AARHUS
UNIVERSITET

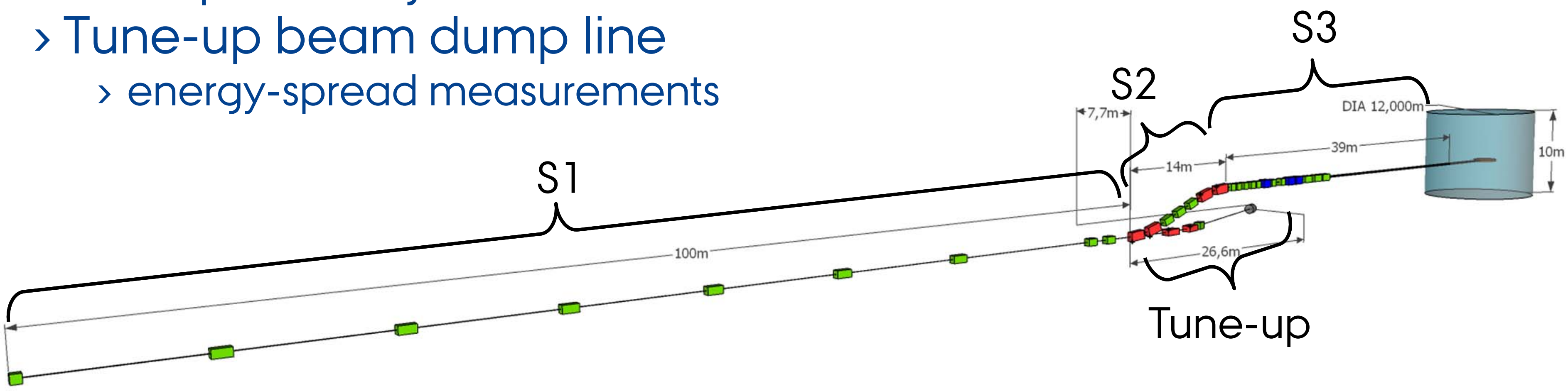
STATUS OF THE BEAM EXPANDER SYSTEM FOR THE EUROPEAN SPALLATION SOURCE

OUTLINE

- General layout of the HEBT
  - Upgrade section
  - Tune-up dump
  - Bending section
- The ESS target and its requirements
- The expander system
  - The ESS baseline system
  - The issues
  - Misalignment
- Collimation
- Radiation
- Open points

THE HEBT

- S1: Space for a power (current or energy) and/or reliability upgrade
- S2: Bending section (elevation ~4m)
- S3: Expander system
- Tune-up beam dump line
  - energy-spread measurements



- Safety beam dump?

HEBT-S1

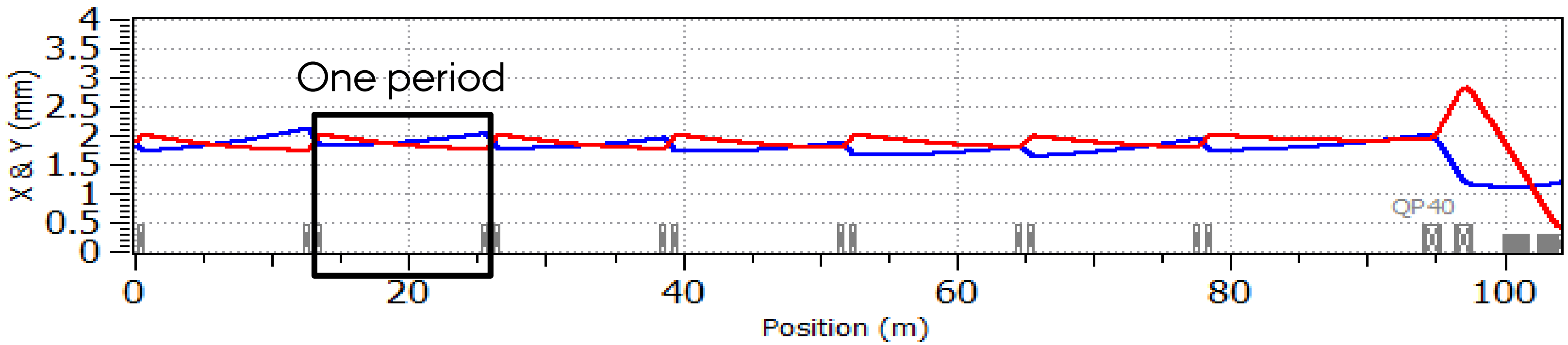
Purpose:

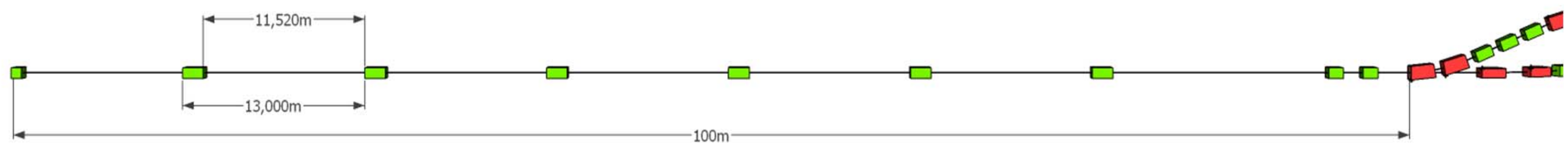
› Space for additional accelerator cryo-modules (7 periods)

Design:

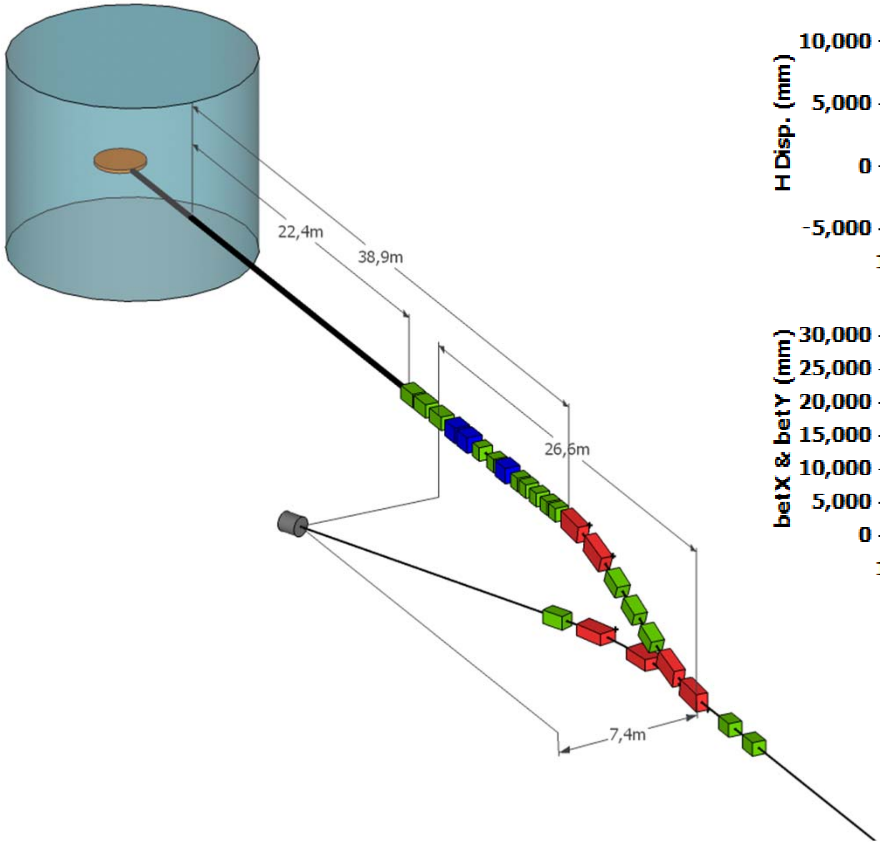
› Maintain linac focusing structure → easy upgrade

