Restricted ECFA Meeting

October 6-7, 2017

Boğaziçi & Bilgi Universities

ISTANBUL

Accelerator R&D in Turkey

National Projects & International Collaborations







Prof. Dr. Ömer Yavaş

Ankara University

Dept. of Eng. Physics &

Institute of Accelerator Technologies

yavas@ankara.edu.tr

Outline

- A summary on the status of accelerator R&D in Turkey
- National Accelerator Projects & Facilities
  - Turkish Accelerator Center (TAC) Project & TARLA Facility
  - Turkish Atomic Energy Authority's (TAEK) Facilities and Projects
  - Ongoing Accelerator R&D Projects in Universities
- International Memberships and Collaborations
  - International memberships
  - International collaborations
- Conclusions

A summary on the status of accelerator R&D in Turkey

- ✓ Turkish Accelerator Center (TAC) Project and TARLA Facility
- ✓ TAEK Proton Accelerator Facility & SPP Project
- ✓ Accelerator related R&D projects in universities
- ✓ Medical linacs for therapy (>225)
- ✓ Baby Cyclotrons for medical pharmaceuticals (>10)
- ✓ Industrial Accelerators (>5)
- ✓ Membership of SESAME (since 2000)
- ✓ Associate membership of CERN (since 2015)

Turkish Acccelerator Center (TAC) Project

http://thm.ankara.edu.tr (TR) http://tac.ankara.edu.tr (EN)

Today's Turkey, at the threshold of the European Union membership, is committed to have world-class research facilities, and **Turkish Accelerator Center (TAC)** is going on to be yet another example of this commitment.

Mission of TAC Collaboration:

- To design, construct and use of high energy particle accelerators for scientific research and technological development in basic and applied sciences in Turkey and the region.
- To form a national accelerator community and a national industrial production base in accelerator technologies.
- To collaborate with international accelerator community.

Phases of the TAC Project

First Phase:

Feasibility Study (1997-2001) by support of State Planing Organization (SPO)

- Outcome: Turkish Accelerator Center (TAC) is proposed and main road map is defined.

Report:
http://www.tarla.org.tr/thm/tac/YUUP/TacFizibilite.pdf

Second Phase:

General Desing Study (2002-2005) by support of SPO (Ministry of Development since 2011)

- Outcome : General/Conceptual Design Report published and main parameters, types, and research potentials of proposed TAC facilities are explained.

Reports:
http://www.tarla.org.tr/thm/tac/YUUP/TAC_Tasarim.pdf
http://www.tarla.org.tr/thm/tac/YUUP/TacIsinimKaynaklariCDR.pdf

▪ Phases of the TAC Project

Third Phase:

Technical Design Study and First Facility by support of Ministry of Development (2006-2016)

TAC collaboration is established as an inter-university (14 Universities) collaboration under the coordination of Ankara University

- Outcome :

- Institute: Institute of Accelerator Technologies (IAT) is established in 2010
- First Facility: TARLA Facility (IR FEL & Bremsstrahlung) is fully funded and under construction
- Technical Design Reports for Proposed Facilities:
  - Synchrotron Radiation Facility (TURKAY)
  - Proton Accelerator Facility (TURKPRO)
  - SASE FEL Facility (TURKSEL)
  - Particle Factory (TURKFAB)

Funding Agency, Coordination, Collaboration and Facilities

Government of Turkey

Ministry of Development

International Machine Advisory Committee (IMAC)

International Scientific Advisory Committee (ISAC)

Ankara University (Coordinator)

Turkish Accelerator Center Collaboration

Ankara, Gazi, Istanbul, Boğaziçi, Doğuş, Gebze Teknik, Uludağ, Dumlupınar, Osmangazi, Erciyes, Niğde, S. Demirel, Gaziosmanpaşa and Adıyaman Universities

TAC Board (17 members)

Director: Prof. Dr. Omer Yavas (Ankara Univ.)

Accelerator Facilities (Sub-Projects)



Board of TAC Collaboration

TARLA
IRFEL & Brems. Facility
15-40 MeV Sc e- Linac
Under construction

TURKAY
Synchrotron Radiation Facility
3 GeV e- Synchrotron
Designed

TURKSEL
SASE FEL Facility
1-6 GeV Sc e- Linac
Designed

TURKPRO
Proton & Neutron Facility
3-2000 MeV p Linac
Designed

TURKFAB
Particle (Charm) Factory
1 x 3.56 GeV
e-e+ Collider
Designed

TAC Collaboration

- **Project Team:** 78 staff with PhD + 78 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 Institute of Advanced Technologies

In April 2013, Gaziosmanpasa and Adıyaman groups are joined to the collaboration

TARLA Facility & Institute of Accelerator Technologies

Opening Ceremony (May 9, 2011)



TARLA Facility



Institute of Accelerator Technologies (IAT)







Institute of Accelerator Technologies (IAT)

http://hte.ankara.edu.tr

Established in February 26, 2010 in Ankara University and unique in Turkey



Institute has **18** full time personal (12 technical)

Main role of the institute is the coordination of TARLA IR FEL facility

Recently, a common graduate programme on accelerator and detector technologies is developed together with Institute of Nuclear Sciences and the programme is started in January 2016.





▪ Infrared FEL & Brems. Facility (TARLA)



TARLA Turkish Accelerator and Radiation Laboratory in Ankara

http://tarla.org.tr







e-beam energy : up to max. 40 MeV
IR FEL wavelength : 3-250 microns
Energy of Brems. : up to 30 MeV









