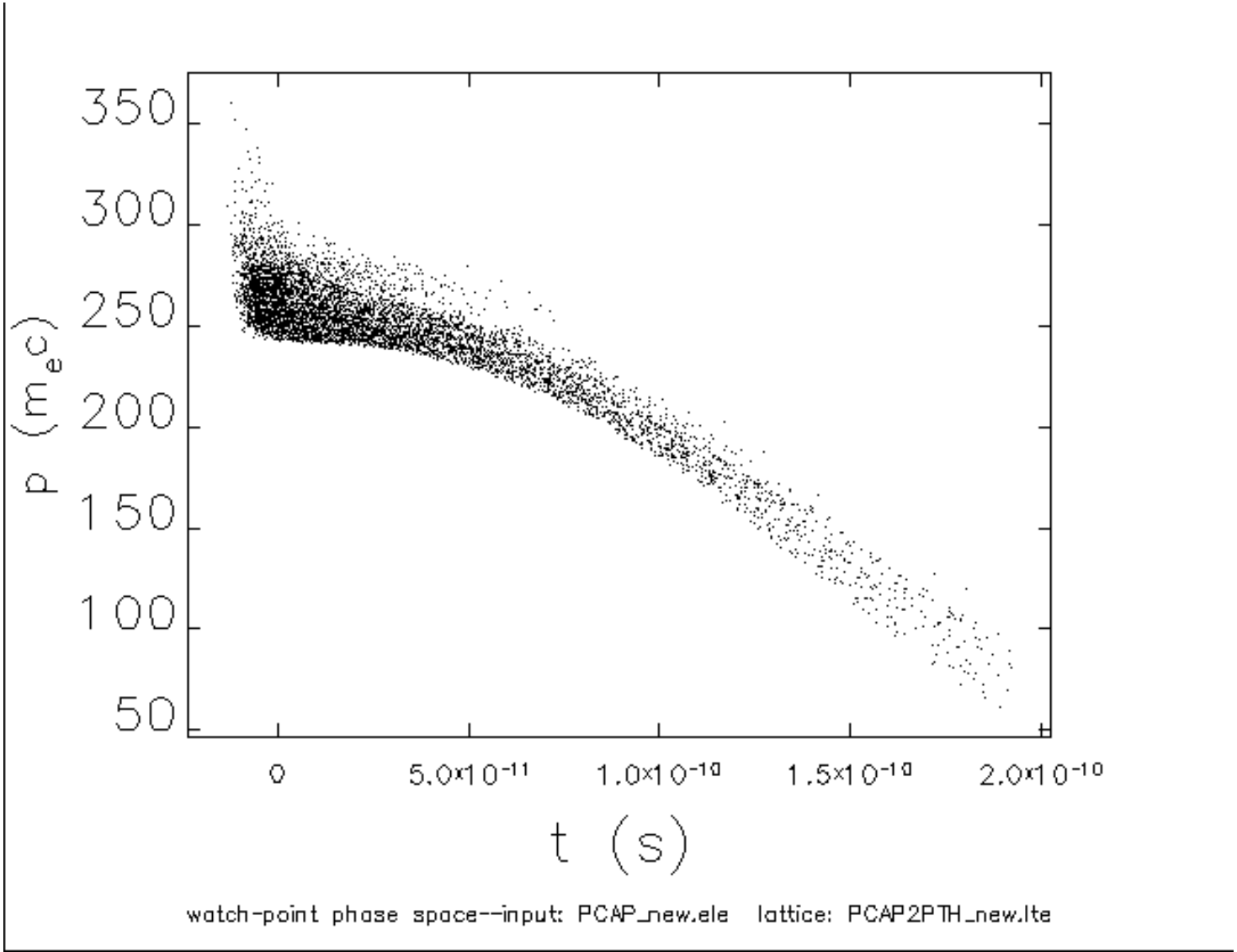
B. List, DESY -IPP- 8.6.2011

PTAPA



- OMD:
  - Flux concentrator: Physical length ~14cm, With ~0.5T on target surface, and decay adiabatically from 3.0T at 2cm from target down into the 0.5T background solenoid field at 14cm.
- Standing wave linac: 11 cells, π mode, 15MV/m, length 1.27m each, total numbers: 2
- Traveling wave linac: 50 cells, $3\pi/4$ mode, 8MV/m, 4.3m long each, total numbers: 3
- Total length of tunnel reserved: 17m per Beno's drawing,
- Minimum length of tunnel needed: ~16m

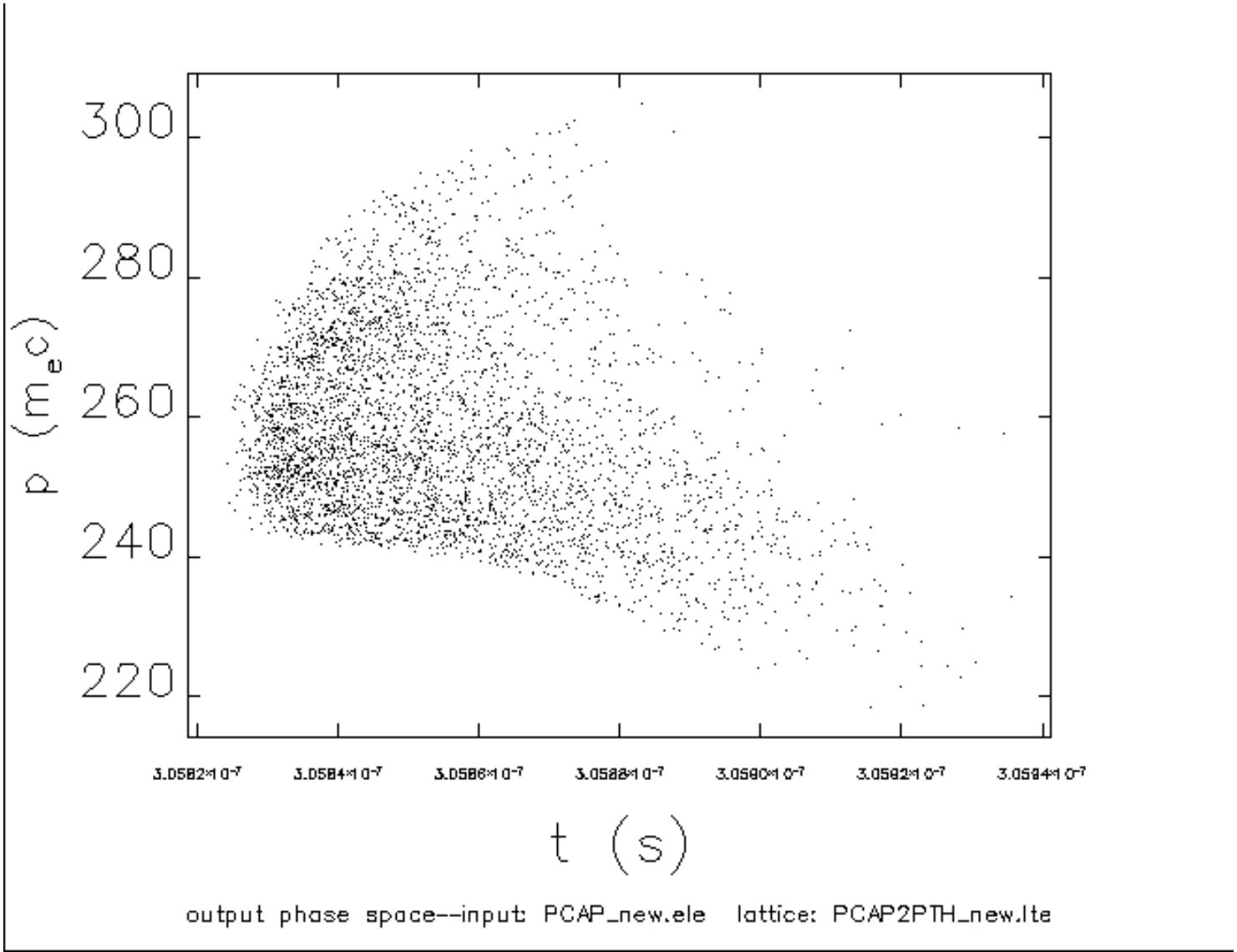
Typical particle distribution at end of PTAPA



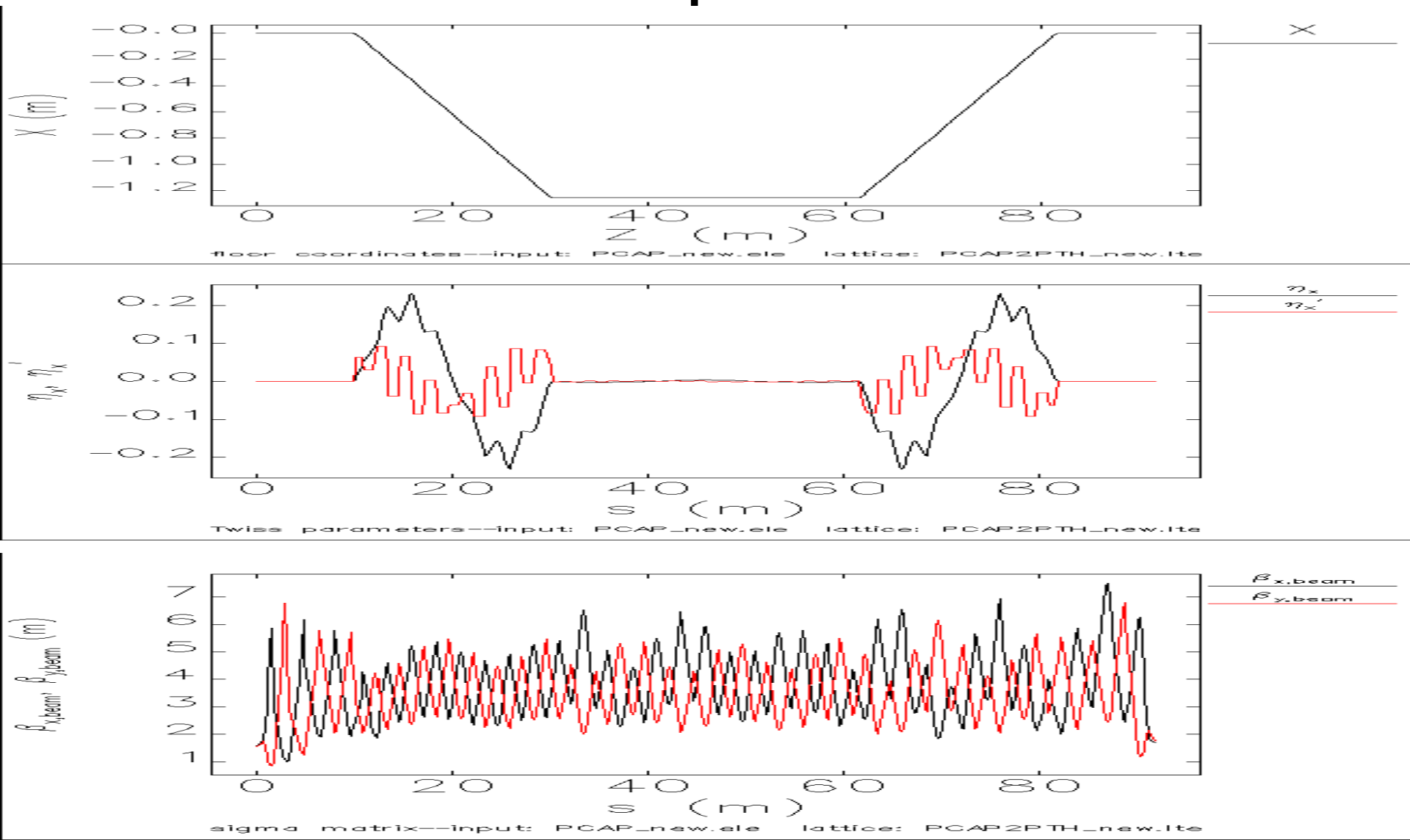
PCAP

- Functions:
  - To separate the positron beam from electrons and photons
  - To collimate unwanted positrons
- Beamline:
  - Chicane with minimized R56 and T566 to minimize the longitudinal phase space distortion
- Parts count:
  - Quad:71
  - Sextuple:4
  - Dipole:4
- Length of beamline:~91.7m

