Turkish Accelerator Center Project

Avni Aksoy
Ankara University

On behalf of TAC Collaboration Team

CLIC Workshop 2013

Outline

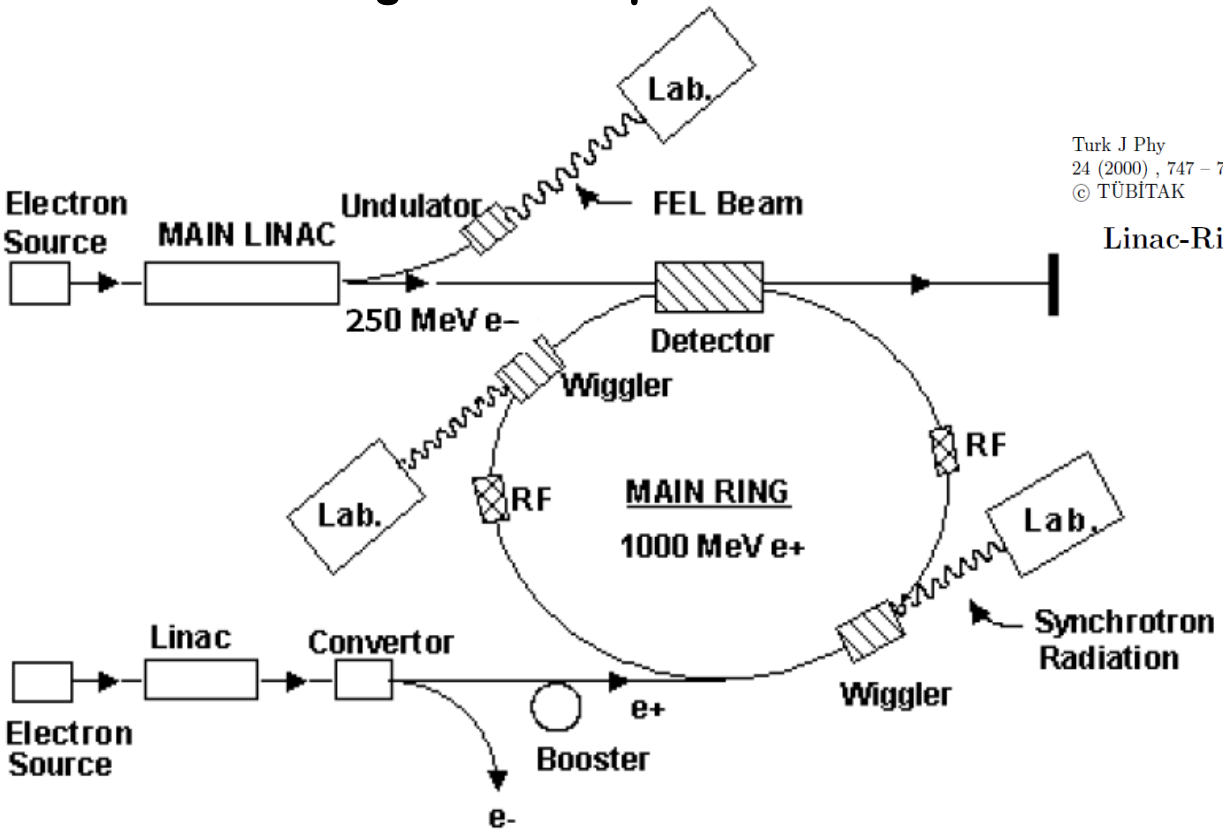
- A brief history of TAC Project
- Phases of TAC project
- TAC sub projects
  - TARLA
  - TAC-SR
  - TAC-SASE
  - TAC-PF
  - TAC-Charm
- Road map
- Conclusion

TAC was born

The TAC project have been first proposed in 2000's as linac-ring type e-e+ collider with 1 GeV center of mass energy as Φ factory.

Additionally in the proposal ;

- **Electron linac of the complex could be used to drive SASE undulators.**
- **Positron ring of the complex could be used as SR source.**



Turk J Phy
24 (2000) , 747 – 758.
© TÜBİTAK

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

Phases

1st phase (Preliminary report / 1997-2001)

- Outcome: The Preliminary Report in 2001
  - Accelerator Center (TAC) Project have been proposed

2nd phase (Feasibility Report /2002-2005)

- Outcome : The 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 the proposed facilities of TAC are explained

Phases

3rd phase (Current Phase / 2006-2014)

The First Facility, Institute, Conceptual and Technical Design Reports of Proposed TAC Facilities

Started in 2006 as collaboration of 12 Turkish universities under coordination of Ankara University (~155 people)

❑Goal of the phase

- Establishment of The Institute of Accelerator Technologies (IAT)
- Establishment of (Oscillator mode IR FEL & Bremsstrahlung) Facility (TARLA, building constructed and installation continuing).
- Achievement of the Technical Design Reports of TAC Synchrotron Radiation facility TAC Proton Accelerator Facility
- Achievement of the Conceptual Design Reports of TAC SASE FEL and TAC Particle Factory

TAC collaboration

- **TAC:** An Interuniversity Collaboration
- **Project Team:** 69 staff with PhD + 86 graduate students and engineers

Ankara University (Coordinator)

