Deutsch-Türkischer Wissenschaftstag
Alman-Türk Bilim Günü

Overview Turkish Projects
TAC / TARLA

Avni Aksoy

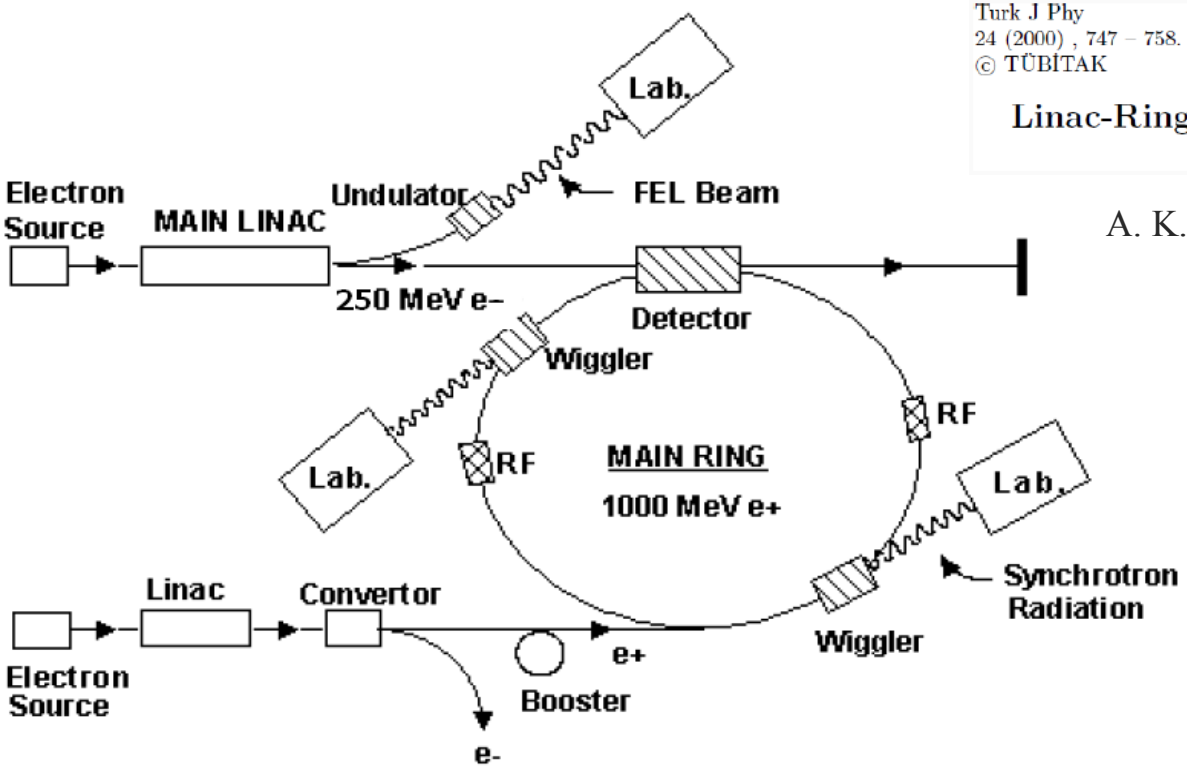
on behalf of TAC team

Ankara University

Institute of Accelerator Technologies

TAC was born

- The TAC project was proposed in 2000's as linac-ring type e^+-e^- collider with 1 GeV center of mass energy as a Φ -factory.
- Additionally in the proposal ;
  - Electron linac of the complex maybe used to drive SASE undulators
  - Positron ring of the complex may be used as SR source.



Turk J Phy
24 (2000) , 747 – 758.
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Linac-Ring Type ϕ Factory of Basic and Applied Research

A. K.Çiftçi, O. Gürkan, T. Olgar, E. Recepoğlu, S. Sultansoy, M. Yılmaz, Ö. Yavaş

Project Phases

- 1st phase: Preliminary phase (1997-2001)
  - A preliminary report Report in 2001 has been reported
    - Turkish Accelerator Center (TAC) Project was proposed
- 2nd phase: Feasibility Report (2002-2005)
  - A Feasibility Report in 2005 has been reported
    - Change from Phi factory to Charm factory
    - Main parameters of the proposed facilities
    - types and technologies of accelerators
    - research potential of proposed facilities of TAC
- 3rd phase (current phase): First Facility (2006 - ...)
  - Started in 2006 as collaboration of 12 Turkish universities under the coordination of Ankara University
  - Goal of the phase
    - Establishment of The Institute of Accelerator Technologies (IAT)
    - Establishment of (Oscillator mode IR FEL & Bremsstrahlung) TARLA Facility
    - Completing the Conceptual/Technical Design Report of TAC Synchrotron Radiation Facility
    - Completing the Conceptual/Technical Design Reports of TAC SASE FEL, Proton Accelerator
    - Writing Feasibility Report of TAC Particle Factory.

TAC collaboration

- **TAC is an Inter University Collaboration**
- **Project Team: 78 staf with PhD + 78 graduate students and engineers**

Ankara University

Gazi University

İstanbul University

Uludağ University

Dumlupnar University

Osmangazi University

Boğaziçi University

Doğuş University

Erciyes University

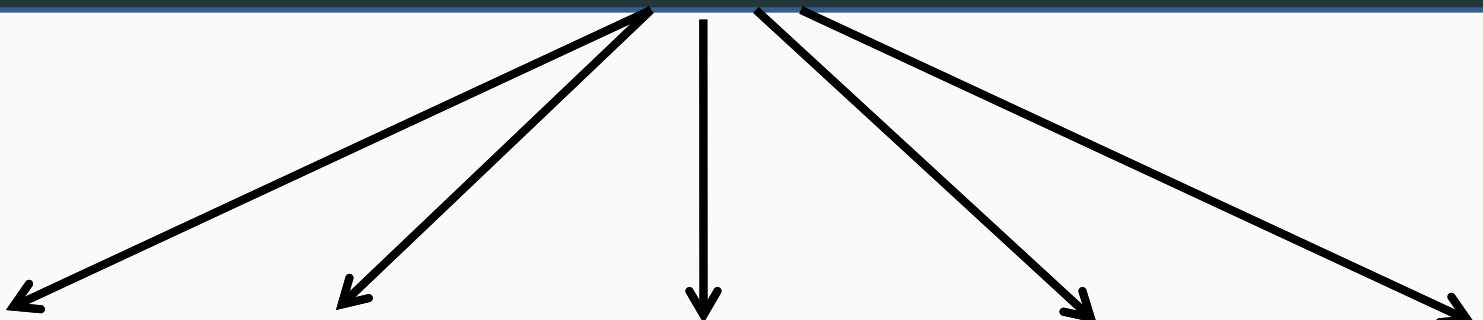
Süleyman Demirel Uni.

Niğde University

Gebze Technical University

TAC sub-projects

TAC Project



TARLA
40 MeV
Oscillator FEL

SR
3 GeV
Synchrotron Rad

PA
3-2000 MeV
Proton Accelerator

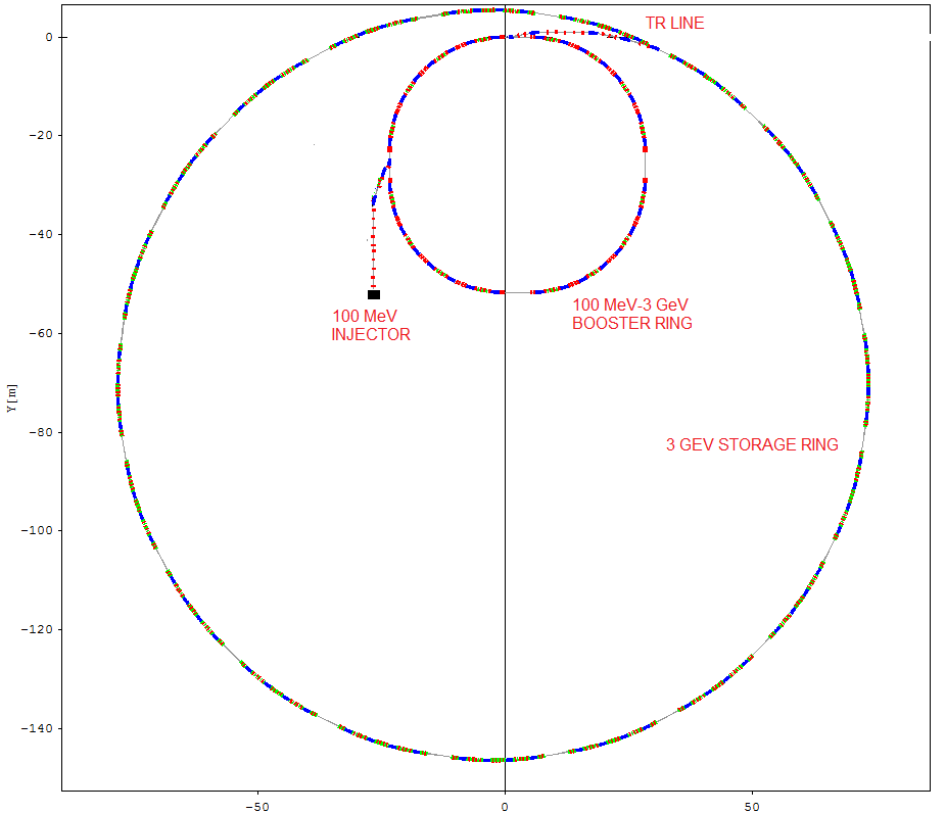
SASE
1-6 GeV
SASE FEL

PF
1 GeV - 3.5 GeV
$e^- - e^+$ collider

- Installation and commissioning phase
- Detailed Design Report phase
- Conceptual Design Report phase
- Feasibility Report phase