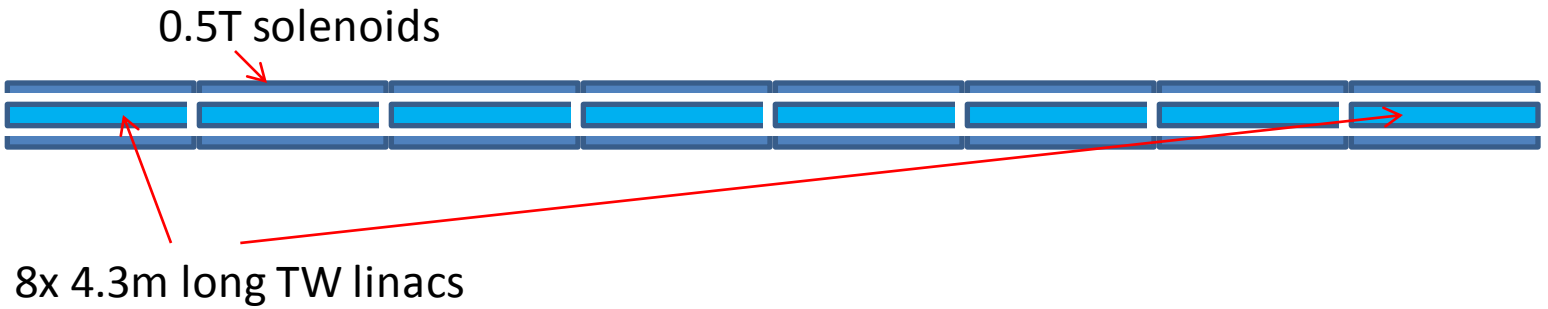
Typical longitudinal distribution at end of PCAP



Beta functions, dispersion and floor map of PCAP



PPA



Beamline lattice for MAD/elegant

The Lattice implementation in MAD/elegant input divided the into short pieces with length of about 8.65cm:

```
PPAKK1: RFCA,L=0.08649999999999999,VOLT=687499.924,PHASE=100,FREQ=1300000000,&
        CHANGE_P0=1,FIDUCIAL="LIGHT",END1_FOCUS=1,END2_FOCUS=1,N_KICKS=10
```

Each piece is followed by a back drift with the same length,8.65cm:

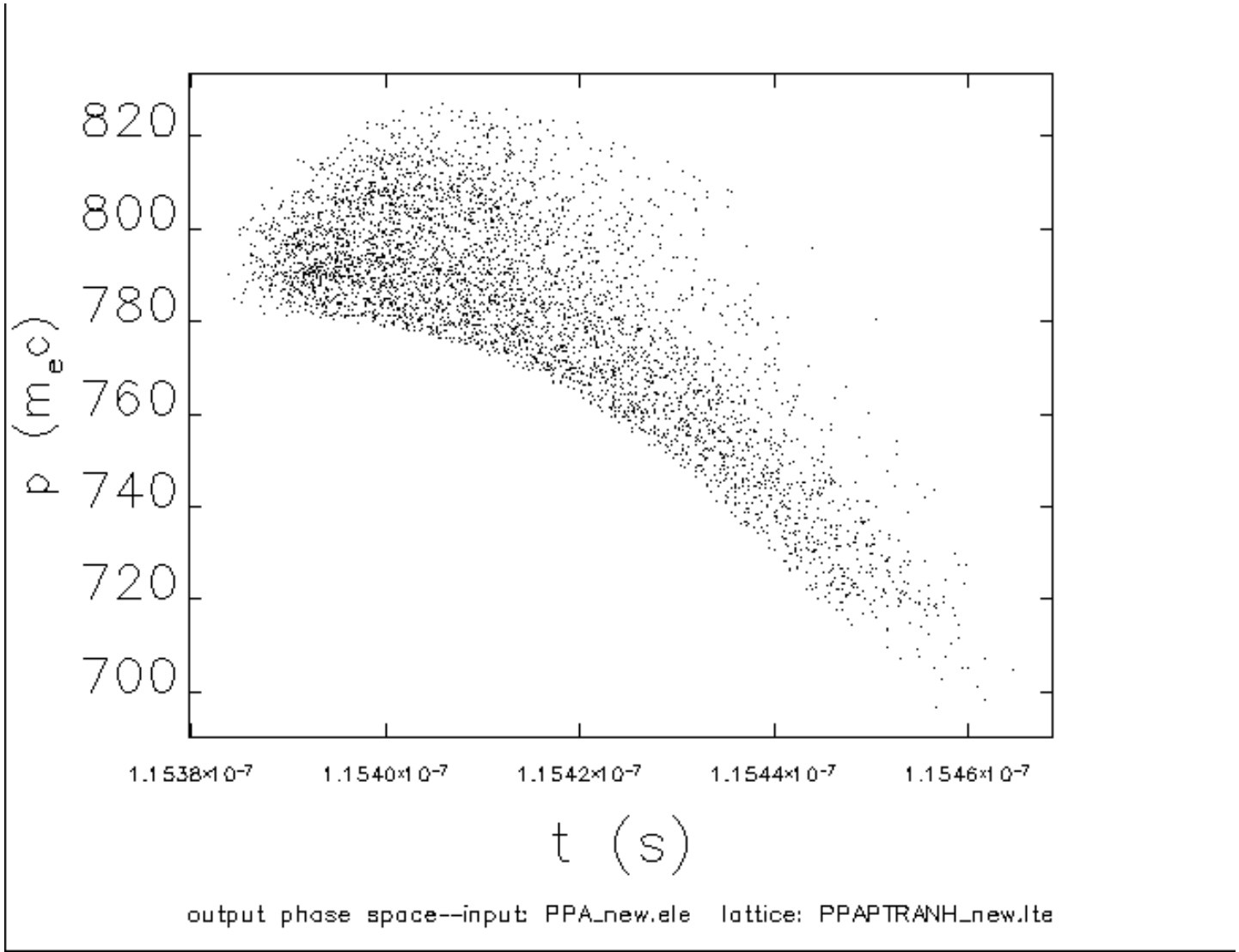
```
BACKD: EDRIFT,L=-0.08649999999999999
```

Then followed by a solenoid with a length of 8.65cm and K according to the expected beam energy

```
PPASOL0: SOLE,L=0.08649999999999999,KS=1.2,ORDER=2
……
PPASOL399: SOLE,L=0.08649999999999999,KS=0.37563839679799,ORDER=2
```

This part of lattice is straightforward and never changed since it was implemented

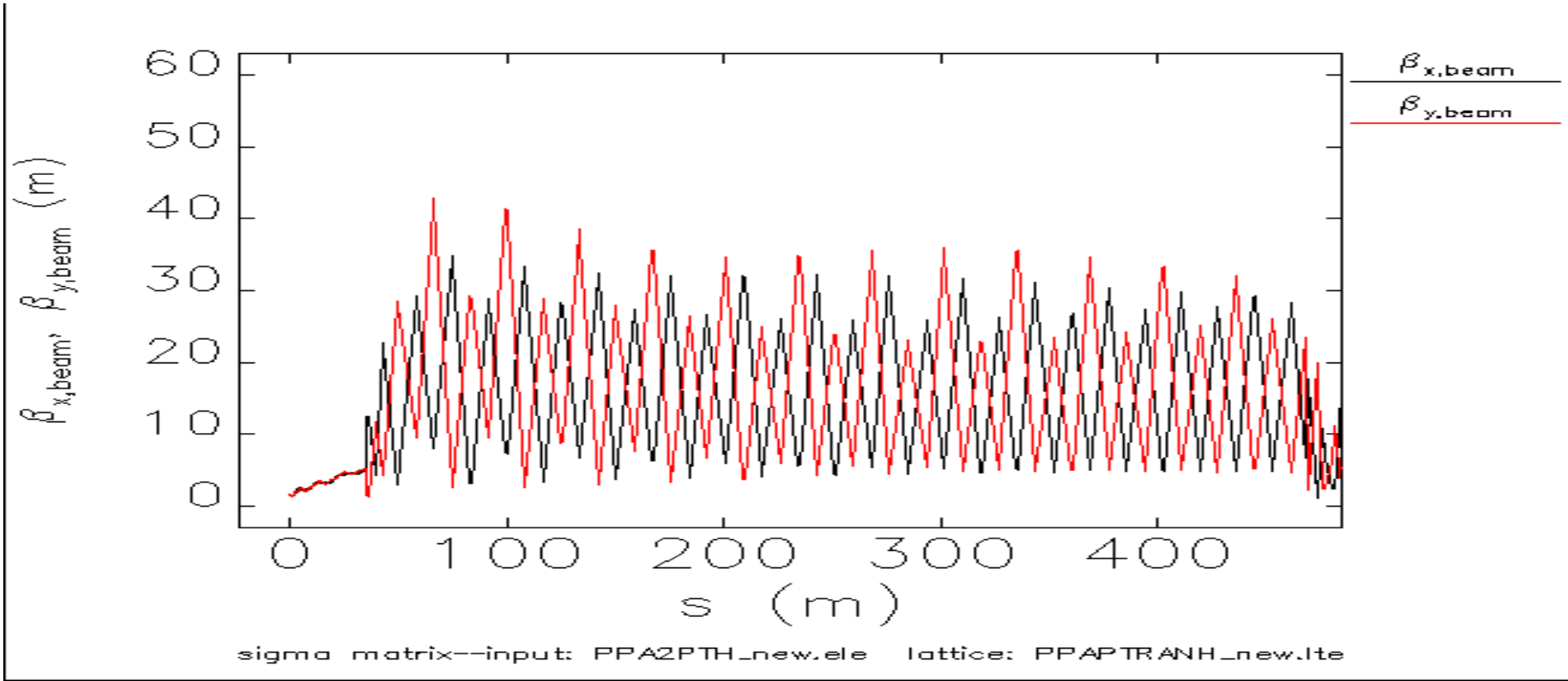
Typical longitudinal distribution at end of PPA



