AUTOMATION OF THE WAVELENGTH CHANGE FOR THE FERMI FREE ELECTRON LASER* TUPPC052

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FERMI is a free electron laser (FEL) fourth generation light source operated by Elettra - Sincrotrone Trieste S.C.p.A., Italy, as a user facility. It produces stable, high brilliance, coherent, narrow bandwidth photons in the VUV soft X-rays wavelength regions, with variable wavelength and polarization. Two FEL lines cover the foreseen range. FEL-1 , based on a High Gain Harmonic Generation (HGHG) single stage source seeded by an external UV tunable laser (230 - 260 nm) covers the range from 100 to 20 nm. In order to get down to 4 nm, still starting from the external UV seed laser, a double stage HGHG cascade is adopted for FEL-2. The FEL-1 line consists of a planar undulator ("modulator") and six APPLE-II type undulators ("radiators"). The FEL-2 line consists of a first stage of one modulator and 2 two radiators followed by a second stage of one modulator and 6 radiators.
The two FEL chains are fed by electrons produced by a laser driven photocathode gun and accelerated to 1.2 or 1.5 GeV energy by a normal conducting 3 GHz linac.
A unique characteristics of FERMI is the possibility to rapidly change the polarization and wavelength of the FEL radiation. The speed and easy of polarization and wavelength change is extremely important for all the experiments exploiting FERMI radiation.
We have developed a software tool, named SuperGap to perform this routine operation in a simple and effective way by means of a graphical use interface.

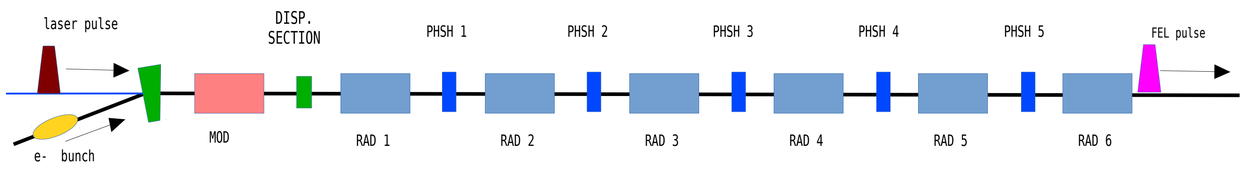

Fig. 1: Schematic of FEL-1.

Overview of Operation

The HGHG FEL mechanism of FEL-1 requires that the "modulator" (an undulator) of the FEL beamline be tuned to emit synchrotron radiation at the same wavelength of seed laser. The seed laser beam and the electron beam travel on that same trajectory in the centre of the undulators. The "radiators" (undulators) are tuned to emit their radiation at a wavelength that is an integer harmonic of the seed wavelength. In between each couple of "radiators" there is a magnetic device known as phase shifter which introduces a small delay in the electron trajectory in order to compensate the delay introduced by the undulators and keep electron and photons in phase. The setting of each magnetic shifter is determined by the operating conditions of the upstream and downstream undulators (see Fig.1).

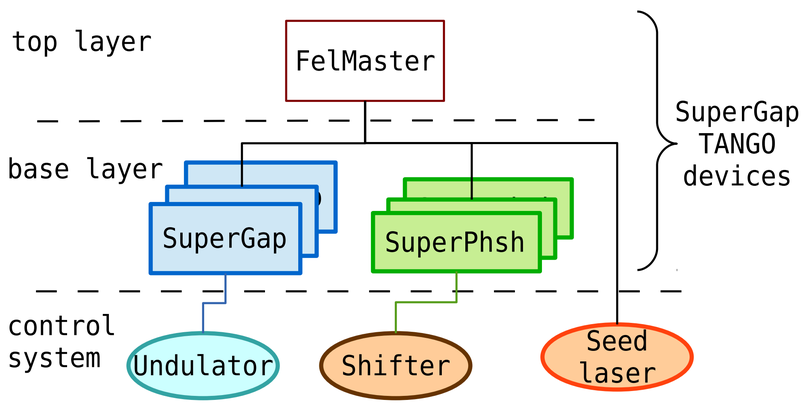

Fig. 2: SuperGap architecture.

SuperGap Architecture

We have designed SuperGap following a classical layered object-oriented architecture (see Fig.2). All the SuperGap objects are implemented as TANGO devices and are fully integrated in the control system of FERMI.

The base layer consists of TANGO devices in charge of controlling the undulators and phase shifters.

The top layer consists of a TANGO device in charge of coordinating and integrating all the devices under a common interface.

All these layers have been designed so that all the calculations, logic, etc. are delegated to the lowest possible layer.

Beside these specifically written devices, SuperGap exploits other already existing TANGO devices for carrying out some of the tasks required for tuning the FEL.

