Institute of Accelerator Technologies of Ankara University and TARLA Facility

Avni Aksoy
Ankara University
avniaksoy@ankara.edu.tr

On behalf of IAT & TARLA Team

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- Brief history of TAC project
- Institute of Accelerator Technologies of Ankara University
- TARLA facility
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  - Proposed FEL applications
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TAC was born

The Turkish Accelerator Center (TAC) project was first proposed in 2000's as linac-ring type e-e+ collider with center of mass energy of 1 GeV as 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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1st phase Preliminary phase (1997-2001)

Outcome: A preliminary report Report in 2001

- Accelerator Center (TAC) Project was proposed

2nd phase Feasibility Report (2002-2005)

Outcome : A Feasibility Report in 2005,

- Change from Φ-factory to Charm factory
- Main parameters of the proposed facilities
- Types and technologies of accelerators
- Research potential of proposed facilities of TAC are explained

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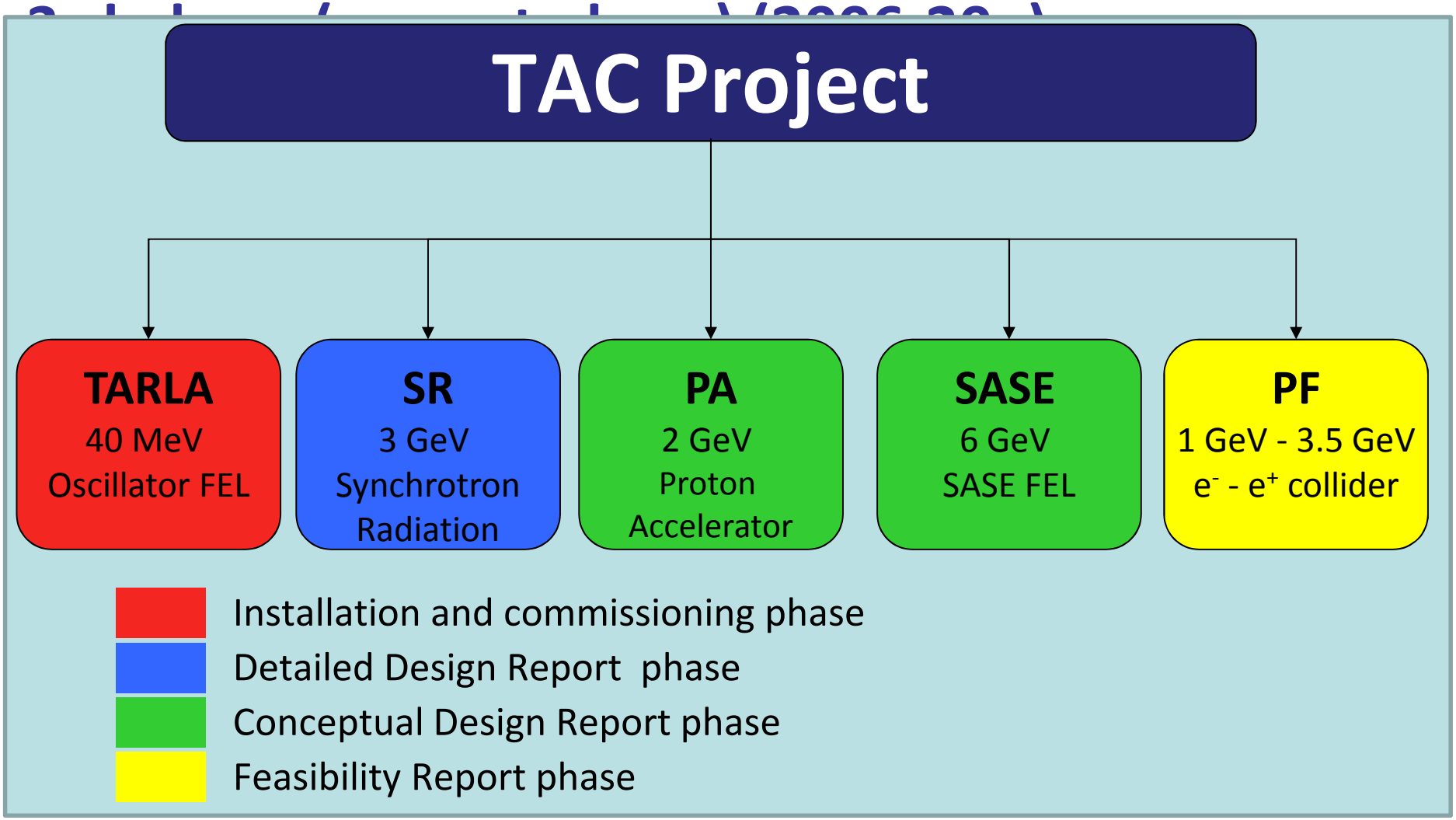
Current phase



