TUPP078

High Gain FEL with a Micro-bunch Structured Beam by the Transverse-Longitudinal Phase Space Rotation

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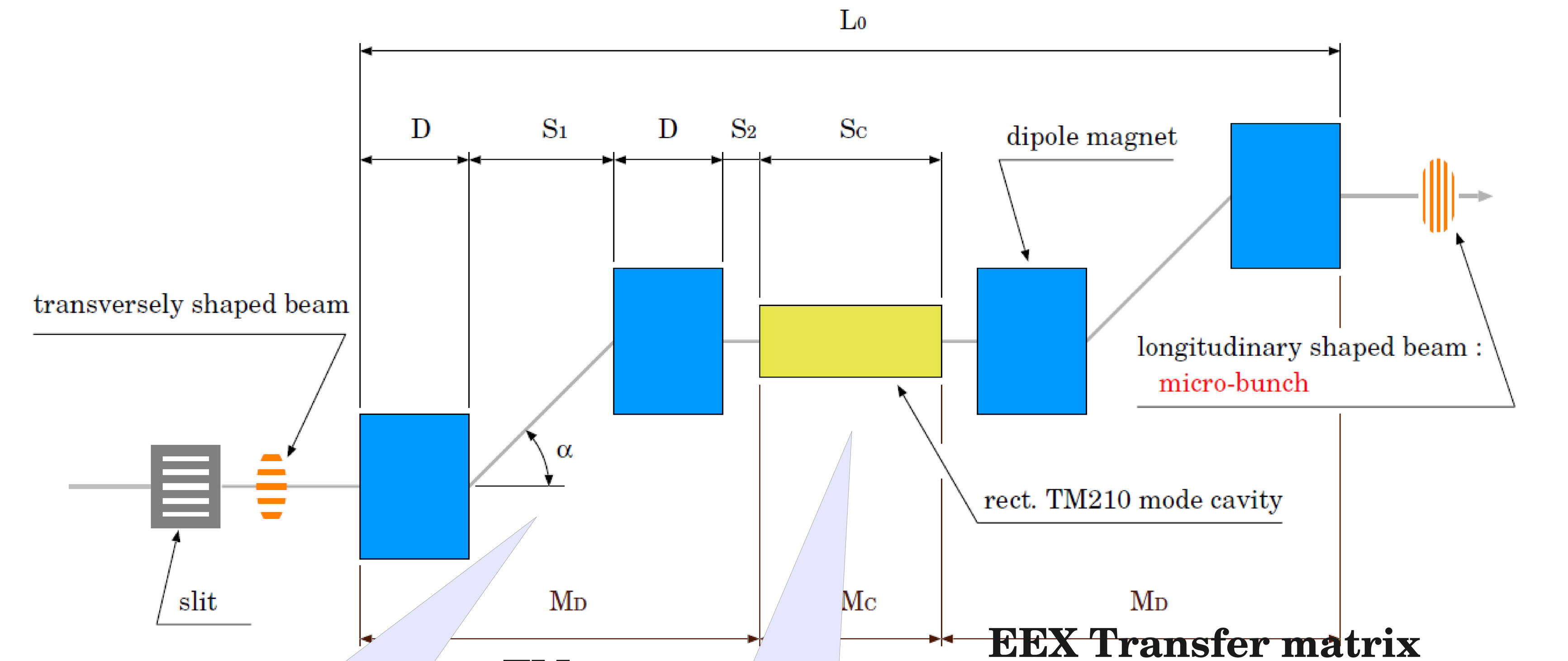
FEL is one of the ideal radiation source over the wide range of wavelength region with a high brightness and a high coherence. Many methods to improve FEL gain has been proposed by introducing an active modulation on the bunch charge distribution. The transverse-longitudinal phase-space rotation is one of the promising method to realize the density modulation as the micro-bunch structure. Initially, a beam density modulation in the transverse direction made by a mechanical slit, is properly transformed into the density modulation in the longitudinal direction by the phase-space rotation. That results the longitudinal micro-bunch structure. The micro-bunch structure made with this method has a large tunability by changing the slit geometry, the beam line design, and the beam dynamics tuning. A compact FEL facility based on this method is proposed.



