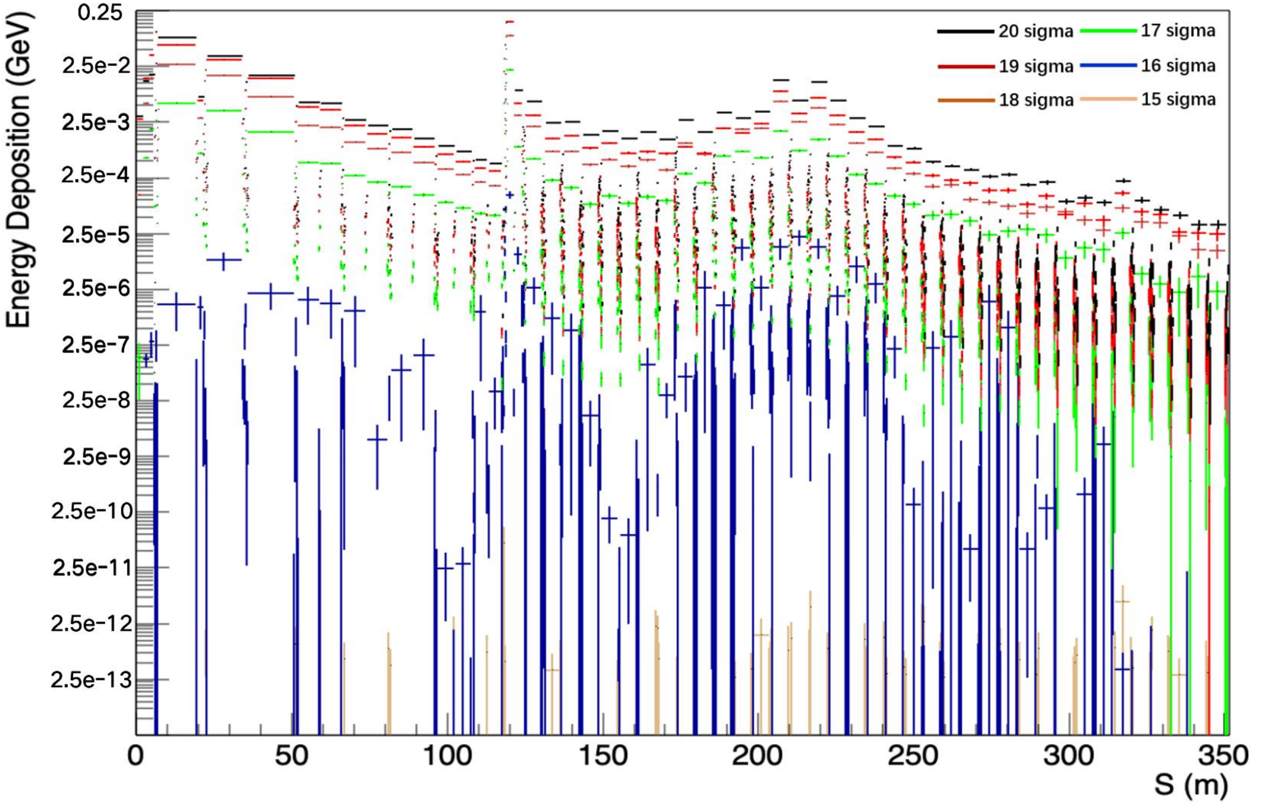
Beam loss study for the implementation of dechirper at the European XFEL



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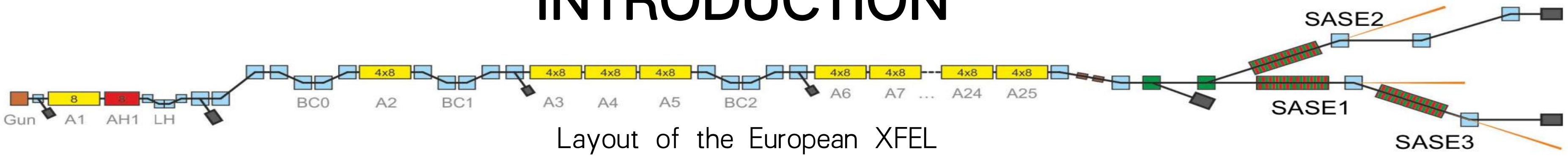
TUPAB 119

