THE ANDRZEJ SOŁTAN INSTITUTE FOR NUCLEAR STUDIES INSTYTUT PROBLEMÓW JADROWYCH im. Andrzeja Sołtana

P o l f e l – the VUV-range free electron laser

Wavelengths: down to 27 nm pulse energy: >10 μJ average power: > 0.1 W

A laboratory that develops a Free Electron Laser facility will be established. The concept is based on the flexibility of the system which facilitates future development of the user facility in accordance to evolving scientific needs. The proposed laboratory will assure various options of the facility upgrade open. The preliminary parameters of the laser are: 600 MeV, wavelenght down to 27 nm, quasi-continues wave linac operation (100 ms RF pulses during which 10^5 electron bunches are accelerated).

- Continuous wave operation
- SASE emission
- External laser seeding,
- High Gain Harmonic Generation
- Undulator development
- Beamline development.
- R&D for the quality and generation of the electron beam (LLRF, SRF e-sources)
- Possibility of THz radiation

new experiments

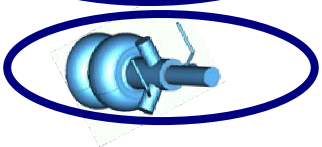
CW operation

high average power

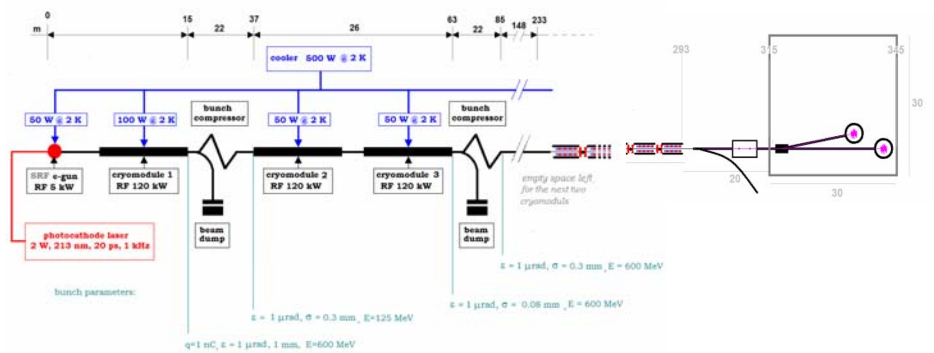
SRF injector

SC photocathode

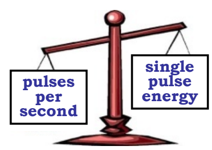
Pb/Nb

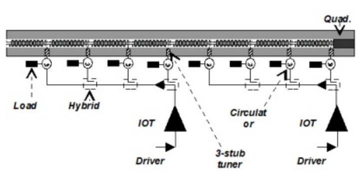


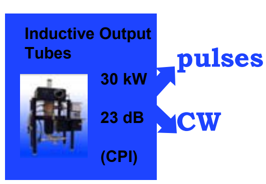
The accelerating unit consists of TESLA type cavities housed in the cryomodules. Four 30 kW IOTs provide the RF power to one cryomodule housing 8 nine-cell cavities. Larger IOT is not offered by vendors at present, on the other hand, the phase and amplitude stabilization is technically easier and higher final energy can be reached when a shorter chain of cavities is supplied by a single RF source.



We assume that distribution system dissipates ~3% of the transmitted power and that maximum available beam power is 77% of the total IOT power, reserving 20% of it for the phase and amplitude stabilization.
In addition, we will assume that an individual bunch charge is 1nC. In reality one can very flexibly change time separation of RF-pulses and charge of bunches keeping constant an average current within the RF-pulse, whose length depends only on the cryogenic load. The repetition frequency is assumed to be 1 Hz.

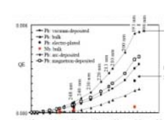


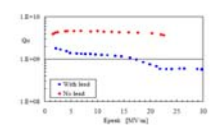


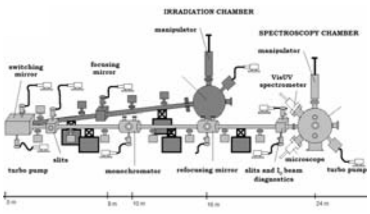


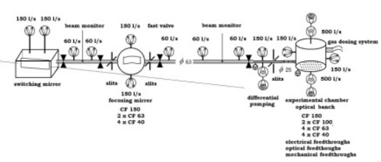
Electron beam energy =125MeV+Linac	MeV		325	375	425	475	525	575
Energy gain per accelerating unit	MeV		100	125	150	175	200	225
E_{acc}	MV/m		12	15	18	21	24	27
Q_o	10^{10}		2.0	2.0	2.0	2.0	2.0	2.0
Dynamic loss per cavity at 2K K	W		7.7	12	17.2	23.5	30.6	38.8
Total loss per cavity at 2K	W		8.7	12.7	17.8	23.9	31.0	39.1
Duty factor	%		72	49	35	26	19	15
Max. beam current	mA		0.93	0.74	0.62	0.53	0.46	0.41
Bunch spacing (q=1nC)	μs		1.08	1.35	1.62	1.89	2.16	2.42
Max. number of bunches per second	10^6		0.668	0.364	0.215	0.136	0.090	0.062
Opimal Q_{ext} to keep the power <14.5 kW/cavity	10^6		11	14	20	27	36	46
Max. microfonics allowed	Hz		<34	<33	<23	<17	<13	<10
3 dB width szerokość rezonansu	Hz		123	93	65	48	36	28
Max pulse beam power	kW		310	290	270	260	250	245
Beam power at the beamdump	kW		222	140	94	66	48	37

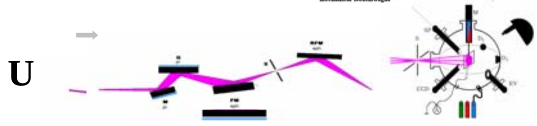
A dedicated development of a superconducting electron gun, with a lead photocathode is in progress. An UHV cathodic arc technology of lead deposition onto a back wall of electron gun resonance cavity has been established. Performed tests showed the promising quantum efficiency of lead photocathode as well as high resonance quality in the region up to the E field intensity of 30 MV/m.











Two beamlines are expected: one dedicated for studies and applications of light induced surface modifications, another, furnished with a monochromator, is dedicated for spectroscopy.

Polfel facility will be located at the Andrzej Sołtan Institute for Nuclear Studies in Świerk, about 30 km from Warsaw. The Feasibility Study submitted to the Ministry of Research and Higher Education has been highly ranked and is awaiting for an approval..According to the preliminary time schedule, the regular operation is expected in 2016.