First beam from DC e-Gun!
April 11, 2013

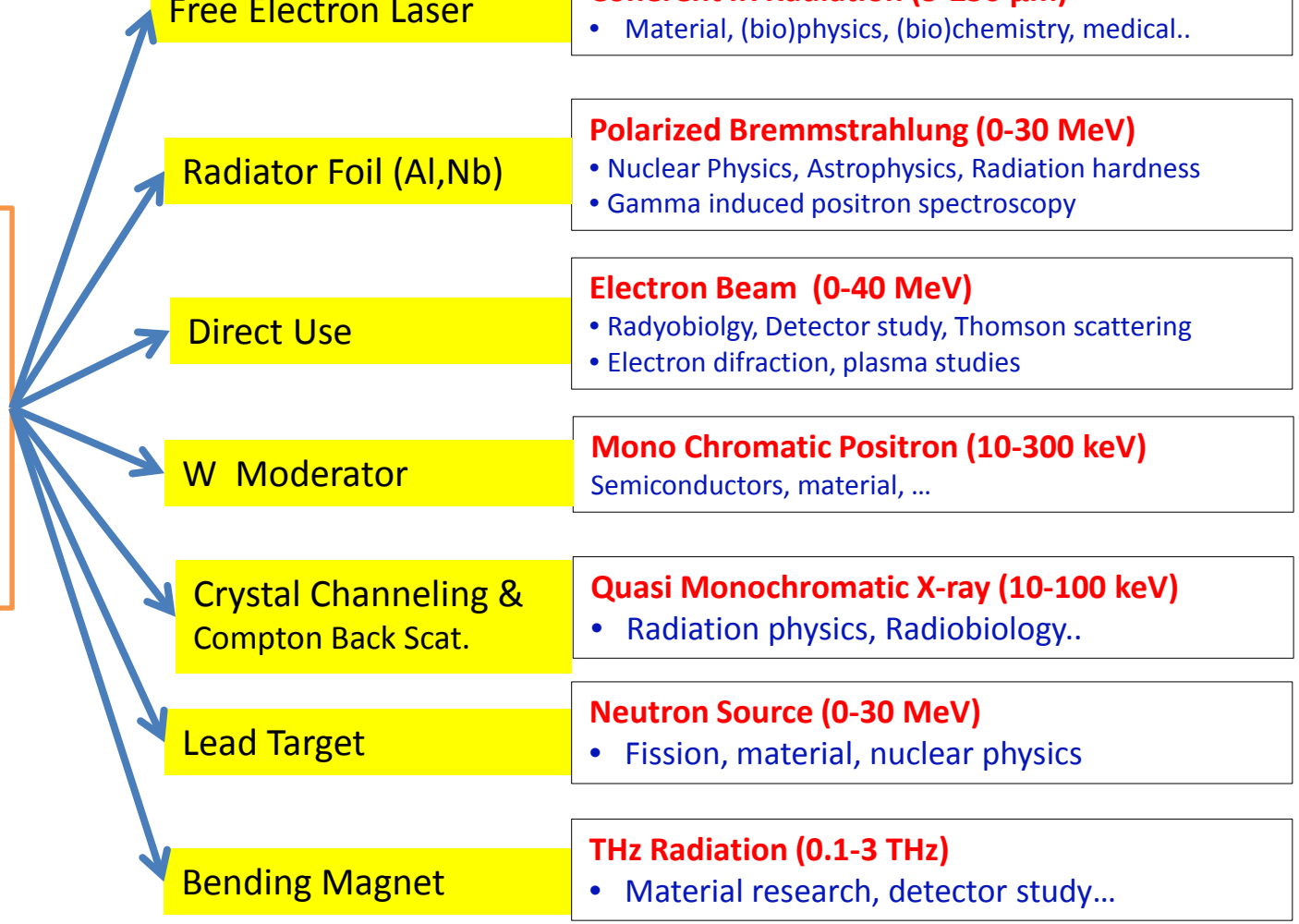




- ✓ TARLA building was completed in 2011
- ✓ E-Gun installed in 2013
- ✓ He and water cooling systems were installed in 2015-2016
- ✓ SRF modules will be installed in 2017-2018
- ✓ IR FEL & Bremsstrahlung beams will be obtained in 2019-2020
- ✓ TARLA will be ready for research in 2020

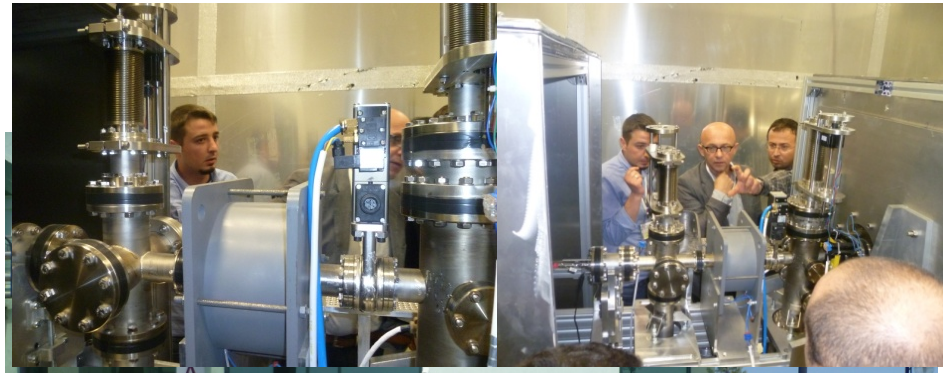
▪ Research Potential of TARLA

Superconducting accelerator based electron beam
0 - 40 MeV ,
0-1 (1.5) mA
40 (60) kW
cw / pulsed



International Machine Advisory Committee (IMAC)

Peter MICHEL (HZDR-ELBE, Germany) (Head)
Ernst WEIHRETER (HZB-BESSY, Germany)
Hideaki OHGAKI (Kyoto University, Japan)
Jean R. DELAYEN (JLab, USA)
Susan SMITH (ASTeC, UK)





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

5th Meeting:
April 22-23, 2013
IAT, Ankara University

6th Meeting:
October 20,21, 2014 IAT,
Ankara University

7th Meeting:
September 7-8, 2015 IAT,
Ankara University

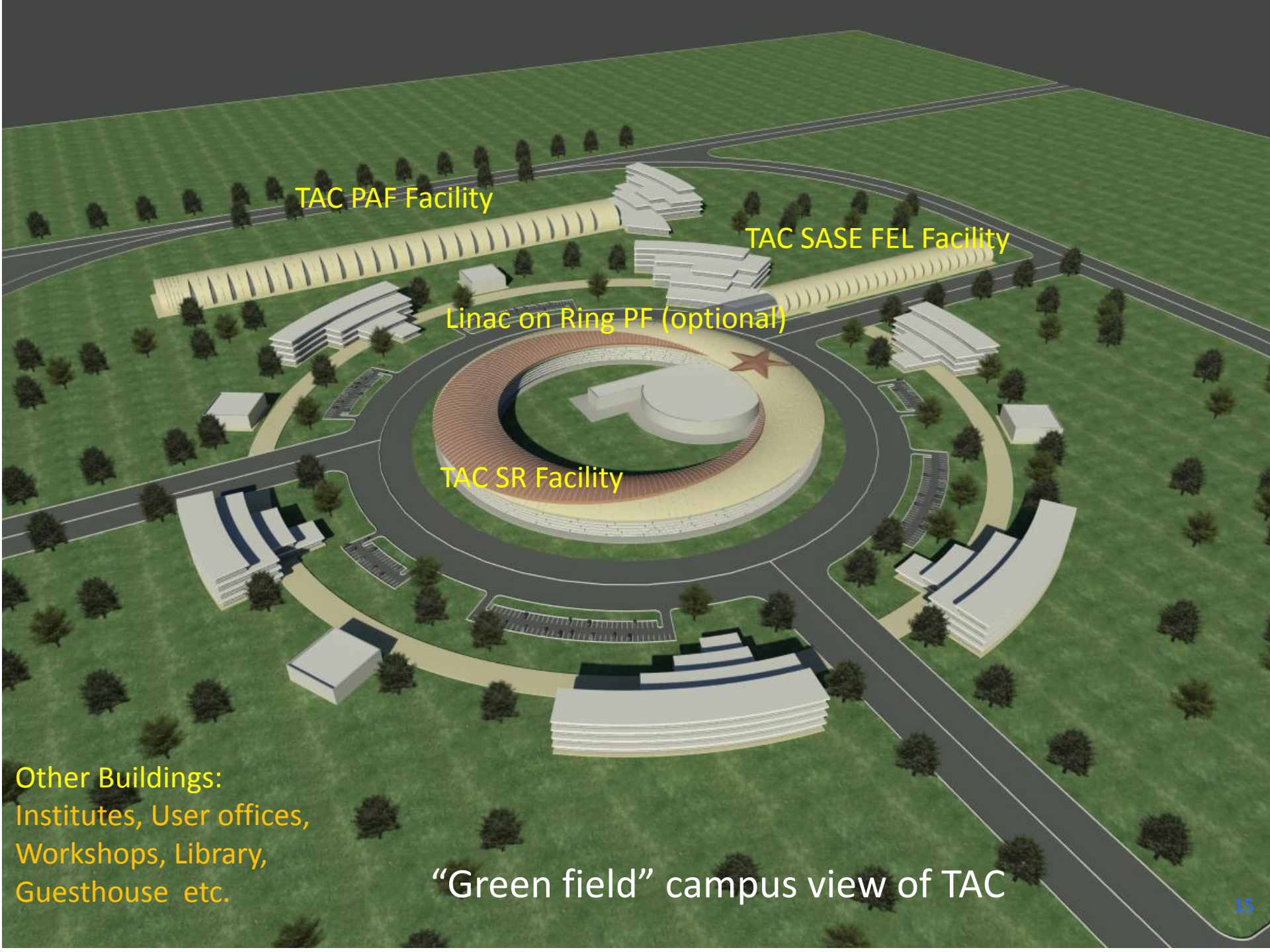
Proposed TAC Facilities

- **TAC Synchrotron Radiaton Facility (SR)**
  A third generation light source based on dedicated 3 GeV electron synchrotron
  http://tac.en.ankara.edu.tr/sr