IPAC21 European XFEL DESY

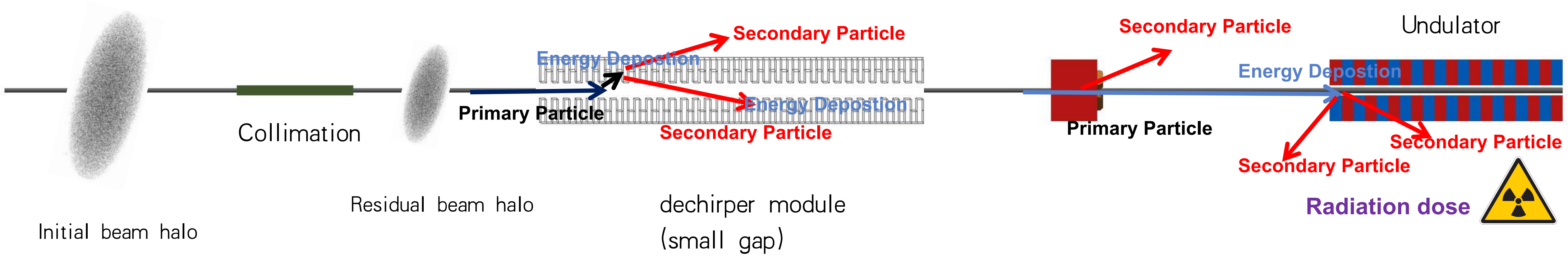
INTRODUCTION



Layout of the European XFEL

Motivation to use Dechirper Structure (or Wakefield Structure)

- WS will allow the longitudinal and the transverse **phase space manipulations** of the electron beams
- The longitudinal wakefields introduce the correlated energy chirp along the bunch which can be used to increase or to decrease the **radiation bandwidth of SASE**
- WS as **kicker** for two color/fresh slice scheme



THE LOCATION AND GEOMETRY OF DECHIRPER STRUCTURE

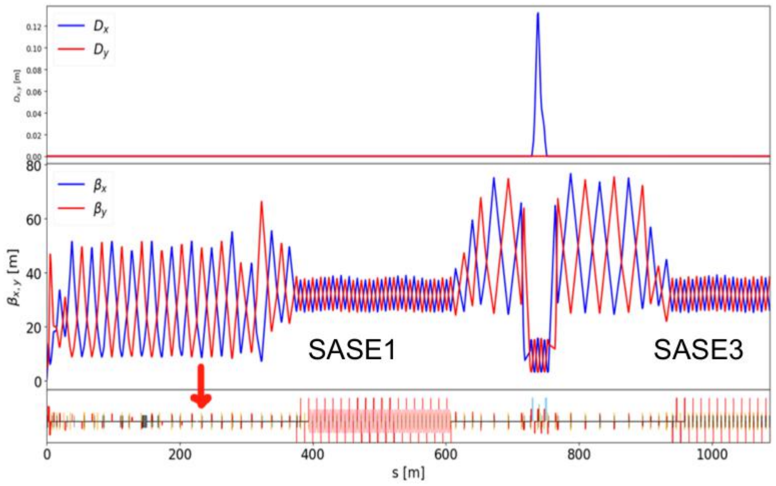


Figure 1: The design optics along SASE1 and SASE3, and The position of dechirper. The red arrow points to the position of dechirper

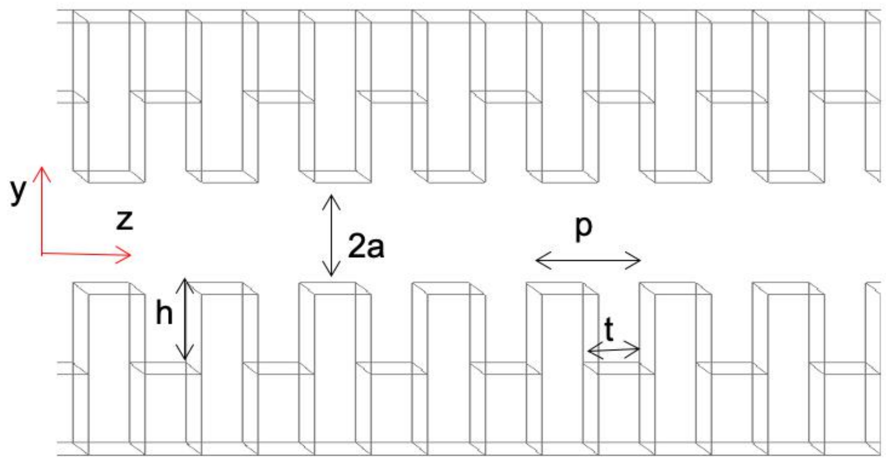


Figure 2: Geometry of the dechirper structure.