Gazi University

İstanbul University

Uludağ University

Dumlupınar University

Osmangazi University

Boğaziçi University

Doğuş University

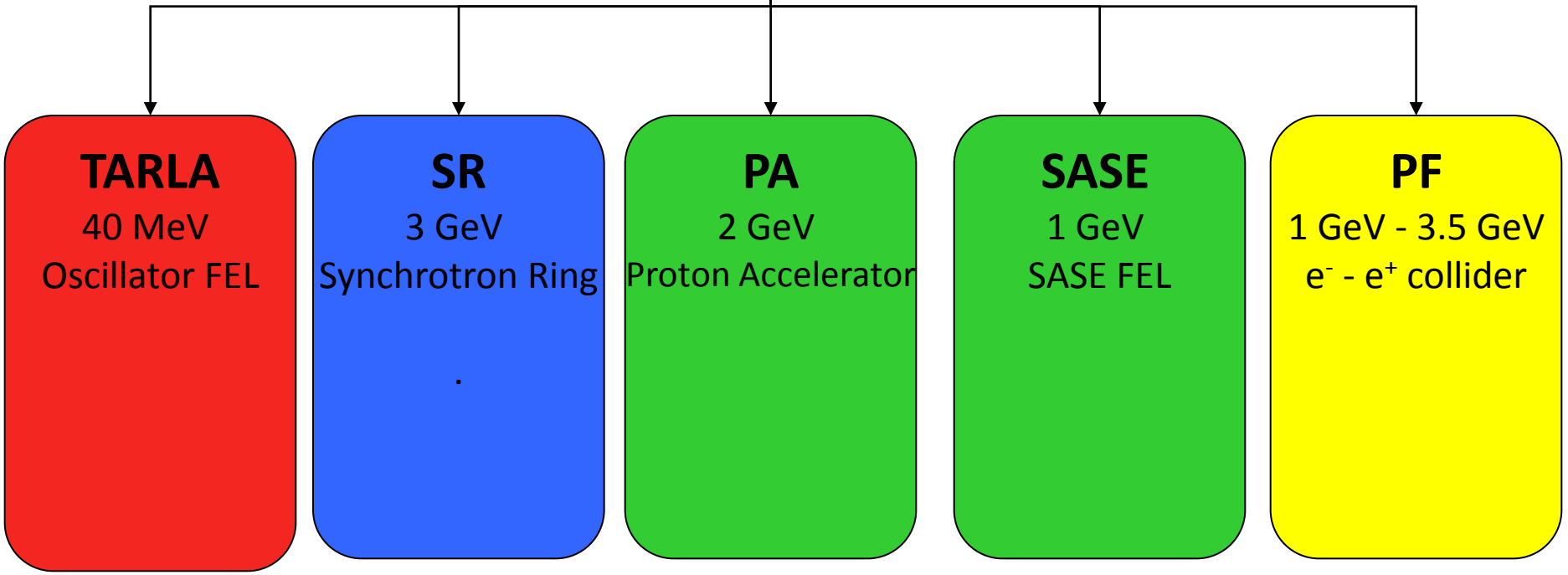
Erciyes University

Süleyman Demirel University

Niğde University

Gebze Institude of Technology

TAC Project



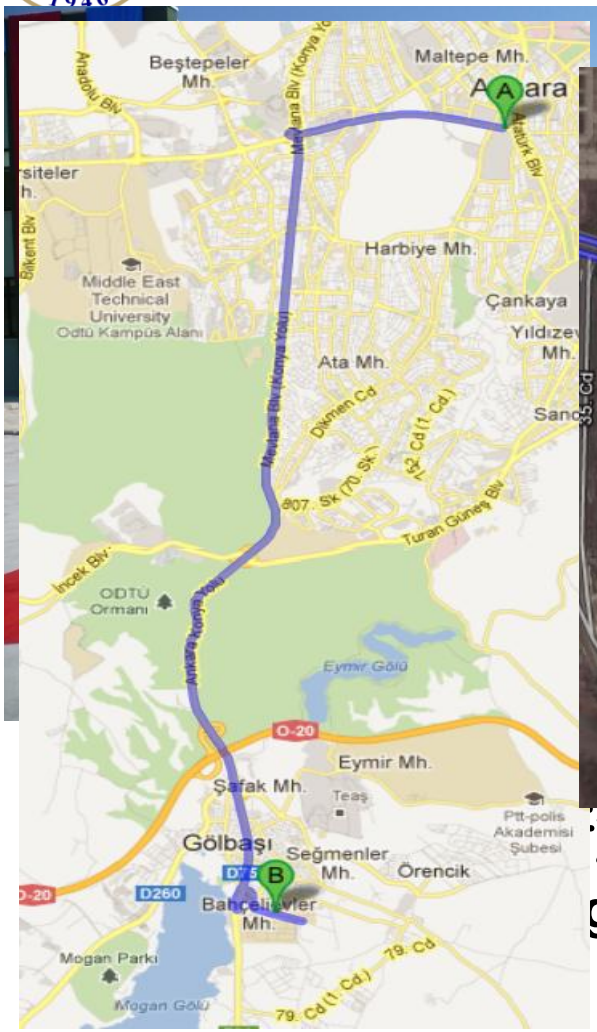
Installation and commissioning continuing