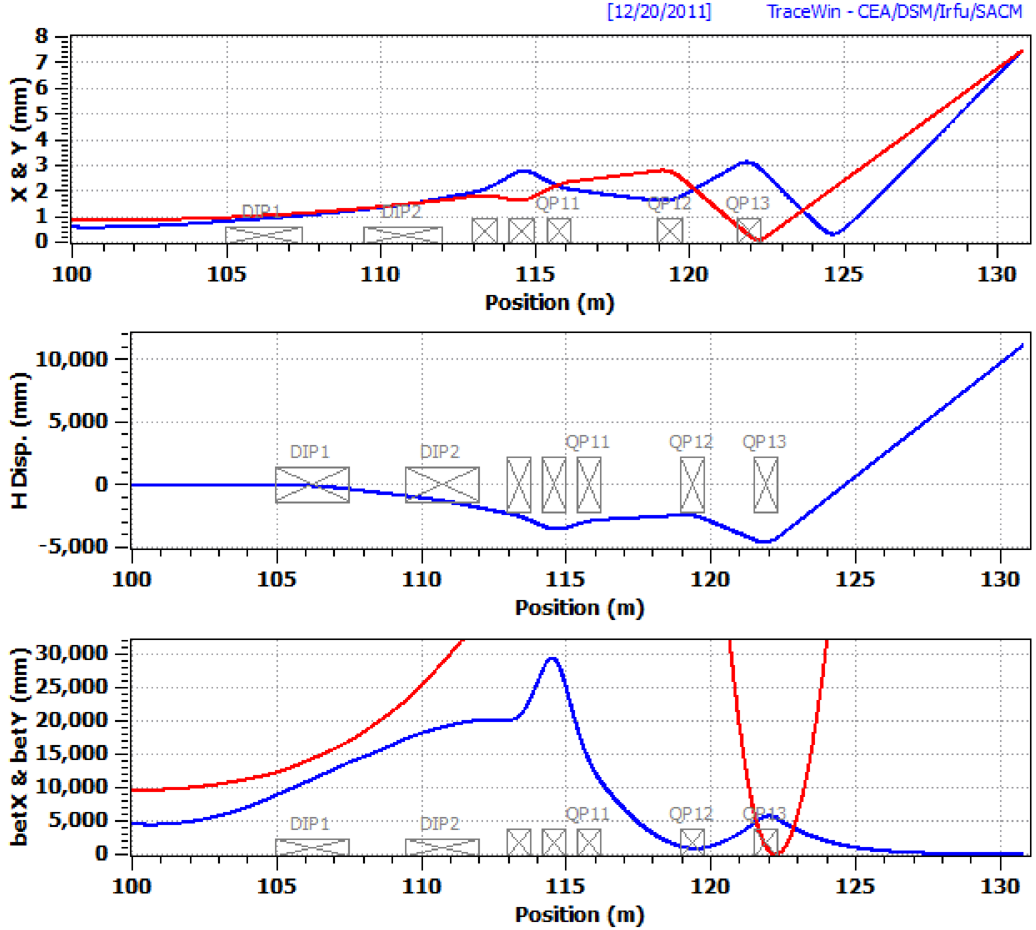
› Low phase advance for halo (~1 deg/m)