- The dechirper structure is located upstream of SASE1, as indicated by the red arrow in the Fig. 1
- The geometry of the dechirper structure is shown in Fig. 2, which is horizontally oriented.
- Detailed parameters of dechirper structure are listed in Table 1.

Table 1: Parameters of the dechirper structure

Parameter name	Value (mm)
Depth, h	0.5
Gap, t	0.25
Period, p	0.5
Half aperture, a	0.7
Half width, w	6
Length, L	2000

BDSIM SIMULATION MODEL

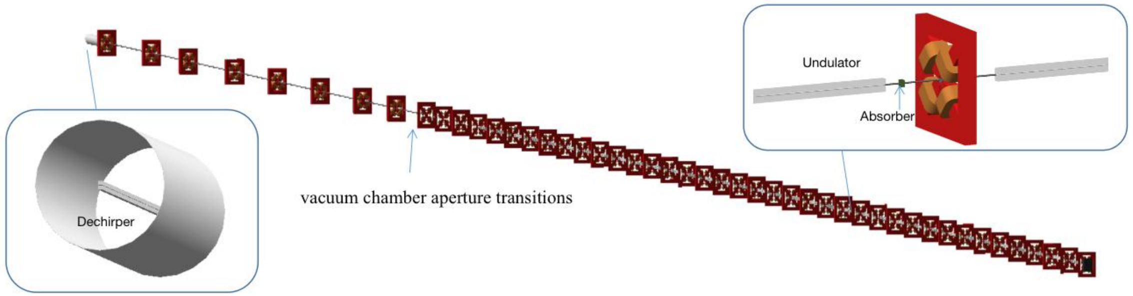
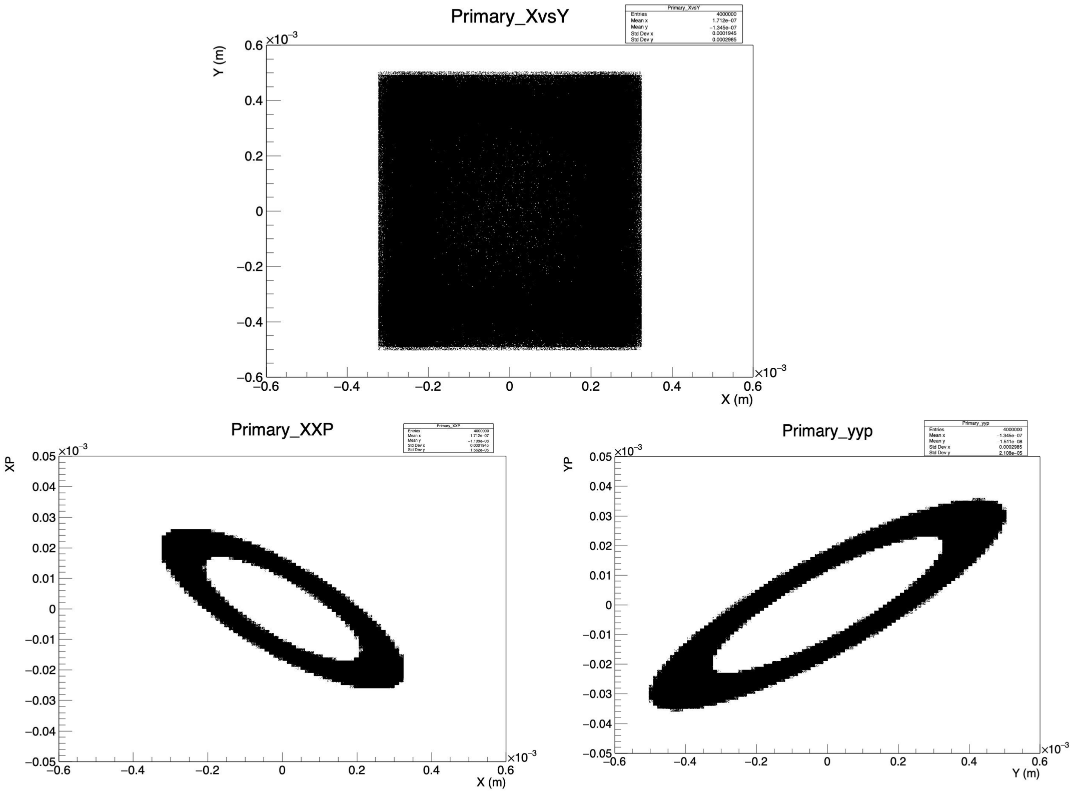