- **TAC SASE FEL Facility (SASE FEL)**
  A fourth generation light source based on 1-6 GeV electron linac
  http://tac.en.ankara.edu.tr/sase-fel

- **TAC Proton Accelerator Facility (PAF)**
  Low and middle energy: 3 - 65 - 250 MeV, high energy: up to 2 GeV
  http://tac.en.ankara.edu.tr/paf

- **TAC Particle Factory (PF)**
  Electron-positron collider as a charm factory (Ec.m.= 3.8 GeV)
  http://tac.en.ankara.edu.tr/pf



"Green field" campus view of TAC

International Scientific Advisory Committe (ISAC)

- Ercan ALP (Argonne National Laboratory, USA) (Head)
- 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)
- Saleh SULTANSOY (TOBB ETU, Turkey)
- Ali TANRIKUT (TAEK, Turkey)
- Gökhan UNEL (UCI & CERN)
- 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**

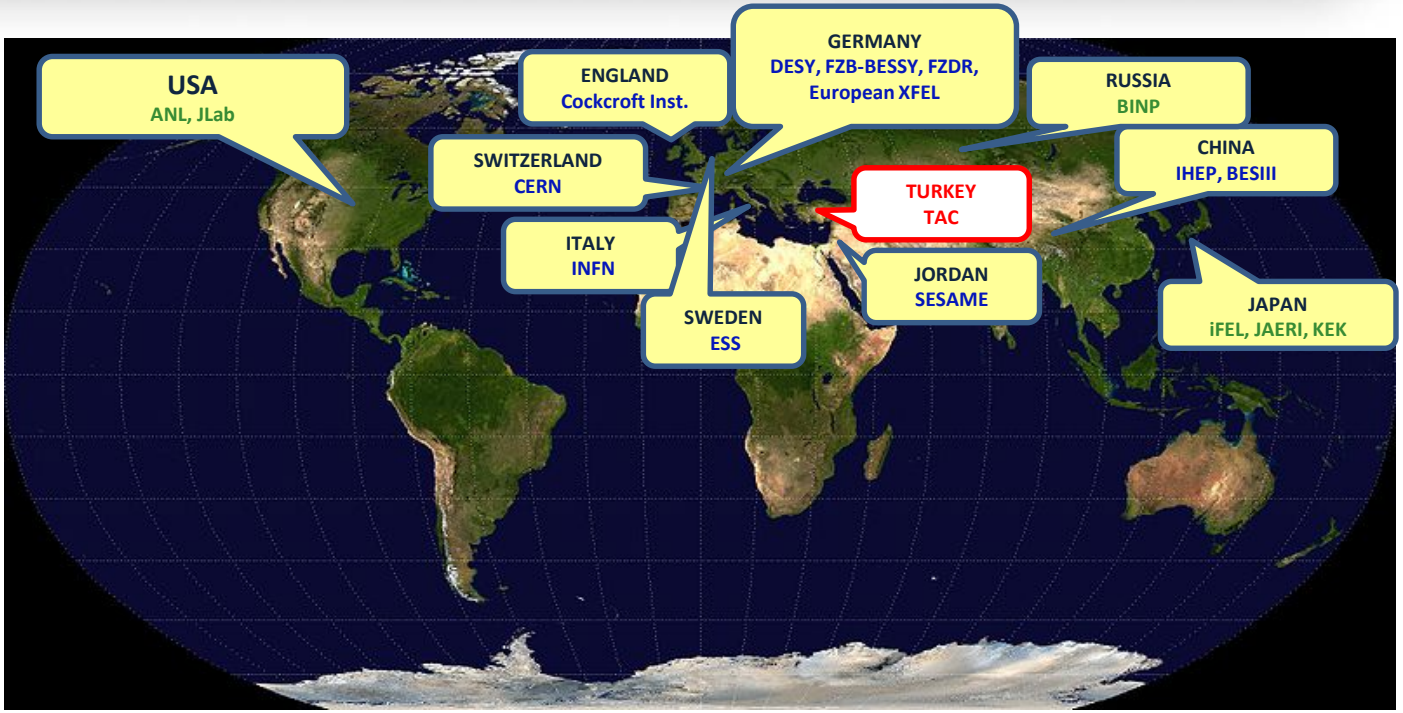
3rd Meeting:
May 9-10, 2011
Ankara University
Ankara, Turkey

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

5th Meeting:
June 24-25, 2013
Ankara University
Ankara, Turkey

6th Meeting:
July 7-8, 2014
Istanbul University
Istanbul, Turkey

International MoUs in Frame of TAC



Memorandum of Understandings between TAC (Turkey) and

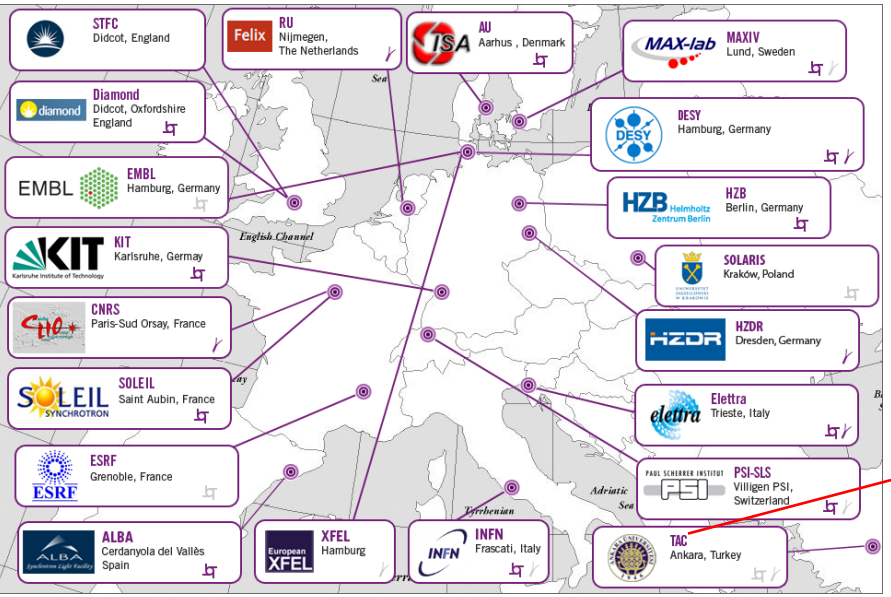
DESY, Germany (1996)
CERN CLIC CTF3, Switzerland (2004)
BESSY-II, Germany (2007)
HZDR, Germany (2007)
The Cockcroft Institute, UK (2011)
IHEP-BEPC, China (2011)
European XFEL, Germany (2012)
ESS, Sweden (2013)
INFN, Italy (2013)