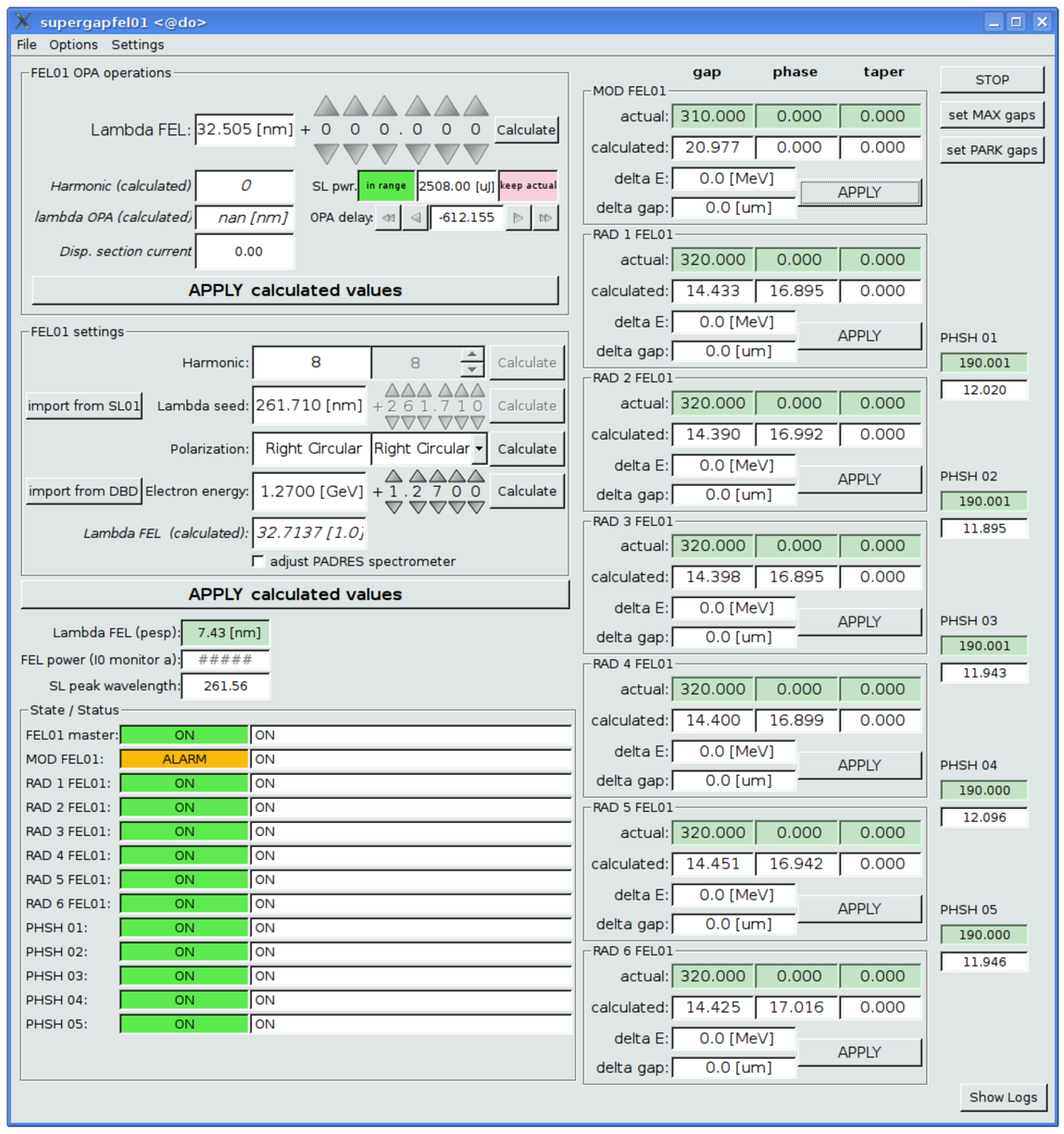

Fig. 3: SuperGap Graphical User Interface.

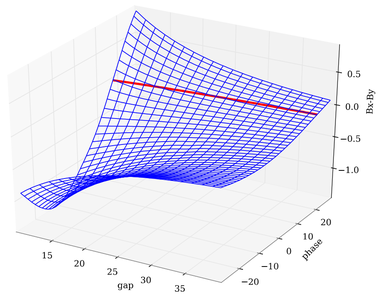

Fig4. Circular polarization.

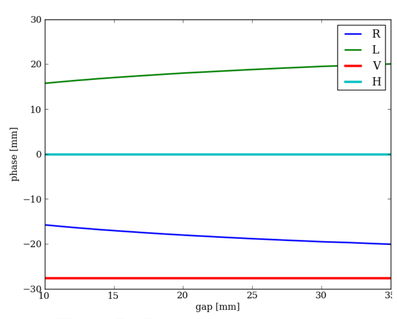

Fig. 5: Phase/gap relation.

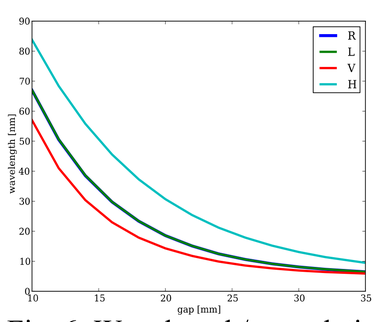

Fig. 6: Wavelength/gap relation.

Calculations & Operations

All the settings of the undulators and shifters are calculated starting from magnetic measurements stored in calibration tables. 1D and 2D spline interpolating functions are extensively used during the calculation steps (See Fig. 4, 5, 6)
The FelMaster device coordinates the work of the undulators and shifters and manages the seed laser tuning.
A Graphical User interface (See Fig. 3) allows operators to change the FEL wavelength and polarization rapidly and easily.

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