Proposed Light sources of TAC
SR & SASE/Seeded FEL

TAC SR source



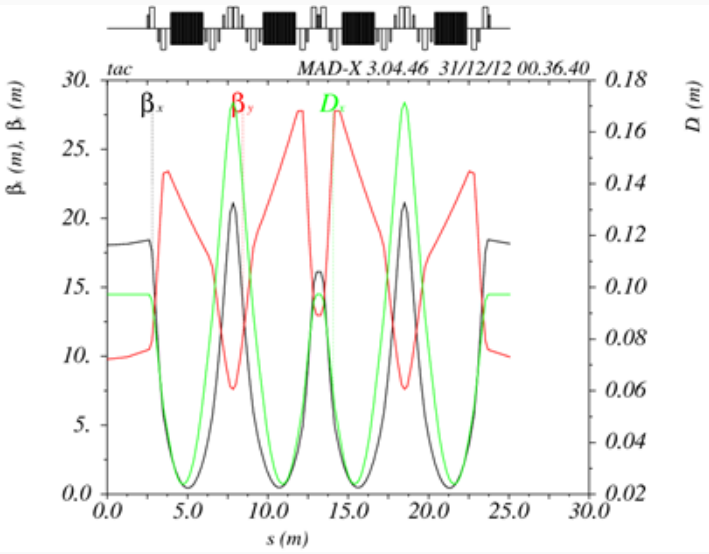
- The design Goals
  - 3 GeV electron beam energy.
  - Low emittance for high brillance
  - Short circumference
  - Long lifetime
  - High dynamical aperture
- Sections
  - 100 MeV Injector (standard S band linac)
  - 0.10 → 3 GeV Booster Ring (500 MHz Multi-cel structure)
  - 3 GeV SR Ring (500 MHz single cell)

Main Cell of Storage Ring

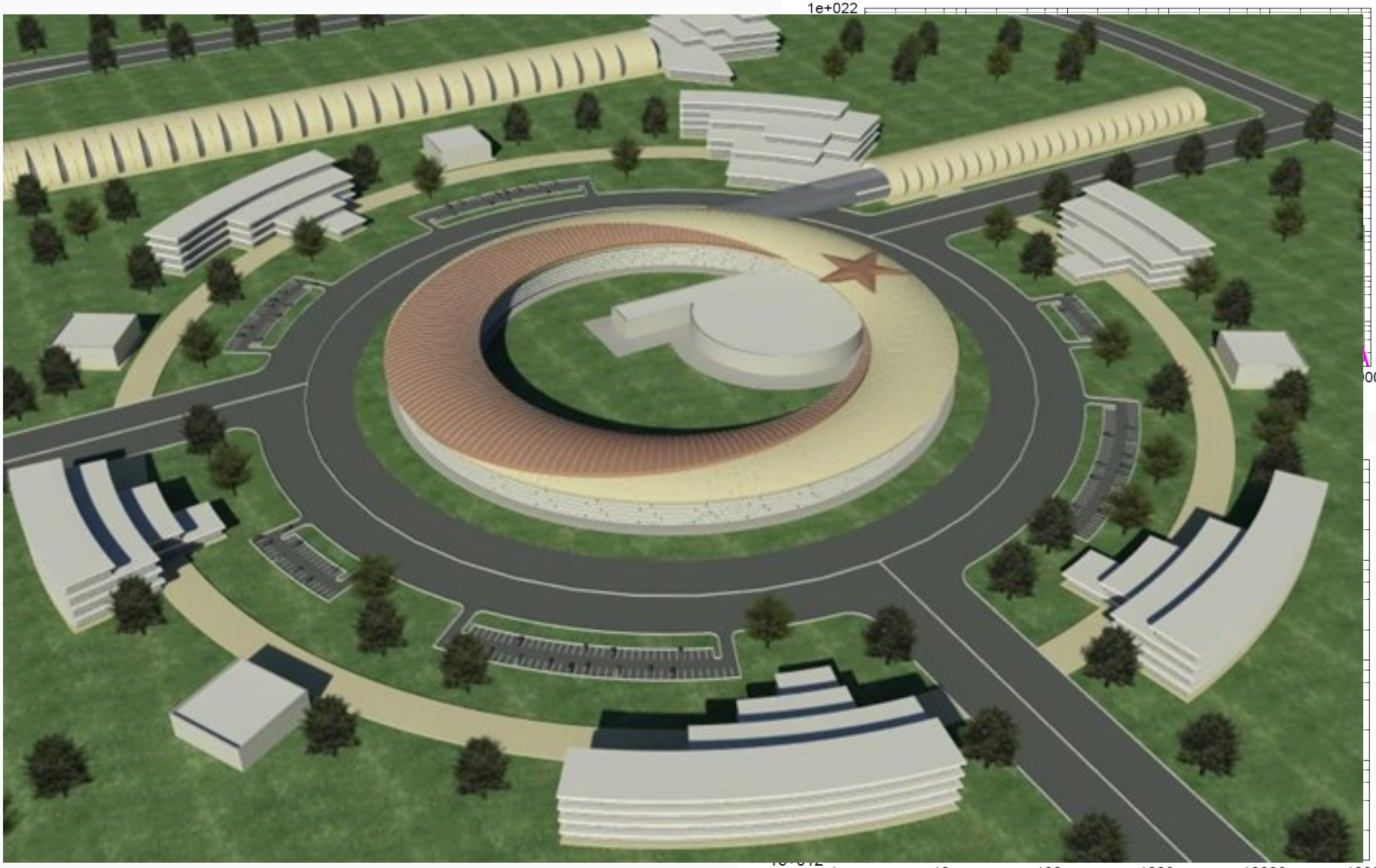
- Four bending magnet of each 2 m length and 5° deflection angle
- 16 quadrupole magnets (4 different type)
- 5 family of sextupoles are placed along the main cell to correct the chromaticity

The ring consist of 18 main cells.