> 300 scientific visits to these centers

International Collaborations on Light Sources

ESUO: European Synchrotron User Organization

CALIPSOPlus: Coordinated Access to LIght sources to Promote Standards and Optimization (EU H2020 Project)



- **The 20 consortium members of CALIPSOPlus**

  ALBA, AU (ISA), CLIO(CNRS), DESY, Diamond, Elettra, EMBL, ESRF, BESSY(HZB), FELBE(HZDR), ANKA(KIT), INFN, MAXIV, PSI-SLS, FELIX(RU), SOLARIS, SOLEIL, STFC, TAC-TARLA, European XFEL

International Collaborations on Light Sources

- FELS OF EUROPE Collaboration

http://www.fels-of-europe.eu

Partners: European XFEL (Germany, Coordinator), DESY (Germany), ELETTRA (Italy), HZB-BESSY (Germany), HZSDR (Germany), IFN (Italy), MAX-IV (Sweden), NCNR (Poland), CNRS (France), PSI (Switzerland), Radbout University (Nederlands), STFC (UK), SOLEIL (France), Institute of Accelerator Technologies (Turkey)


Euro XFEL visit, 2014

- X-Band XFEL Collaboration (COMPACTLIGHT)

Partners: CERN CLIC- Switzerland, Elettra - Italy, Jagiellonian University - Poland, Daresbury Laboratory- UK, Shangai Institute of Applied Physics – China, VDL ETG T&D B.V., Eindhoven – Netherlands, University of Oslo - Norway, National Technical University of Athens – Greece, Uppsala University, Uppsala – Sweden, Australian Synchrotron, Clayton – Australia, Lancaster University, Lancaster- UK, Institute of Accelerator Technologies, Ankara-Turkey (EU H2020 Project)

- J. Pfingster et al., The X-Band FEL Collaboration, FEL2015, S. Korea.

- G. D'Auria, Compactlight Proposal, CLIC Workshop 2017, CERN

From 2006 to date

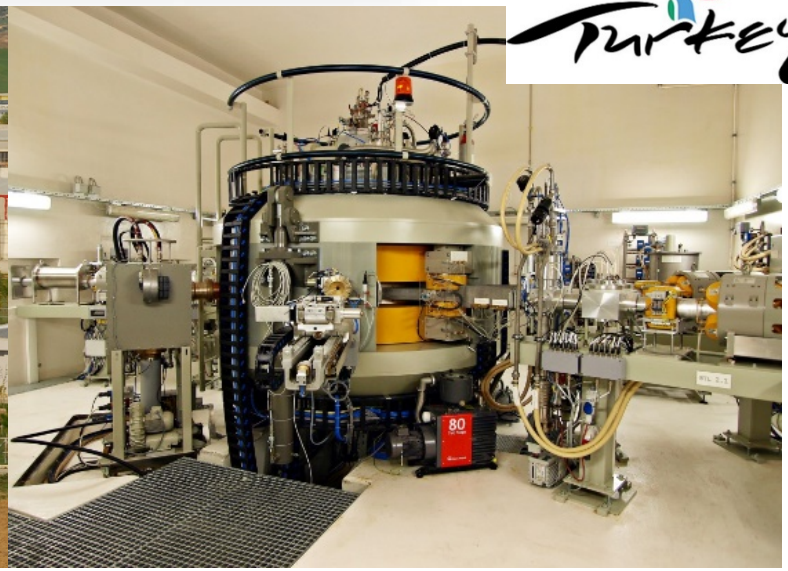
- Inter-University TAC Collaboration was established (2006)
- TAC-ISAC and TAC-IMAC were established (2009)
- User Committee on TARLA was established (2009)
- The Institute of Accelerator Technologies was established (IAT) (2010)
- Buildings and IAT and TARLA were opened to the service (2011)
- User Committee on TAC SR was established (2011)
- TARLA facility is the first facility of TAC (under construction)
- The first beam from TARLA DC e-Gun was obtained (2013)
- Design of TAC Synchrotron Radiation Facility is developed
- Design of TAC Proton Accelerator Facility is developed
- Design of TAC SASE FEL Facility is developed
- Design of TAC Particle Factory is developed
- Many MoUs are signed with well known Accelerator Centers
- More than 350 scientific visit to abroad
- Around 200 Msc - PhD thesis on accelerators and light sources
- 6 National Accelerator Congress (UPHUK) are organized
- 11 National Accelerator Summer Schools (UPHDYO) are organized

Conclusion on TAC & TARLA

- ✓ TAC is planned as a world-class R&D and technology center in basic and applied sciences for Turkey and our region.
- ✓ TARLA facility is under construction as the first facility of TAC. It is planned that TARLA will be ready to operate for R&D studies as a national and regional **"user facility"** in 2020.
- ✓ **Technical Design Reports of proposed TAC facilities are completed and presented to the Ministry of Development (MD) in February 2016.**
- ✓ At the begining of 2016, **a new period for three years** is defined by MD to complete TARLA and in this frame the title of project revised as «**Electron Accelerator and Laser Facility** TARLA» and project team is revised, also.
- ✓ Turkish Parlament (TBMM) is approved a new law (Law No: 6550) to re-organize of existing and developing reserach centers. It is expected that TAC will get a new statute as a **National Research Center** due to this law. This law will regulate a new management, personnel and financial support and review mechanism.

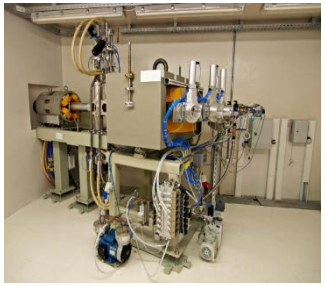
TAEK Proton Accelerator Facility





- 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







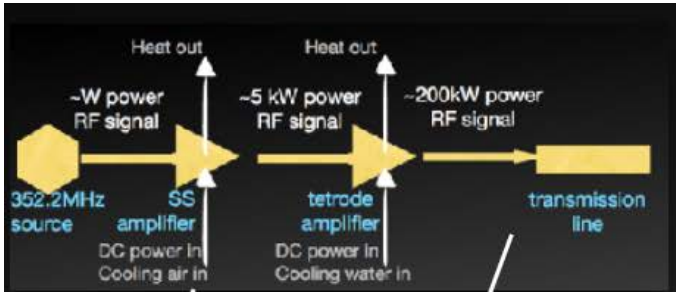


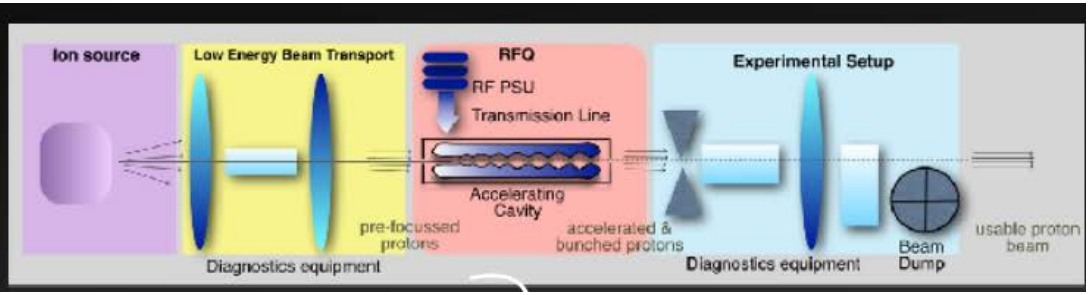
TAEK's SANAEM Prometheus Project (SPP)