Institute of Accelerator Technologies

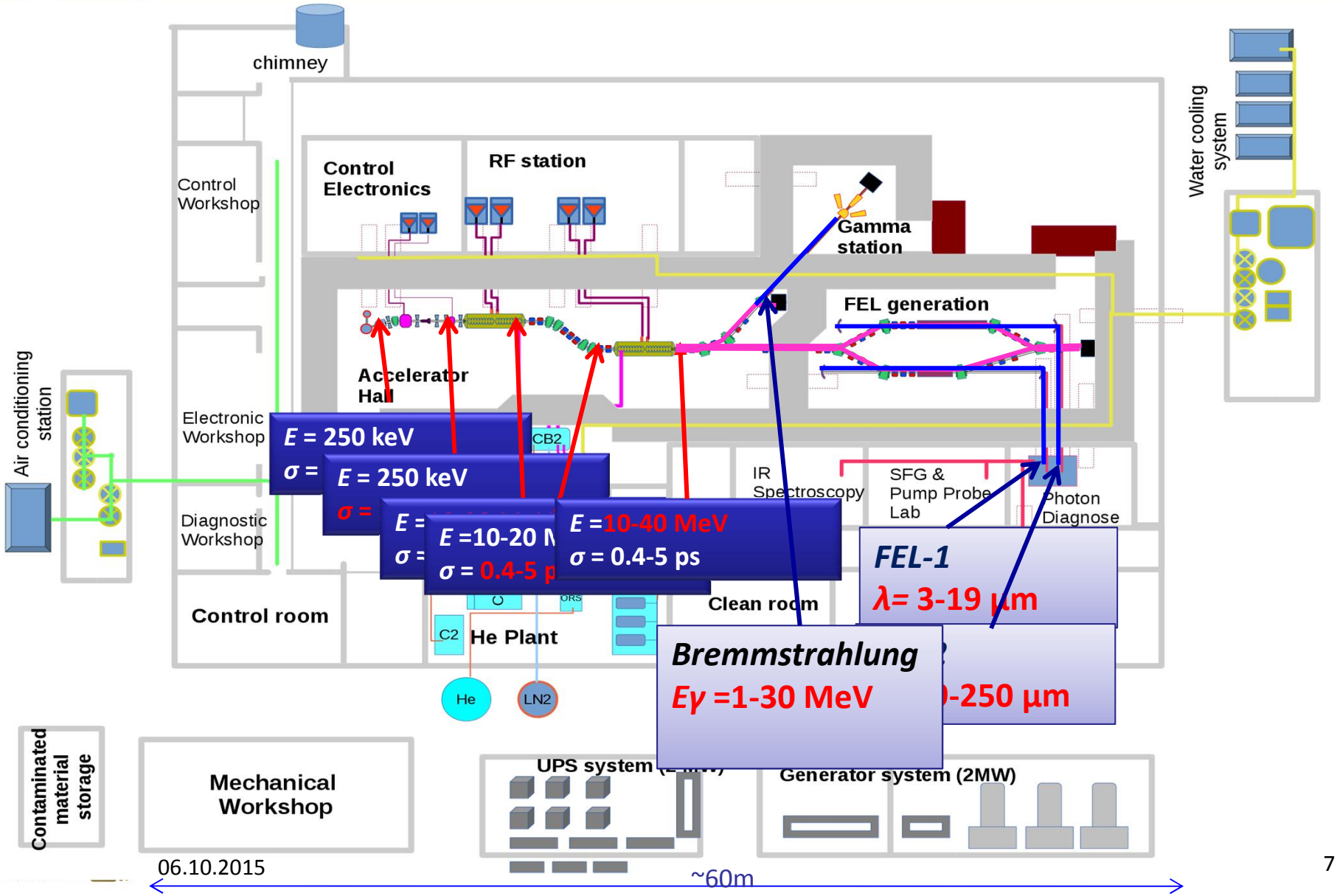
- IAT is proposed to
  - To train people about accelerators
  - To host and construct the "Test facility "of TAC
  - To establish collaborations with international communities
- Institute of Accelerator Technologies has been established in Ankara University in 2011

- The institute which is located in Gölbası (15 km south of Ankara) housing the TARLA facility
- It 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 (11 technical, 5 administrative)
- About 5 part time collaborator from different universities

Scope of the test facility, TARLA

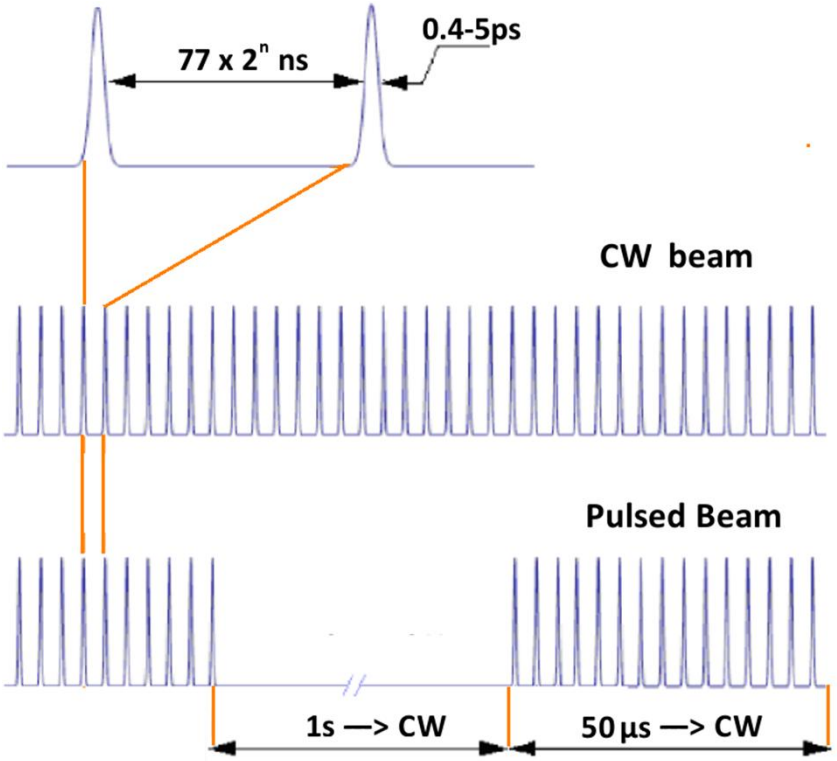
- Constructing accelerator based research facility in order to serve our country and our region within the frame of Turkish Accelerator Center Project.
- In TARLA facility we propose;
  - To generate Free Electron Laser between 3-250 μm using 15-40 MeV electron beam and two different optical resonator 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