- The length of straight sections between cells are 5 m

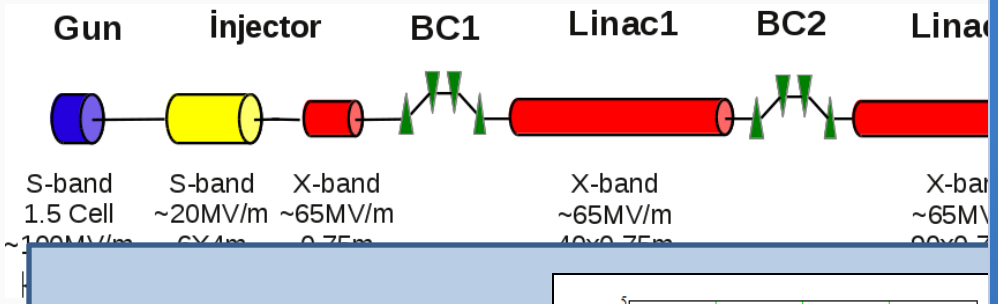


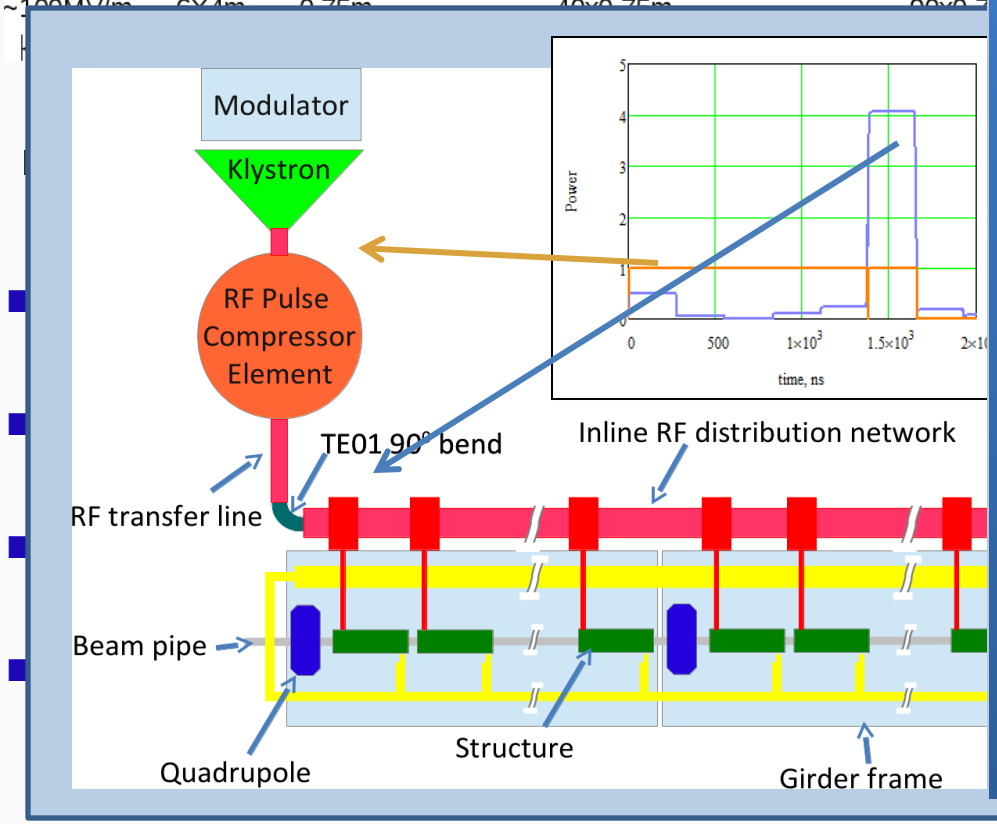
TAC SR source



TAC SASE FEL

S-Band based injector + X-Band bas



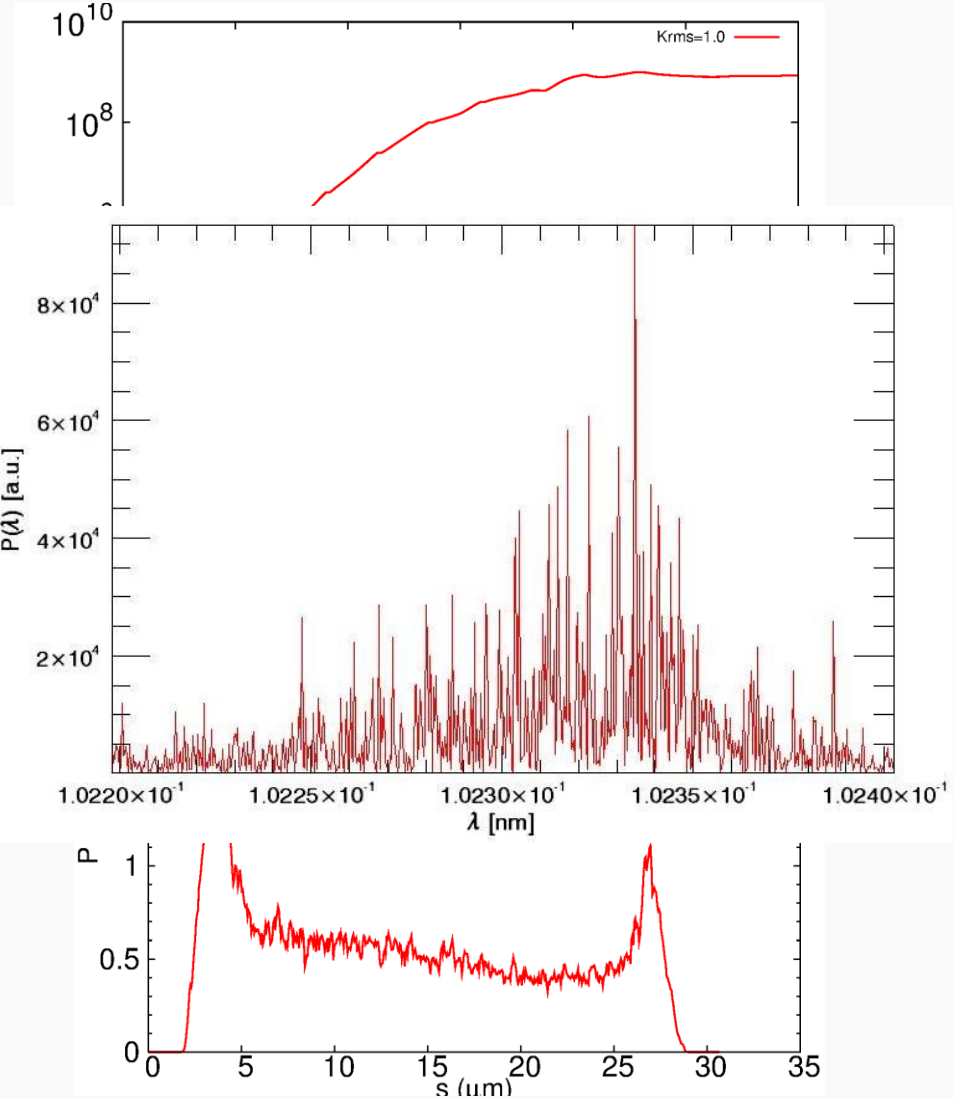


Parameter	Unit	Parameter
Beam energy	GeV	6
Bunch charge	pC	250
Electron Energy	GeV	6
Emittance	μm	<0.5
Peak Current	kA	3
Energy Spread (sliced)	%	0.01
Undulator Period	mm	15
FEL wavelength	nm	0.1
Und. Strength	#	1
Mean Und Beta	m	15
Sat. Length	m	~60
Sat. Power	GW	~1
Pulse Length	fs	~15
Photons/Pulse	#	~5×10^{10}

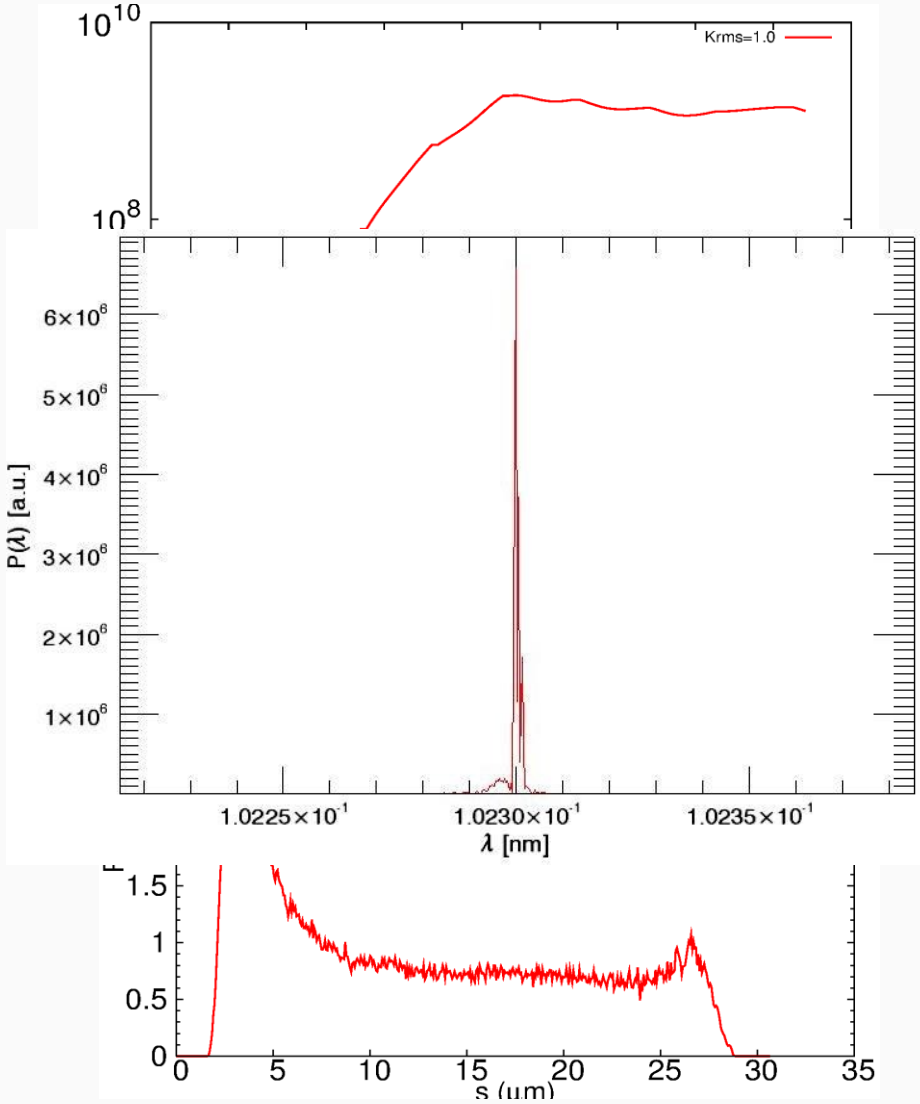
Sample FEL simulation for 1 Å FEL

(FODO type of lattice housing 2x4m undulator)

For SASE mode



For Seeded mode



TARLA Project

Turkish Accelerator and Radiation Laboratory in Ankara - TARLA

- TARLA project which is essentially one of the sub-project of national project (TAC) has been coordinated by Ankara University since 2006.
- TARLA facility is in the same place with the Institute of Accelerator Technologies (IAT) of Ankara University (located in Gölbası, 15 km south of Ankara) and the main role of IAT is to coordinate TARLA studies.