PTRAN

Matching section

FODO lattice with earth bend every 16.8m to match to the earth curvature.
Total number of quads: 54
Length of beamline: ~426.3m



PBSTR

Matching section

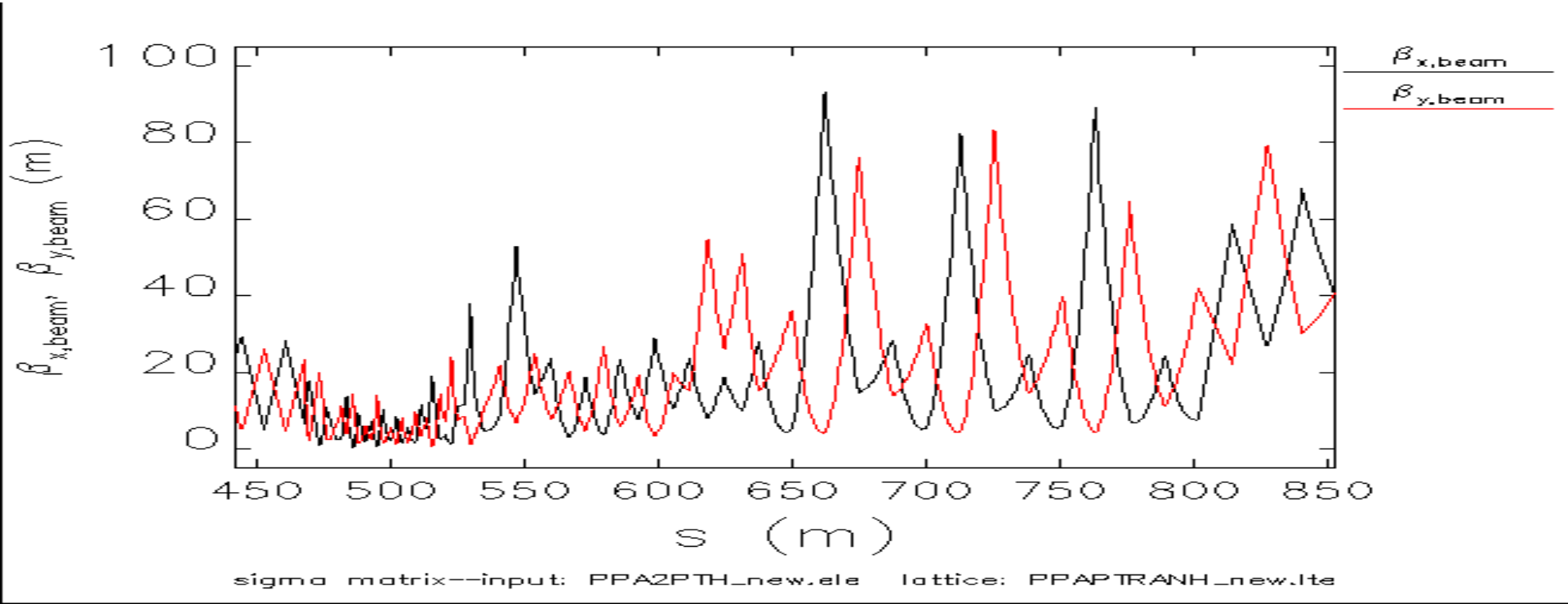
Matching to PTRANH

PBSTR1:
400MEV TO
1082.5649MEV

PBSTR2:
1082.5649MEV TO
2507.0321 MeV

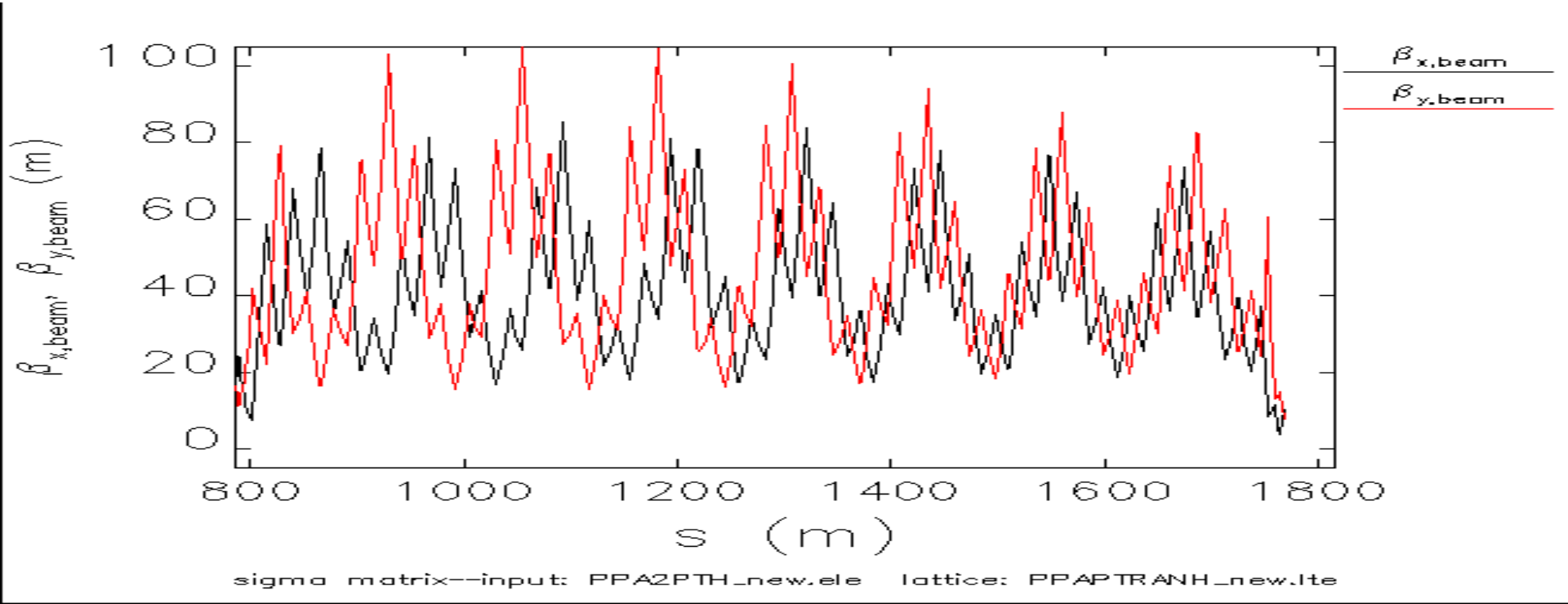
PBSTR3:
2507.0321 MeV
to 5GeV

Total number of quads: 56
Total length of beamline: ~372.56m
Cryomodules: 6 4C4Q; 8 8C2Q; 12 8C1Q