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Research Potential of TARLA

Superconducting accelerator based electron beam

0 - 40 MeV ,
0-1 (1.5) mA
40 (60) kW
pulsed/ CW

Free Electron Laser	Coherent IR Radiation 3-250 µm • Material, (bio)physics, (bio)chemistry, medical..
Radiator Foil (Al,Nb)	Polorized Gamma 0-30 MeV • Nuclear Physics, Astrophysics, Radiation hardness • Gamma induced positron spectroscopy
Direct Use	Electron Beam 0 -40 MeV • Radyobiolgy, Detector study, Thomson scattering • Electron difraction, plasma studies
W Moderator	Mono Chromatic Positron • Semiconductors, material, …
Christal cannelling Compton Back Scattering	Quasi Monochromatic X-ray • Radiation physics, Radiobiology..
Lead Target	Notron Source • Fission, material, nuclear physics
Bending Magnet	THz Radiation • Material research, detector study…

TARLA Superconducting accelerating module

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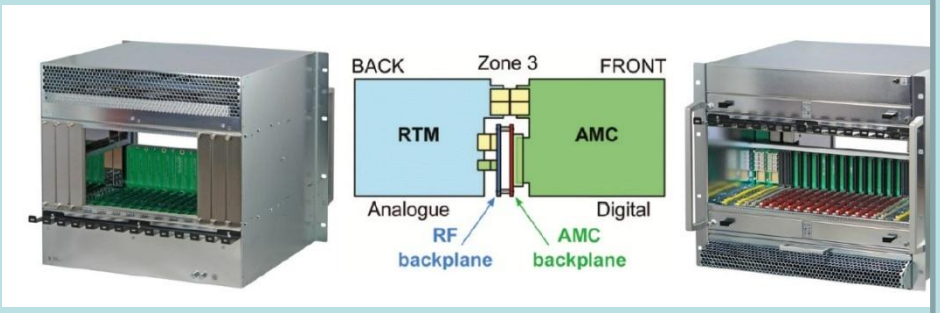
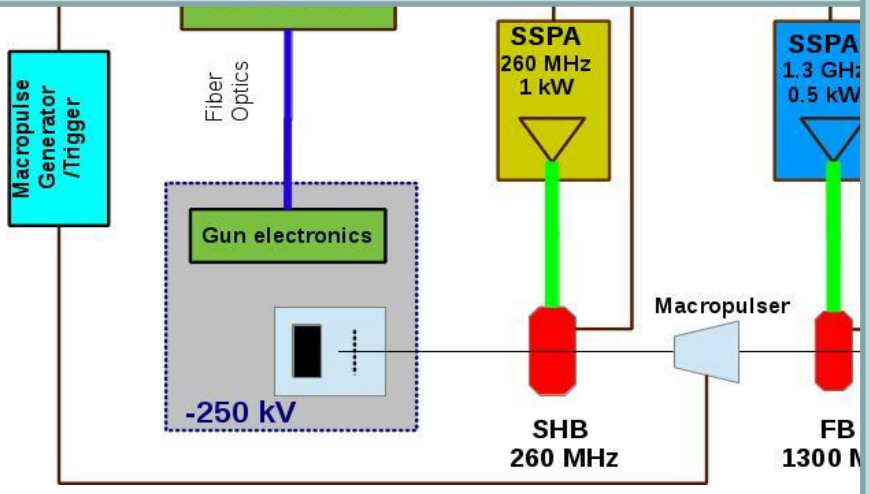
1mA

