DIAGNOSTIC SYSTEM OF TAC IR FEL FACILITY

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ABSTRACT

The TAC (Turkish Accelerator Center) IR FEL facility which is named as Turkish Accelerator and Radiation Laboratory at Ankara, TARLA will be based on a 15-40 MeV electron linac accompanying two different undulators with 2.5 cm and 9 cm periods in order to obtain IR FEL ranging between 2-250 microns. The electron linac will consist of two sequenced modules, each housing two 9-cell superconducting TESLA cavities for cw operation. It is planned that the TARLA facility will be will be completed in 2013 at Golbasi campus of Ankara University. This facility will give an opportunity to the scientists and industry to use FEL in research and development in Turkey and our region. In this study, the main structure of the facility and planned electron beam diagnostics system is given in detail.

1. INTRODUCTION

It is generally accepted that to obtain high quality FEL, the electron beam should have high peak current, short bunches (depending on wavelength), minimum energy spread and low emittance, so on. Furthermore, in order to serve wide range of experimental needs of users, the time structure of electron should have both continuous wave and pulsed mode. In addition, the system should have minimum setup time, maximum beam time and stable parameters.

The TARLA aims to obtain FEL between 2.5-250 µm using electron beam in the range of 15-40 MeV and two undulators with 25 and 90 mm period lengths. The electron source is chosen to be a high average current thermionic DC gun running at up to 250 keV, which is in manufacturing phase at the moment. The injector system will be completely based on normal conducting technology with two bunchers that operate 260 MHz and 1.3 GHz, respectively. The injector will be sufficient to establish well-defined beam before electron enters the first superconducting accelerator (SC) module. The main acceleration structures will consist of two ELBE modules that each houses two TESLA 9-cell SC structures. These modules are designed to operate at 1mA electron beam current but they are capable of operating at 1.6mA continuous wave operation (CW) that we plan to achieve in the further upgrade. The main parameters of TARLA electron beam are given in Table 1. General layout of TARLA is showed in figure 1.

Table 1: TARLA Expected Beam Parameters

Parameters	Current	Upgrade
Energy [MeV]	15-40	15-40
Bunch Charge [pC]	80	120
Average Beam Current [mA]	1.0	1.6
Micro Bunch Rep. Rate [MHz]	13-26	13-26
Macro Pulse Duration [µs]	10 to CW	10 to CW
Macro Pulse Rep. Rate [Hz]	1 to CW	1 to CW
Bunch Length [ps]	0.5-8	0.6-8
Nor. RMS trans. Emit. [mm mrad]	<12	<15
Nor. RMS Long. Emit. [keV.ps]	<40	<50

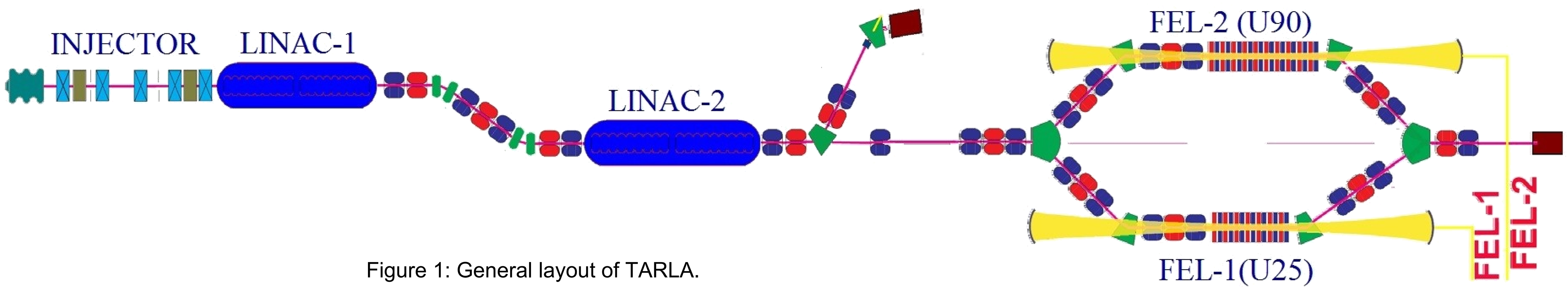

Figure 1: General layout of TARLA.

2. DIAGNOSTIC REQUIRMENTS

Beam Position Monitors: The signal of the button type BPM would not be strong enough for the bunch charge of electron beam of TARLA. Therefore stripline monitor will be more appropriate.

Beam Profile Monitors: OTR monitors is appropriate at high energies (40 MeV). In the injector, scintillating screens will be used. Chromox (Al_2O_3:Cr) and YAG:Ce screens will be used at injector.