- The institute which is 4 years old is the first institute established in Turkey as research in the fields of accelerators and related topics
- We have 16 full-time employee in the institute (12 technical, 4 administrative)
- About 5 part time collaborator from different universities

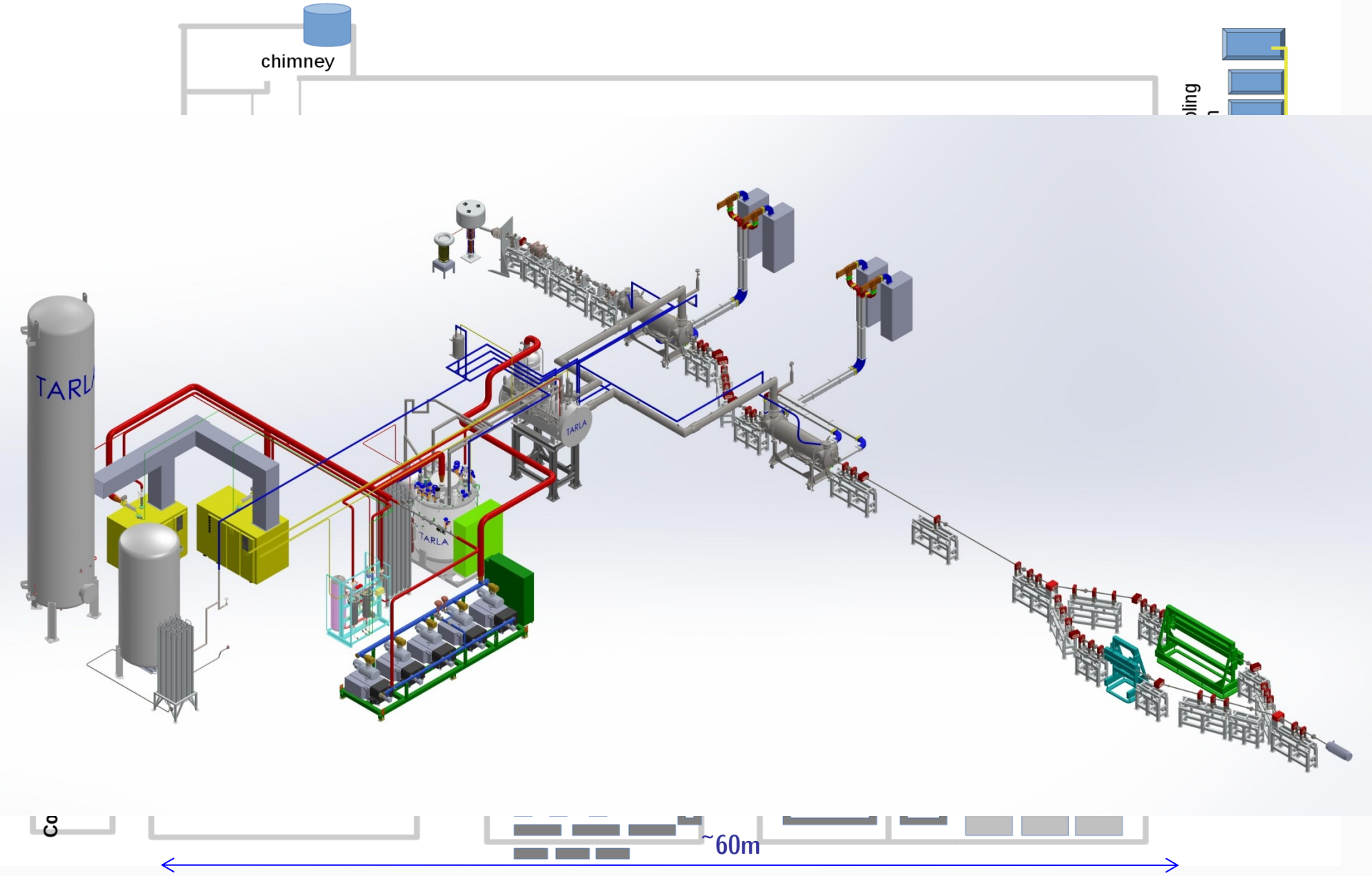
Scope of TARLA

- Constructing accelerator based research facility in order to serve our country and our region within the frame of Turkish Accelerator Center Project.

❑ In TARLA facility we propose;

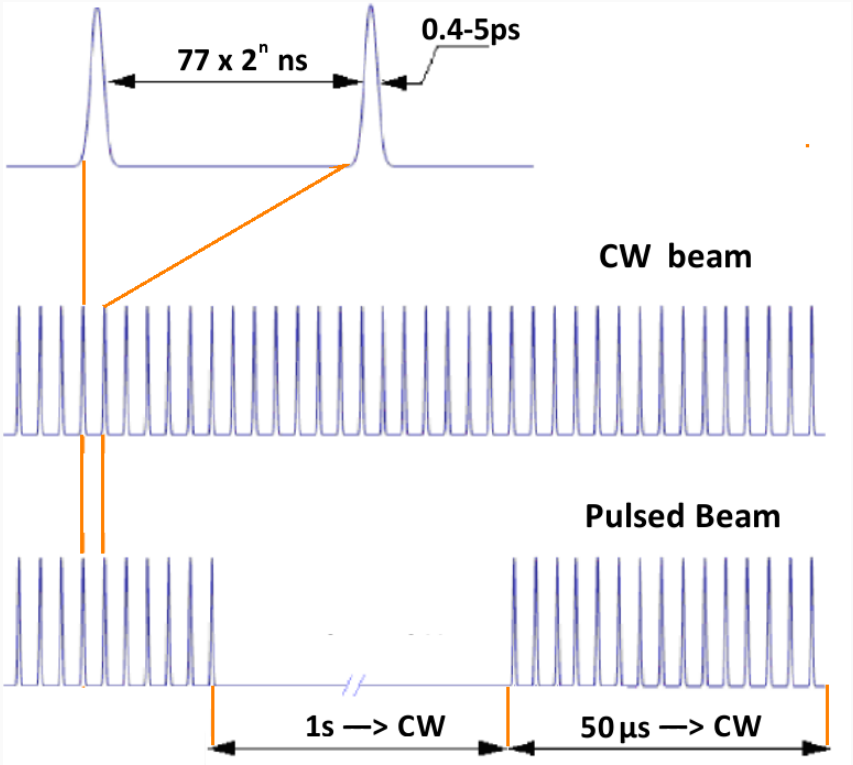
- To generate Free Electron Laser between 3-250 μm using 15-40 MeV electron beam and two different optical resonator system housing two different undulators with 25 mm and 90 mm period length
- To generatre Bremsstrahlung radiation using 0-30 MeV electron beam and three different radiator-colimator setup and study nuclear physics
- To use 0-40 MeV electron directly in order to make fixed target experiments

TARLA layout



TARLA Electron Beam

Spacing between bunches will be adjusted with grid modulation installed on gun.



Macropulse time structure is manipulated with macropulsed installed on injector.