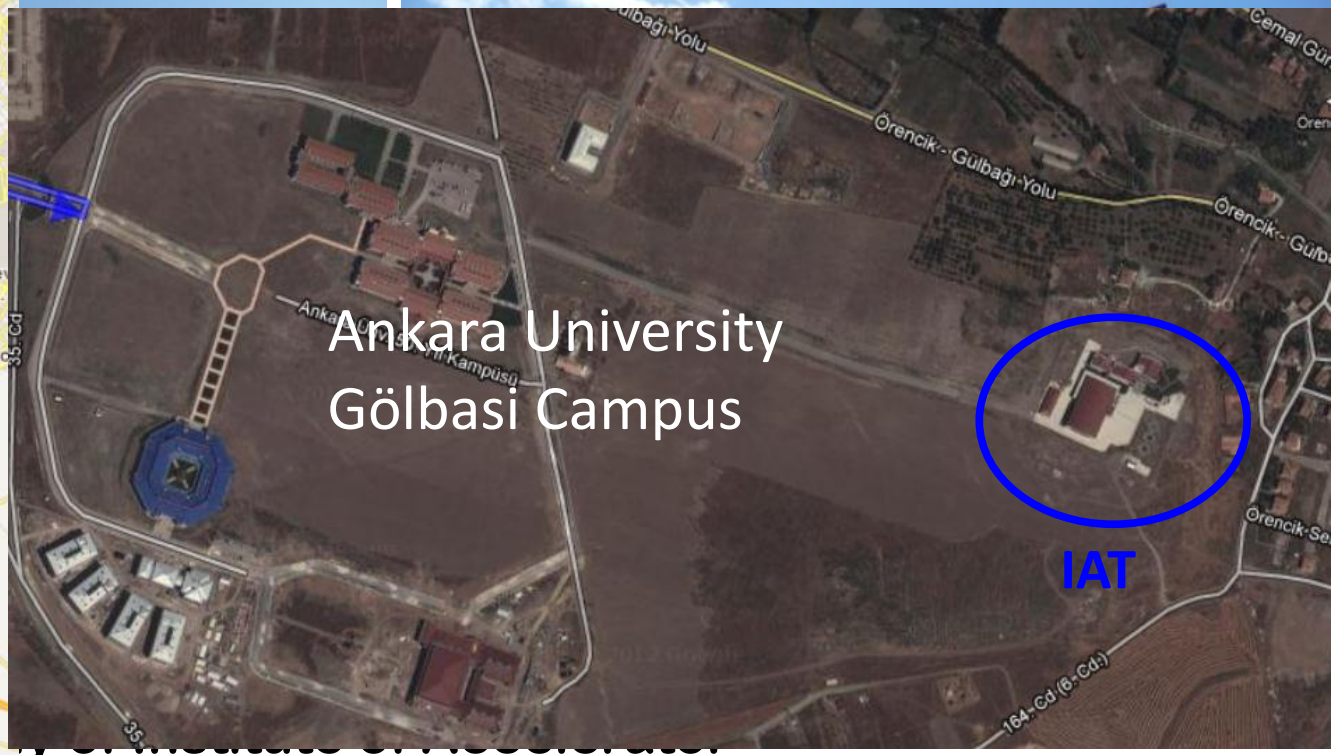
Detailed Design Report phase

Conceptual Design Report phase

Feasibility Report phase

Institute of Accelerator Technologies of Ankara University

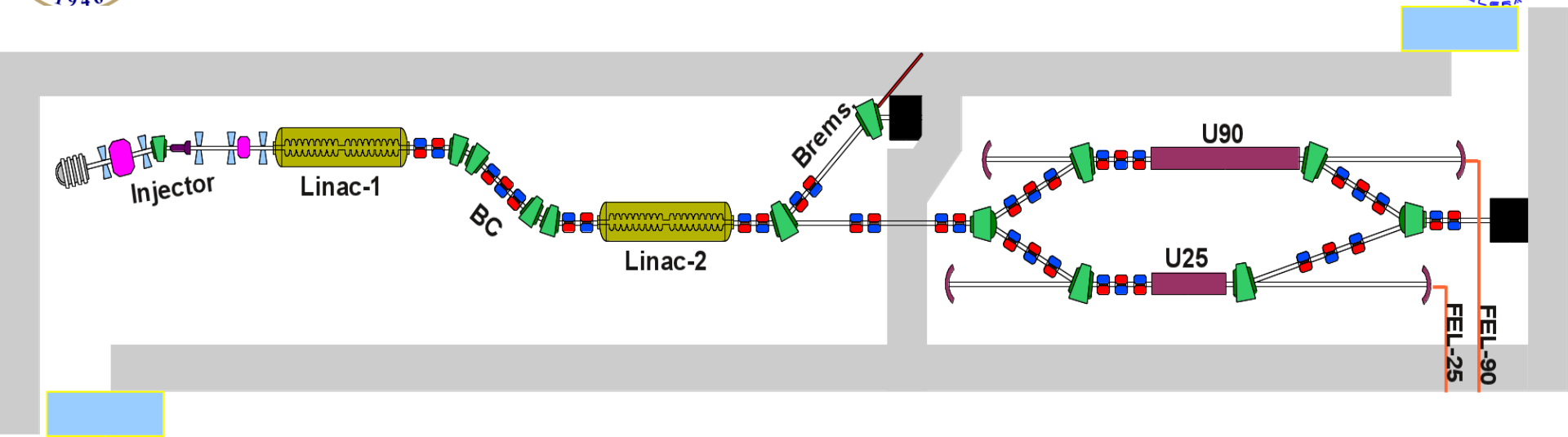




ARLA facility building May 9, 2011.
gs to Ankara University also houses

- Is is located about 15 km south of Ankara, in Gölbası campus area of Ankara University