Figure 3：Geometry from dechirper to SASE1 used in the BDSIM simulation.

- Beam parameter settings is listed in Table 2
- The model used in the simulation shown in Fig. 3

Table 2: Beam parameters used in simulations

Parameter name	Value	Unit
Beam energy, E	14	GeV
Alpha function, α_x/α_y	1.25/-1.67	
Beta function, β_x/β_y	19.93/27.56	m
Emittance, ϵ_x/ϵ_y	0.64/1.09	μm
Number of primary particle, N	4×10^6	
Beam halo start sigma, σ	±10	
Beam halo stop sigma, σ	±(15-20)	



Initial Beam halo uniform flat distribution with 15 sigma extension (10 sigma beam core have been removed)

ENERGY DEPOSITION AND RADIATION DOSE

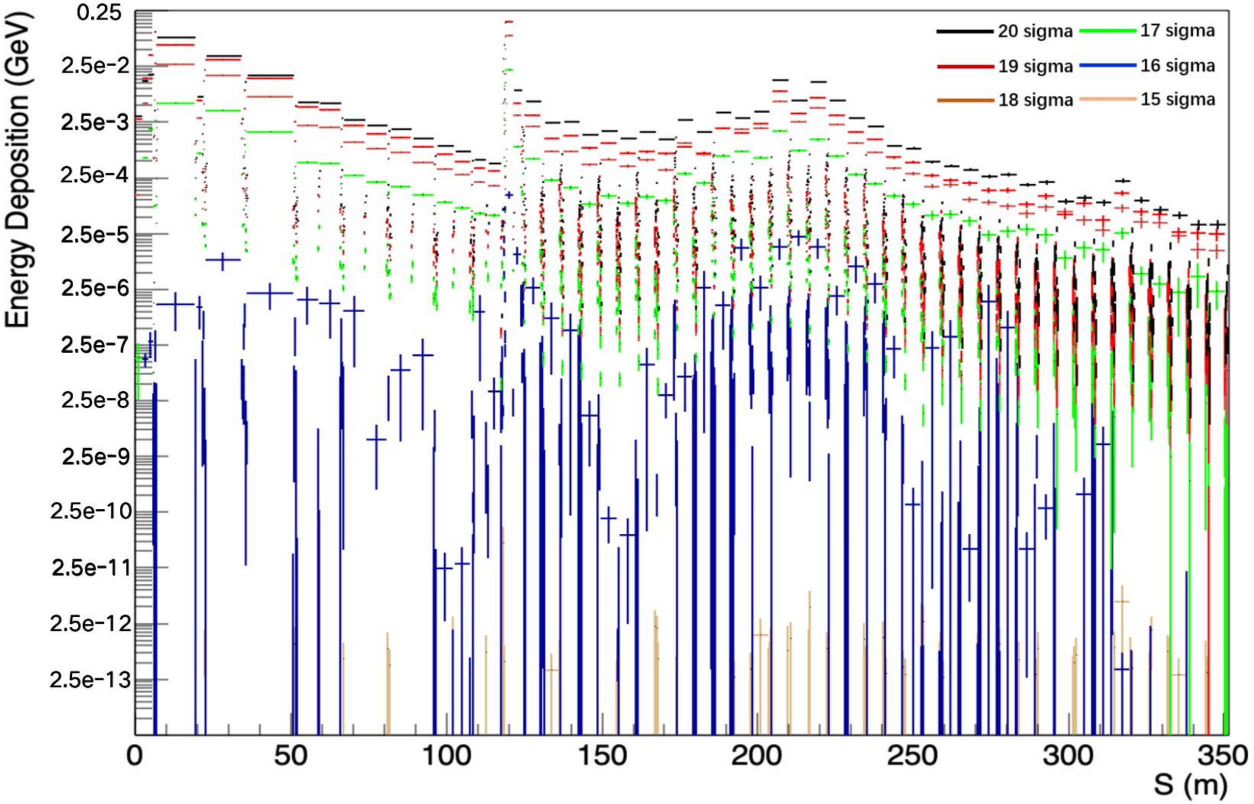


Figure 4：Energy loss per element.