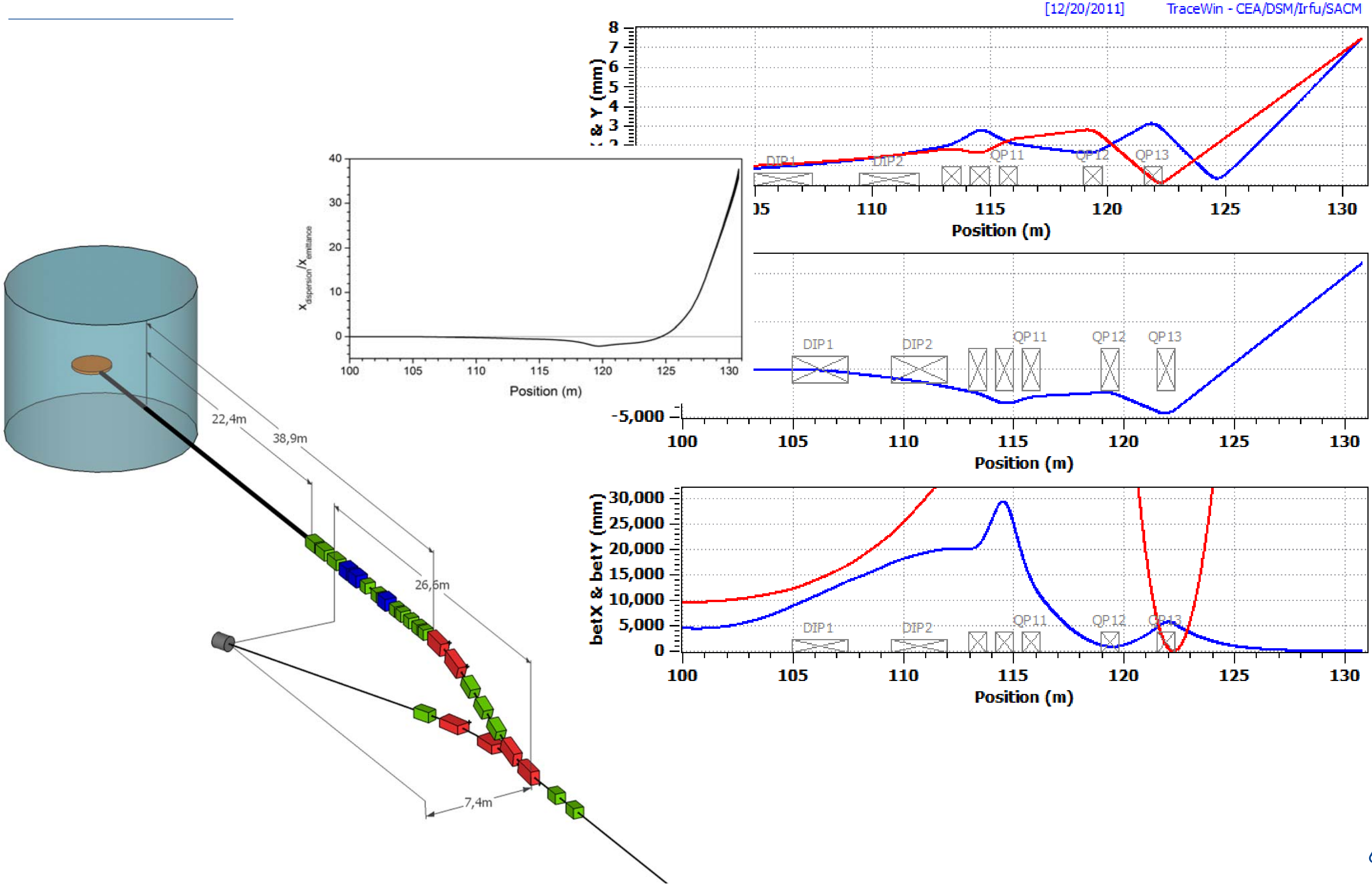


HEBT-TUNE-UP DUMP

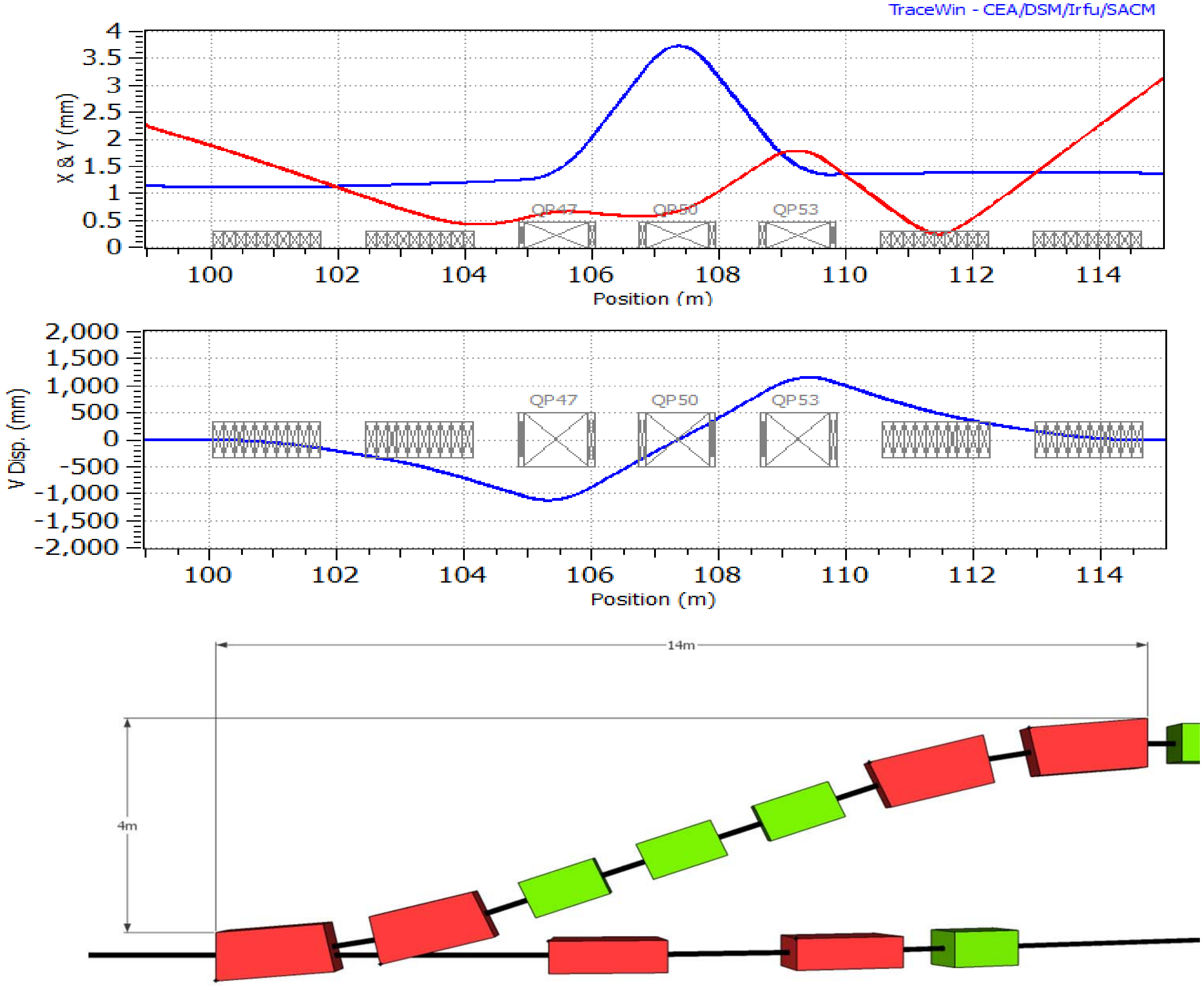




HEBT-TUNE-UP DUMP



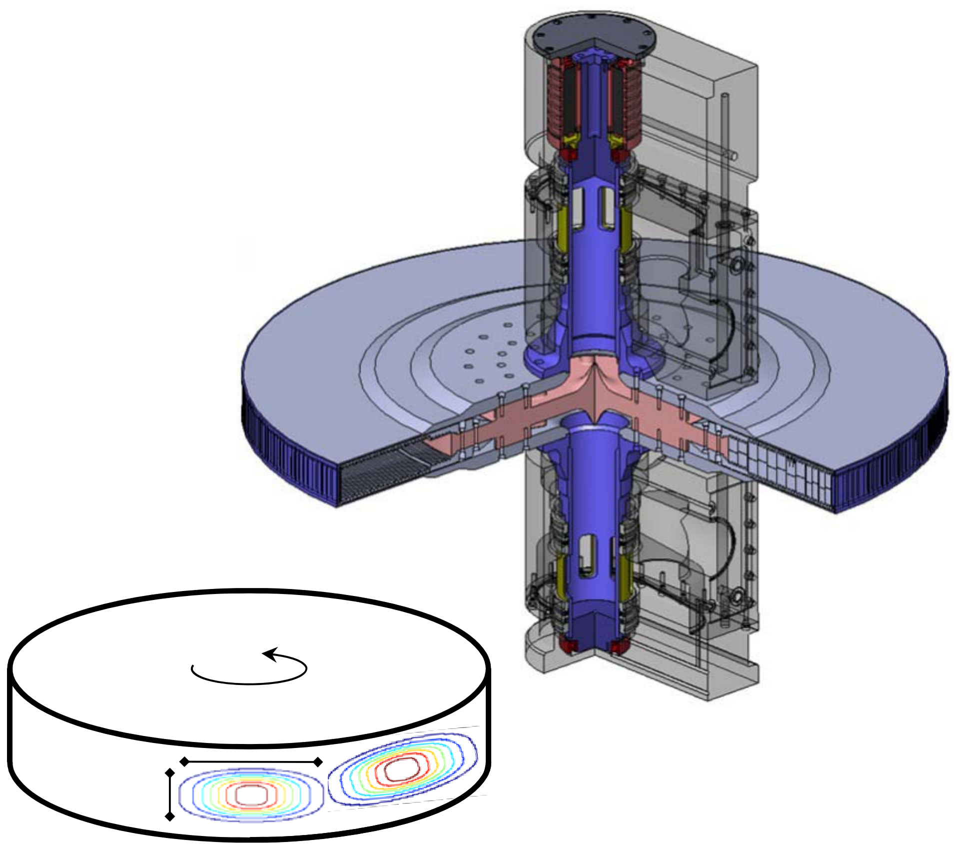
HEBT-S2


TraceWin - CEA/DSM/Irfu/SACM
X & Y (mm)
4
3.5
3
2.5
2
1.5
1
0.5
0
QP47
QP50
QP53
100
102
104
106
108
110
112
114
Position (m)
V Disp. (mm)
2,000
1,500
1,000
500
0
-500
-1,000
-1,500
-2,000
QP47
QP50
QP53
100
102
104
106
108
110
112
114
Position (m)
14m
4m

THE ESS TARGET

› A rotating tungsten wheel

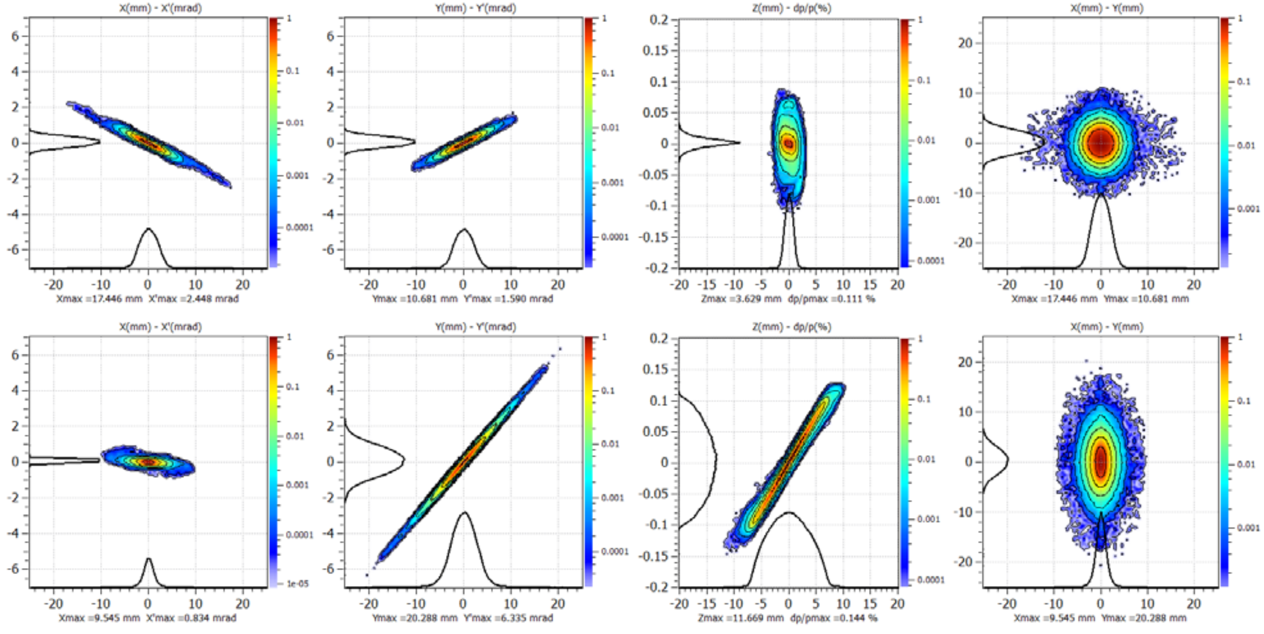
BEAM		
Frequency	14	Hz
Pulse length	2.86	ms
TARGET		
Diameter	2.5	m
Rot. Frequency	0.5	Hz
height	10	cm
Distance between pulses	27	cm



› Requirements:

- › Beam footprint of **160 mm (H) x 60 mm (V)**
- › **No** sharp edges
- › **Low** peak current density (~70 μA/cm^2)

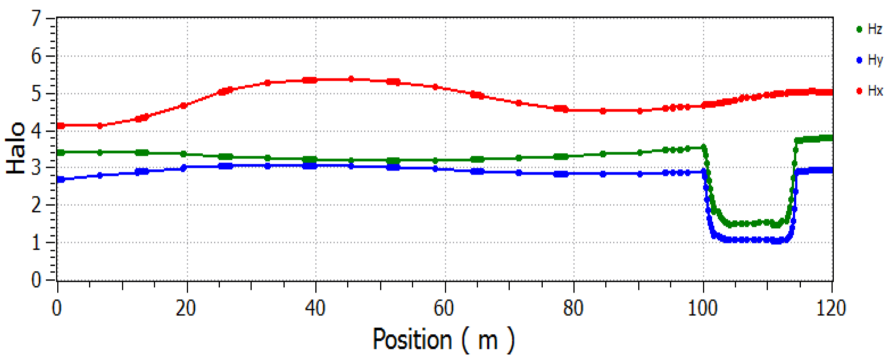
PARTICLE DISTRIBUTIONS



Linac output= HEBT input
(3M particles generated at the entrance of the RFQ with a Gaussian distribution (5 sigma tail) and tracked all the way through the linac)