TARLA Project

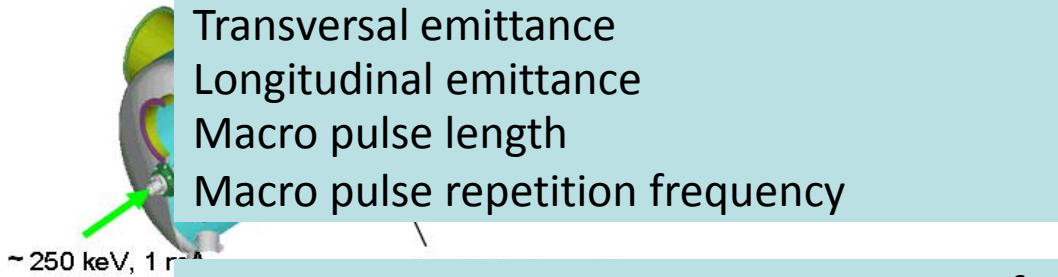


- TARLA basically has been proposed as a first step of TAC project.
- It will generate Free Electron Laser between 3-250 μm using 15-40 MeV CW electron beam and two different undulators.
- Additionally, a Bremsstrahlung station has also been proposed for nuclear studies.

Main accelerator of TARLA

Electron beam parameters of TARLA

Parameter	Value	Unit
Beam energy	15-38.5	MeV
Max average beam current	1	mA
Micro pulse repetition frequency	13	MHz
Micro pulse length	0.5-6	ps
Transversal emittance	< 13	mm.mrad
Longitudinal emittance	< 50	keV.ps
Macro pulse length	CW / 40-100	µs
Macro pulse repetition frequency	CW / 1-100	Hz



FEL Parameters of TARLA

Parameter	U25	U90
Wavelength [µm]	2-30	15-250
Micropulse repetition [Mhz]	13	13
Max. peak power [MW] *0.1-3	0.1 – 6	0.01-2
Pulse length [ps] *	1-10	1-10
Average power [W] *	1-100	1-100
Max. pulse energy [µJ] *	0.1-3	0.1-3
Brightness [ph/(s mm^2 mrad^2 0.1% B.W.)]*	~10^30	~10^29

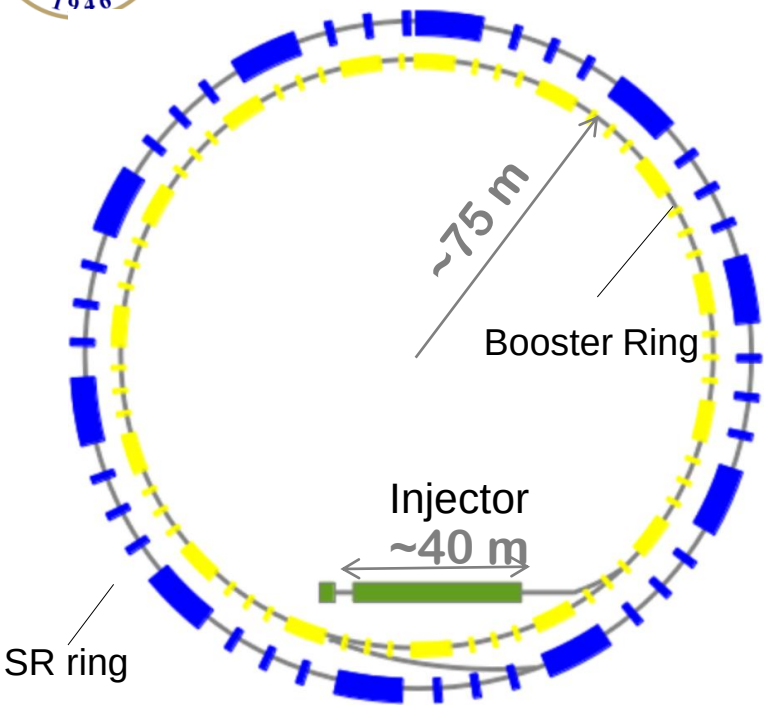
- Supe… be u…
- This … cavit… oper… 15 to…
- The … ELBI…