Dog-Leg

$$M_D(\eta,\xi,L) = \begin{bmatrix} 1 & L & 0 & \eta \\ 0 & 1 & 0 & 0 \\ 0 & \eta & 1 & \xi \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

TM210

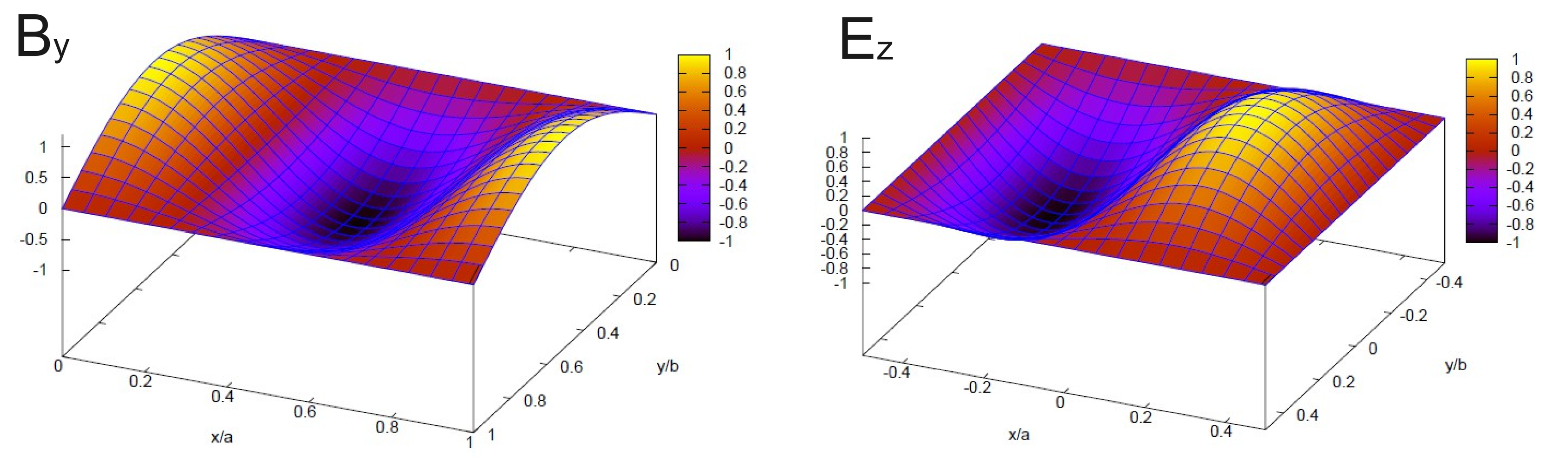
$$M_C(k) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & k & 0 \\ 0 & 0 & 1 & 0 \\ k & 0 & 0 & 1 \end{bmatrix}$$