S2 output
= input to the expander system

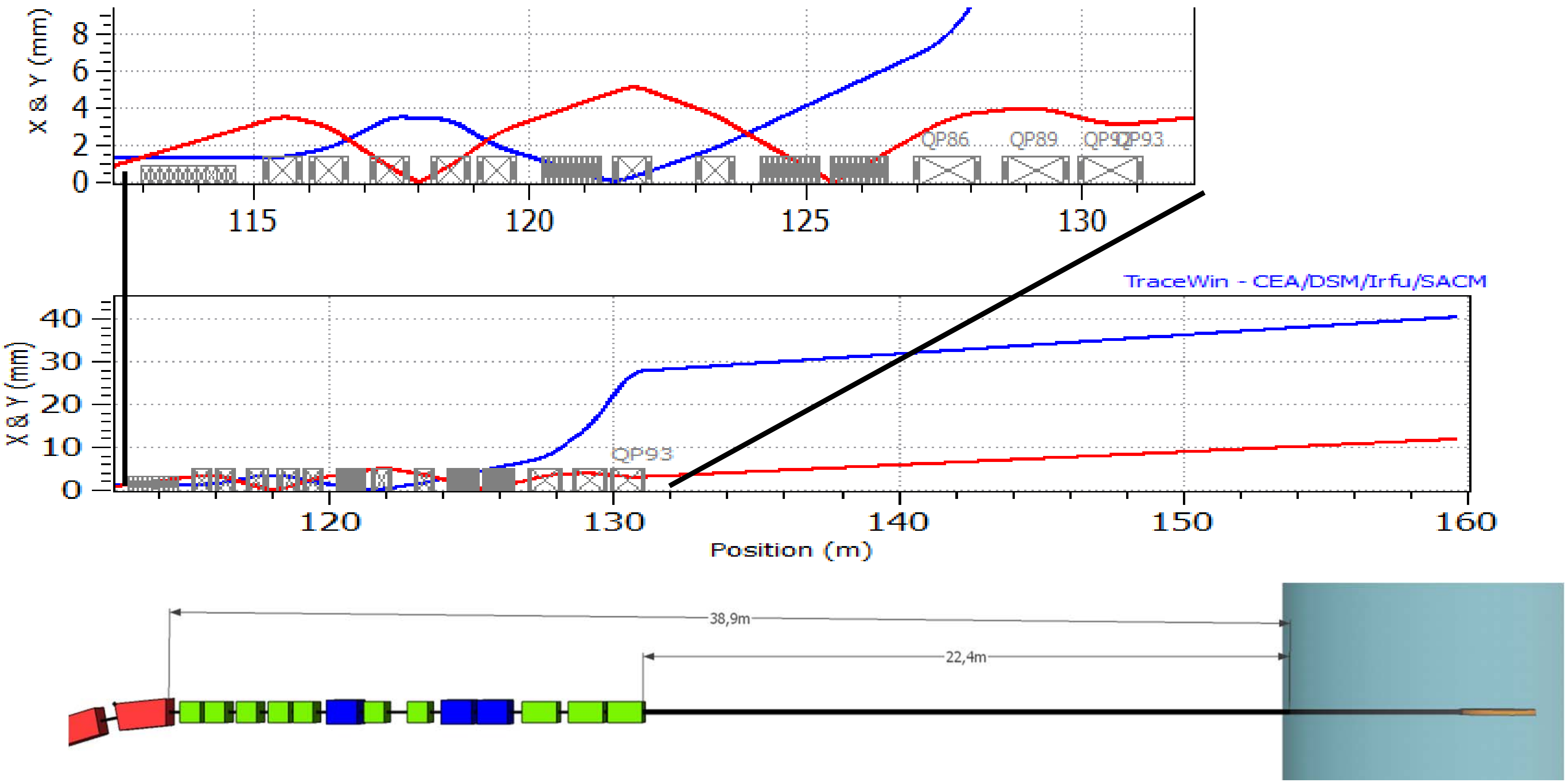
$$\mathrm{RMS_y}=3\ \mathrm{mm} \rightarrow \frac{current\ particle\ density}{gaussian\ particle\ density}(5\ rms) \approx 100$$



H is a measure of the spatial halo formation.
H = 6/7 → Gaussian beam
Large H → long tails

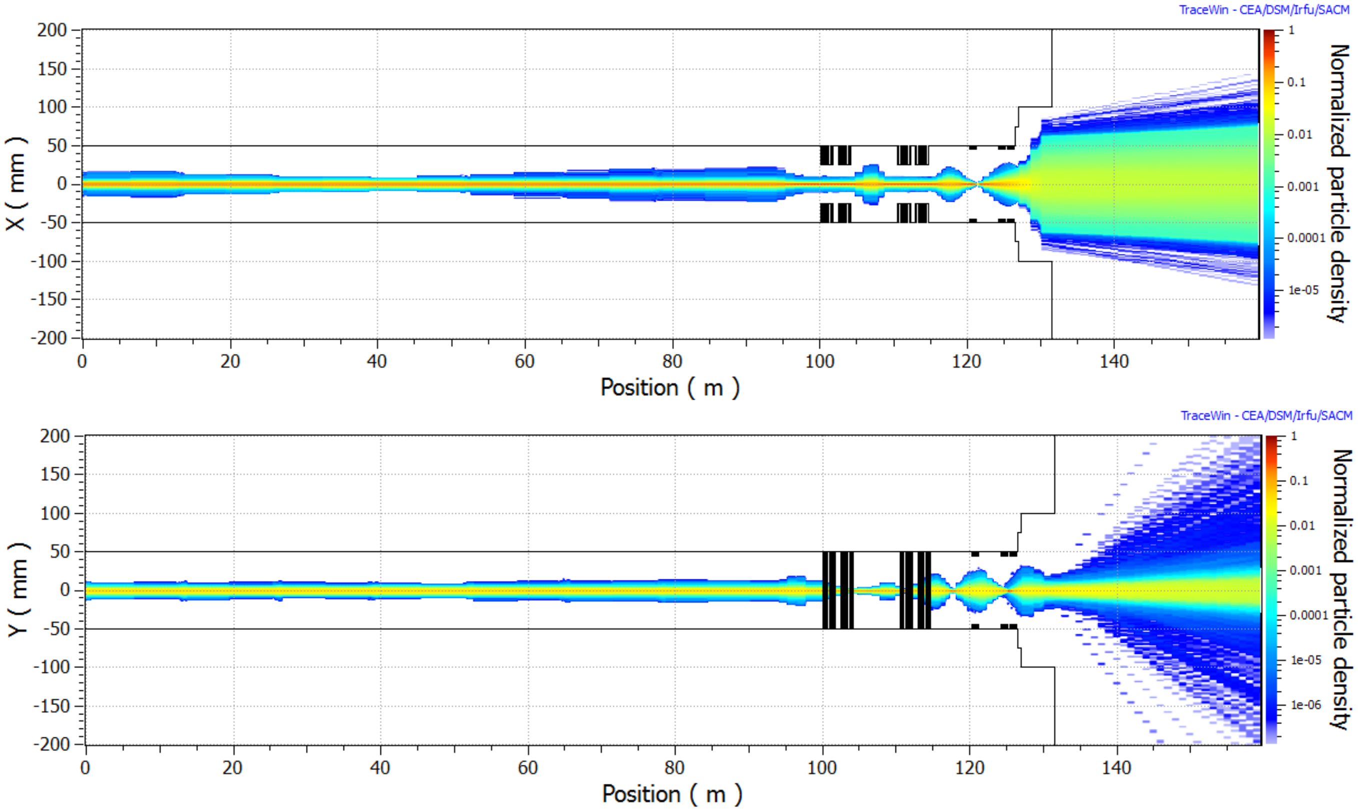
HEBT-S3

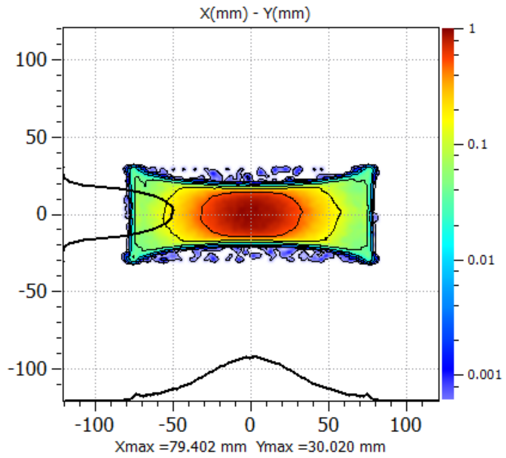
› Expander system
  › Octupole folding and quadrupole spreading