Main parameters of p-RFQ Linac:

E > 1 MeV and I > 1 mA, pulsed, H+, RF = 352.21 MHz, d.f. > 0.01

- ✓ Main goal of project: All components to be designed and built in Turkey!
- ✓ Run by SANAEM, TAEK's Sarayköy Research and Training Center since 2012
- ✓ Participation of scientists and engineers from several universities







Current status of p-RFQ linac facility



RFQ accelerating cavity is produced in Turkey



- All components produced and installed
- First protons out of LEBT seen in December 2015
- Protons at the end of RFQ seen in Winter 2016 vanes' shadow can be seen
- RF training & power coupling tests ongoing …

Accelerator-Related Ongoing Projects

Accelerator R&D in Turkey

Ankara University

- Design and manufacture of 1.3 GHz RF pulse compressor
- Design, production and tests of high gradient quadrupole magnets
- Development of 3D e-beam printer for industrial use
- Radio frequency quadrupole (RFQ) design and simulation software
- Demirci-Pro: Design & simulation of a radiofrequency quadrupole (RFQ) based linear accelerator for light ions

Middle East Technical University

- Design and contruction of a p-beam line in TAEK's p-Cyclotron Facility for radiation hardness tests of space equipments

Boğaziçi University

- High-power 800MHz RF circulator and transmission line project
- Building a trial low-energy electron gun for industrial applications

Akdeniz University

- Modifications of a clinical linac (30 µA, 18 MeV) for use in nuclear physics research

TOBB ETU

- Development of an e-gun for electron beam welding; design and handling MeV energy e-beam using klystrons donated by CERN

Membership to SESAME

- **S**ynchrotron-light **E**xperimental **S**cience and **A**pplications in **M**iddle **E**ast
- Turkey is member of SESAME Project since 2002

  - Members: Bahrain, Cyprus, Egypt, Iran, Israel, Jordan, Pakistan Palestine Authority
  - Council member of Turkey: Z. Demircan
  - Head of SAC : Z. Sayers
  - Head of User Com.: Ö. K. Öztürk
- Contributions

  - Design of beam lines and exp. stations, user & financial support



TR Participation to CERN CLIC Collaboration

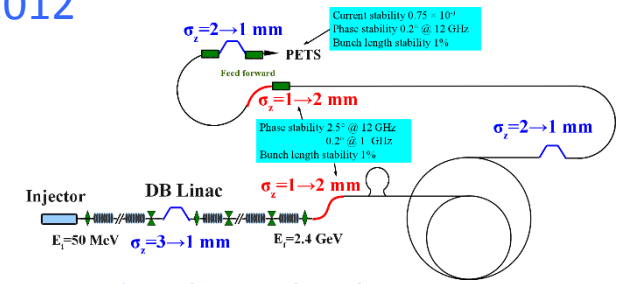
Accelerator R&D in Turkey

Turkish contribution:

7 research projects are completed on CLIC accelerator, detector and physics studies by support of TAEK between 2004-2012

Accelerator related contributions:

- CLIC-LHC based ep, eA, γp, γA and FELγA colliders
- Drive beam injector, beam dynamics & optics



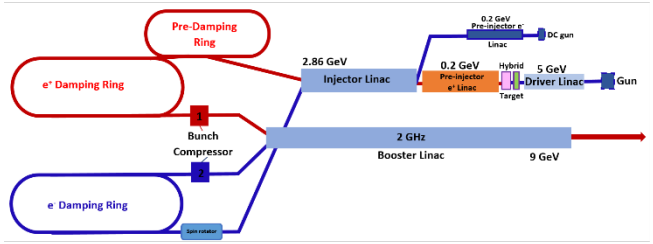
- The beam dynamics of CLIC drive beam studies has been completed as a PhD thesis
- Many contributions for bunch compressors for individual sections of Drive Beam has been done such as injector desing and bunch compressors-decompressors

Ongoing project on 'CLIC Beam Dynamics and Beam-Beam Interactions' since 2013 by support of TAEK.

Project Team: 17 members from 7 Turkish Universities (Ankara, Istanbul, ITU, AIBU, Giresun, Nigde, Uludag)

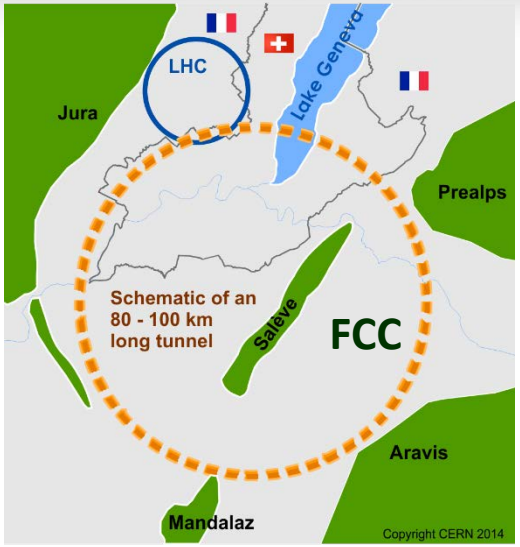
Studies are going on*:

- Drive beam dynamics
- Injector options & bunch compressor senarios
- X-Band X-FEL magnetic lattice and undulator magnet optimizations
- X-Band klystron amplifiers
- CLIC main beam injector (5 GeV linac) parameter optimization
- Effects of beam-beam interactions on detector design and physics research



* M.J. Boland et al. *Updated Baseline for a Staged Compact Linear Collider,* CERN-2016-004, arXiv: 1608.07537

TR Participation to CERN FCC Collaboration



FCC-hh: 100 TeV pp collider as long-term goal → defines infrastructure needs

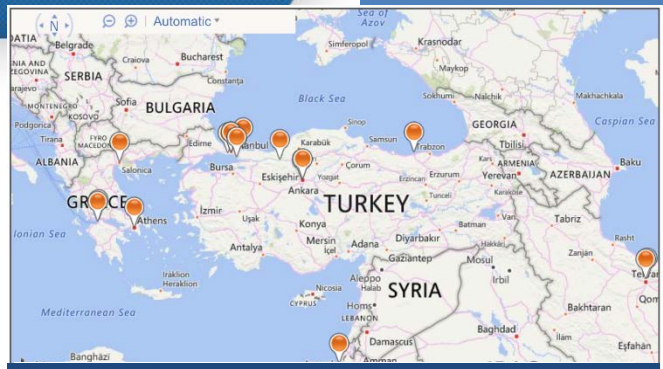
FCC-ee: e^+e^- collider, potential intermediate step

FCC-eh: LC-FCC based ep, eA, γp, γA and FELγA colliders

Main goal of FCC collaboration is to complete CDR of FCC at the end of 2018

Accelerator related presentations of Turkish scientists in FCC Week 2017 (29 May-02 June 2017, Berlin, Germany)

- Linac and damping ring
- Prebooster ring



Collaborating Universities

9 Turkish Universities are signed MoU and three of them (Ankara, AIBU and Giresun) signed an Addendum with CERN-FCC to give contributions on accelerator, detector and physics studies.