EEX Transfer matrix

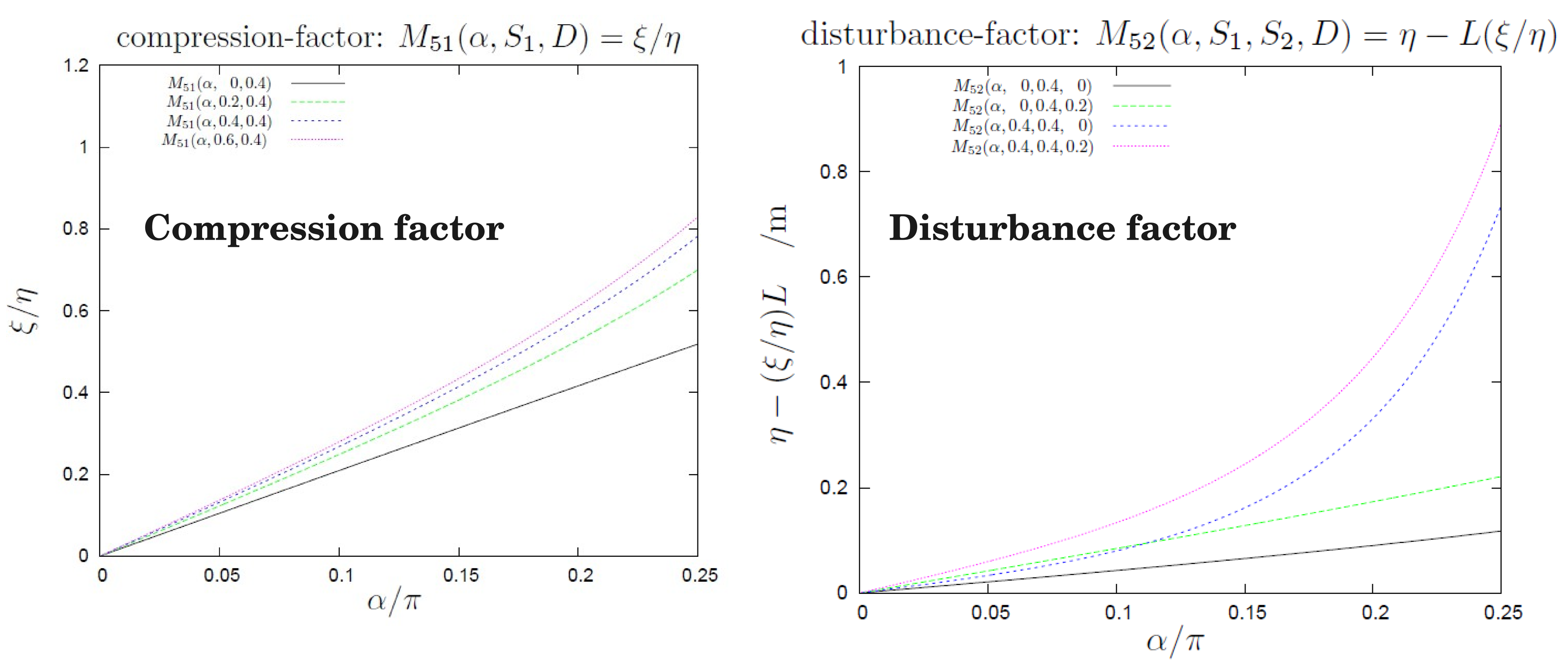
$$M_{EX}(\eta,\xi,L,k) = M_D M_C M_D$$

$$= \begin{bmatrix} 0 & 0 & -L/\eta & \eta - L\xi/\eta \\ 0 & 0 & -1/\eta & -\xi/\eta \\ -\xi/\eta & \eta - L\xi/\eta & 0 & 0 \\ -1/\eta & -L/\eta & 0 & 0 \end{bmatrix}$$