…nics plant

…c system taken by

…missioning

TAC SR Source



Storage Ring Parameters

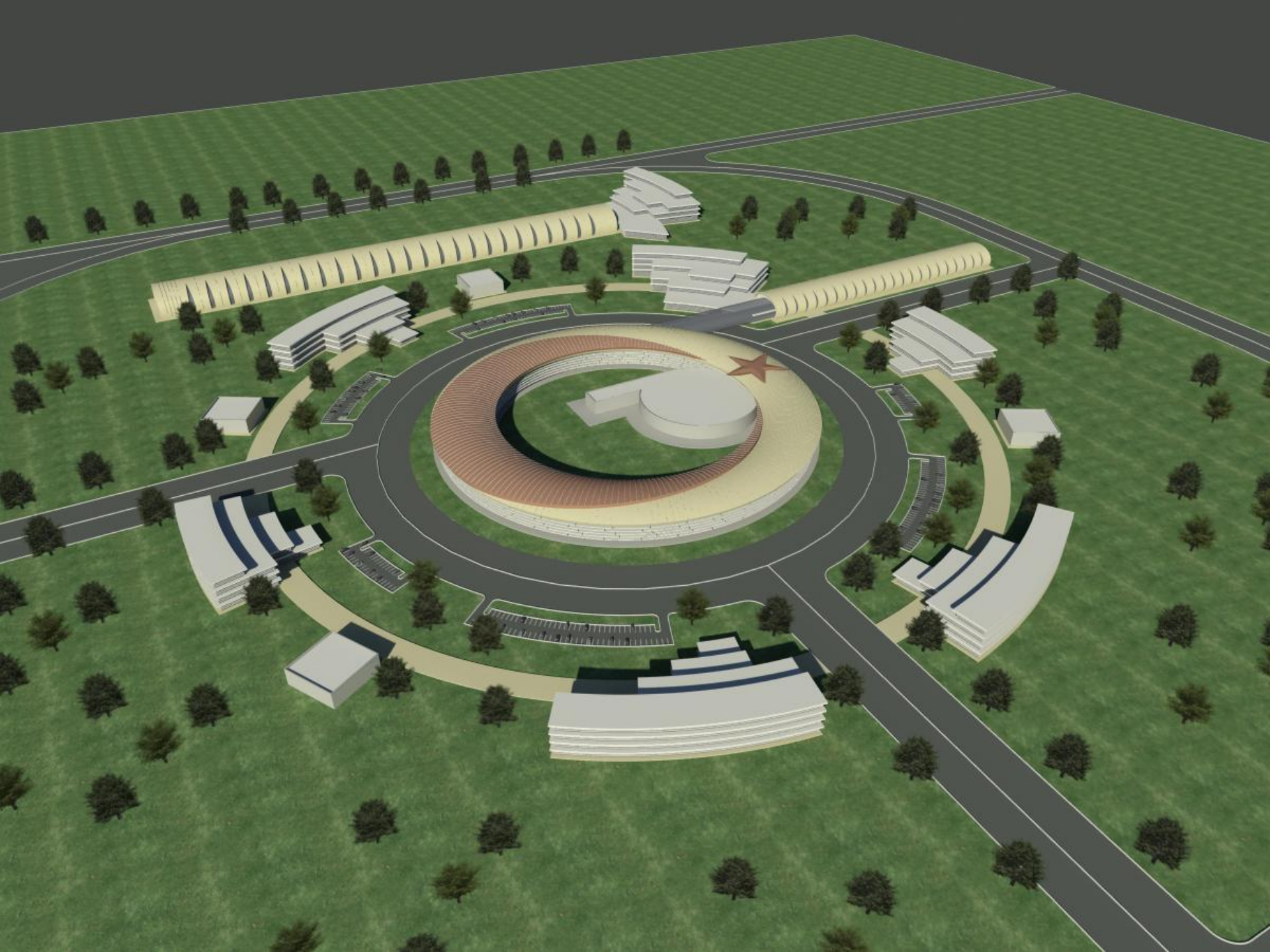
Parameter	Value
Energy (GeV)	3
Circumference (m)	474
Beam Current (mA)	500 mA
Bet. Tunes Qx/Qy	32.22/5.17
Nat. Chromaticity x0x /x0y	-89.3/-32.22
Cor. Chromaticity x0x /x0y	0.0/0.0
Energy loss / turn (keV)	312.6
H. emittance (nm)	0.65
V. emittance (nm)	0.0065
Betaxmax (m)	21.10
Betaymax (m)	27.2
Betax in the mid. of straight sect.	18.0
Betay in the mid. of straight sect.	9.8
Dispx in the middle of straight sect.	0.097
Number of straight section	18
Length of straight section (m)	5
Rf Voltage (MV)	3.5
Harmonic number	760
Max. Number of bunch	760
Bunch charge (nC)	1.04
RMS Bunch length (mm)	2.24
Momentum Acceptence (%)	4.5
Coupling (%)	1
Toushek Life time (h)	OPA: 10.5
El. Scat. Lifetime (h)	142
Inel. Scat. Lifetime (h)	619
Tot lifetime (h)	9.0

Main Cell of Storage Ring

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

The ring consist of 18 main cells.

The length of straight sections between cells a



TAC SR user committees

First International Workshop on Machine and Research Aspects of the Proposed Turkish Light Sources
(TAC-LSUM2011)
July 4–6, 2011
Doğus University, Istanbul, Turkey

TAC SR User Committe
with 13 staff is established.
July 6, 2011
Coordinator : Dr. Ozgul Kurtulus

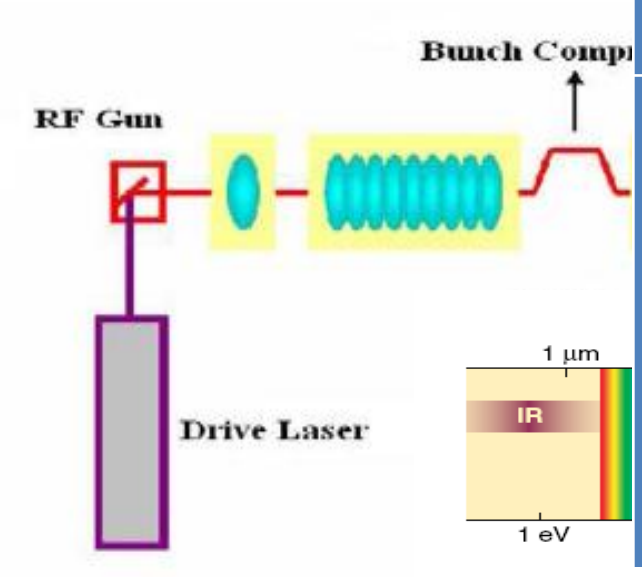
Scientific collaboration between TAC and European Synchrotron User Organisation (ESUO) and European Light Sources Activities (ELISA) (September 2011)

1st meeting of TAC SR User Committee: Oct. 22, 2011, IAT, Ankara
2nd meeting of TAC SR User Committee: March 24, 2012, Dogus Univ, Istanbul

It is planed to apply government in 2014 for the support to TAC SR in three phase.
(1- TDR , 2- Injector section , 3- SR and user labs)