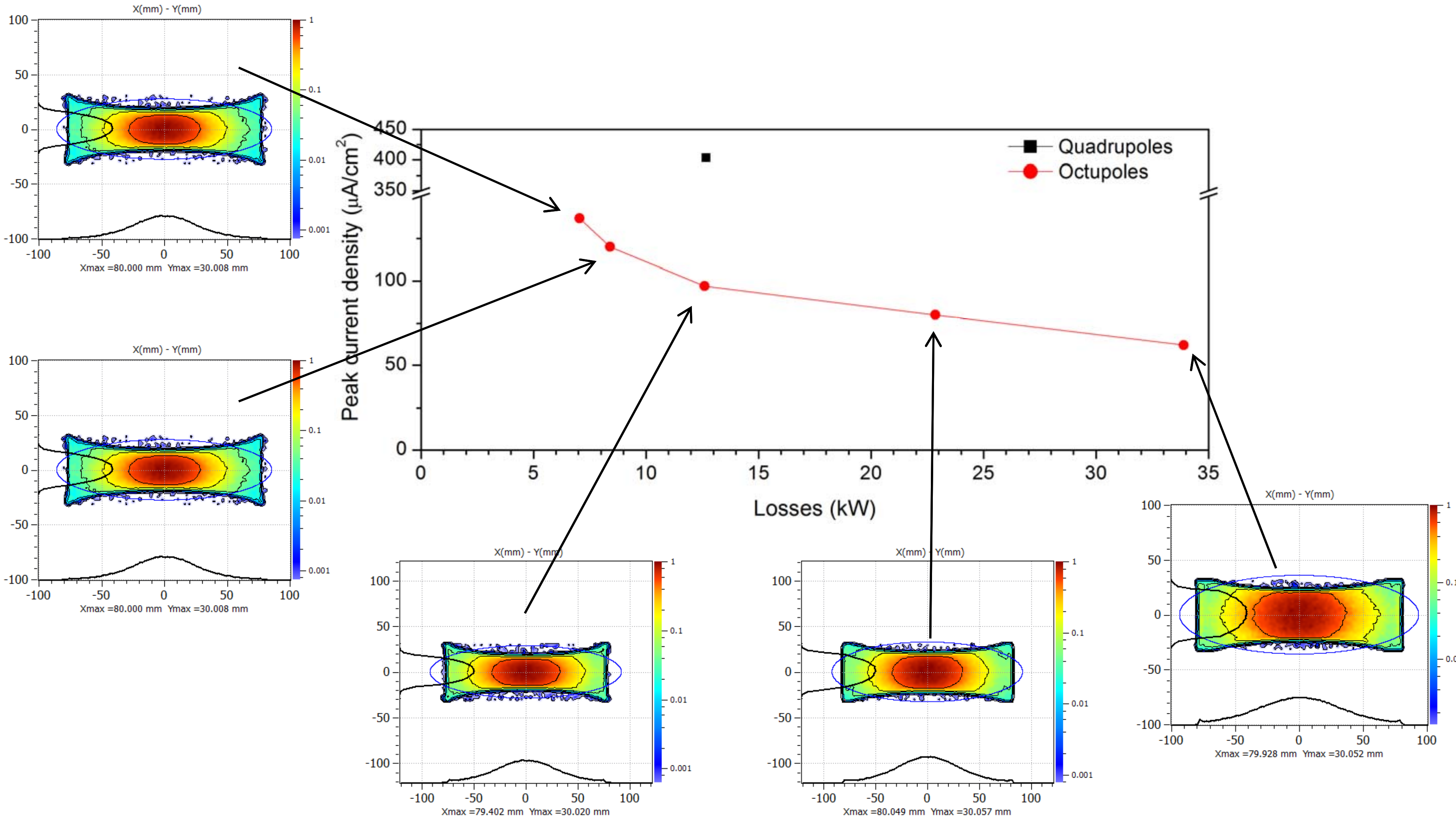
HEBT-S3 (EXAMPLE 12.6 KW IN COLLIMATOR)

› Expander system
  › Octupole folding and quadrupole spreading



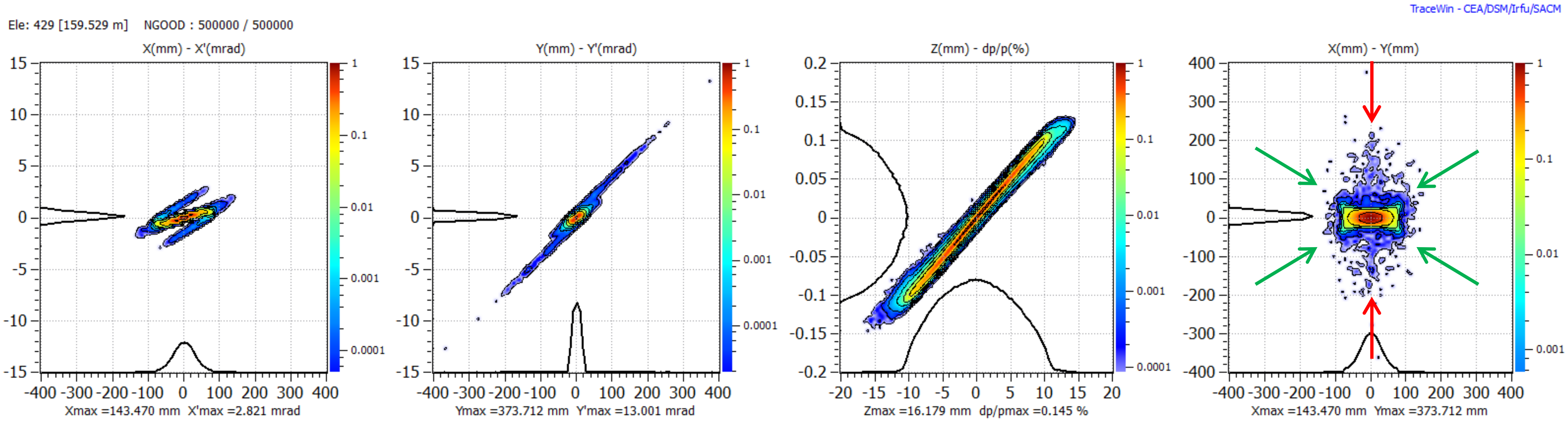


HEBT-S3 (PARTICLES OUTSIDE FOOTPRINT)