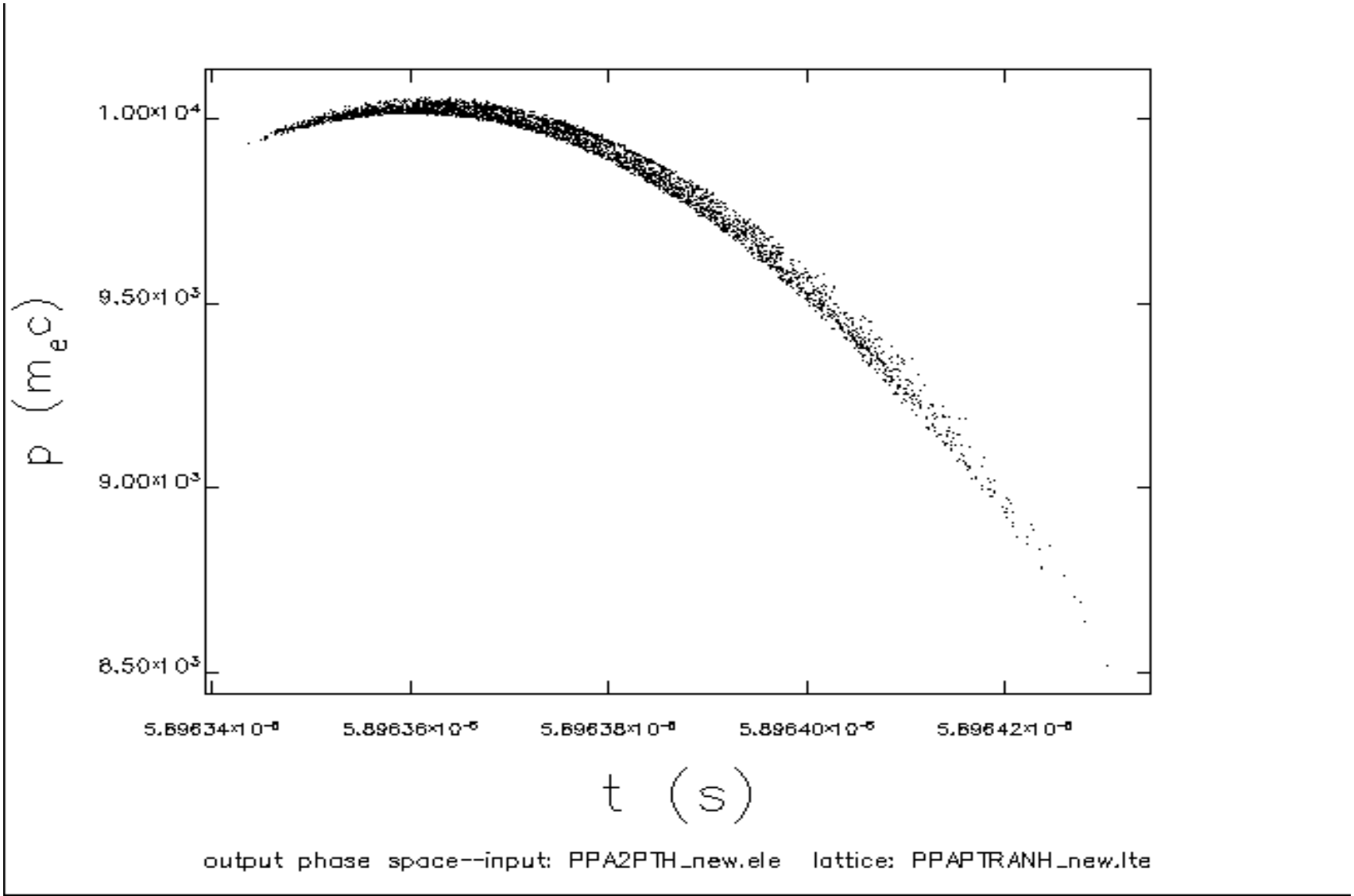


PTRANH

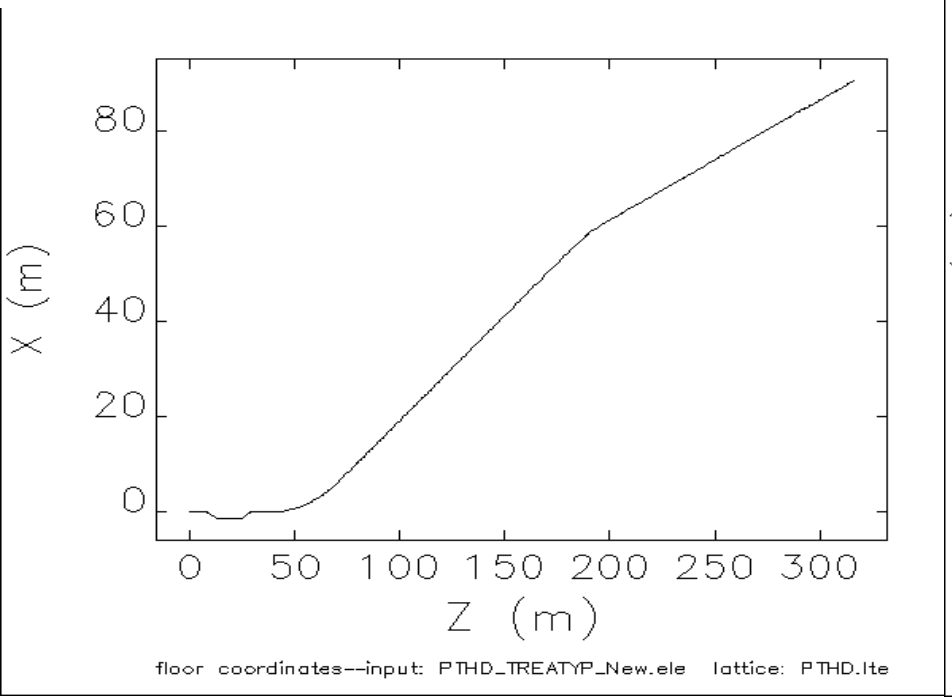
- Simple FODO lattice to transport the 5 GeV e+ beam to PLTR
- With matching section between PTRANH and PLTR
- Total number of quads: 79
- Total length of beamline: 934.23m

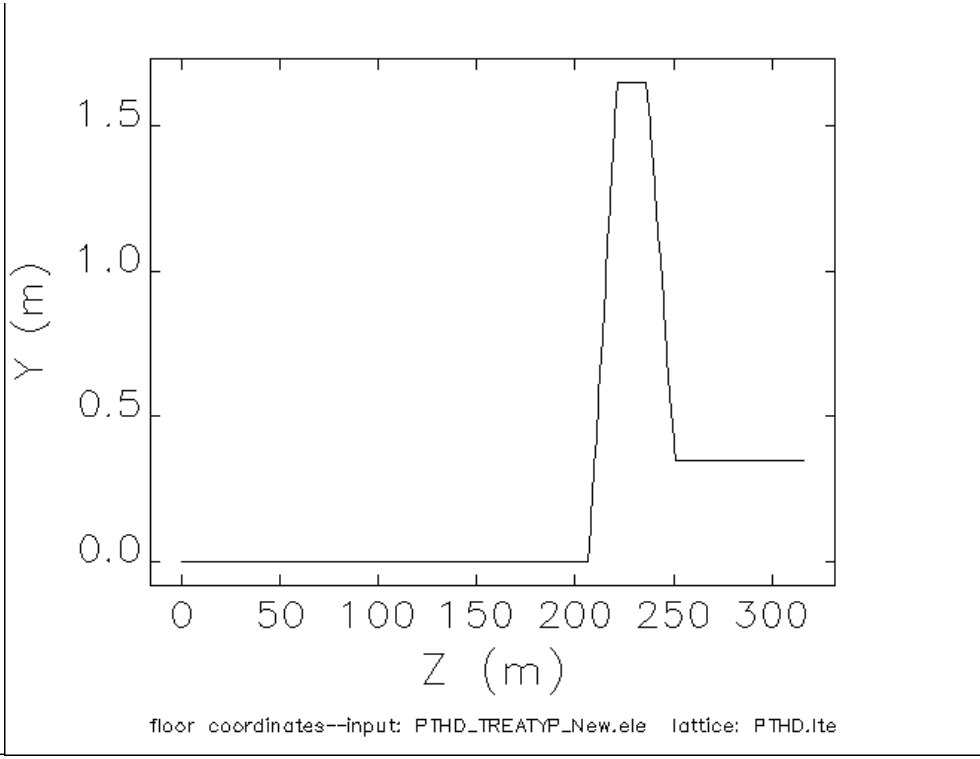


Typical longitudinal distribution at end of PTRANH

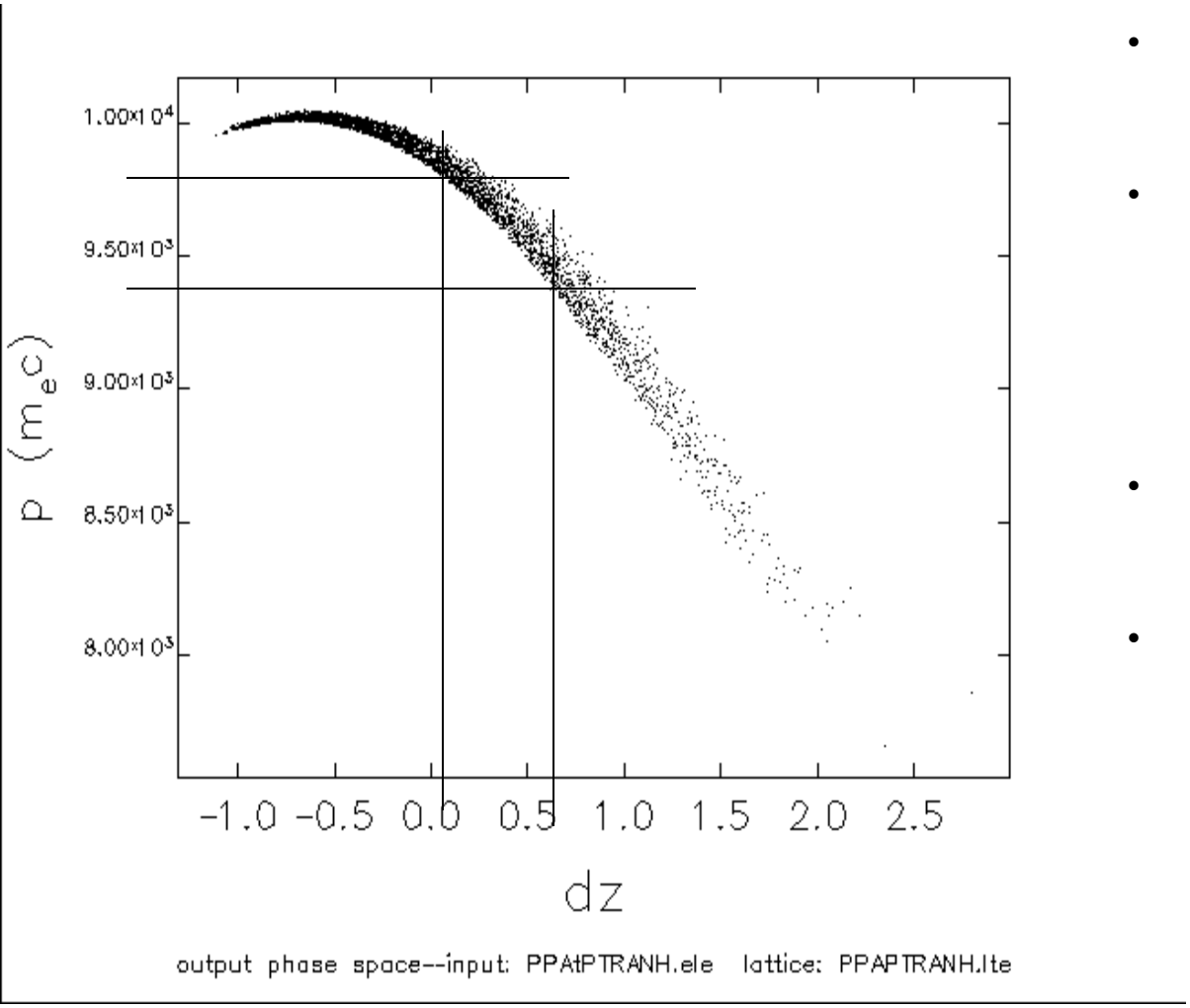


PLTR


X (m)
80
60
40
20
0
0 50 100 150 200 250 300
Z (m)
floor coordinates--input: PTHD_TREATYP_New.ele lattice: PTHD.lte