TAC SASE FEL project

- **Main goal of this light sourc**
  - high power (GWs),
  - ultra bright (~ 10^{30} photons/s/m
  - tunable free electron laser (VU
  - aiming to enable femtosecond
    physics, plasma and condense
- **Machine: Machine 1 GeV ele technology**
- **Wavelength range: VUV - S**



	Parameter	Unit	Value
Electron beam	Electron beam energy, Ebeam	GeV	1
	Bunch charge, Q	nC	1
	Normalized emittance, εN	π.mm.mrad	2
	FWHM bunch length, σz	ps	0,5
	Peak current, Ipeak	kA	2
	Energy spread, ΔE/E	-	2.10^{-4}
Undulator Par.	**Parameter**	**Unit**	**Value**
	Undulator gap, g	cm	0,8
	Undulator period, λu	cm	1,5
	Peak magnetic field, B_{peak}	T	0,787
	K parameter	-	1,1
	Number of undulator periods, Nu	-	1580
	Undulator length, Lu	m	23,7
FEL parameters	**Parameter**	**Unit**	**Value**
	Pierce parameter, ρ	-	$6,327.10^{-4}$
	1D gain length, LG,1D	m	1,089
	3D gain length, LG,3D	m	2,659
	Saturation length, L_{sat}	m	21,8
	FEL wavelength, λ_{FEL}	nm	3,15
	Saturation power, P_{sat}	GW	1,265
	FEL energy, EFEL	keV	0,392
	Photons per pulse#	-	$1,29.10^{13}$
	Energy per pulse#	J	$8,15.10^{-4}$
	Peak flux#	photons/s	$1,45.10^{25}$

X-band Linac based FEL facility

- **Meeting on X-band Linac based FEL facility** 17-18 January 2013, Ankara, Turkey

Report on the Feasibility of an X-Band Linac Based FEL in Turkey
January 17-18, 2013, Gölbaşı, Ankara, Turkey

Participants:

ISAC: **Ercan Alp** (Argonne, USA), **Ken Peach** (Oxford, UK), **Frank Zimmermann** , **Gökhan Ünel** (CERN, Geneva, Switzerland), **Helmut Wiedemann** (SLAC, USA), **Ali Tanrıkut** (TAEK, Turkey),

CERN: **Steinar Stapnes** (Linear Collider Study Leader), **Daniel Schulte**
TR Ministry of Science, Technology and Industry: **Mecit Yaman**
TR Ministry of Development: **Mustafa Alpaslan**
Turkish Atomic Energy Authority (TAEK): **Irfan Koca**

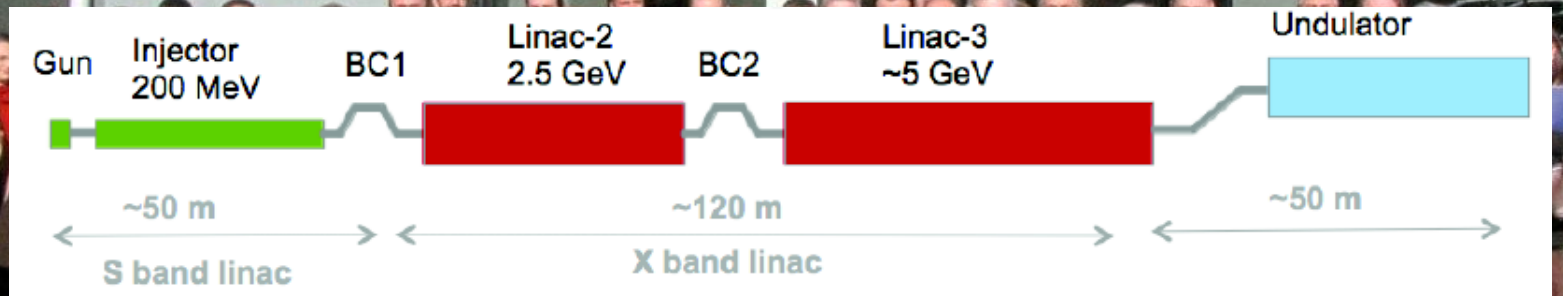
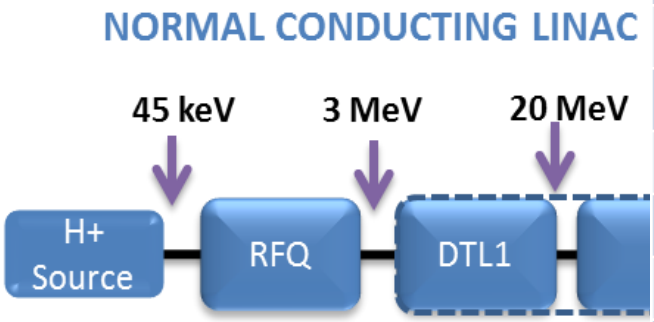