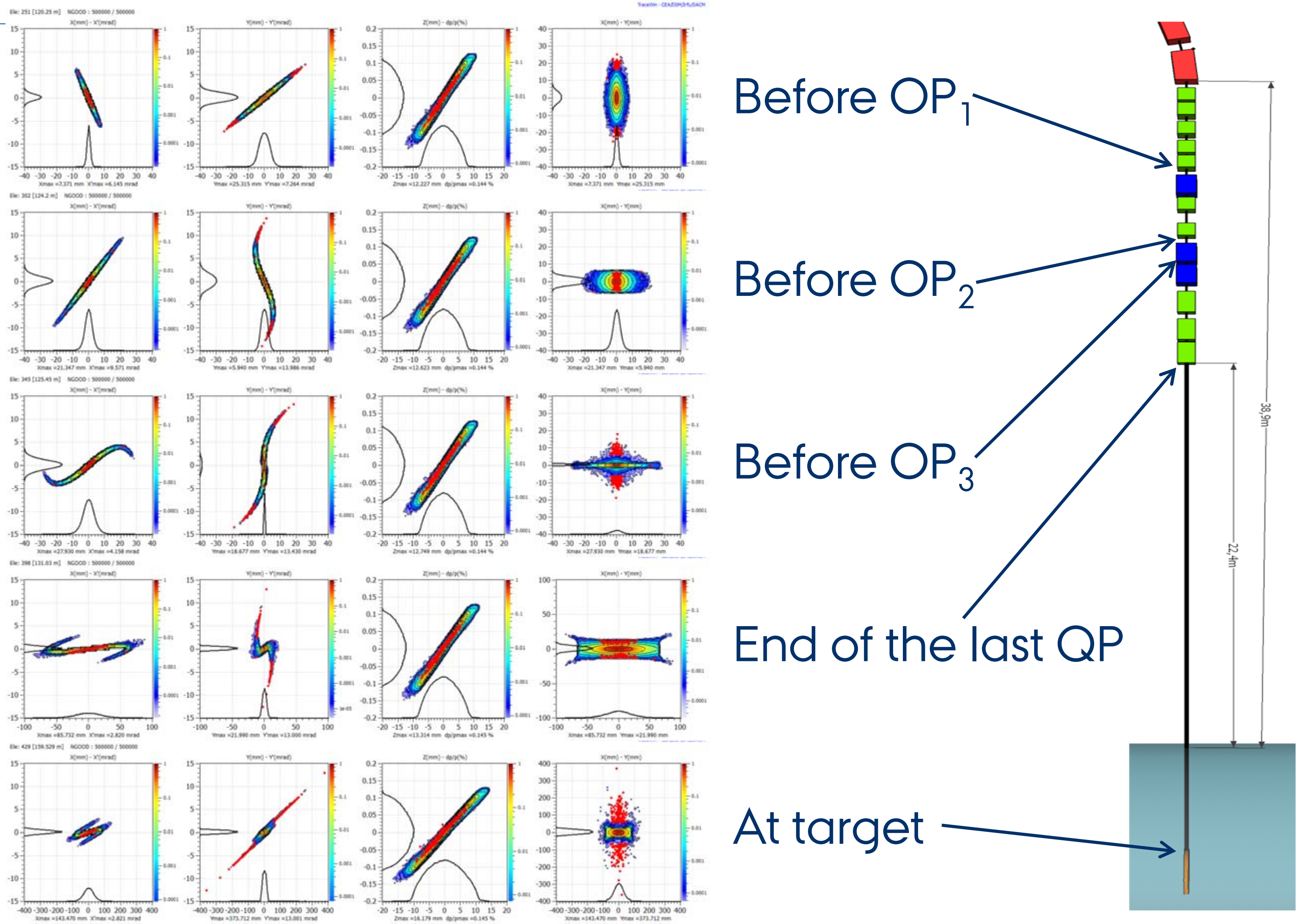


LARGE AMPLITUDE PARTICLES

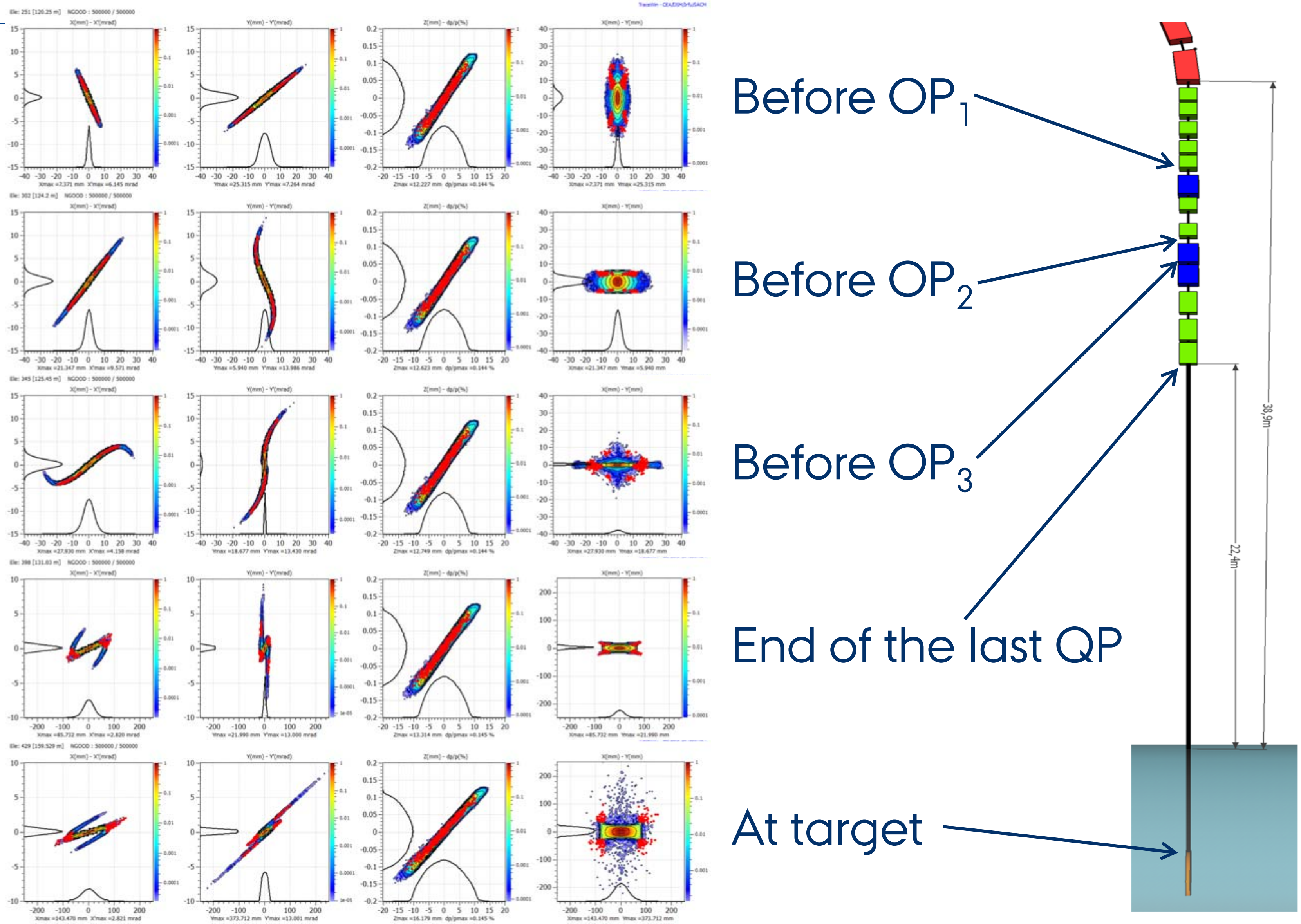
› Two issues



OVER-FOCUCED PARTICLES

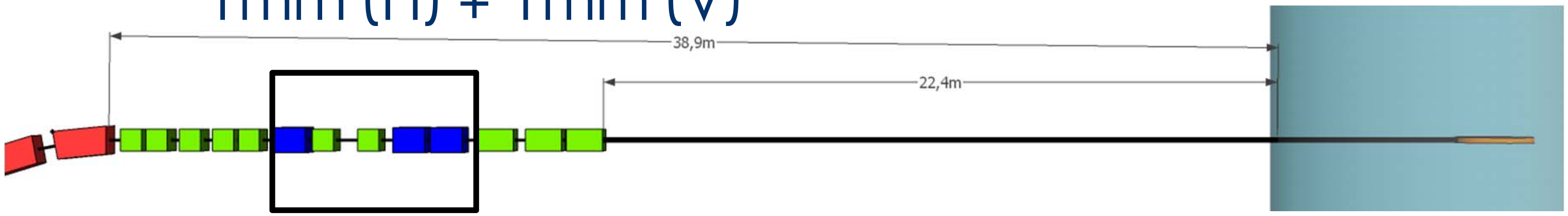


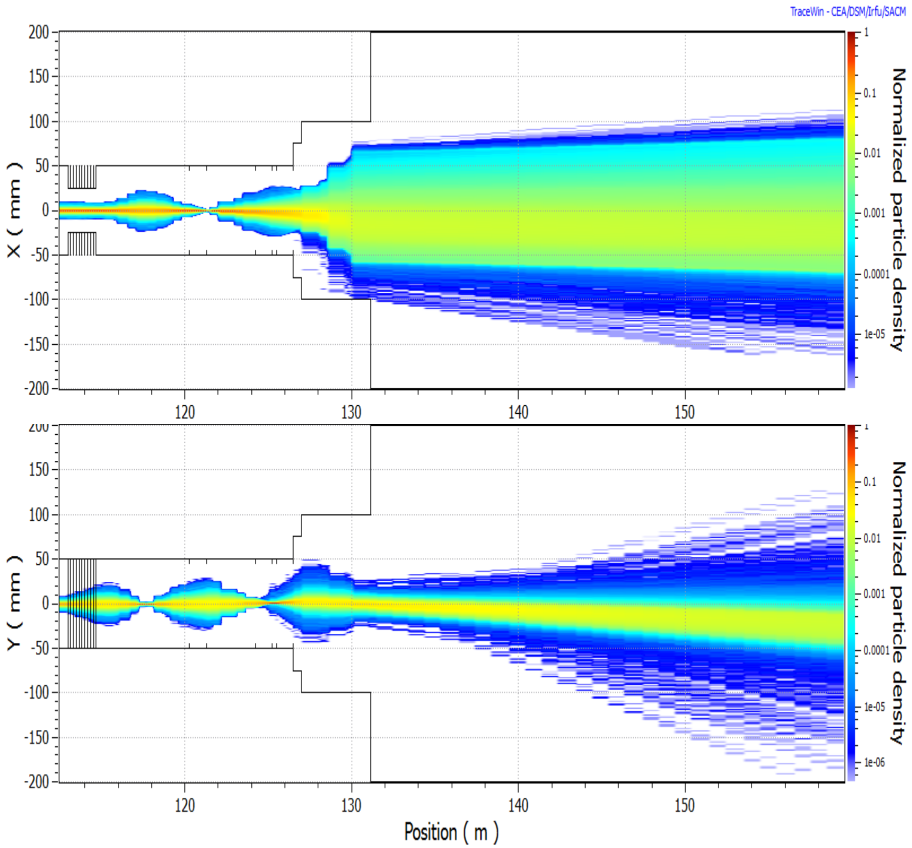
UNDER-FOCUCED PARTICLES

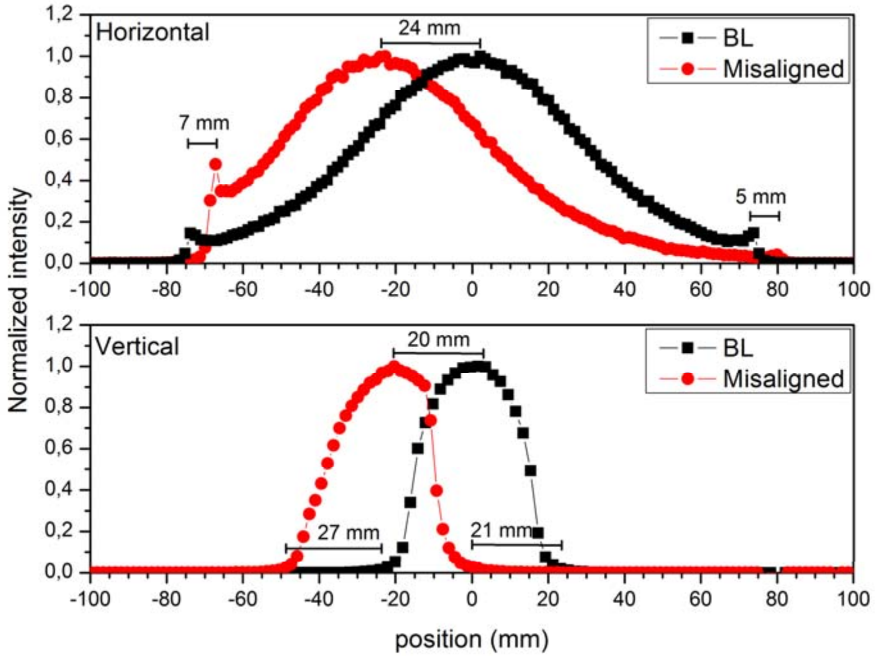


MISALIGNMENT

1mm (H) + 1mm (V)