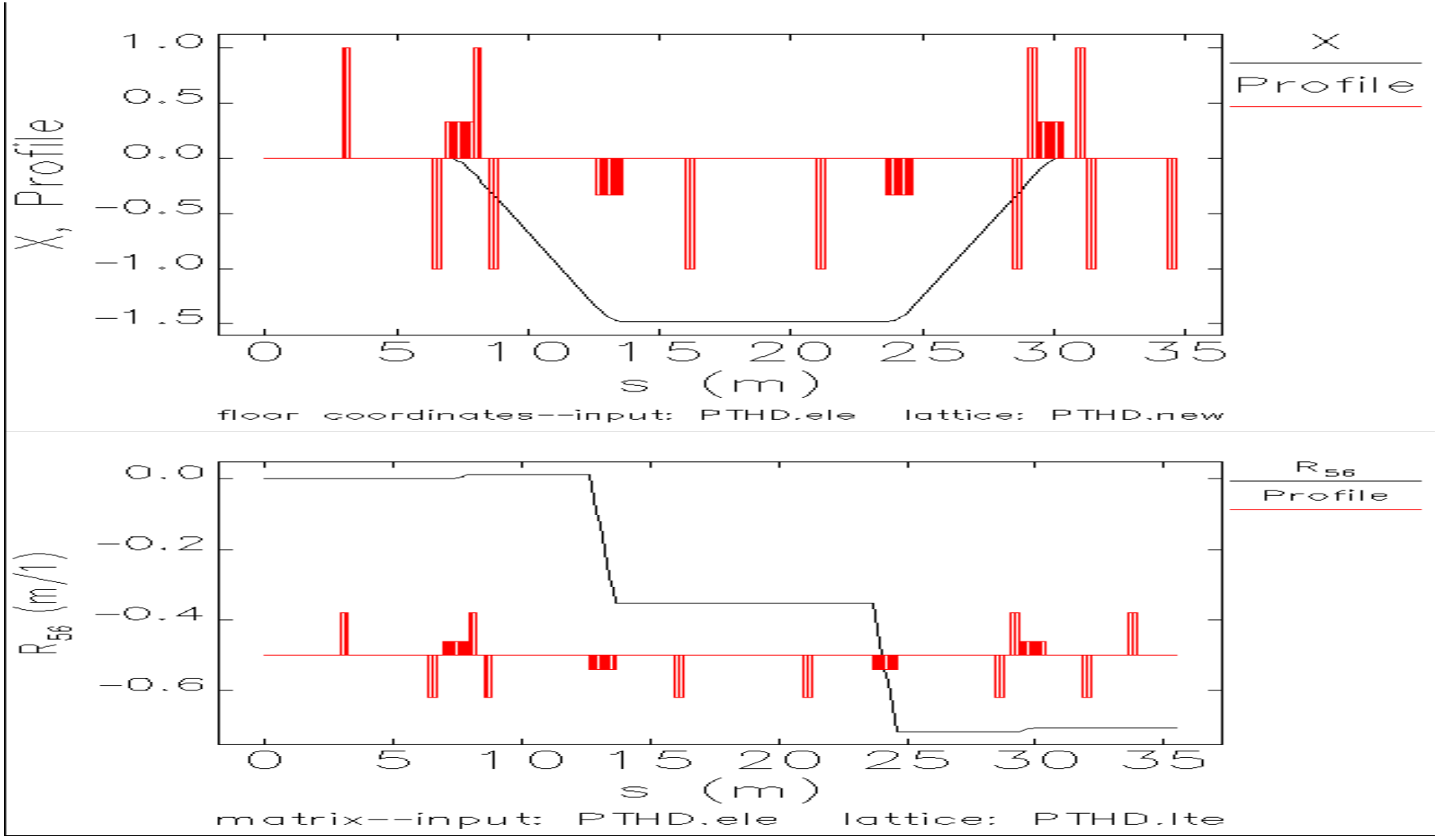

Y (m)
1.5
1.0
0.5
0.0
0 50 100 150 200 250 300
Z (m)
floor coordinates--input: PTHD_TREATYP_New.ele lattice: PTHD.lte

New Longitudinal Phase Space and Required R56

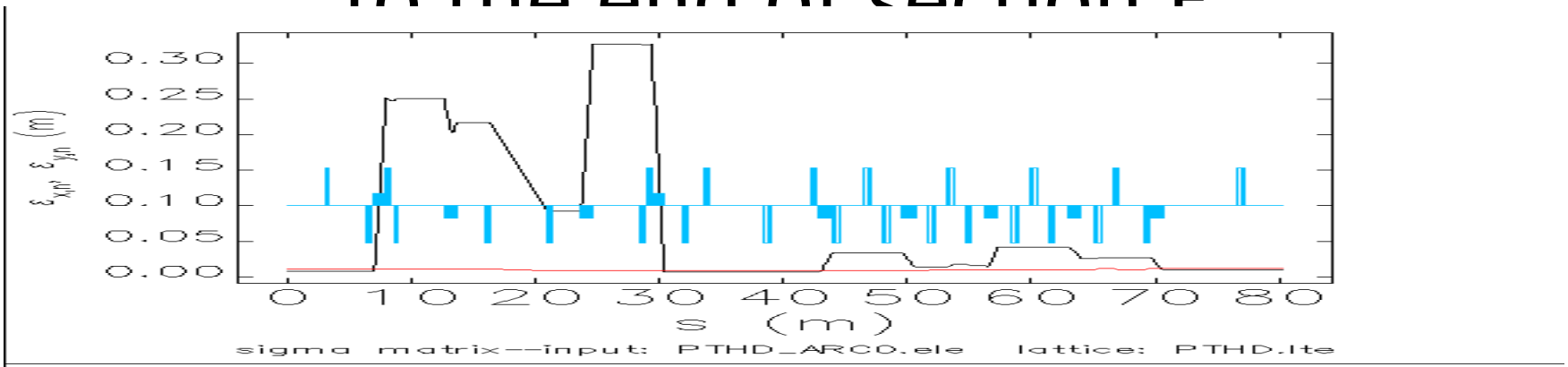


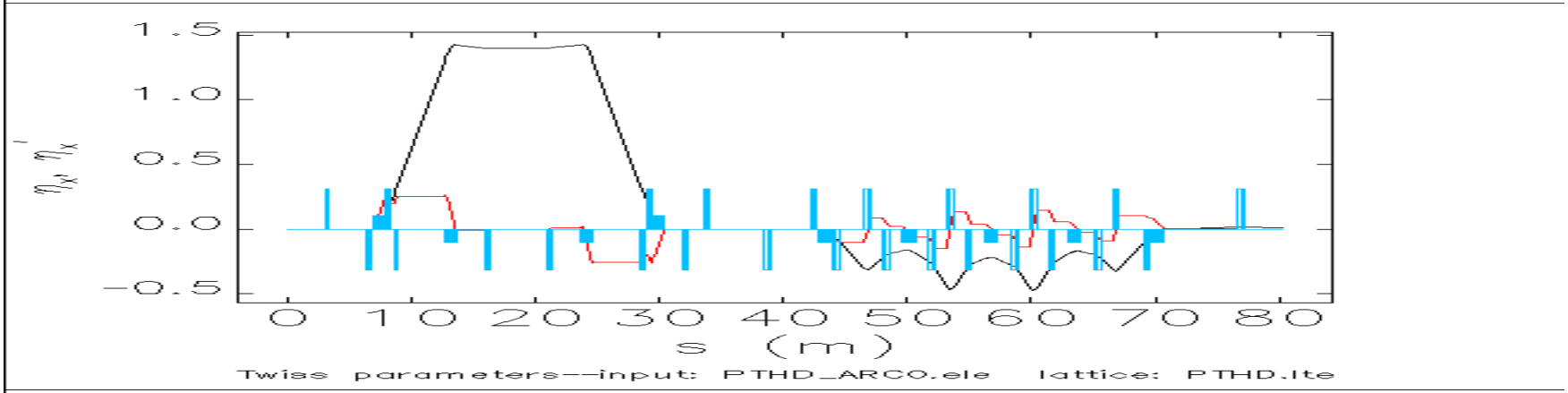
- 0.75% of 5GeV is only 37.5MeV, so the acceptance window after compressor is from 4.9625GeV to 5.0375GeV (9711.3mec to 9858mec)
- 35mm is 54.6 degrees measured in 1.3GHz RF phase. Which also corresponding to 0.815 of peak field. Given 25MV per linac, then total of 9 linac can yield 183MeV energy correction. So the energy spread acceptable before energy compressor will be 37.5+183= 220.5MeV.
- The energy window should be 5GeV-220.5MeV=4.7795GeV to 5GeV+220.5MeV=5.2205GeV or 9353 mec to 10216 mec (center at 9784.7)
- As illustrated in the left figure, dz for 9353mec to 9784mec is about 6mm. To extend it to 35mm, the required R56 will be about -65cm