CW Beam
1 mA, 0-40 MeV

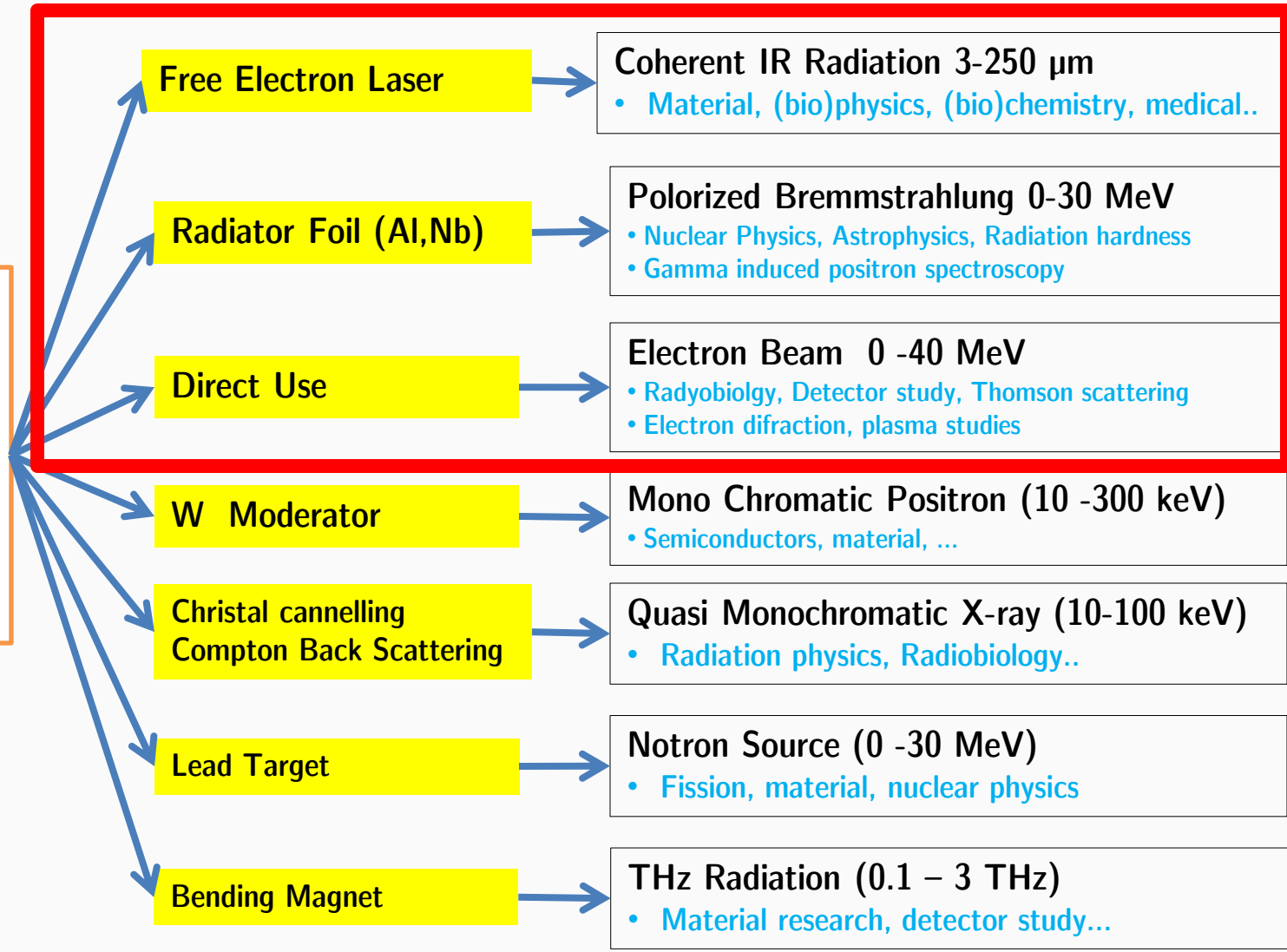
Coherent IR Laser
3 – 250 µm
- materials research
- biophysics
- biochemistry
- environment

Polarized Gamma
0 – 30 MeV
- Nuclear physics
- Nuclear astrophysiscs
- Radiation physics

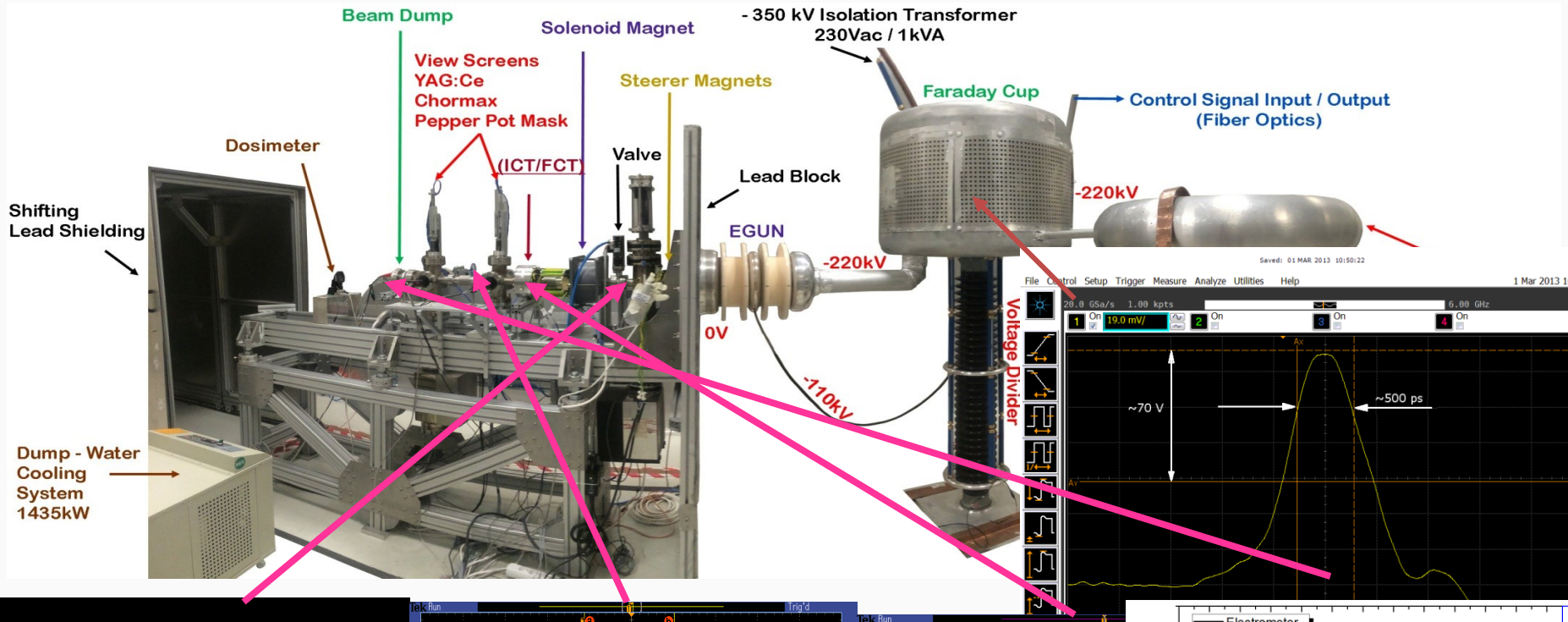
Electrons
0 – 40 MeV
- radio biology
- detector studies
- materials research

Research Potential of TARLA

Superconducting accelerator based CW electron beam
0 - 40 MeV ,
0-1 (1.5) mA
40 (60) kW
sürekli / atmalı



Electron gun test setup



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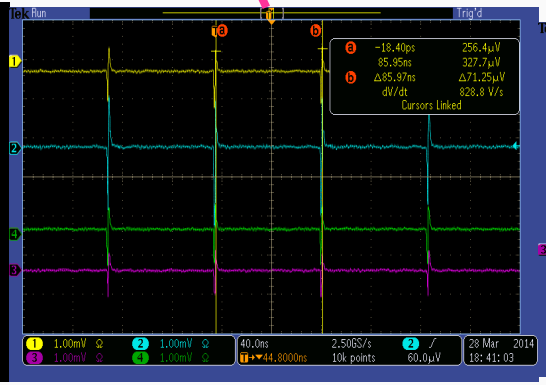
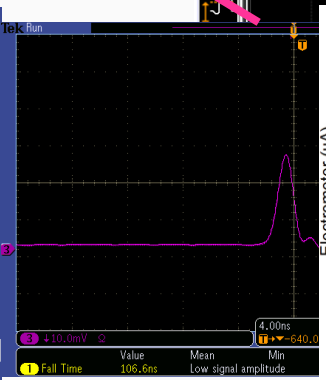
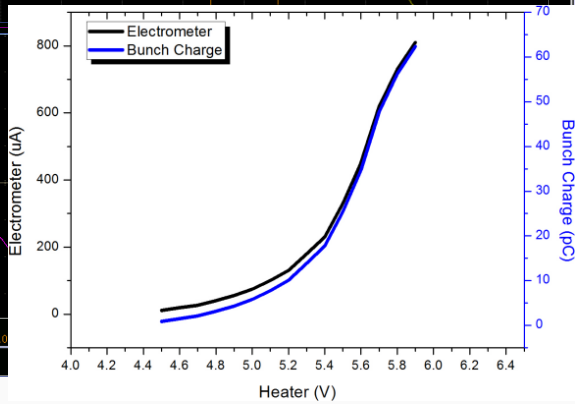