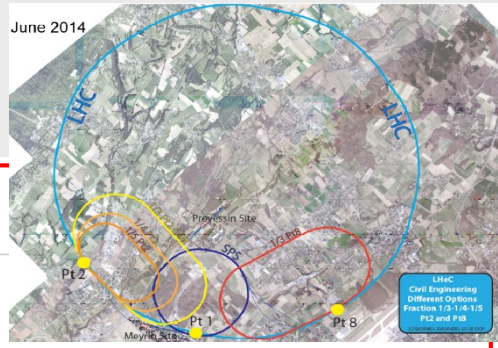
- *AIBU*, Bolu
- *Ankara U*, Tandogan/Ankara
- *Giresun U*, Giresun
- *Isik U*, Sile, Istanbul
- *Istanbul Aydin U*, Istanbul
- *Istanbul U*, Vezneciler-Istanbul
- *Okan U*, Istanbul
- *PRU*, Tuzla/Istanbul
- *TOBB ETU*, Ankara

TR Participation to CERN LHeC Collaboration

A Large Hadron electron Collider at CERN

http://lhec.web.cern.ch

CDR of LHeC is published in 2012



13 scientists from 7 Turkish Universities (Ankara, TOBB, Nigde, Uludag, Giresun, AIBU and Kastamonu) are collaborating with CERN LHeC Project to give contributions on parameter optimisation of LHeC based ep, eA, γp, γA, FELγA and $\gamma\gamma$ colliders, positron production, detector design and invetsigation of new physics processes

Journal of Physics G: Nuclear and Particle Physics

A Large Hadron Electron Collider at CERN

Report on the Physics and Design Concepts for Machine and Detector

J L Abelleira Fernandez[16,23], C Adolphsen[57], A N Akay[3], H Aksakal[39], J L Albacete[52], S Alekhin[17,54], P Allport[24], V Andreev[34], R B Appleby[14,30], E Arikan[39] +Show full author list

Published 30 June 2012 • \copyright\ CERN for the benefit of the LHeC Project, published under the terms of the Creative Commons Attribution licence 3.0 by IOP Publishing Ltd. Any further distribution of this work must maintain attribution to the author(s) and the published Article's title, Journal citation and DOI.

Journal of Physics G: Nuclear and Particle Physics, Volume 39, Number 7

A paper on LHeC e+p collider by Turkish scientists in NIM-A: (2012)

Positron source investigation by using CLIC drive beam for Linac-LHC based e^+p collider

Ertan Arıkan, Hüsnü Aksakal

Show more

https://doi.org/10.1016/j.nima.2012.04.058

Get rights and content

Conclusion

- The accelerator technologies and applications are very important for national and regional development.

- Realization of the Turkish Accelerator Center (TAC) will boost the development in almost all fields of science and technology in our country.

- It is clear that, we need more closer collaborations with international accelerator community to realize TAC and other accelerator related projects.

- TR industry has good potential to develope and production of acceletor hardware for national and international projects.

- TR accelerator and particle physics community is ready to give contributions for 2019 update of the European Strategy (ES).

Many thanks for your attention…

ISTANBUL Turkey

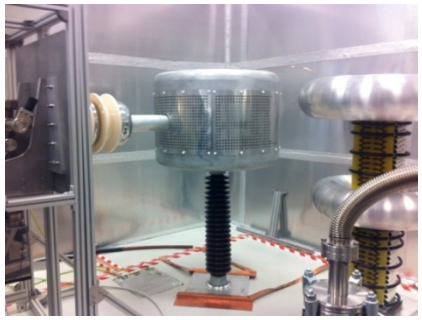





BACKUP SLIDES

▪ Main Parameters of TARLA Facility

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

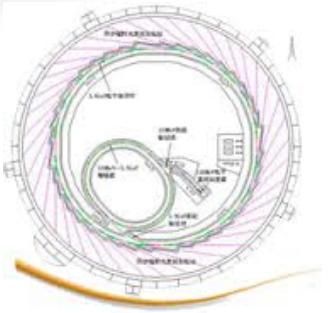





▪ Main Parameters of TARLA Facility

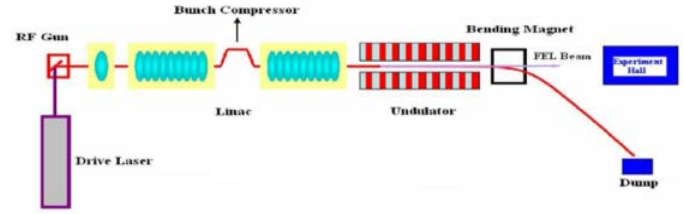
	Parameter	Unit	U25	U90
Resonator Parameters	Period Length	mm	25	90
	Number of Poles	#	60	40
	Type	#	Planar	Planar
	Pole Material	#	NdFeB	NdFeB
	Undulator Strength	#	0.25-0.7	0.8-2.4
	Minimum gap	mm	15	30
	Resonator Length	m	11.53	11.53
	Curveture of mirrors (R_1=R_2)	m	5.86	6.32
	Outcoupling hole radius	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 TAC Facilities

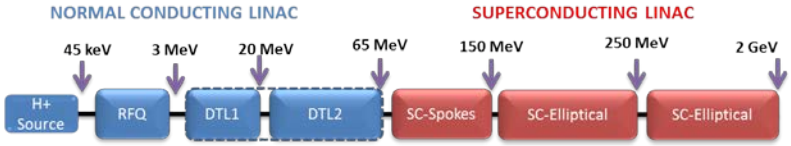


✓ TAC-Synchrotron Radiation Facility (TURKAY)

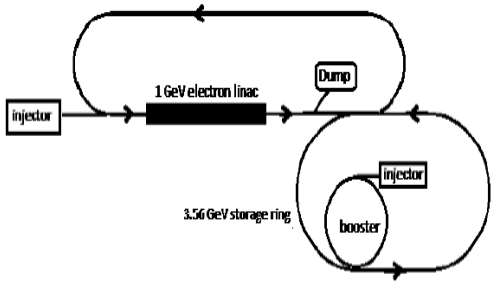
✓ TAC-SASE FEL Facility (TURKSEL)



✓ TAC-Proton Accelerator Facility (TURKPRO)

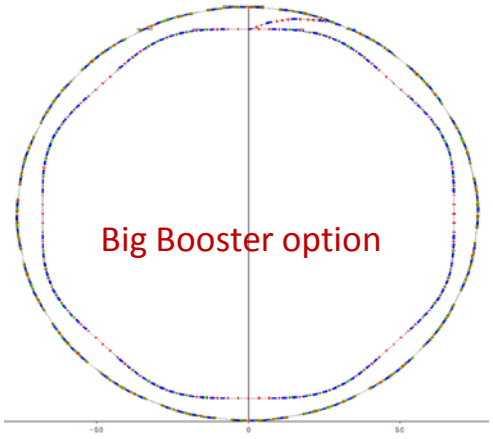


✓ TAC- Particle Factory Facility (TURKFAB)