ervoir

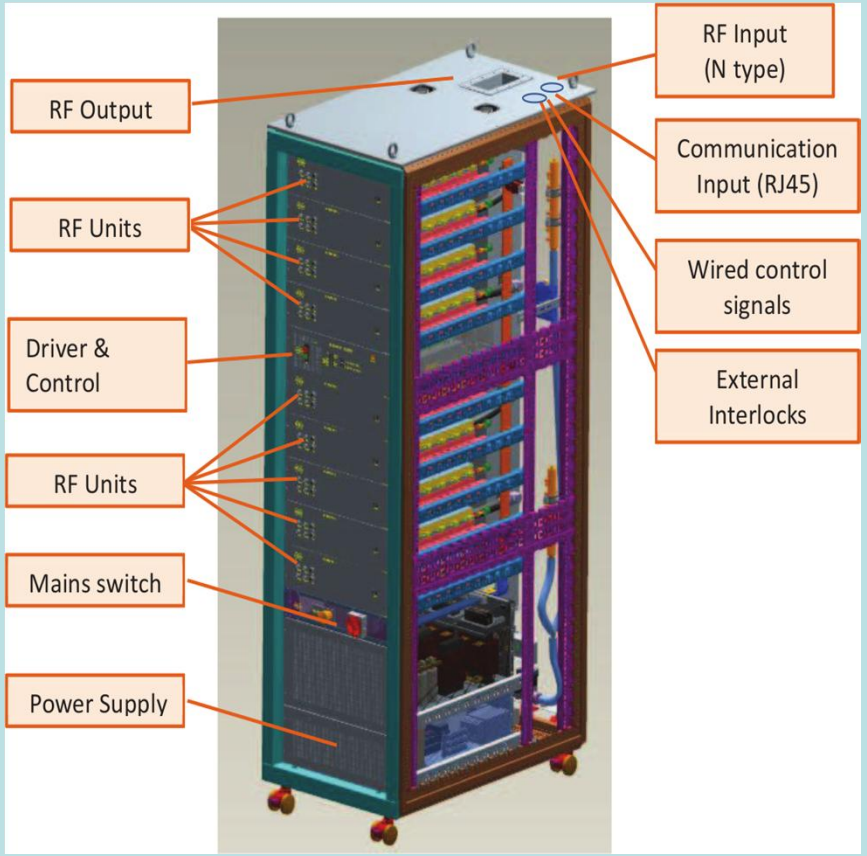
TARLA RF – System, Block Diagram

→ RF control is DESY design digital LLRF (µTCI4)





- Each structure will be fed by individu
- Each amplifier will have its own drive

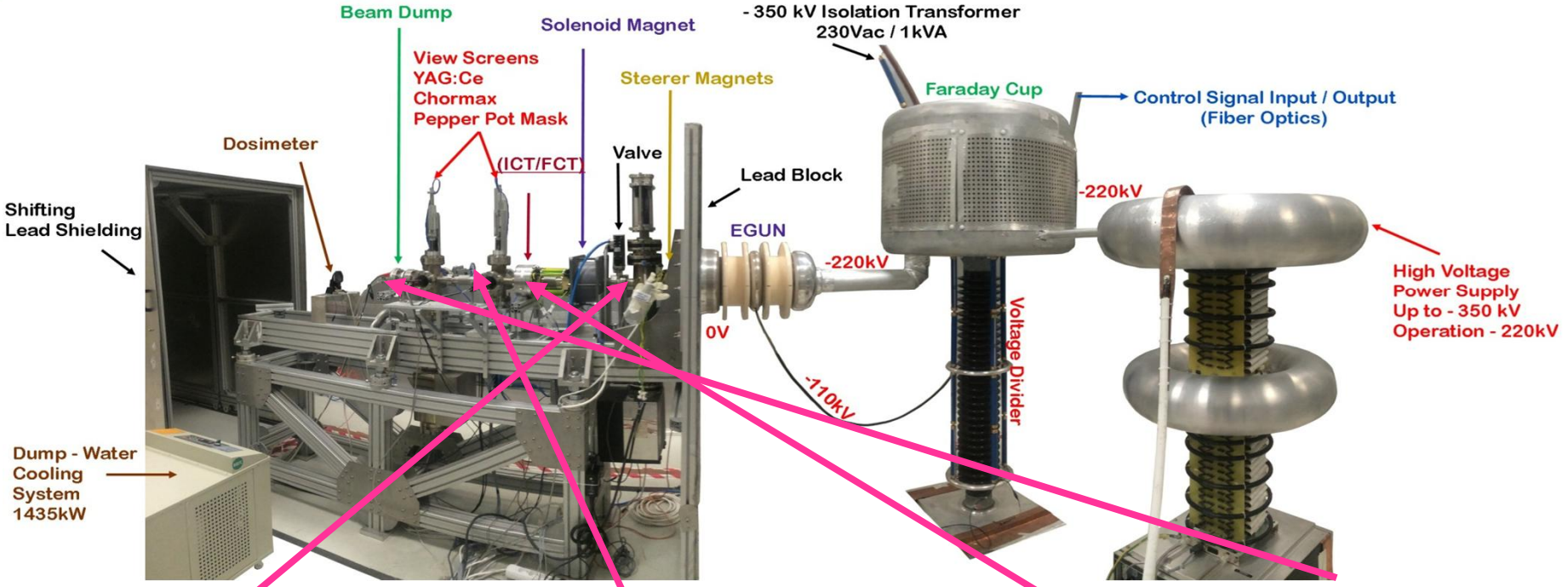


→ RF amplifiers are solid state power amplifiers

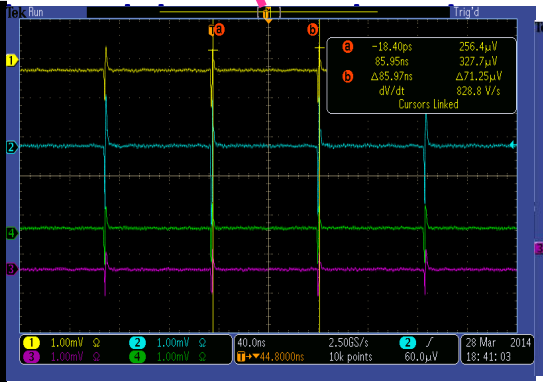
TARLA Electron Beam Parameters

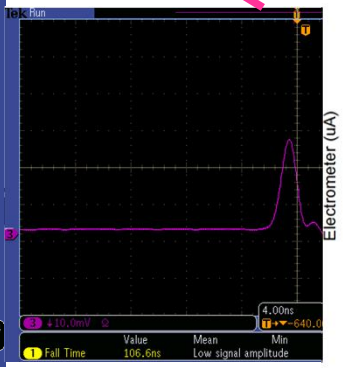
Parameter	Unit	Base	Upgrade
Beam Energy	MeV	5-40	5-40
Max average beam current	mA	1	1.5
Max bunch charge (@ 13 MHz)	pC	77	115
Horizontal emittance	mm.mrad	< 15	< 16
Vertical emittance	mm.mrad	< 12	<13
Longitudinal emittance	keV.ps	< 85	<100
Bunch lenght	Ps	0.4-6	0.4-6
Bunch repetition	MHz	13	13-26
Macropulse duration	µs	50→ CW	50→CW
Macropulse repetition	Hz	1 → CW	1 → CW