Bunch Charge Measurement: Current transformers and Faraday Cup will be used at several points of the line.

Beam Loss Monitor: Long ionization chambers using a single coaxial cable is sufficient for one-shot accelerators or transport lines.

Energy and Energy Spread Measurements: *Beam energy will be measured by spectrometer after the first and second linac. Bending magnets on the beam line and beam viewers can be used to measure the beam energy spread.*

Bunch charge Measurment: The bunch charge will be measured with two different method; Faraday Cup and beam Current transformer.

Emittance Measurement: In the injector the emittance can be measured by multi-slit or pepper pot techniques. After the second linac, the quadrupole scan method is more appropriate.

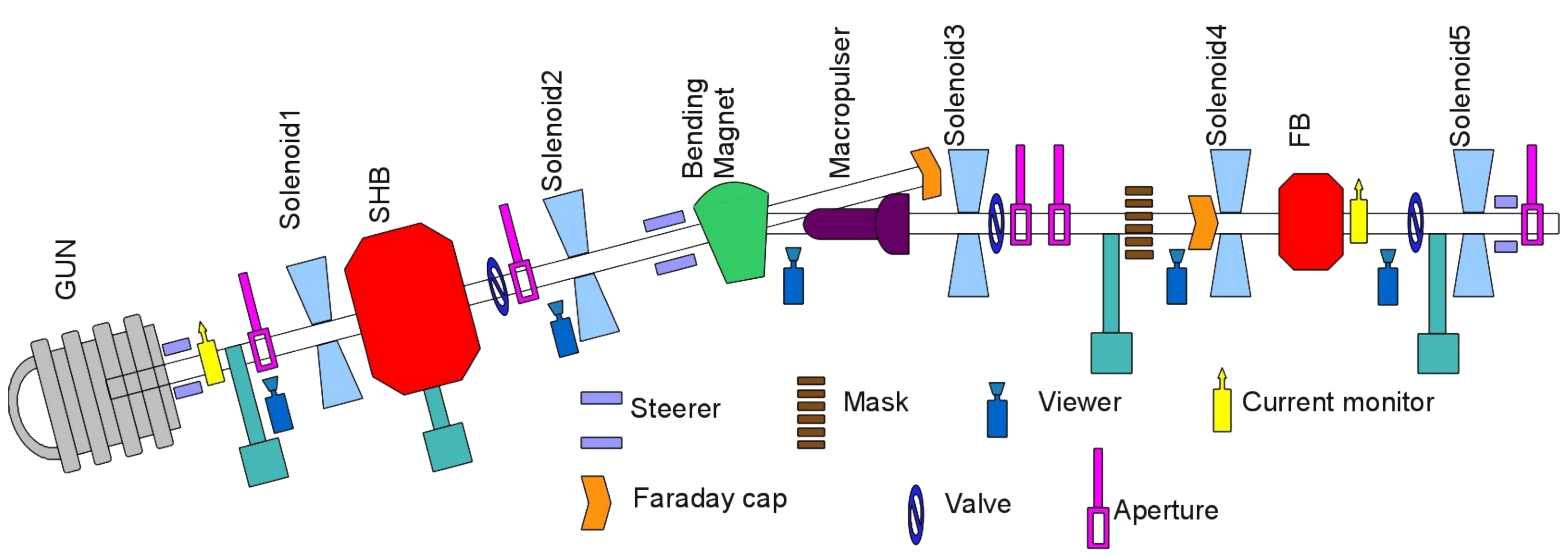

Figure 2: Layout of the injector of TARLA.

Table 2: Beam Diagnostic devices of TARLA

Devices	Location	Number
BPM	All beam line	15
Scintillation Screen	Injector	5
OTR Screen	All beam line	16
Faraday Cup	Injector	1
FCT-ICT	Exit of the gun	1
ICT	All beam lline	6
Spectrometer	Exit of linac 1	1

3. CONCLUSION

Diagnostic layout of the injector of TARLA is showed in figure 2. At the exit of the gun a current transformer will be used to measure the beam current. This device will be used also for preliminary test for the gun which is under manufacturing. The bunch charge will be measured several point of the beam line with faraday cup and current transformers. Beam profile is viewed by using the chromox and YAG:Ce screens at five point on the injector line. After the first linac the beam can be viewed by OTR monitors.

The energy spread will be measured by using the bending magnet and beam viewer in injector. A spectrometer can be used also to measure energy after the first and second linac. Multi-slit method will be used to measure the emittance after the third solenoid with a mask and beam viewer. Quadrupole scan method is appropriate after the second linac to measure the emittance. The beam diagnostic devices along the beam line are given in table 2.