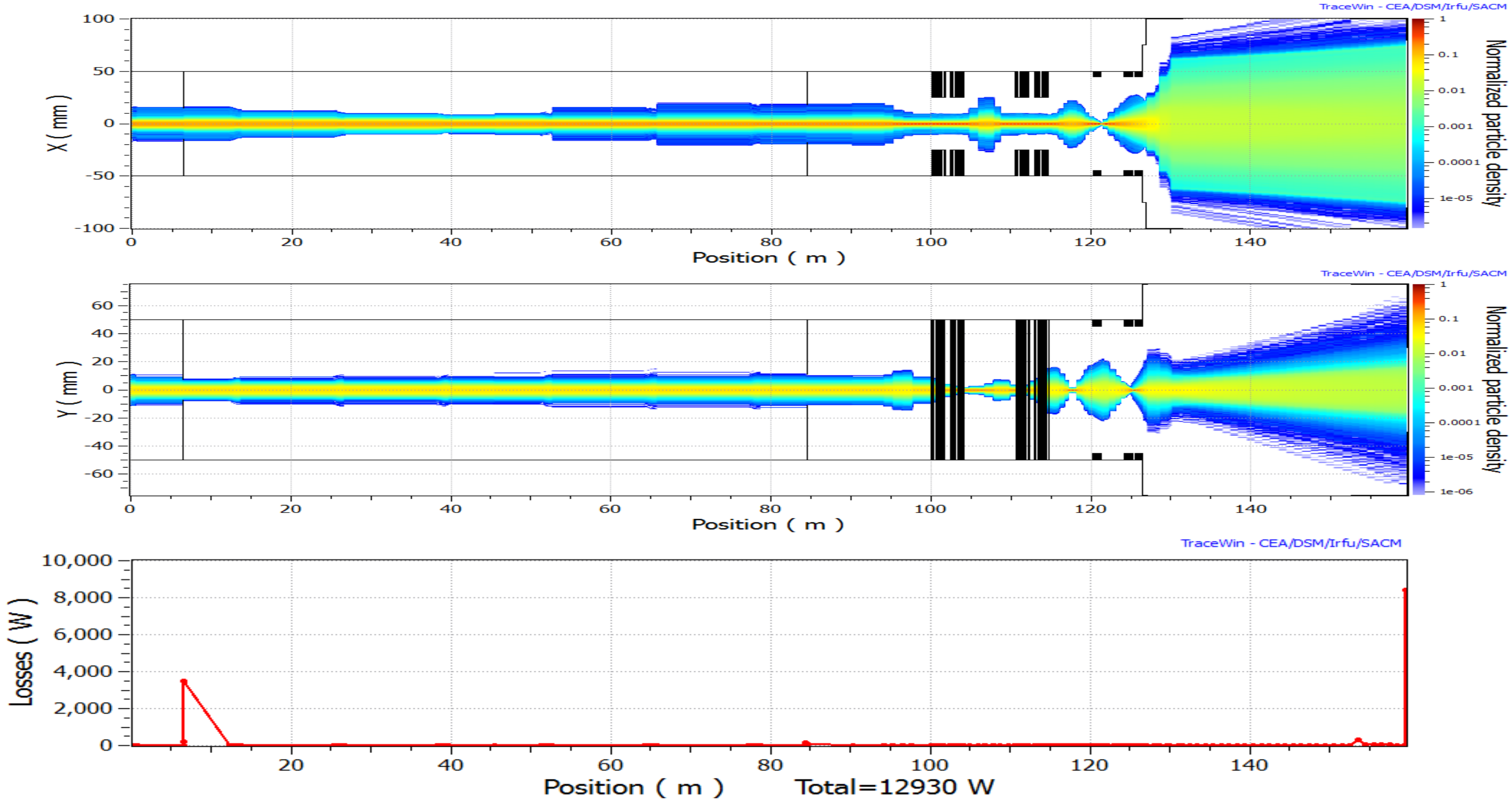




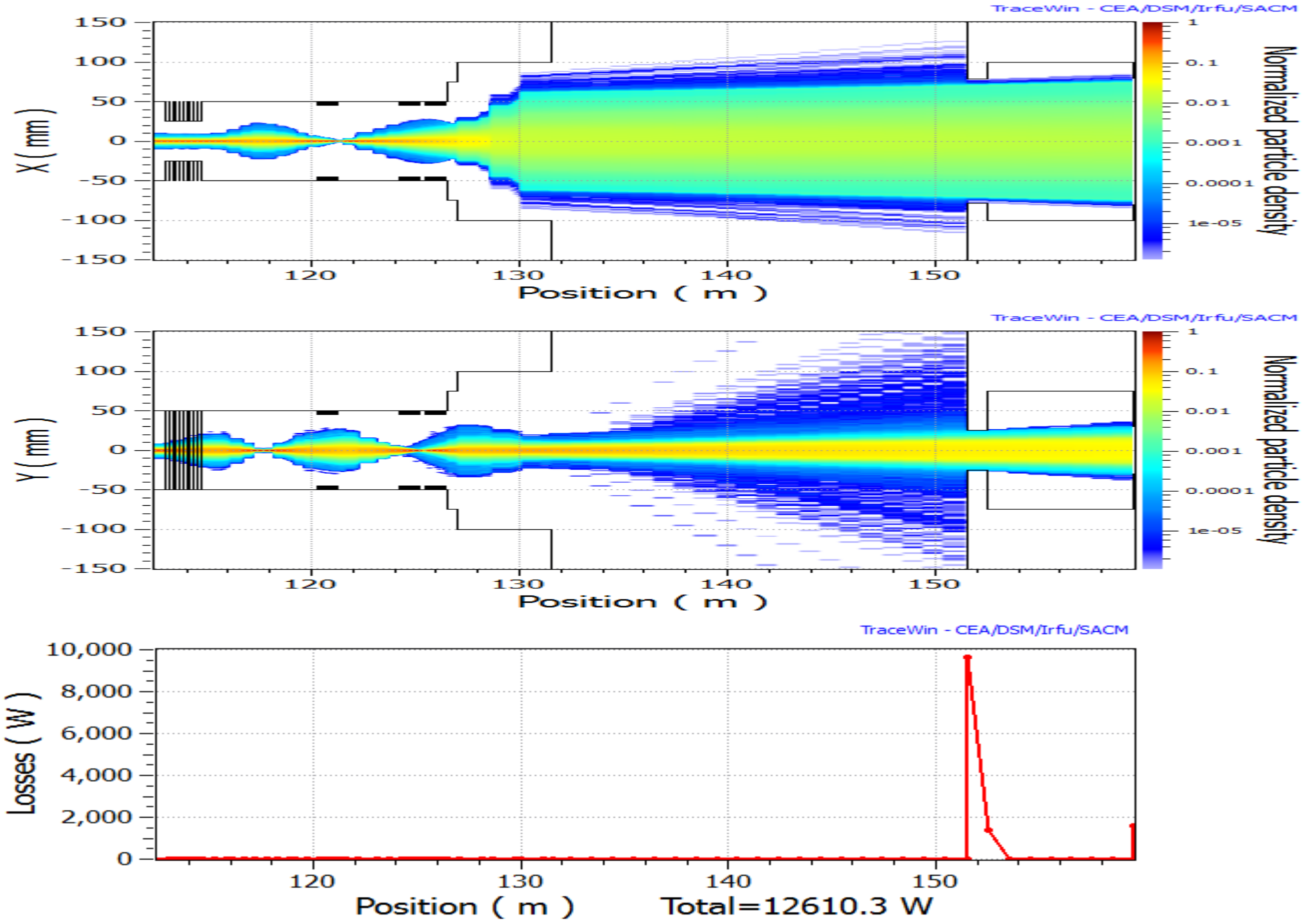
COLLIMATION

- What collimation strategy to use?
  - Movable collimators
    - In S1: Low phase advance, would take space away from upgrade
    - In S2: No space
    - In S3: E.g. before octupoles
  - Fixed collimators
    - In S3 !