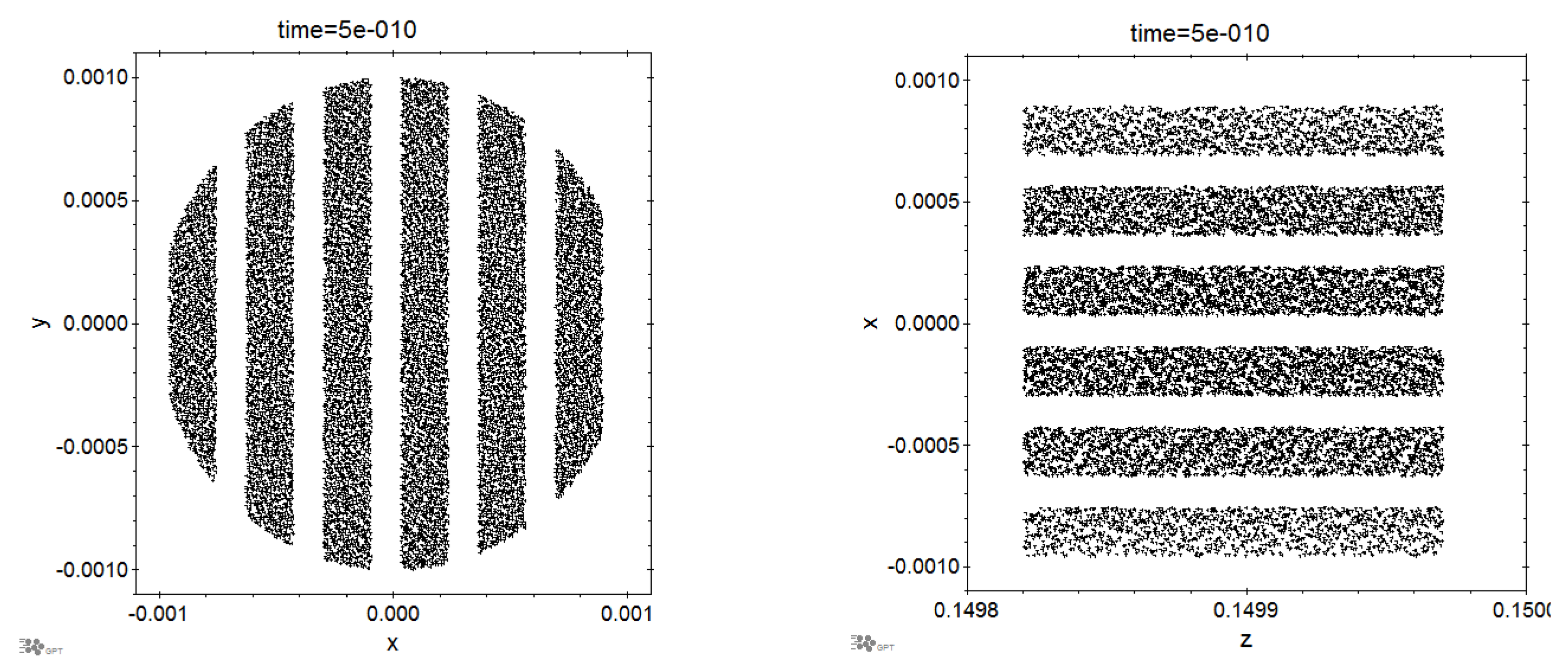
TM210 mode cavity



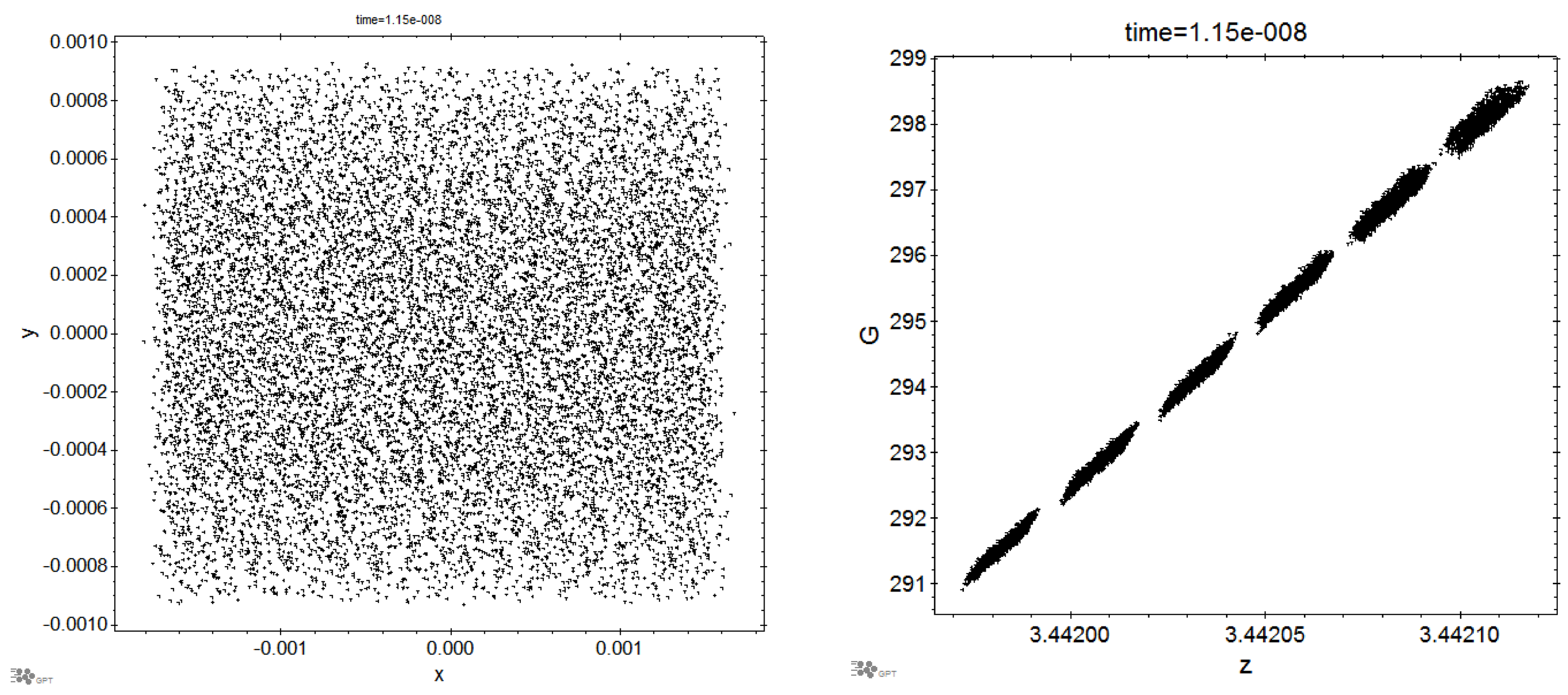
Parameter	Value	unit
Beam Energy	**150**	**MeV**
Dipole length	**400**	**mm**
Bending angle	**5.07**	**deg.**
EEX total Length	**2.8**	**m**
Dispersion	**61.7**	**mm**
Compression factor	**0.0946**	
Cavity Max. field	**25.9**	**MV/m**
Cavity Freq.	**2856**	**MHz**
Cavity length	**315**	**mm**