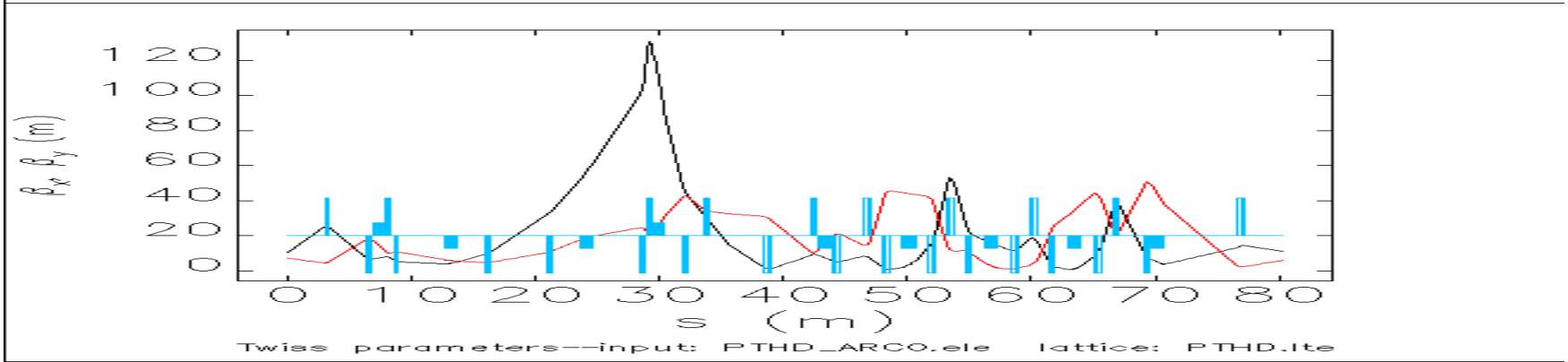
Single R56 chicane



emittance,dispersion, beta functions to the end of section F



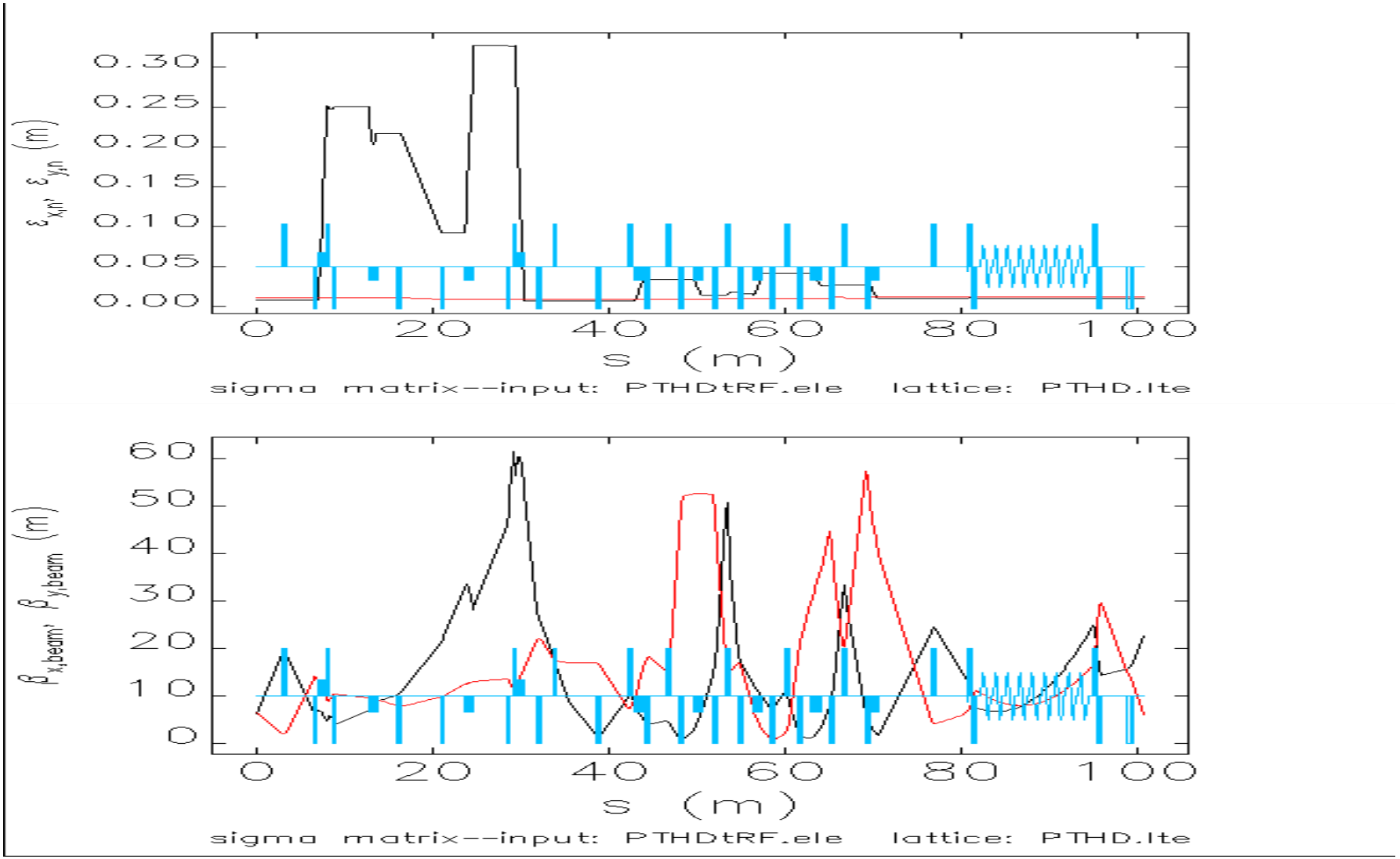




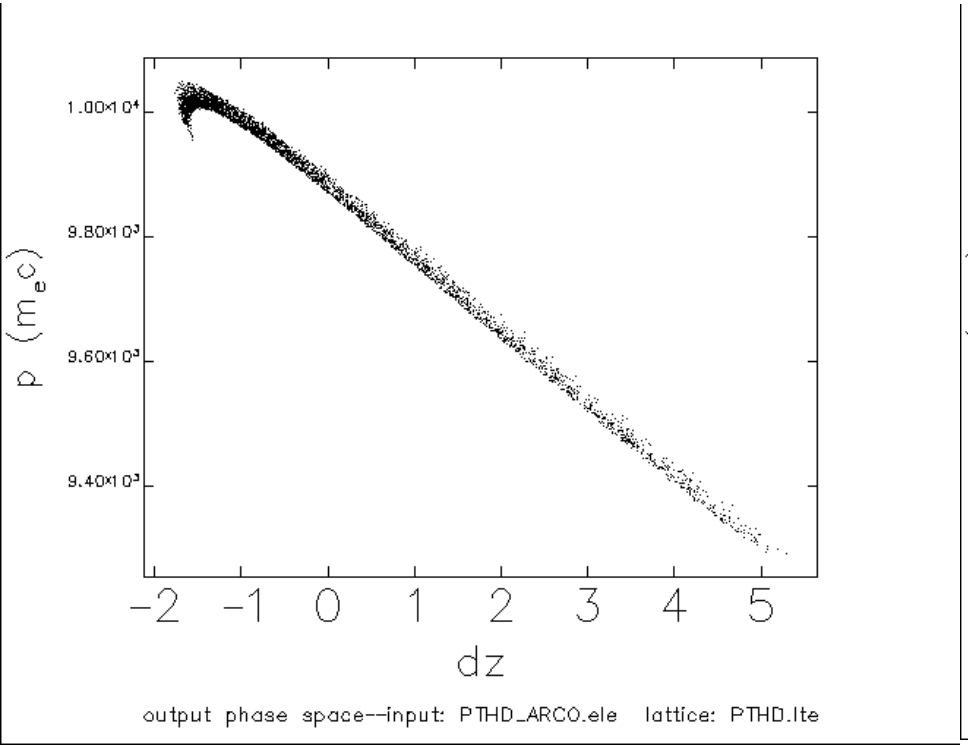
Energy Compressor

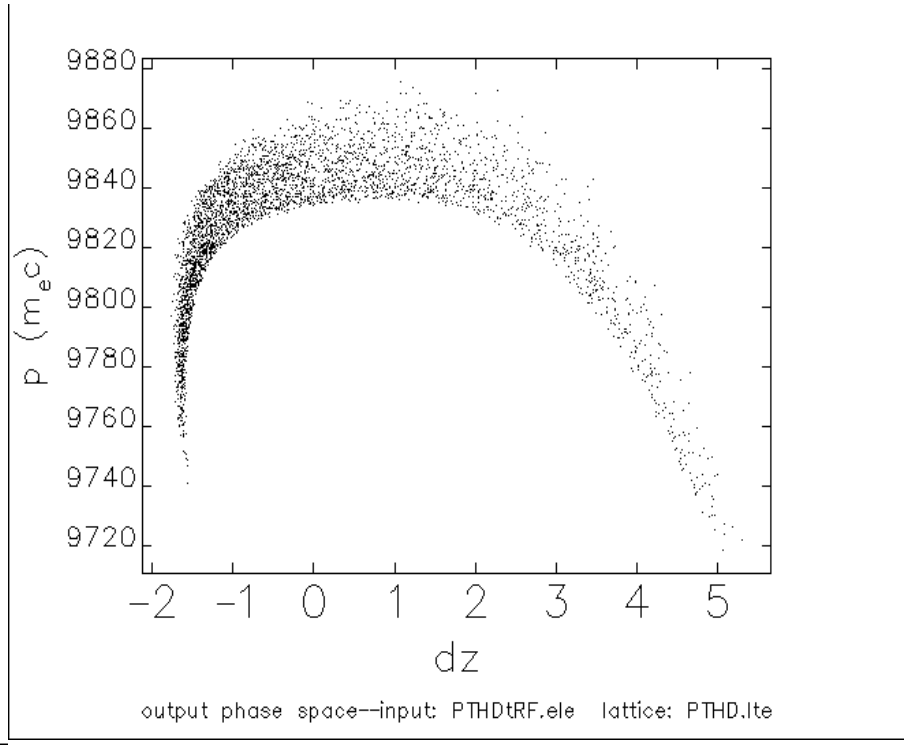
- RDR Energy compressor RF is only 6m long and 180MV in total, equivalent to 6 SCRF cavities with 30MV each.
- New compressor is a cryomodule with 9 cavities and no quads. Each cavity has a voltage of 25MV.
- The total length of cryomodule is 12.474m including flanges and interconnect pipes.