Electron gun test setup

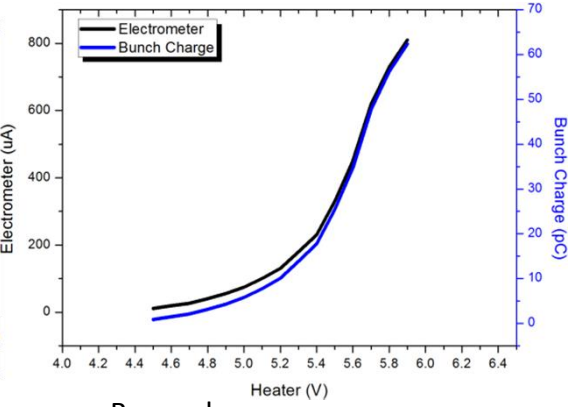


BPM





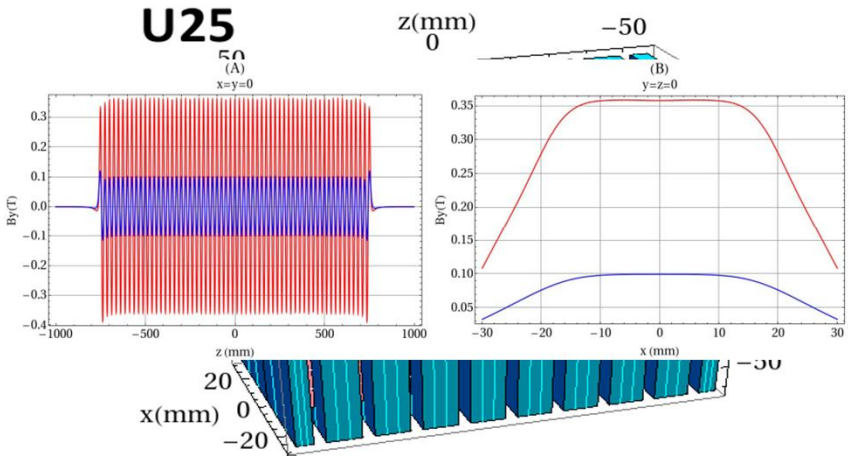
FCT



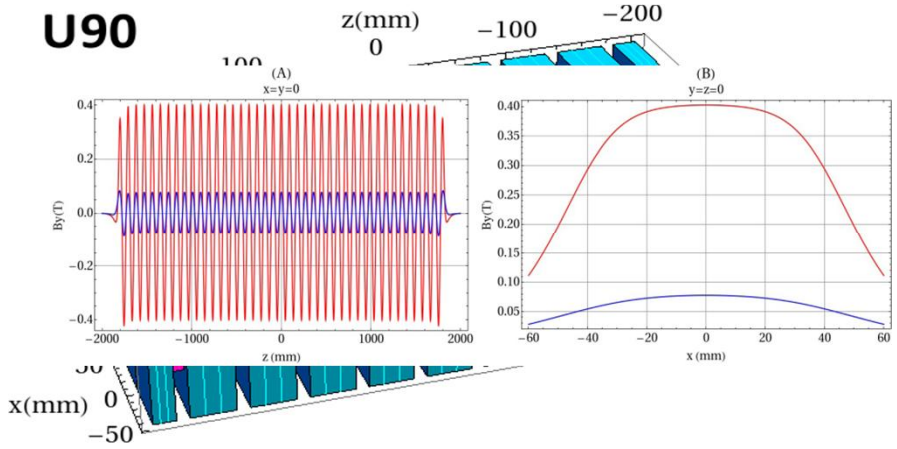
Beam charge

Free Electron Laser Section

- We propose to use 2 different optical resonator in order to scan all wavelengths between 3-250 μm.
- The beam is injected to undulators with achromatic beamlines (dipole-quadrupole triplet-dipole).
- U90 ⇒ undulator with 90 mm period length and U25 ⇒ undulator with 25 mm period length
- Besides the length of the periods of the undulators, the waveguide structure of U95 is another main difference between resonators.
- Preliminery design for undulators



- NbFe pole material, vanadium permandur blocks
- Roll off filed for max field is 0.04