BPM



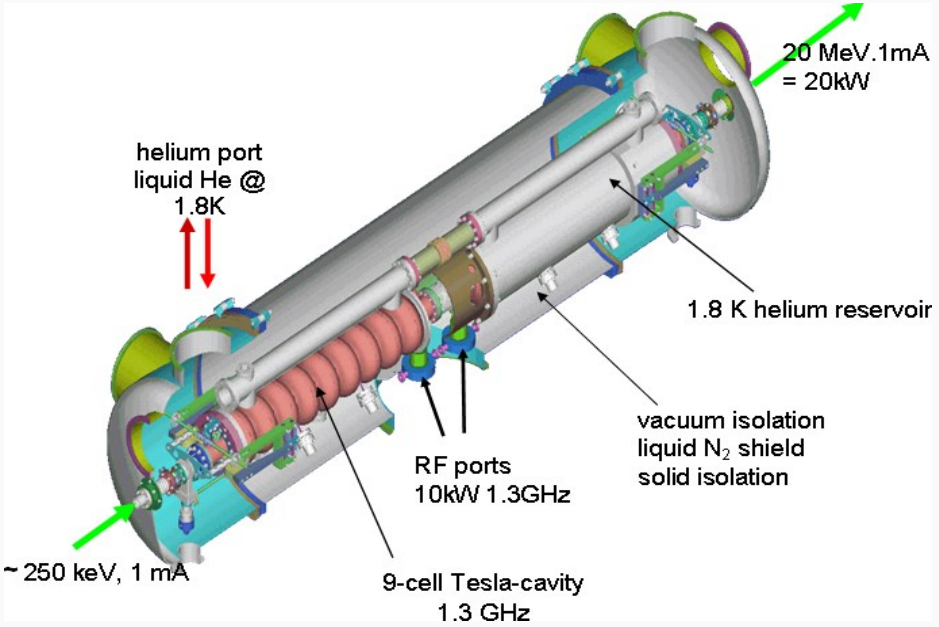
FCT



Beam current

TARLA Superconducting accelerating module

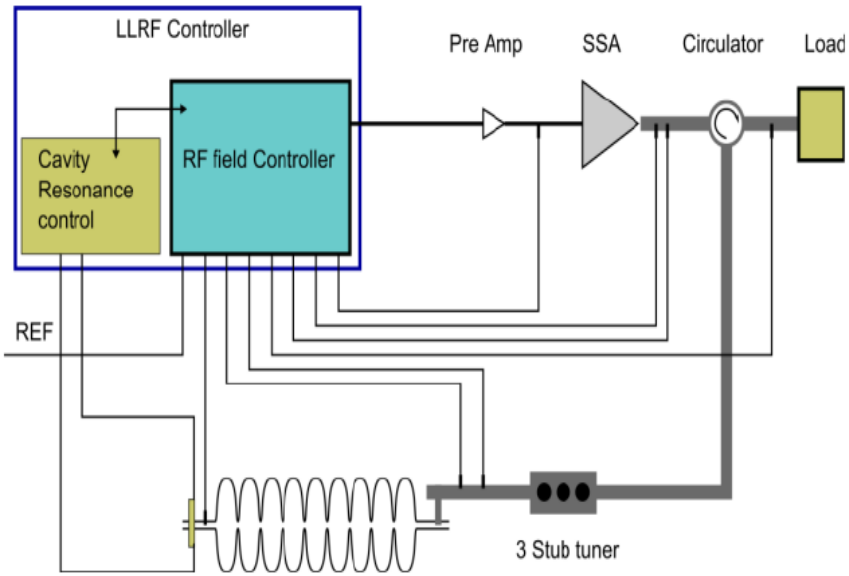
- Super conducting RF accelerating modules is being manufactured by Research instruments (Contract in 2012 Oct)
- This module is compact and houses two TESLA cavities It is designed for continuous operation with accelerating gradient up to 15 MV/m.
- The cryostat design has been developed by ELBE team (HZDR) and is used under a license agreement.
- Modules will be delivered by the mid of 2016



Module Parameters

Frequency (@ 2K)	1300 ± 0.05	MHz
Tuning range	120	kHz
External Q of input couplers	$(1.2 \pm 0.2) \times 10^7$	
External Q of HOM couplers	$> 5 \times 10^{11}$	
Accelerating voltage / module	>20	MV
Total cryogenic losses at 20 MV (@ cw)	< 75	W
Power coupler performance (standing wave)	≥ 8	kW

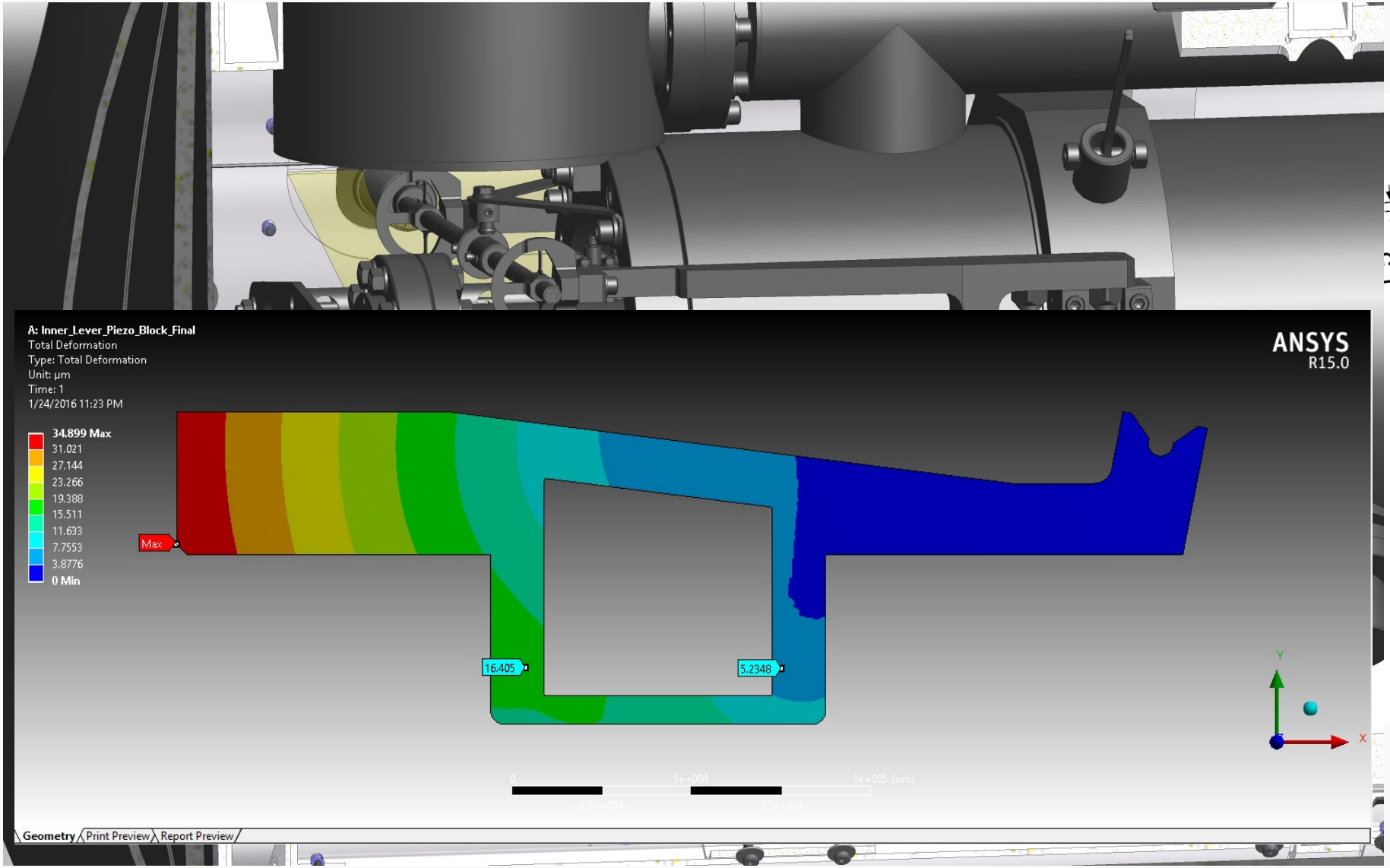
DESY µTCA LLRF controller @ TARLA



Channel	Description
1.	Cavity pickup
2.	Cavity forward
3.	Cavity reflected
4.	Power to load
5.	Klystron forward
6.	Klystron reflected
7.	Klystron drive
8.	Reference tracking

- Based on MoU with DESY and XFEL we develope LLRF control system of TARLA together with DESY MSK group.
- We are going to sign with DESY contract/addendum soon for the deliverables of;
  - Field controller
  - heater controller
  - stepper motor driver
  - piezo controller
- Contract issues are continuing..