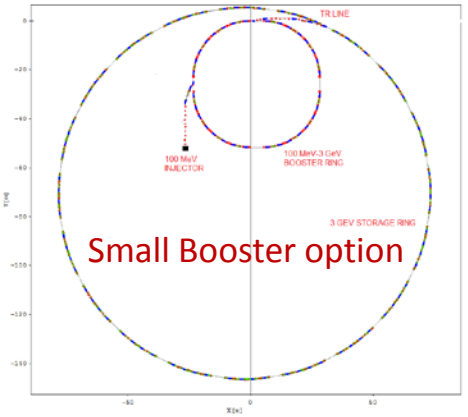
TAC Synchrotron Radiation Facility (TURKAY)

http://tac.en.ankara.edu.tr/sr



Parameters of main ring

Parameter	Value
Energy (GeV)	3
Circumference (m)	477
Beam current (mA)	500
Horizontal emittance (nmrad)	0.51
RF frequency (MHz)	500
RMS bunch length (mm)	2.1



Lattice and Magnet Structure

Big Booster Ring:

C = 445.6 m

Supe period: 8

A super period constits of 6 FODO cell

Main Ring:

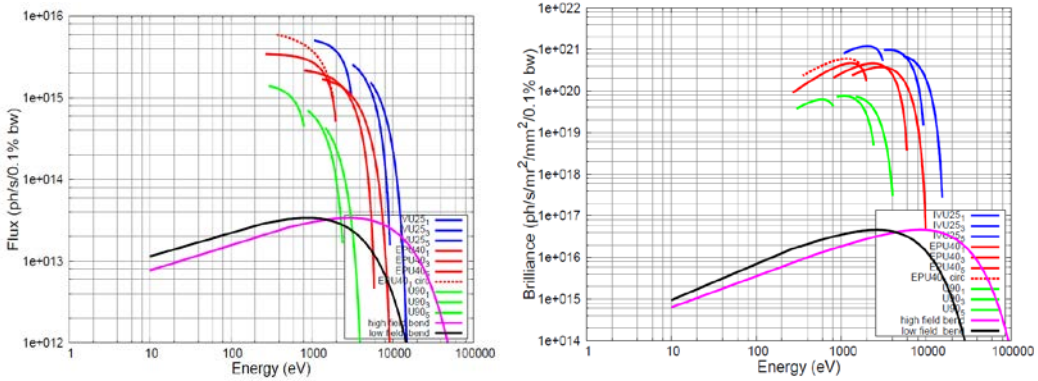
C = 477 m

Main cells: 20

A main cell constits of 4 BM + 16 QM

BM: 1.5 m, 0.52 T

QF: 0.30 m, 23.8 T/m



Some of Planned IDs, Expected SR Spectrum

▪ Research and User Potential of TURKAY

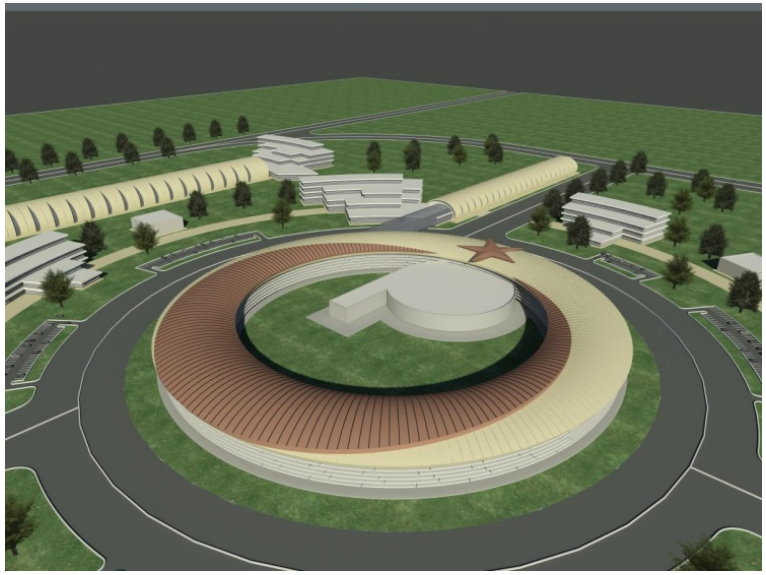


- **Turkey**
- 185 Universities in 81 cities
- National Institutes on:

  Biotechnology, Nanotechnology, Accelerator, Mining, Medicine, Pharmachology, Ceramics, Metrology, Superconductivity, Space etc.
- National Authorities: TUBİTAK , TAEK, MAM
- Industry, Technocities, Technoparks …
- **Our region:**

  Turkic States, West South Asia, Balkan Countries, Middle East, North Africa

Research Potential: to produce and use of synchrotron radiation in scientific research and technology development studies in basic and applied sciences



▪ TAC Light Sources User Committies and Meetings

IR FEL Experimental Stations and User Committee is established in 2008 (Head: Dr. P. Arikan)
SR User Committee is established in 2011 (Head: Dr. Ö. Kurtuluş Öztürk)









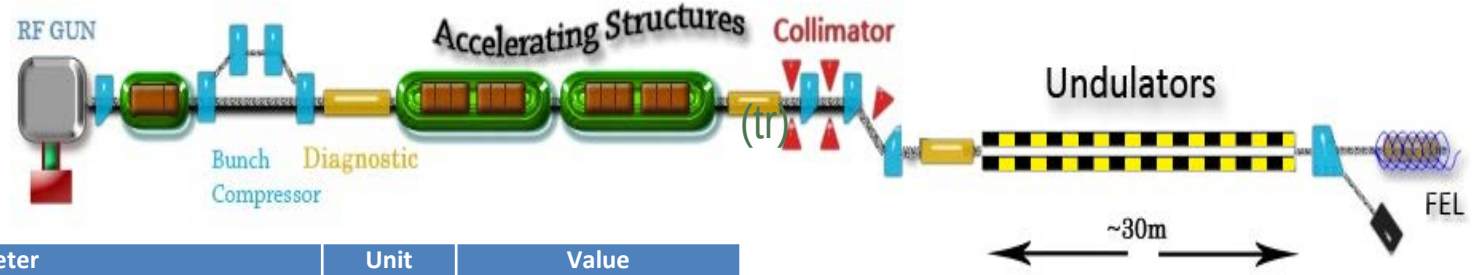
Third TAC Light Sources International Users' Meeting (TAC-LSUM2013)
October 5-7, 2013, Ankara University, Ankara

TAC-SASE FEL Facility (TURKSEL)

http://tac.en.ankara.edu.tr/sase-fel

TAC SASE FEL facility is developed as 3 GeV (taking into consideration 1-6 GeV region) superconducting electron linac based SASE FEL facility to cover VUV and soft X-ray region.

TAC SASE FEL facility aims to use beams in many fields as material science, biotechnology, nanotechnology, chemistry, space, environment etc. with its unique properties.