The radiation loss generated per hour can be derived from the following equation：

$$D = R \cdot N_e \cdot F \cdot N_b \cdot T, \qquad (1)$$

- D：radiation dose per hour
- R：radiation dose per event in Gray
- N_e：number of events (input number of electrons)
- F：fraction of beam halo within one bunch
- N_b：number of bunches per second
- T：one hour of machine running time

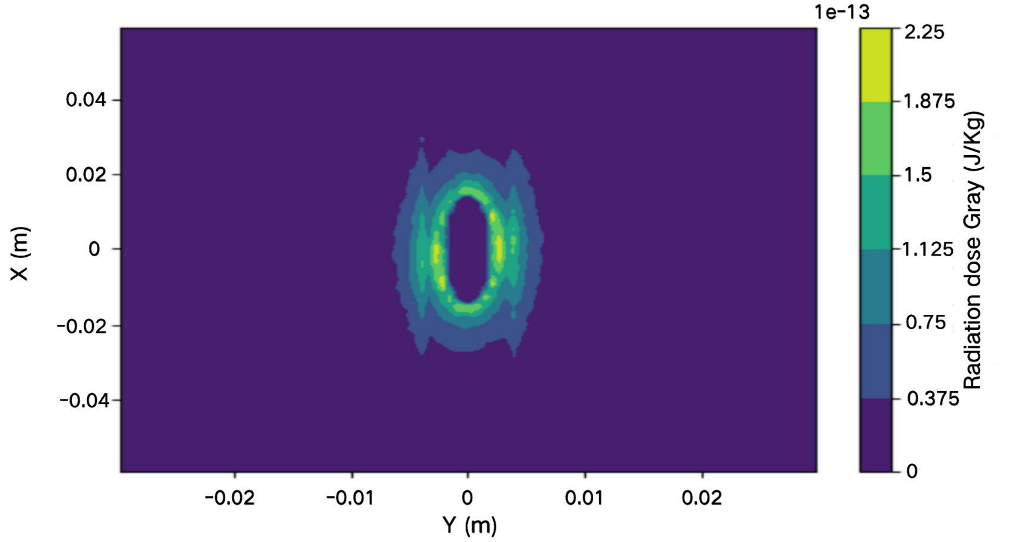


Figure 5：Scoring map of undulator cross—section for beam halo extension with 20 sigma.

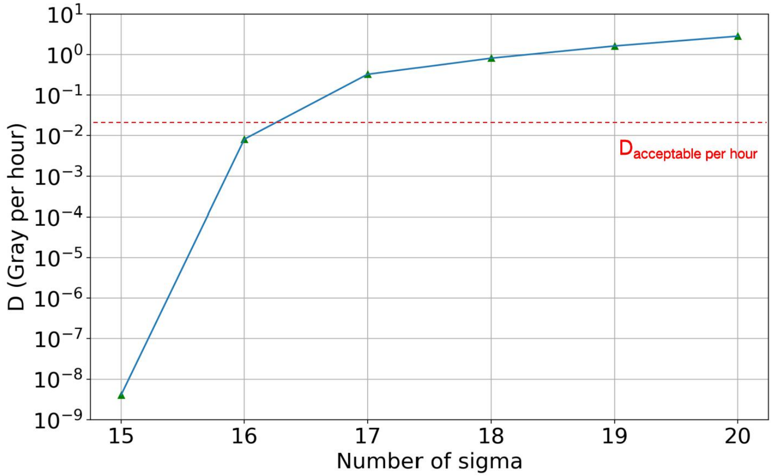


Figure 6：Radiation Dose obtained from simulation with different extension of beam halo.