Figure 1. The schematic of the proposed X-Band LINAC and FEL facility

Proton Accelerator facility

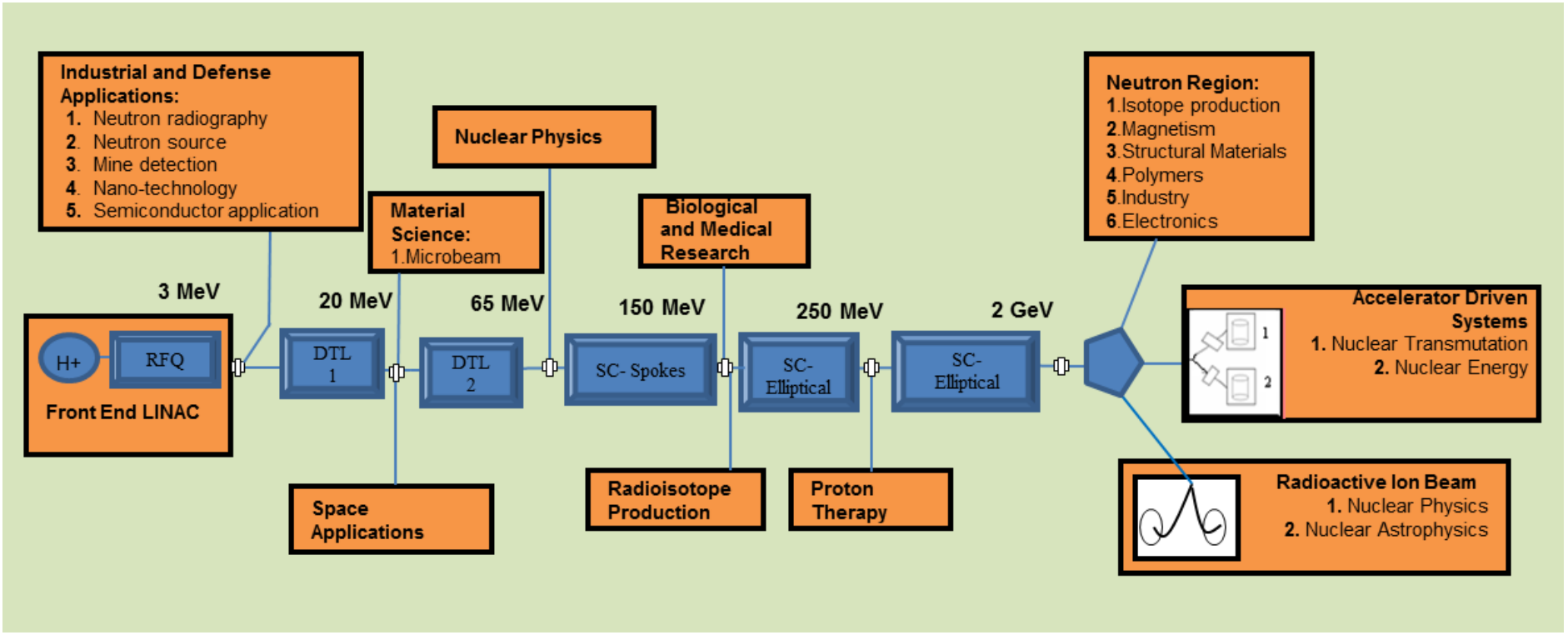
- TAC Proton Accelerator is proposed as a multipurpose, GeV energy and MW power scale machine

- 3 -20-65-150-250 MeV steps are planned as low energy part and high energy part of machine will be achieve to 2 GeV



Parameter	Unit	Value
Particle Type	H-	
Input Energy	3	MeV
Exit Energy	2000	MeV
Bunch Frequency	350	MHz
Peak Current	30	mA
Average Current	0.03	mA
Beam Pulse Length	300	µs
Beam Duty factor	9	%
Repetition Frequency	30	Hz
Number of Particles Per Pulse	$5{,}3\times10^{14}$	--
Input Norm. Emittance (Transverse)	0,276	mm.mrad

Some applications for PA



- It is planed to apply government for the support to first 3 MeV section and TDR of PA facility

Particle (Charm) Factory

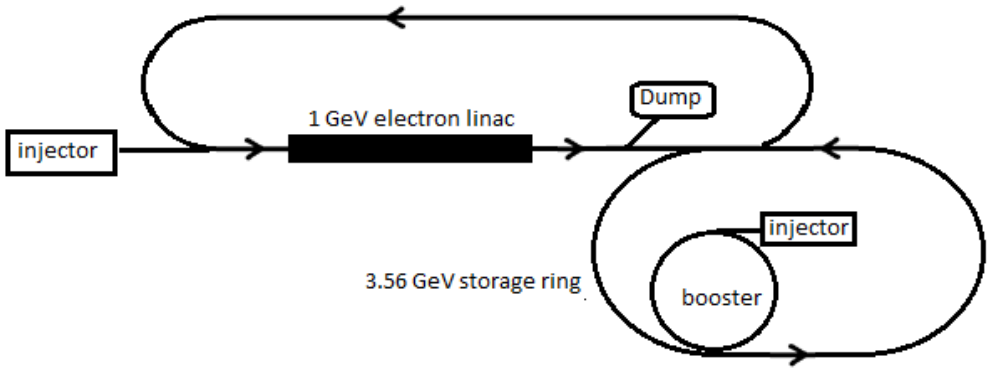
Asymmetric linac- ring type $e^- - e^+$ collider.