End of Compressor,emittance and beta functions

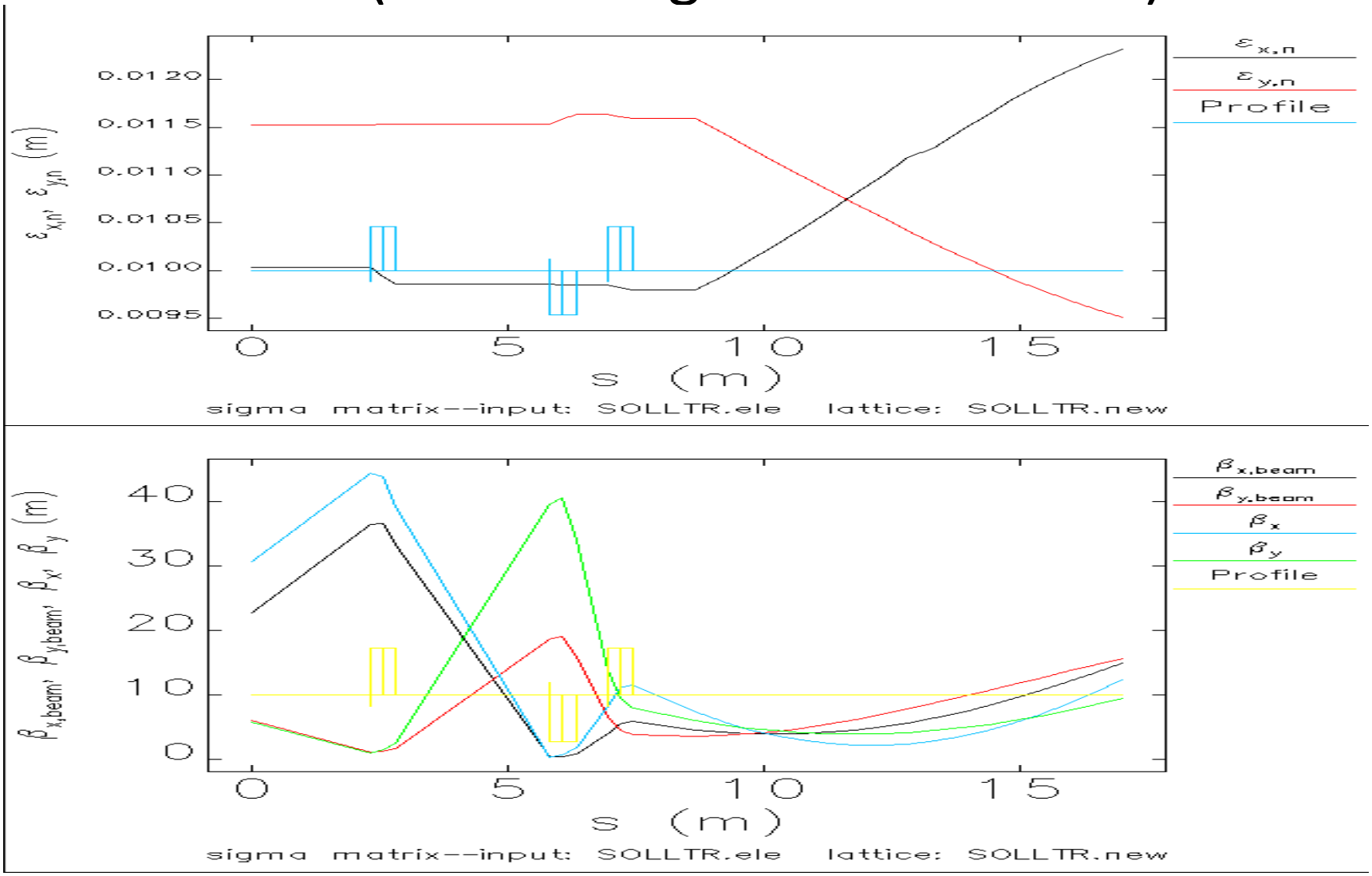


Longitudinal phase space at the end of section E and energy compressor

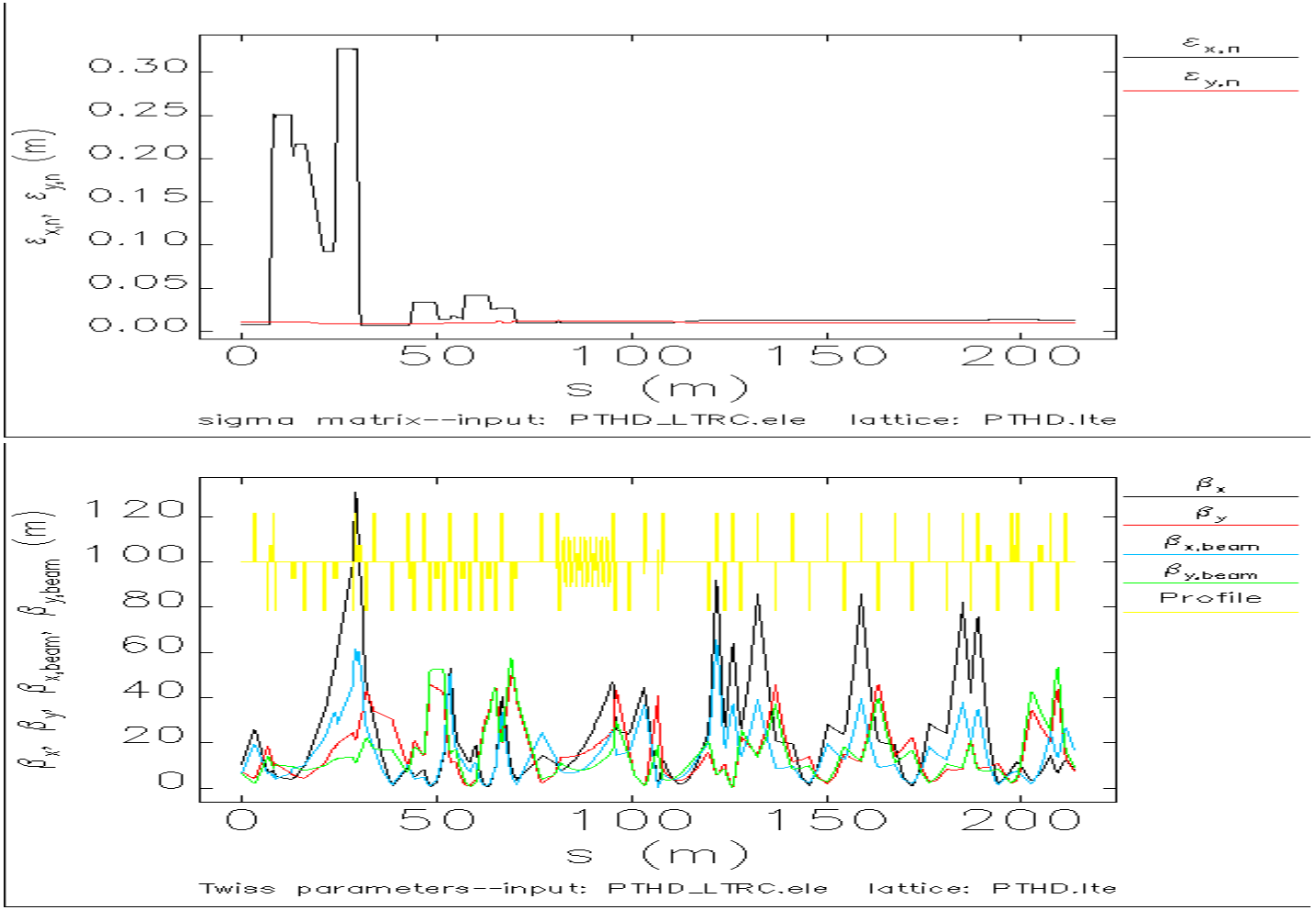




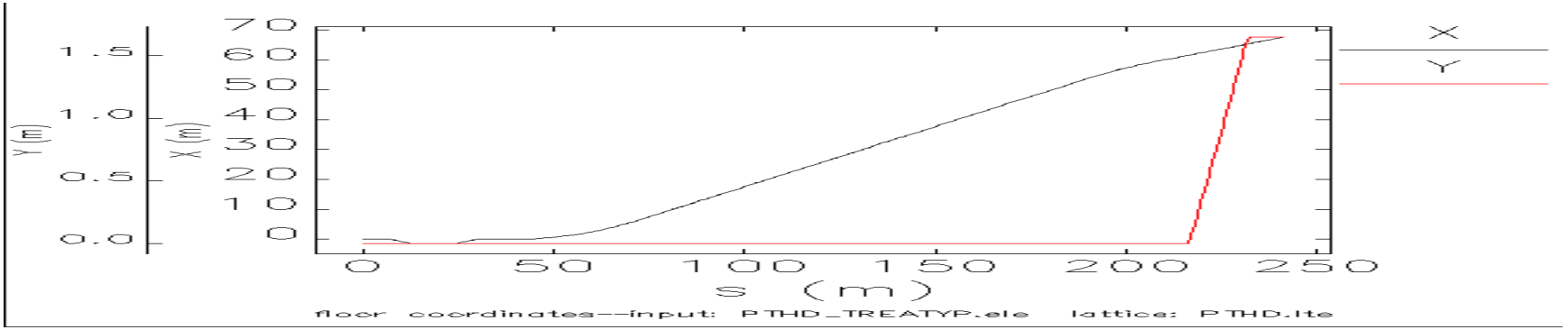
Spin Rotator, the solenoid is the same as in RDR lattice(8.32m long with 3.12T field)