Change on TARLA tuning system with DESY support

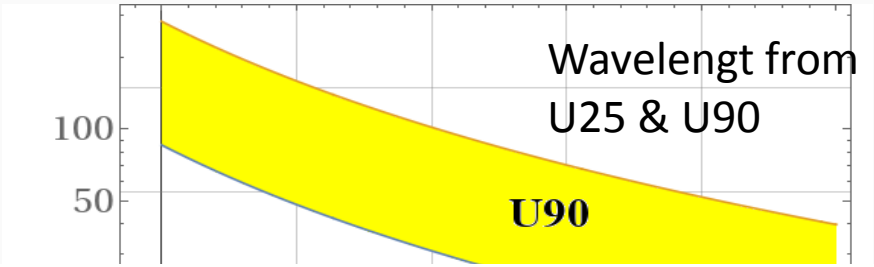


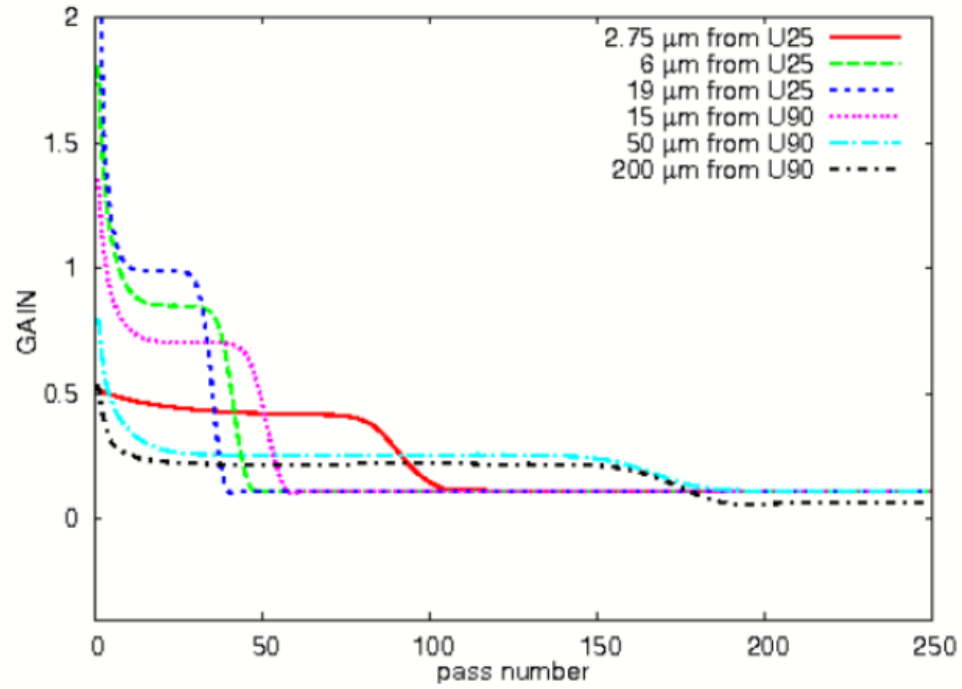
Helyum Plant

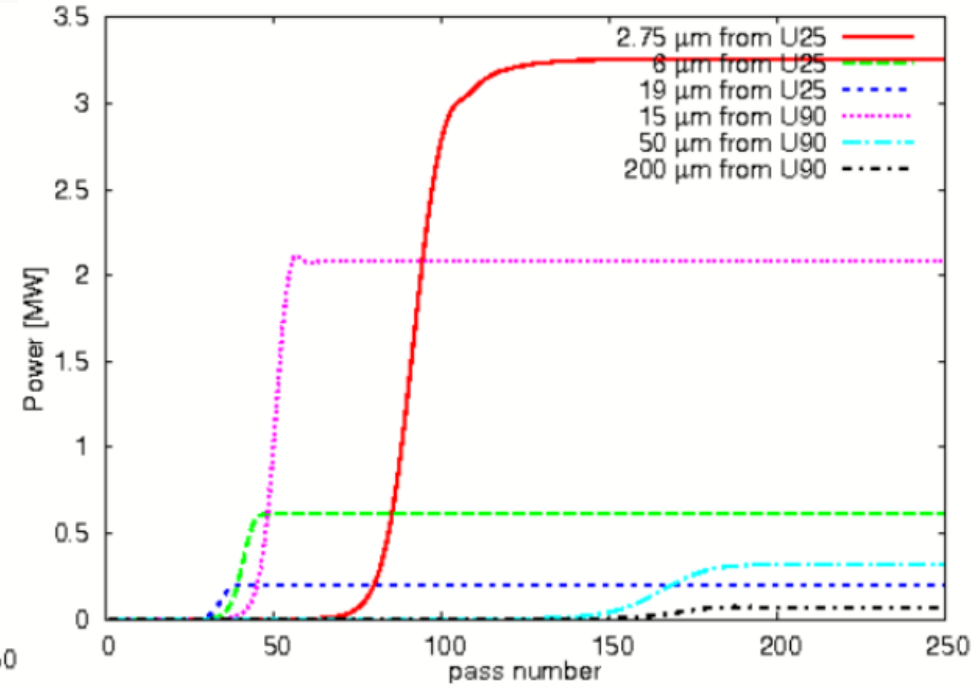
TARLA Electron Beam Parameters

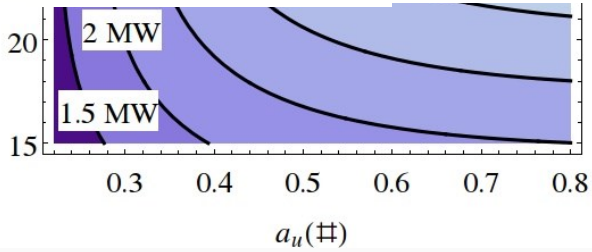
Parameter	Unit	Base	Upgrade
Beam Energy	MeV	10-40	10-40
Max average beam current	mA	1	1.5
Max bunch charge (@ 13 MHz)	pC	77	115
Horizontal emittance	mm.mrad	< 15	< 16
Vertical emittance	mm.mrad	< 12	<13
Longitudinal emittance	keV.ps	< 85	<100
Bunch lenght	Ps	0.4-6	0.4-6
Bunch repetition	MHz	13	13-26
Macropulse duration	μs	50→ CW	50→CW
Macropulse repetition	Hz	1 → CW	1 → CW

