Dispersion Analysis for a High-repetition-rate, Multi-GW Femtosecond Laser System

Donghoon Song[1*], Sung In Hwang[1], Tae Jun Yu[2], Do-Kyeong Ko[1,2]

[1] *School of Photon Science and Technology, GIST, Gwangju 500-712, Korea*

[2]*Femto Science Laboratory, Advanced Photonics Research Institute, GIST, Gwangju 500-712, Korea,*

dhsong@gist.ac.kr

Recently, not only industrial applications such as laser machining [1], medical surgery, but also basic science applications such as high-order harmonic generation [2] require the high-average power, high-repetition-rate femtosecond laser system. To meet the requirements, a 100 kHz, Sub-GW femtosecond laser system [3] incorporating downchirped pulse amplification technique has been demonstrated, which generated 39 fs pulses with a peak power 0.7 GW. Due to imperfect dispersion compensation, two times larger than a transform-limited pulse duration of 20 fs were recorded. Our laser system is basically the same as the system in Ref.3. We have analyzed that group delay dispersion, third order dispersion and fourth order dispersion have an impact on pulse width as well as calculated all of dispersion in the high-repetition-rate, multi-GW femtosecond laser system we designed (Fig.1). Moreover, the possibility of a stretcher of grism pair(gratings written onto prisms)[4], whose efficiency is better than present stretcher's, are investigated. The high-repetition-rate Multi-GW femtosecond laser system based on the results is under the construction.

Optical Elements	Function	GDD [fs2]	TOD [fs3]
SF10 prism pair (1.38 m separation, 3 roundtrips)	stretcher	-34708	-170356
Grating pair (600 gr/mm, 70 deg, 9.83 cm separation)	stretcher	-86635	87192
AR-coted SF10 block (67.73 cm long)	compressor	11202	69686
Other materials (Bragg cell, Faraday Isolator,Ti:S,3CM)	Amplifier	9320	13459
Total		~0	~0

Fig. 1. Dispersion calculation

References

1. Sohn, I.-B., Noh, Y.-C., Choi, S.-C., Ko, D.-K., Lee, J., "Femtosecond laser pulse switching for rapid patterning", Pacific Rim Conference on Lasers and Electro-Optics, CLEO - Technical Digest (2007).
2. Santra, R., Dunford, R.W., Kanter, E.P., Ren, H., Nazarkin, A., Nold, J., Kapteyn, H.C., Murnane,

M.M., Christov, I.P., "Extreme nonlinear optics: Coherent X rays from lasers", PHYS TODAY 58/3, 39-44 (2005).

3. Hong KH, Kostritsa S, Yu TJ, Sung JH, Choi IW, Noh YC, Ko DK, Lee J, "100-kHz high-power femtosecond Ti : sapphire laser based on downchirped regenerative amplification", OPT EXPRESS 14/2, 970-978 (2006).

4. Kane, Steven J., Squier, Jeff A., Yakovlev, Vladislav V., Barty, Christopher P., "Grisms: novel dispersive devices for the manipulation of femtosecond pulses", Proceedings of SPIE - The International Society for Optical Engineering 2701, 183-189 (1996).