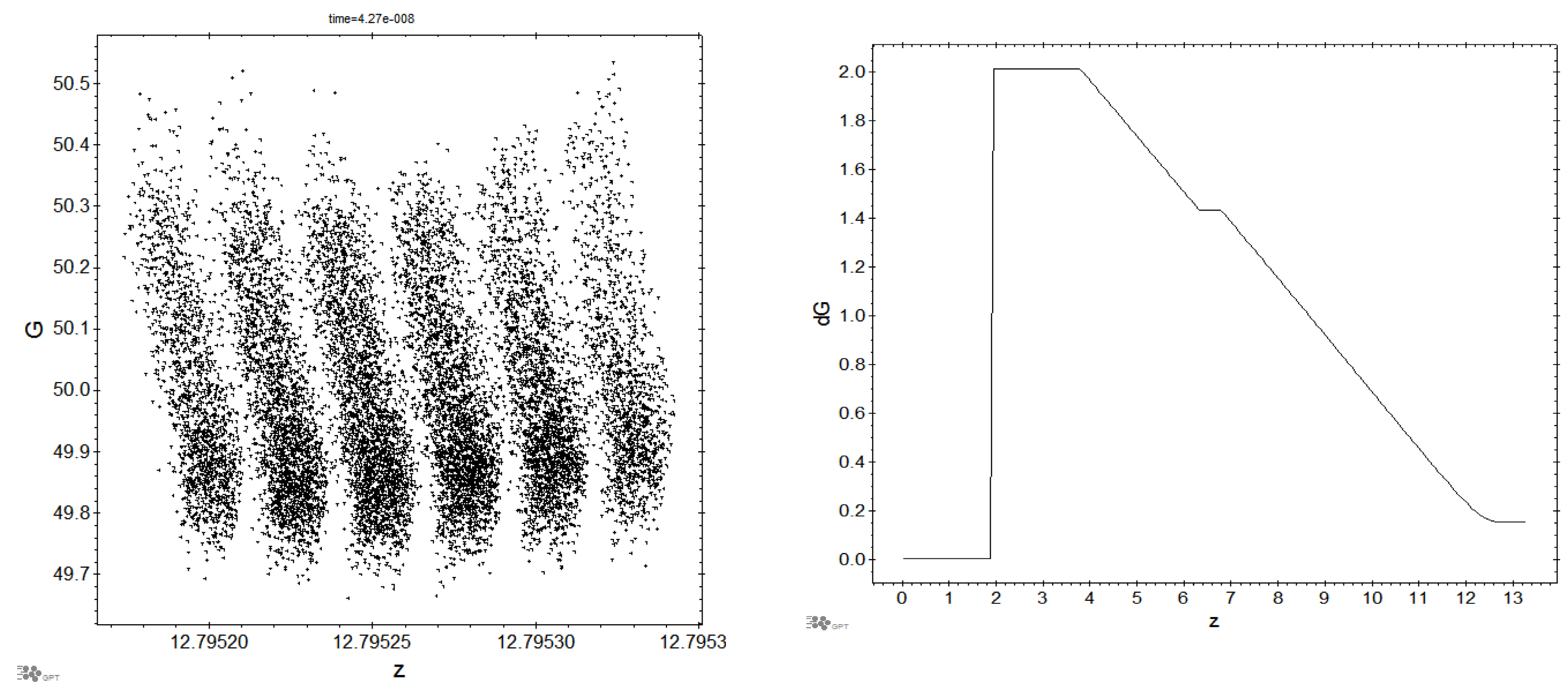
Clipped Beam Profile

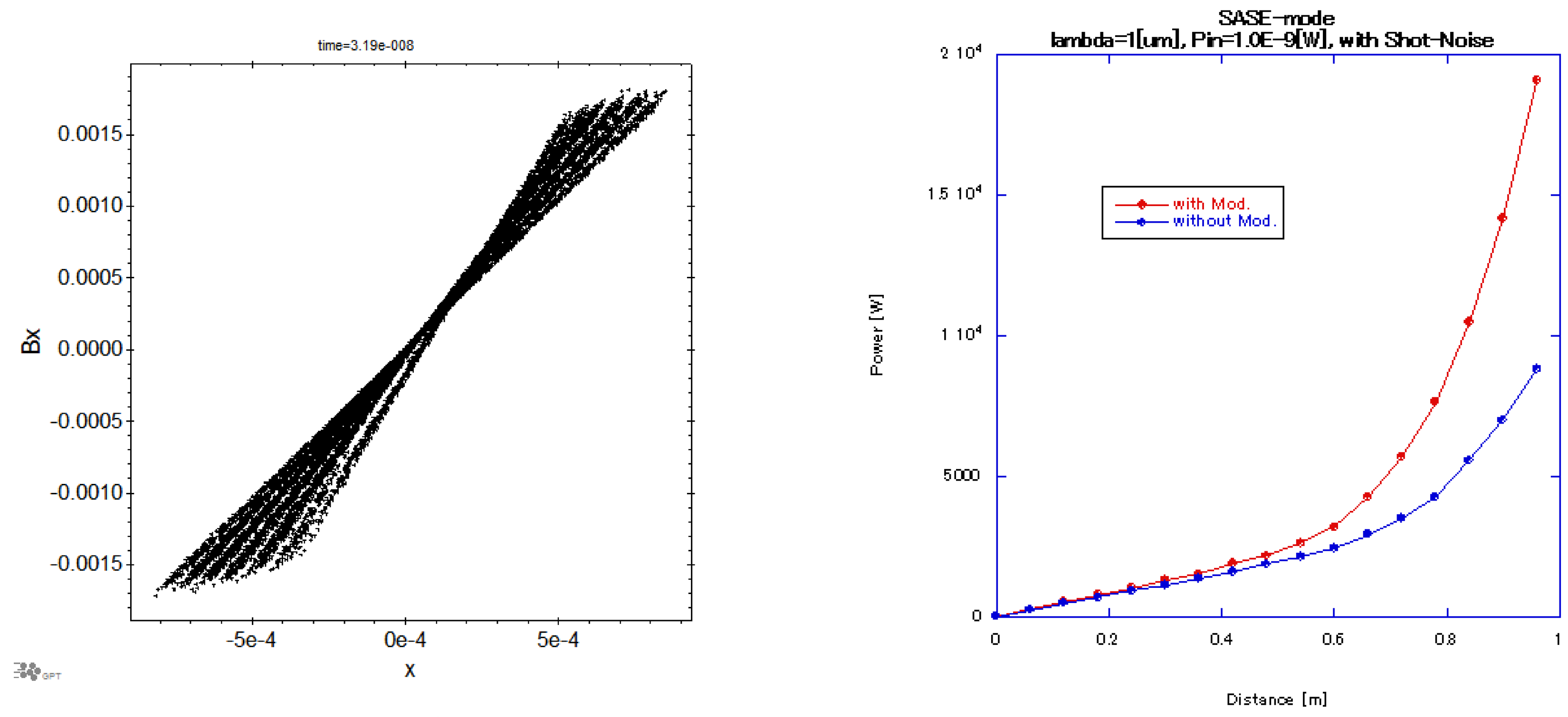


After EEX beam line



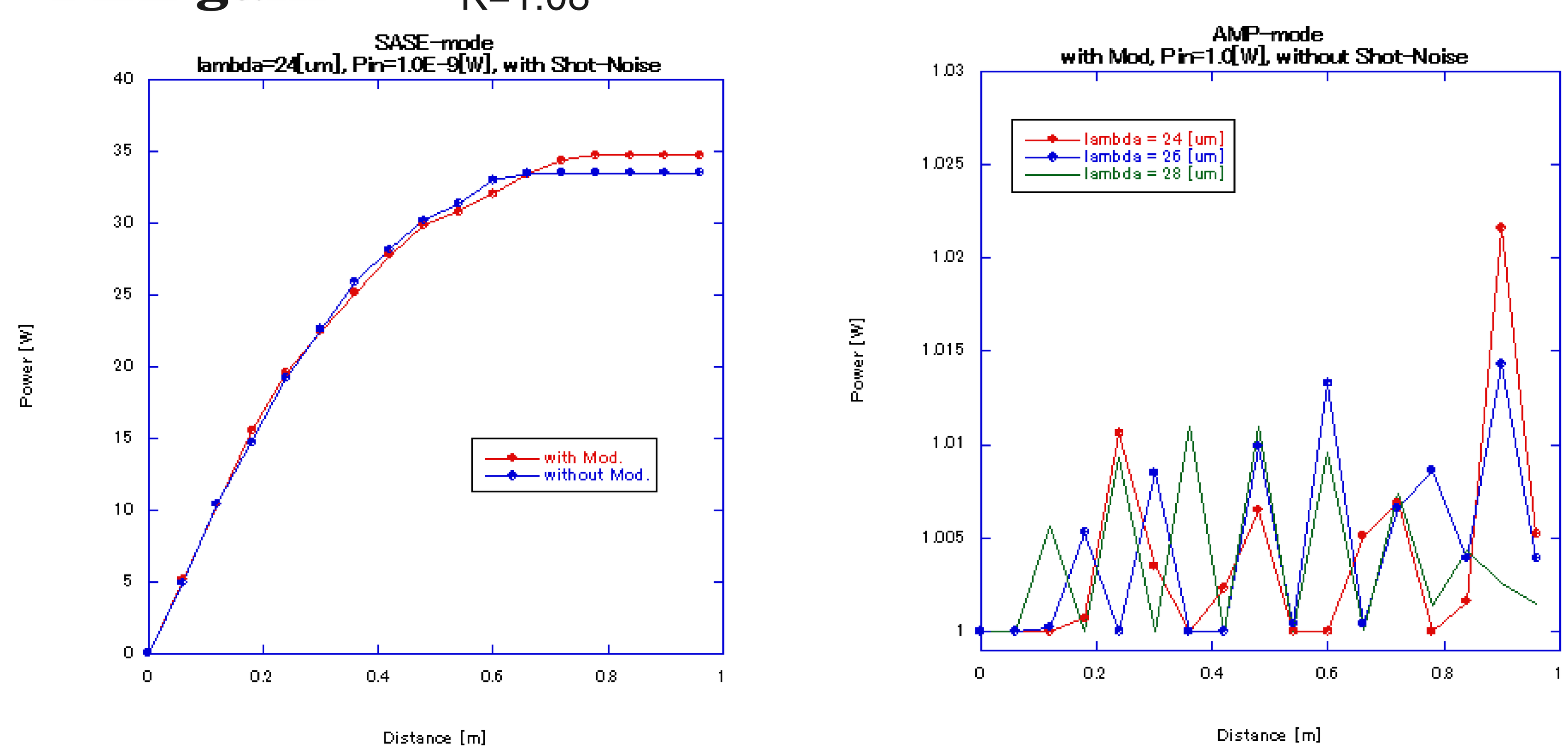
After Energy Chirp Compensation





FEL gain

λu = 60mm
K=1.08



- Micro-bunch formation and high gain FEL with EEX technique was studied.
- A clear micro-bunch structure is formed by clipping with slits and EEX.
- No significant enhancement on FEL gain with this micro-bunch structure.