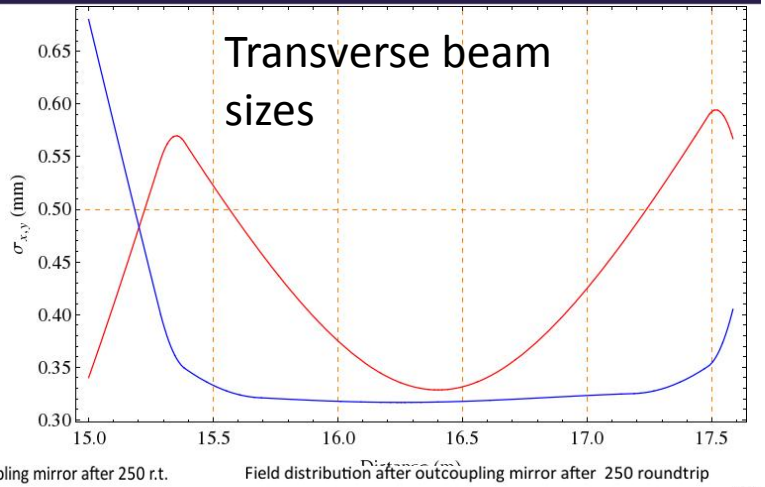


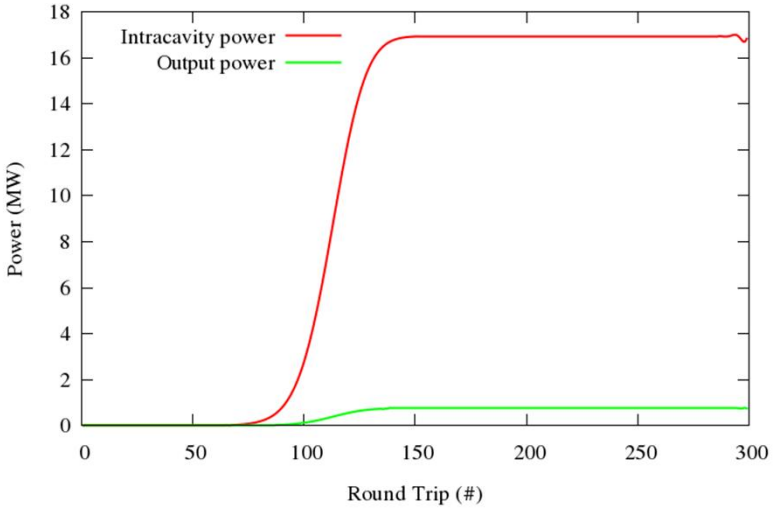
- NbFe pole material, vanadium permandur blocks
- Roll off filed for max field is 0.1

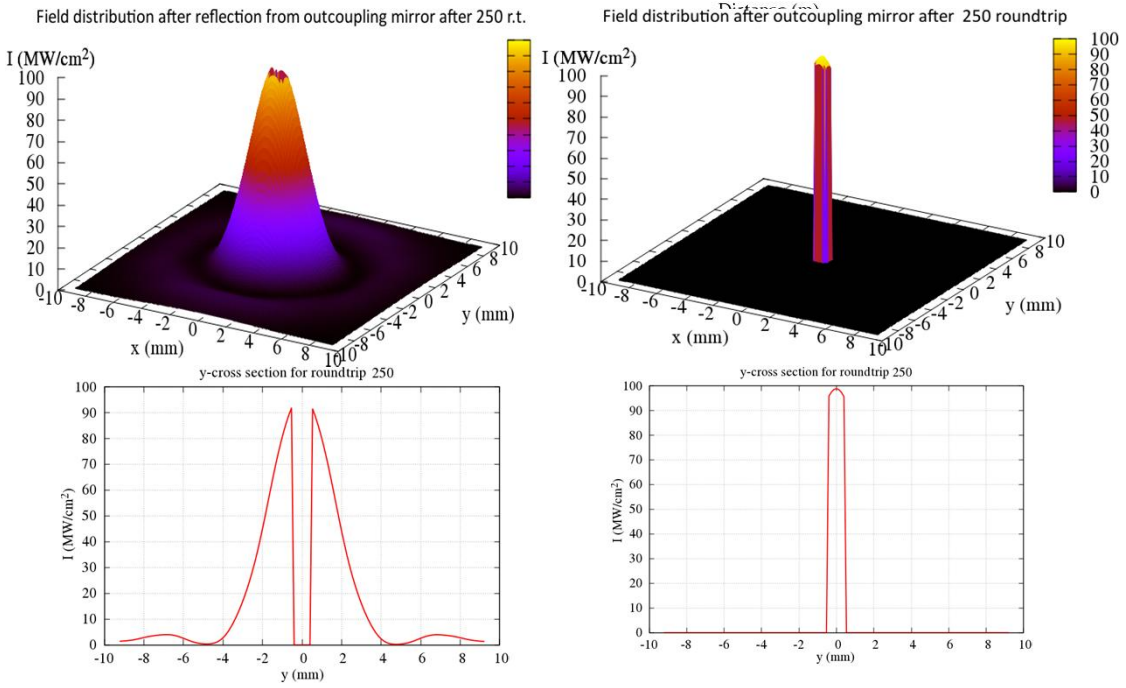
FEL Simulations in progress

- Time depended simuiation for FEL with 3 μm wavelength

  - E=38:2 MeV
  - K_u = 0.35
  - Z_r=0.75
  - σ_b= 0.5 ps
  - No detunning
  - R_1=R_2=5.86
  - Mirror Reflection ratio=%98