Beam energies: Ee^-=1 GeV,

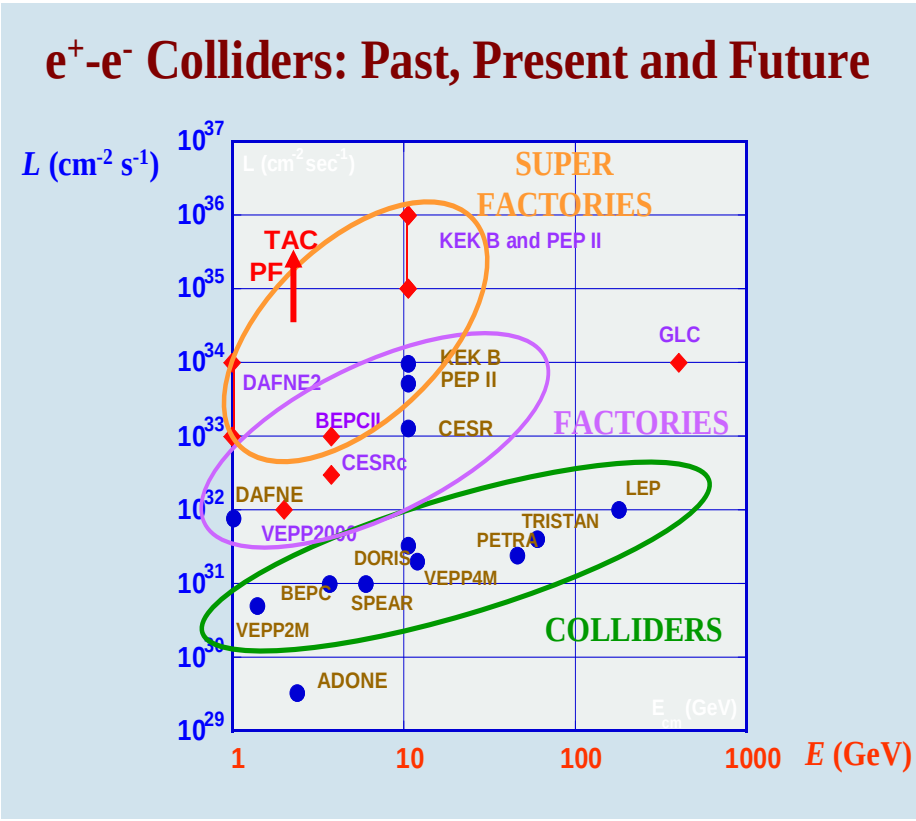
Ee^+=3.56 GeV,

Lumi=$1.4 \times 10^{35} cm^{-2} s^{-1}$

Ec.m.= 3.77 GeV



Based on ISAC and ECFA recommendations, it is planned that, TAC PF will be transformed to a global project with international collaborations.



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)

Scientific Advisory Committee of TAC

- Ercan ALP (Argonne National Laboratory, USA) **(Chairman)**
- Behçet ALPAT (INFN Perugia, Italy)
- David M. ASNER (PNL, USA)
- Swapan CHATTOPADHYAY (Cockroft Institute, UK)
- Eugene LEVICHEV (BINP, Russia)
- Yasar ONEL (Univ. of Iowa, USA)
- Luigi PALUMBO (INFN Frascati, Italy)
- Ken PEACH (Oxford University, UK)
- Roland SAUERBREY (FZD, Germany)
- Zehra SAYERS (Sabancı University, Turkey)
- Gökhan UNEL (UCI & CERN)
- Ali TANRIKUT (TAEK, Turkey)
- Helmut WIEDEMANN (Stanford University, USA)
- Frank ZIMMERMANN (CERN)

1st Meeting:
October 8-9, 2009
Ankara University
Ankara, Turkey

2nd Meeting:
June 21-22, 2010
Boğaziçi University **Istanbul, Turkey**

3rd Meeting:
May 9-10, 2011
Ankara University
Ankara, Turkey

4th Meeting:
June 11-12, 2012
Istanbul University
Istanbul, TURKEY

Machine Advisory Committee of TARLA

- Peter MICHEL (HZDR-ELBE, Germany) (Chairman)
- Hideaki OHGAKI (Kyoto University, Japan)
- Dieter TRINES (DESY, Germany)
- Ernst WEIHRETER (HZB-BESSY, Germany)
- Jean R. DELAYEN (JLab, USA)

1st Meeting:
December 4-5, 2009
Ankara University

2nd Meeting:
September 2-3, 2010
Bodrum, Mugla

3rd Meeting:
May 12-13, 2011
IAT, Ankara University

4th Meeting:
March 8-9, 2012
IAT, Ankara University

National Organizations

- National Congress on Particle Accelerators and Their Applications (UPHUK): Every three years since 2001
- National Summer School on Particle Accelerators and Detectors (UPHDYO): Every year since 2005.

International planned organizations

- Linear Collider School (LCS, 2013, Turkey)
- CERN Accelerator School (CAS, 2014, Turkey)
- International Beam Instrumentation Conference (IBIC, 2019, Turkey)

Turkish Atomic Authority (TAEK) Proton Accelerator Facility

- **The machine**
  - 15-30 MeV proton cyclotron
    - (Cyclon 30, IBA)
- **Purpose**
  - Radioisotope production
  - R&D with proton beam
- **Facility Location:**
  - Sarayköy Nuclear Research and Training Center (SANAEM), Ankara
- **The facility has already been commissioned and opened to service on May 29, 2012 by Prime Minister.**

Conclusions

- We have a time schedule for the proposed facilities of TAC, up to end of 2020's.

- Schedule for near future:
  - TARLA accelerator will be ready at the end of 2015.
  - A new project (TARLA-II) is developed to set up experimental stations.
  - LE PAF project will be presented to the MD in 2013, for a 2014-2018 period.
  - TAC SR project will be presented to the MD in 2014, for a 2015-2023 period.
  - The Industrial Strategy Report of TAC is under consideration.
  - Site choice for the Turkish Accelerator Center will be worked on 2013.

- Turkish parliament is working on a new **constitution** and laws of higher education and national research centers. These dedicated laws will open new horizons for TAC.

- We wish to collaborate with CERN-CLIC team for a FEL facility based on X-band linac for TURKSEL