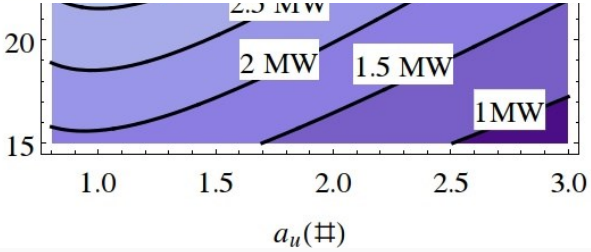
FEL performance









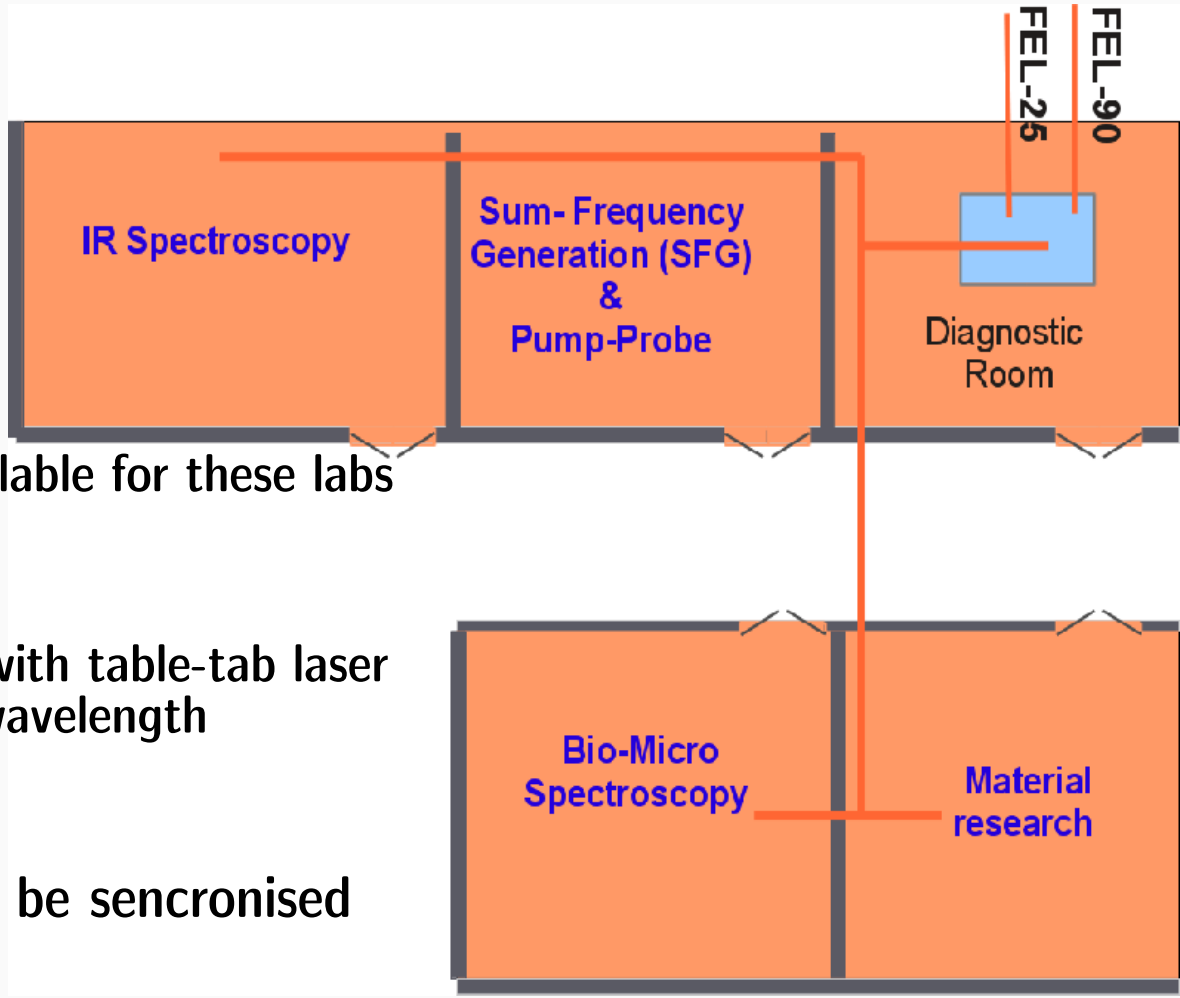


FEL Parameters of TARLA

	Parameter	Unit	U25	U90
Resonator Parameters	Period Length	mm	25	90
	Number of Poles	#	60	40
	Type	#	Planar	Planar
	Pole Material	#	NdFeB	NdFeB
	Undulator Strength	#	0.25-0.7	0.8-2.4
	Minimum gap	mm	15	30
	Resonator Length	m	11.53	11.53
	Curveture of mirrors (R_1=R_2)	m	5.86	6.32
	Outcoupling hole radius	mm	TBD	TBD
Laser Parameters	Wavelength	μm	3-19	18-250
	Micropulse repetition	MHz	13	13
	Micropulse Length	ps	0.5-10	0.5-10
	Maximum Peak Power	MW	~5	2.5
	Maximum Average Power	W	100	50
	Max Pulse energy	μJ	~10	~8
	Macropulse duration	μm	40-CW	40-CW
	Macropulse Repetition	Hz	10-CW	10-CW

Proposed FEL User-Stations

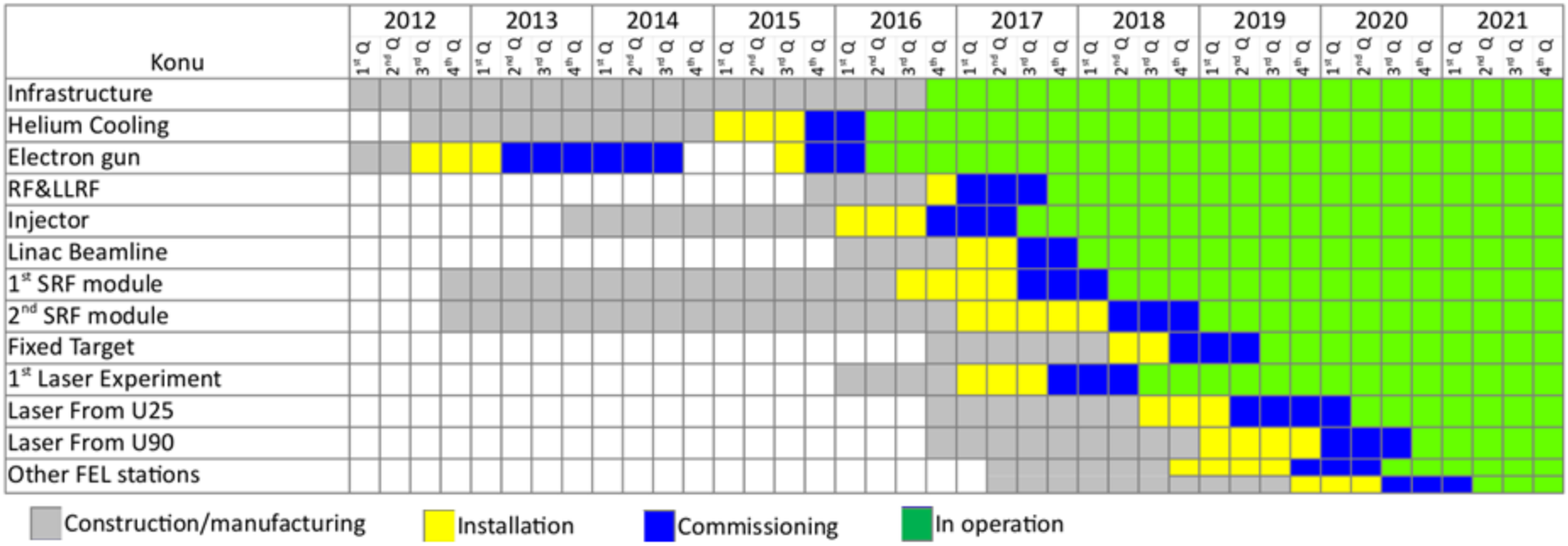
- Proposed FEL stations are:
  - IR spectroscopy lab.
  - SFG-PP lab.
  - Bio-Micro Spectroscopy lab.
  - Material research lab.



- Main FEL parameters are available for these labs
  - wavelength range: 3-250 m
  - Average FEL power: 1-100 W
- Each room will be occuppied with table-tab laser sources with 700 – 1000 nm wavelength
  - Ti-sapphire laser
  - Nd:Yag laser
- FEL and external lasers will be sencronised
  - $\Delta\sigma < 100$ fs
- The rooms will have class 1000 standart

Conclusion-TARLA

- TARLA is the first step of TAC project and will be the first FEL user facility in Turkey and around our region.
- The facility will give opportunity to scientists and industry to make research about material, biotechnology, optics, semiconductors, medicine, chemistry and



- We expect to get first lasing by 2019.

Conclusions-TAC

- Turkey has ambitions to build electron and proton accelerators to strengthen her scientific infrastructure.
  - In this frame, collaboration with German Institutes play very crucial role and we want more closer collaboration for proposed facilities with German industry, also.
- It is expected that TAC will be officially defined as a National Research
  - Research Center by new law in 2014; management, financial and personnel structure will be reorganized. (We already started negoations with ministry)
- We have a road map for proposed TAC facilities up to 2030.
- TAC collaboration aims to accomplish the following steps in next years
  - Make more collaboration with DESY for accelerator R&D
  - Join Euro XFEL project as a member state
  - Formal involvement in DESY-PETRA-III scientific and technical activities
- These activities will boost our efforts to build large scale scientific infrastructure in Turkey

Overall project milestones

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
TARLA																
SR																
SASE FEL																
LE PA																
HE PA																
PF																

Feasibility | CDR | TDR | Build. and Installation | In operation

TARLA :Turkish Accelerator and Radiation Laboratory in Ankara (Oscillator FEL)
LE PA :Low Energy Proton Accelerator
HE PA :High Energy Proton Accelerator
SR :Synchrotron Radiation
SASE FEL :Self Amplified Spontaneous Emission Free Electron Laser
PF :Particle Factory (Super Charm Factory)

Law for Research Centers

- Law for Research Infrastructure published in July 2014. The objective is to define issues related to support to ensure a more effective use of research infrastructure and their sustainability. it brings;
  - Legal entity
    - Independent from many governmental agencies, direct connection to ministry or large coordination unit.
  - Effective coordination
    - It will have own management structure including, industry, university, ministry, advisory committee and director.
    - Opportunity to hire professional administrator
  - Human resource; opportunities
    - to hire high qualified staff with high salary
    - to make short time contract with employee
    - to hire foreign employee
  - Sustainable financing
    - Be able to have its own revenue and expenditure
    - Financed for operation from the central budget based on performance
    - Tax exemptions
  - Collaboration with related industry, institutions (also with foreign institutions)

Thank you for your attention!

Dikkatiniz için teşekkür ederim!

Danke für Ihre Aufmerksamkeit!