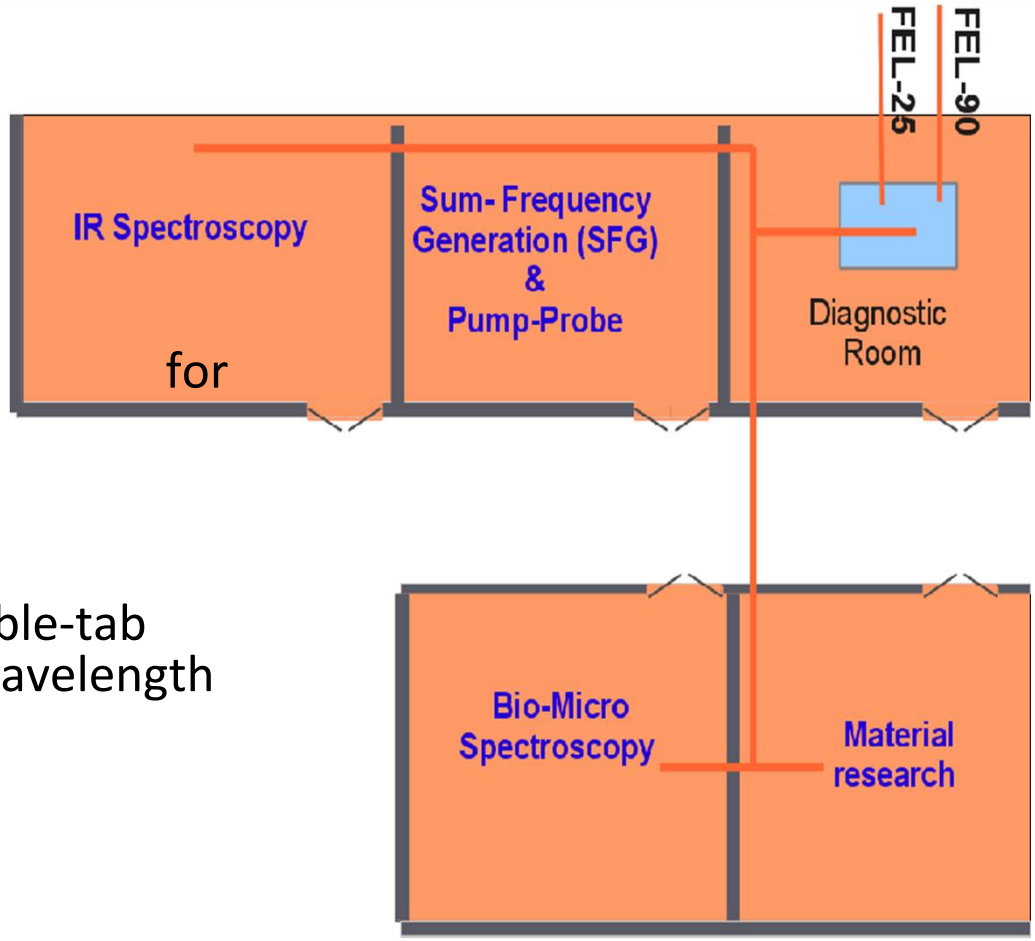
Helyum Plant

Auxiliary systems

- Water cooling, (installation completed for non-radioactive areas)
  - 24±1 C^{o} , 850.000 kcal/h
- Nitrogen Cooling (installation completed)
  - 500 l/day LN2 will be provided by storage system. The shielded lines are installed arround facility..
- Power network
  - 2+1 (main + backup) MW Transformer ,
  - 2+1 (main + backup) MW Generator,
  - 6 ×300 kW UPS
- EPICS and PLC based Control system
  - EPICS → Machine control
  - PLC → Control of auxialiry systems
    - PSS
    - Cooling
    - Building control …

Proposed FEL Stations

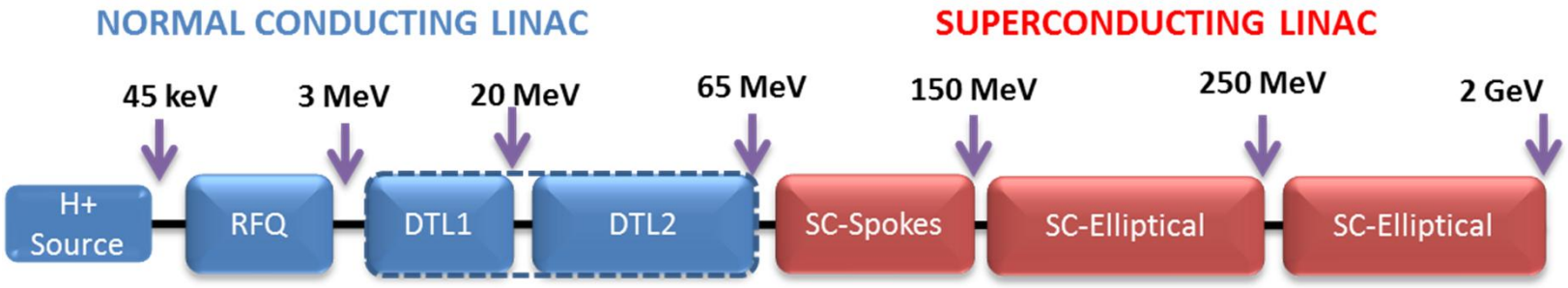
- Proposed FEL stations are:
  - IR spectroscopy lab.
  - SFG-PP lab.
  - Bio-Micro Spectroscopy lab.
  - Material research lab.
- Main FEL parameters are available for these labs
  - wavelength range: 3-250 m
  - Average FEL power: 1-100 W
- Each room will be equipped with table-tab laser sources with 700 – 1000 nm wavelength
  - Ti-sapphire laser
  - Nd:Yag laser
- FEL and external lasers will be synchronized
  - Δσ<100 fs
- The rooms will have class 1000 standard



TAC Proton Accelerator Facility (PAF)

http://tac.ankara.edu.tr/paf

TAC Proton Accelerator is proposed as a multipurpose, multi GeV energy and MW power machine



(Low enery → 3-65 MeV & 65-250 MeV, High energy → up to 2 GeV)

The project is planned progress in three stages:

Stage 1: ion-source, Low Energy Beam Transport and a RFQ (up to 3 MeV);

Stage 2: 250 MeV linear accelerator, which could be built in two step

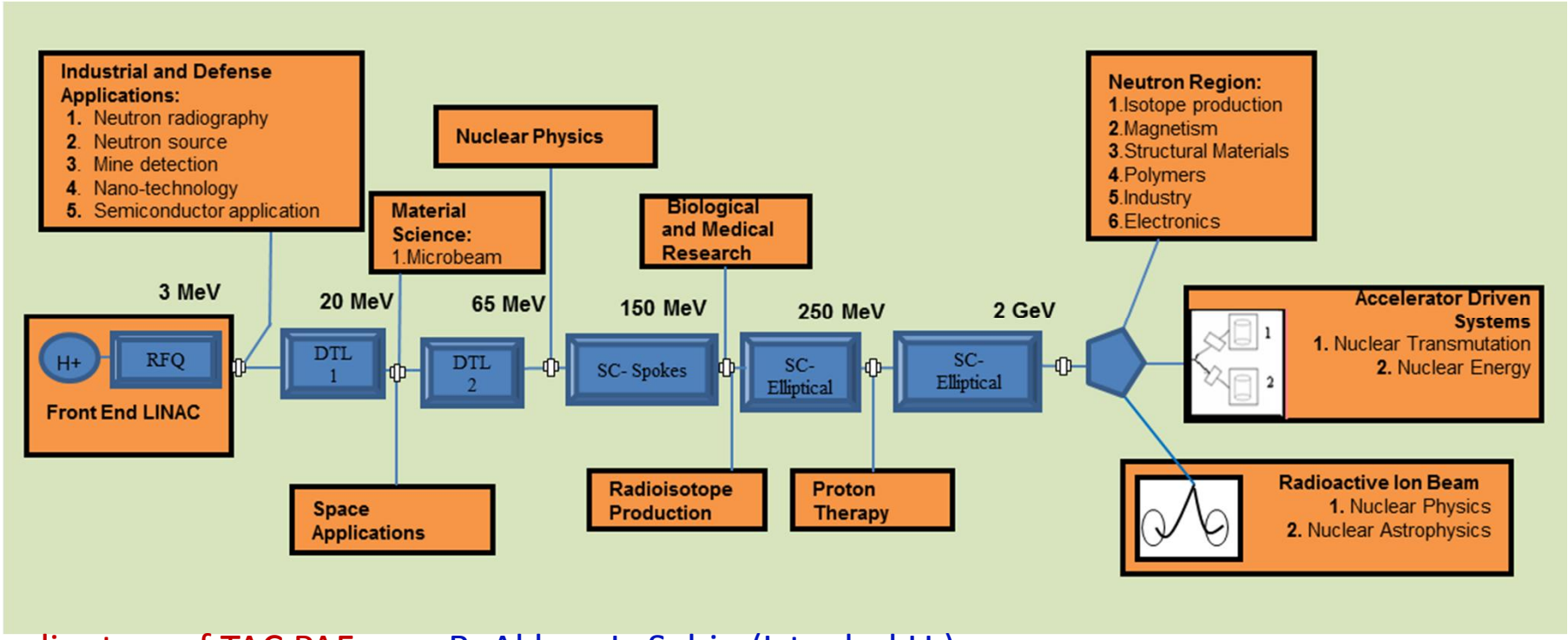
- Step 1- a 3-65 MeV Drift Tube Linac (DTL)
- step 2 - a Medium energy beam transport and 65-250 MeV SC-spoke cavity and SC-elliptical cavity

Stage 3: a 1 MW proton facility up to 2 GeV – probably a SC-Elliptical cavity

Ö.Yavaş (omer.yavas@ankara.edu.tr)
L. Şahin (latife.sahin@istanbul.edu.tr)

TAC Proton Accelerator Facility

This proton accelerator facility could serve as a neutron source, a radioactive ion beam facility as well as a number of lower energy facilities for use in nuclear, material, biological, and medical sciences.



Coordinators of TAC PAF: B. Akkuş, L. Şahin (Istanbul U.)
E. Algin (ESOGU)
M. Yılmaz (Gazi U.)

Ö.Yavaş (omer.yavas@ankara.edu.tr)

Conclusion

- TARLA is the first step of TAC project and will be the first accelerator based 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 nanotechnology as well..
- The infrastructure has almost been completed…
- The milestones of TARLA is
  - The helium plant will be ready by the beginning of 2016,
  - The injector will to be ready by the end of 2016.
  - First cyromodule will be delivered by June of 2016. We expect to get first beam from SRF1 by 1st Q of 2017, and beam from SRF2 is expected in 2018.
  - Purchasing components of laser station(s) will be started by next year and parallel to TARLA construction experiments with traditional laser sources will start by 2018
  - We expect to get first lasing by the end of 2019.

Conclusion

- Besides constructing TARLA, one of the scope of IAT is proposed to train people in accelerator related technologies
  - We established first accelerator technogies post-graduate education program in our university..
- Law for Research Infrastructure and legislations of related law has been published in July 2014 and September 2015, respectively.
  - The objective is to define issues related to support to ensure a more effective use of research infrastructure and their sustainability.
- IAT is candidate to be a research center.
  - To lead accelerator related projects in Turkey
  - To establish proposed facilities of TAC
  - To prepare accelerator based research infrastructure to the researches in our region.

TARLA

Turkish Accelerator and Radiation Laboratory in Ankara

Thanks for your attention!