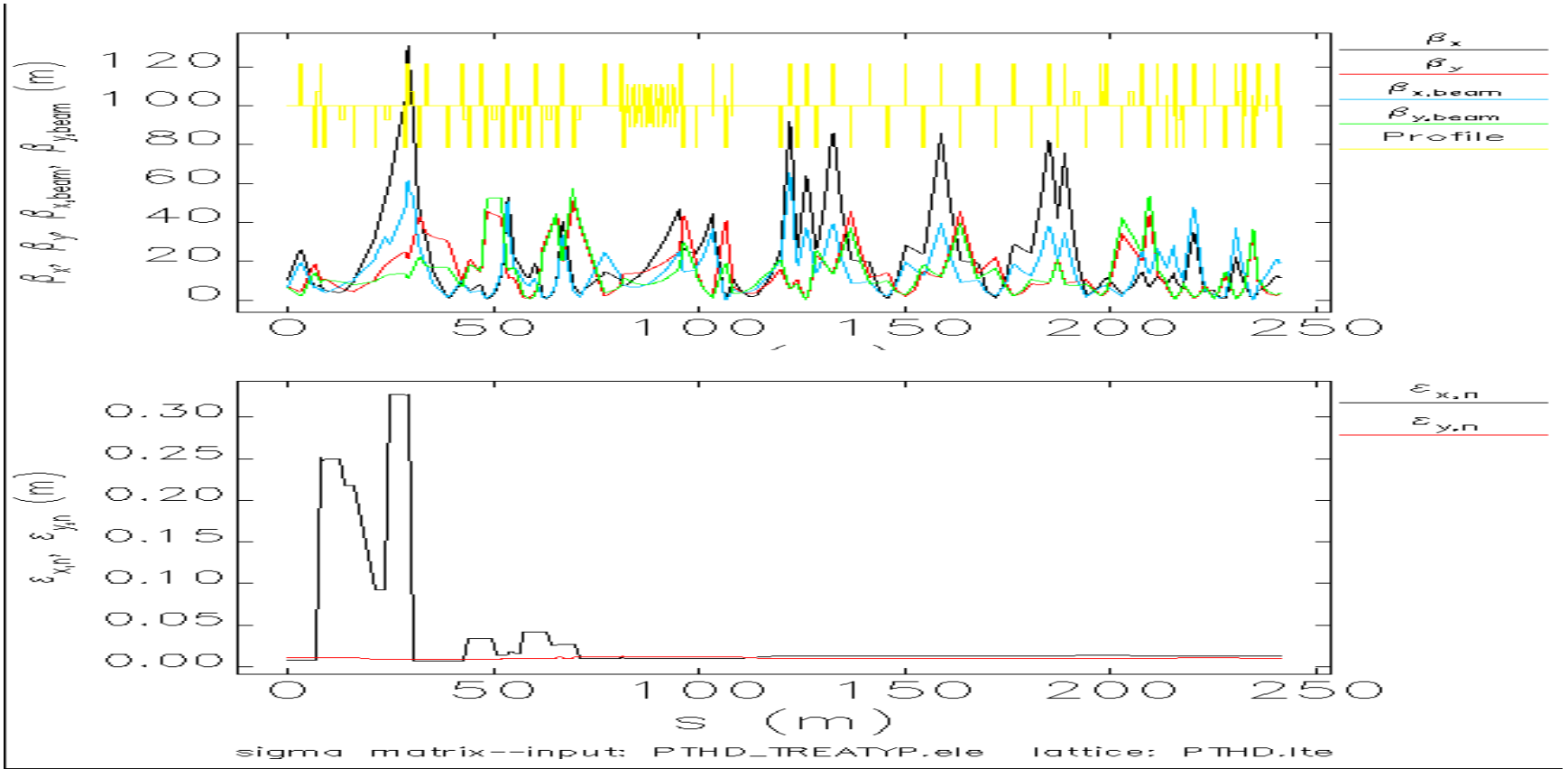


End of 2nd horizontal arc

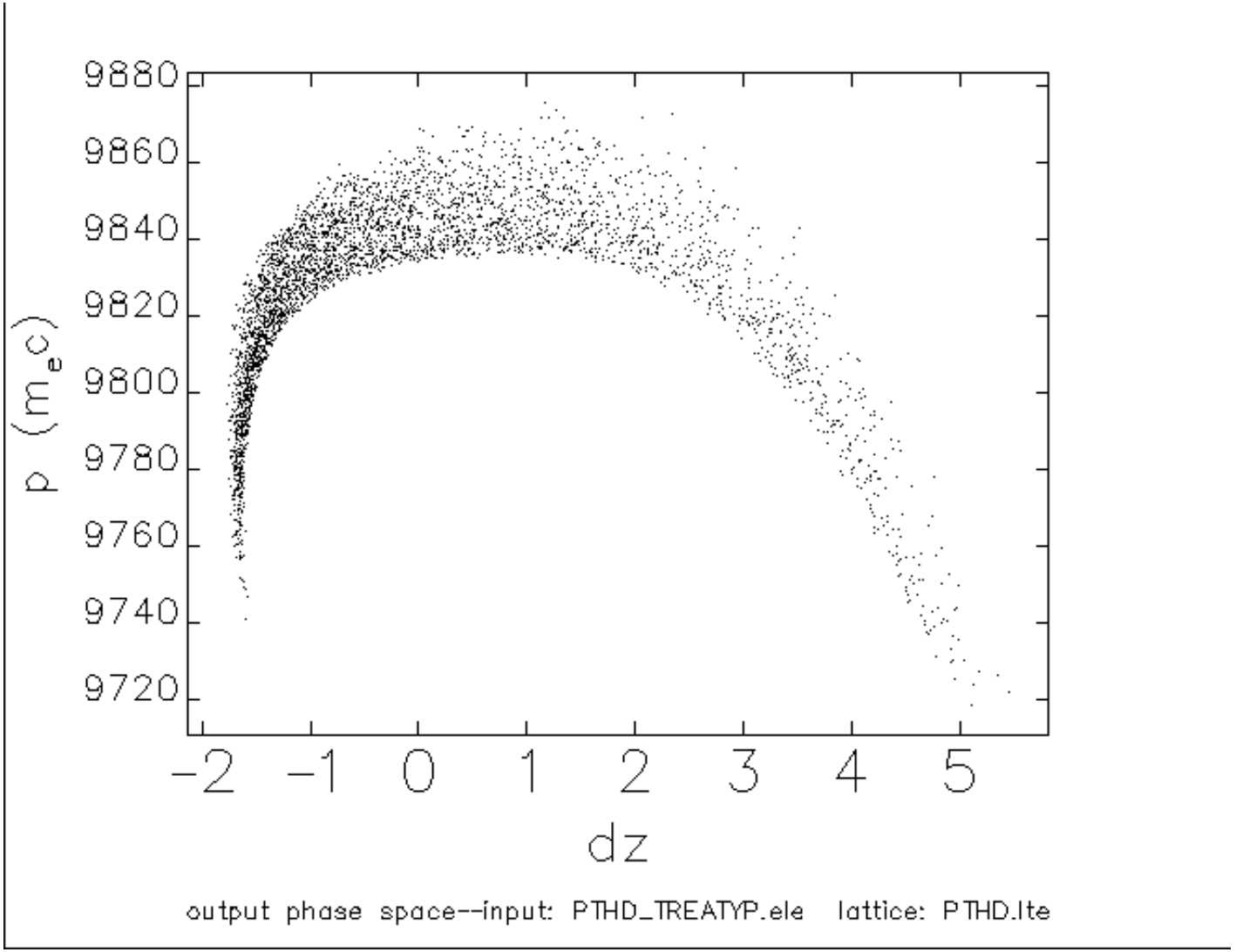


From Beginning of Chicane to the old Treaty Point



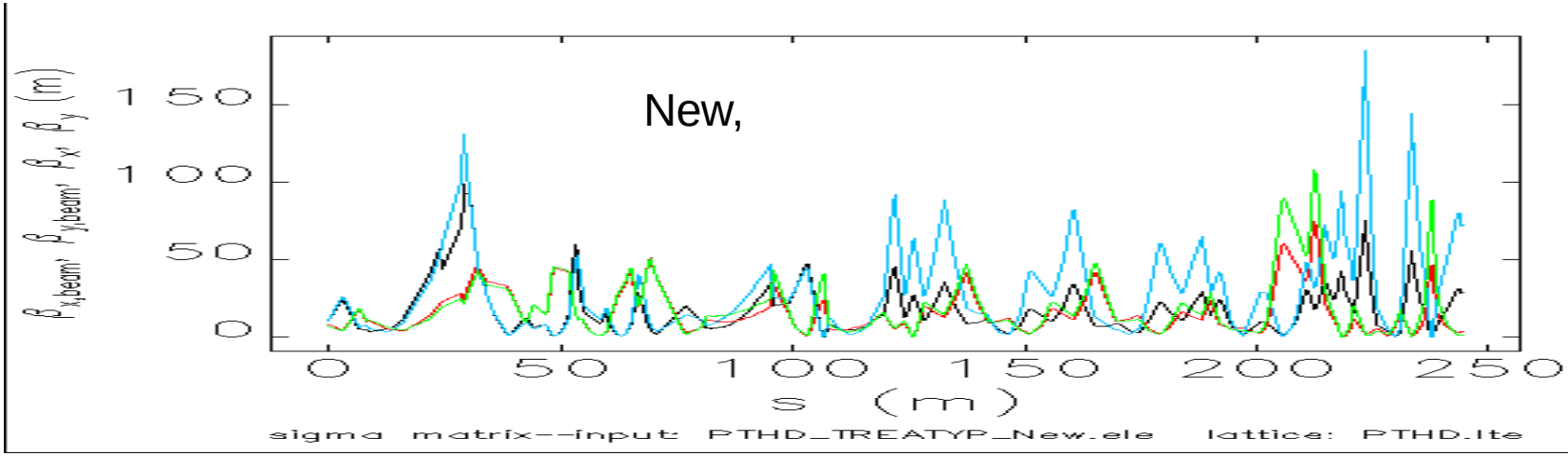


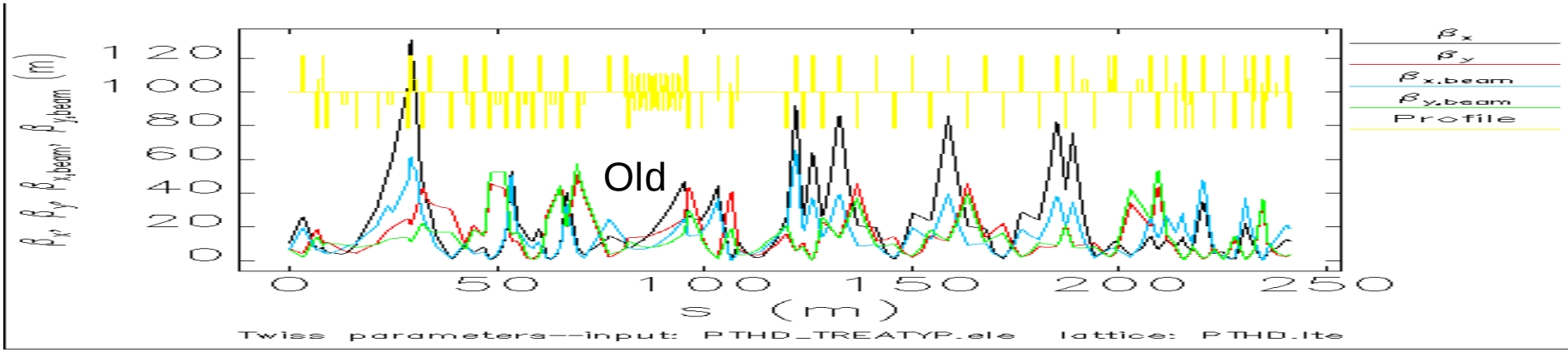
Longitudinal phase space at end of PLTR



PLTR tracking with new upstream lattice tracking output

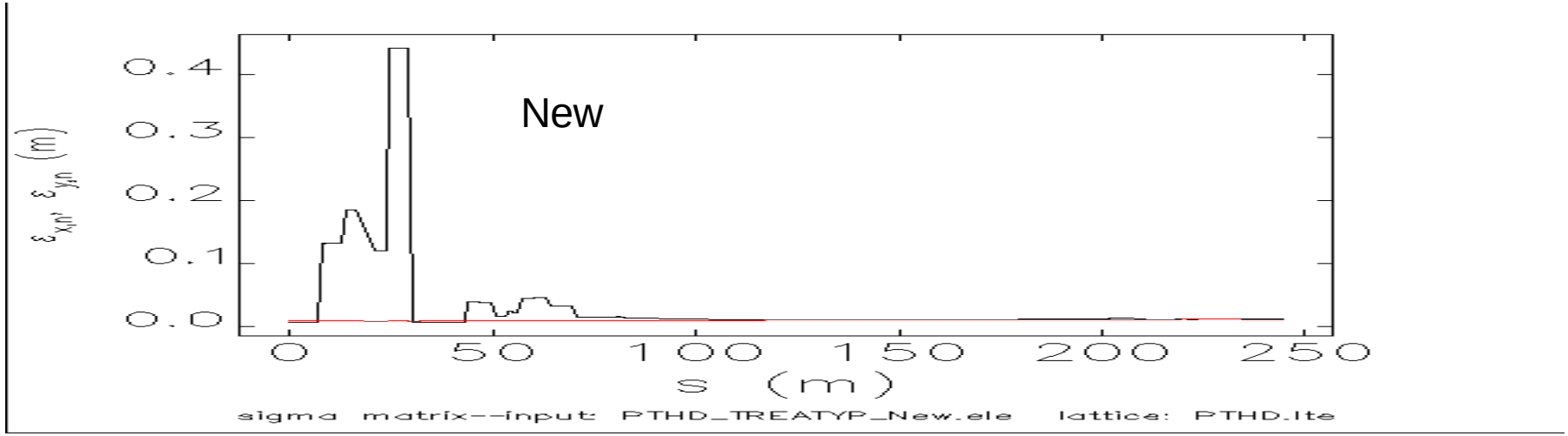
Beta functions

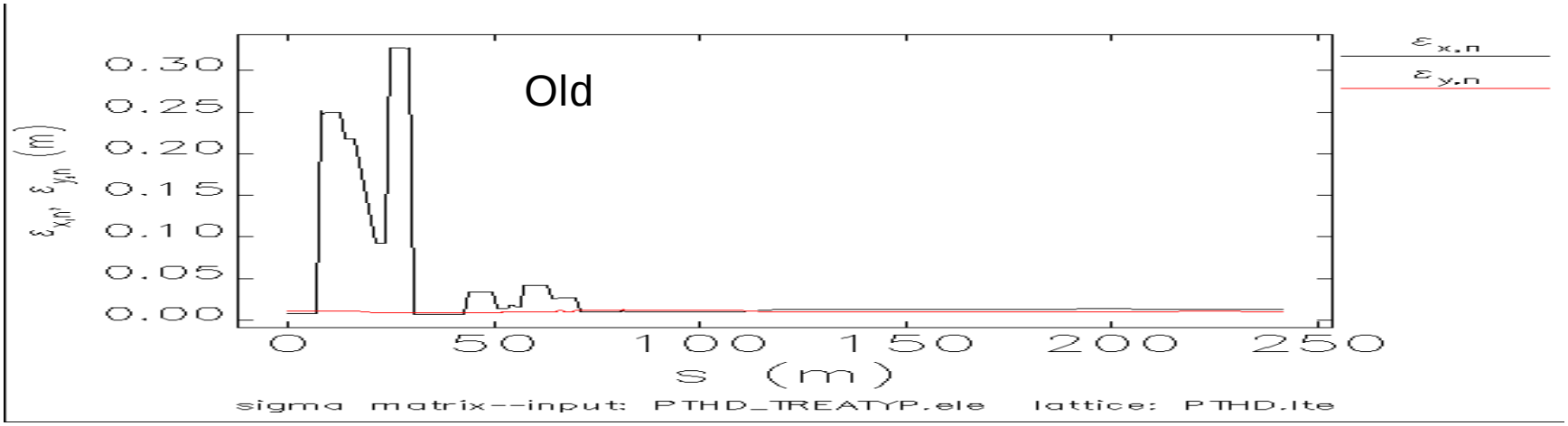




The beta functions before spin rotator is still the same. The beta functions changed after spin rotator as a result of the changes made in section D FODO lattice to correct the geometrical layouts. The lattice is not optimized yet because the vertical offset needs to be brought down and the lattice needs to be extended to the end of section B which I wasn't aware of and I did no have a chance to do yet.

emittance


New
$\varepsilon_{x,n}$, $\varepsilon_{y,n}$ (m)
0.4
0.3
0.2
0.1
0.0
0
50
100
150
200
250
s (m)
sigma matrix--input: PTHD_TREATYP_New.ele lattice: PTHD.lte


Old
$\varepsilon_{x,n}$, $\varepsilon_{y,n}$ (m)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
50
100
150
200
250
s (m)
sigma matrix--input: PTHD_TREATYP.ele lattice: PTHD.lte
$\varepsilon_{x,n}$
$\varepsilon_{y,n}$

Longitudinal distribution at end of lattice