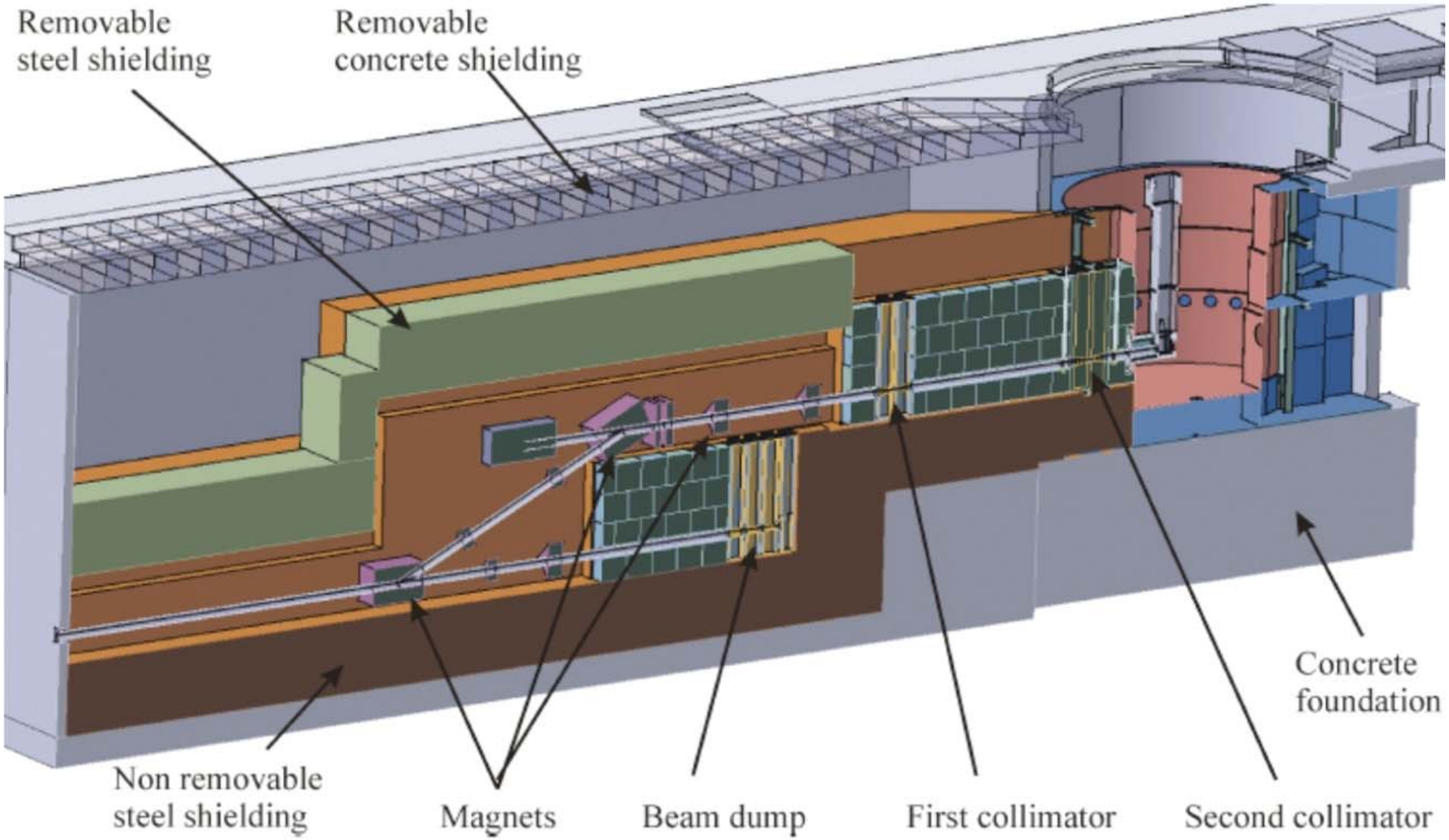
COLLIMATION IN S1 = MOVEABLE



COLLIMATION IN S3 = FIXED

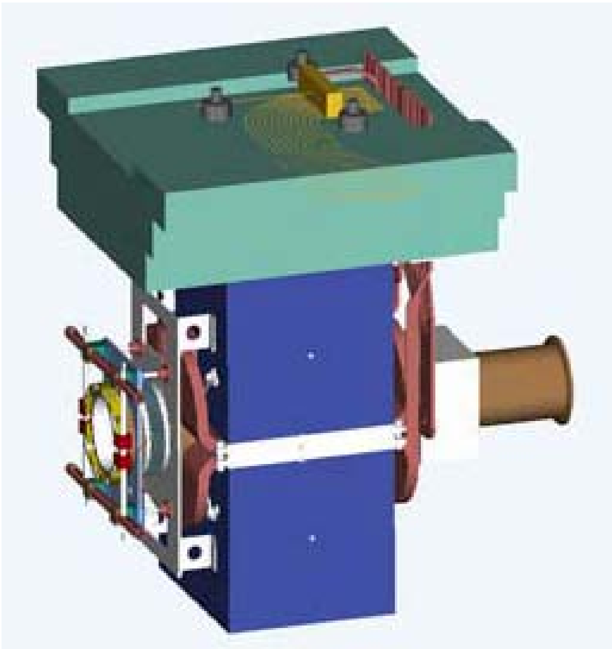


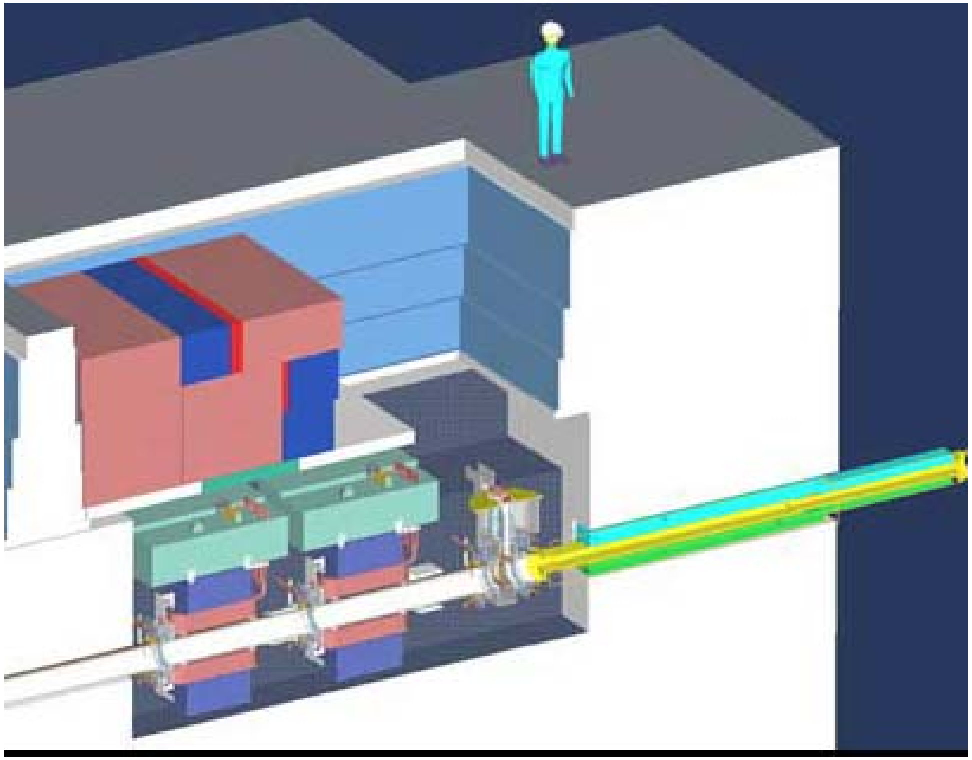
HIGH RADIATION LEVEL (→ 10 MGY/Y)



HIGH RADIATION LEVEL (→ 10 MGY/Y)

- Remote exchange





OPEN POINTS…

- Apertures in magnets?
- Optimize peak current density *vs.* Power on the fixed collimator?
- How useful would S1 collimation be?
- How do we define a ”worst case” beam?
  - For commissioning
  - For operation
- Influence of errors?

OUR JOB

› Part of work package 7

2.1.7.2 1.7.2: High-Energy Beam Transport (S. Pape-Møller, Aarhus)

This work unit is designing the high-energy beam transport from linac output to targets. It includes the following main points

- Beam transport and expander design
- Upgrade transport systems
- Collimation systems design
- HEBT Mechanical systems

COLLIMATION

Steel/Marble mask to protect downstream magnets

Steel/Concrete mask to capture out-scattered particles and neutrons