BEAM HALO MEASUREMENTS

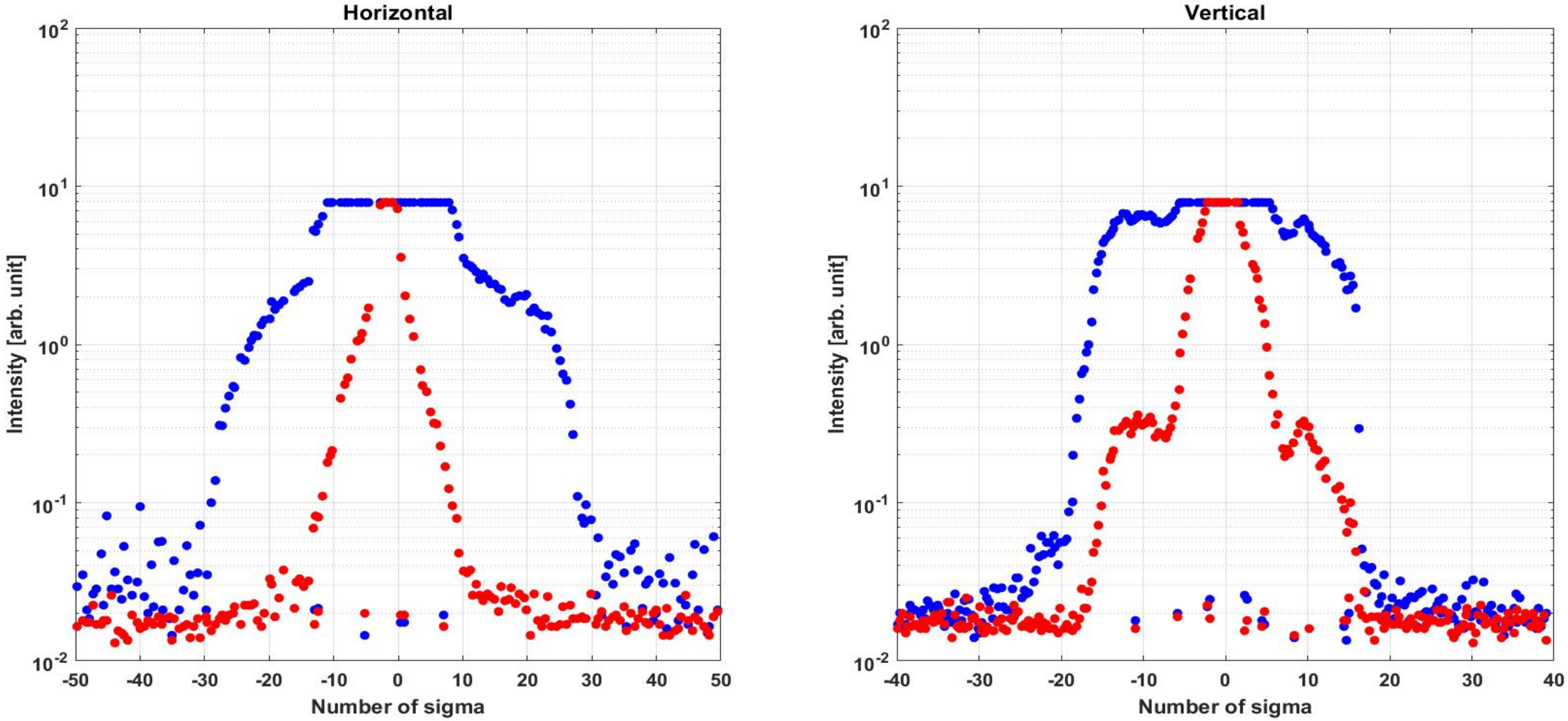


Figure 7: Beam halo distribution measured upstream dechirper. Left side is horizontal , and right side is vertical. Dots from two different detector channels. Solid line is Gaussian fit for beam core

Discussions and Future plan

- Above 16 sigma of beam halo is not acceptable for the horizontally orientated dechirper with the design optics.
- If two dechirper modules were installed vertically, maximum acceptable sigma of beam halo would be 32 sigma.
- By extending the number of dechirper modules to three, even more energy deposition and radiation dose in the downstream undulators have been observed.
- *In the future, we will add additional shielding/collimation downstream of the dechirper module in our simulation.*

Thankyou for your attention!