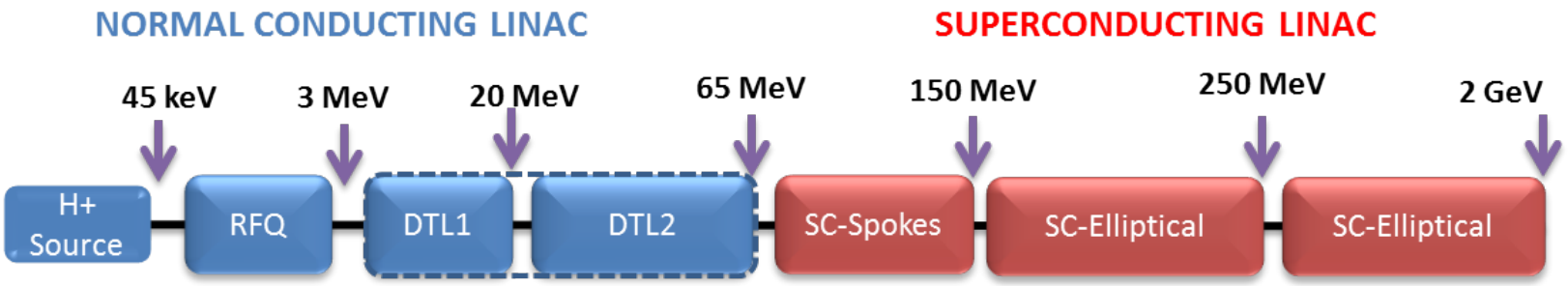
Parameter	Unit	Value
Beam energy	GeV	3
RF frequency	GHz	1.3
Number of Sc Nb cavities	-	12 x 9 cell cavity
Accelarating gradient	MV/m	<40.7
Cell to cell coupling, k	-	1.8
Quality factor, Q_0	-	$>10^9$
Peak current	kA	2

Parameter	Unit	U15
Period length	mm	15
Magnetic gap	mm	12
Central magnetic field	T	0.48
Undulator material	-	NdFeB
Wavelength	nm	1-100
Saturation FEL power	GW	1.4
Saturation length	m	28
Peak brilliance (photons/s/mrad^2/mm^2/0.1%bw)		10^{29}

TAC-Proton Accelerator Facility (TURKPRO)

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

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



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

The project will progress in three stages:

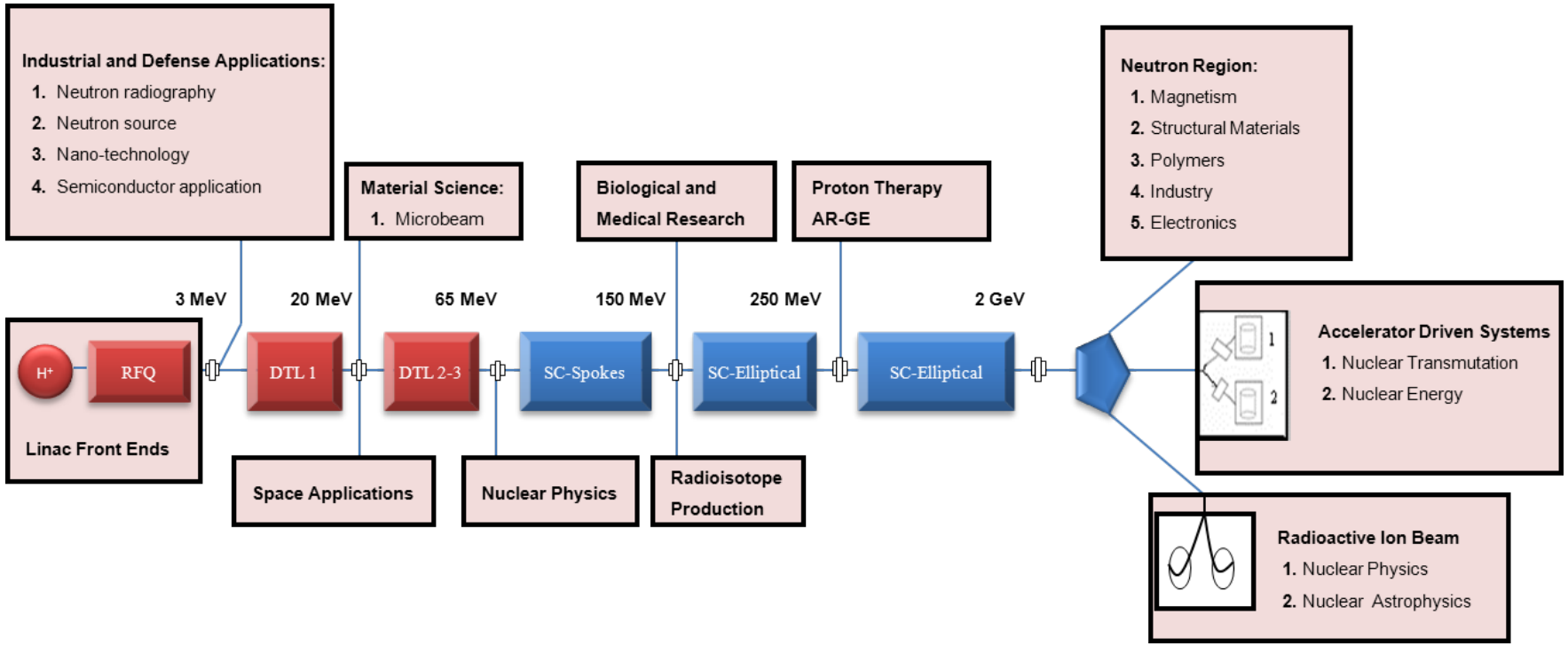
Stage 1: an ion-source, Low Energy Beam Transport (LEBT) and a Radio-Frequency Quadrupole (RFQ) (up to 3 MeV);

Stage 2: a 250 MeV linear accelerator, which could be built in two phases – phase 1 is a 3-65 MeV Drift Tube Linac (DTL) and phase 2 is a MEBT 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

TAC Proton Accelerator Facility (TURKPRO)

This proton accelerator facility could serve as a neutron spallation source, a radioactive ion beam facility, a prototype facility to conduct research into accelerator-driven sub-critical reactors, as well as a number of lower energy facilities for use in nuclear, material, biological, and medical sciences.



▪ TAC Particle Factory (TURKFAB)

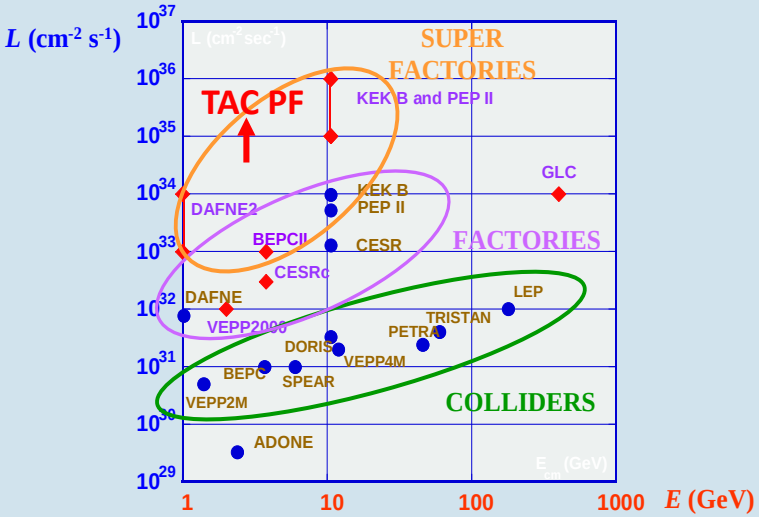
http://tac.en.ankara.edu.tr/pf

Turkish Accelerator Center (TAC) Particle Factory is a super charm factory with the asymmetric beam energy setup consisting of an electron beam with **1 GeV** from a linac and a positron beam with **3.56** GeV from a ring, proposed to be designed as a linac-ring type collider at the center of mass energy of **3.77 GeV**. A super charm factory with luminosity **L=10^35 cm^(-2) s^(-1)** will give opportunity to investigate charm physics well further than *B* factories, benefiting from a boost parameter (*bg*=0.68) for some processes.

Main parameters of TAC Particle Factory

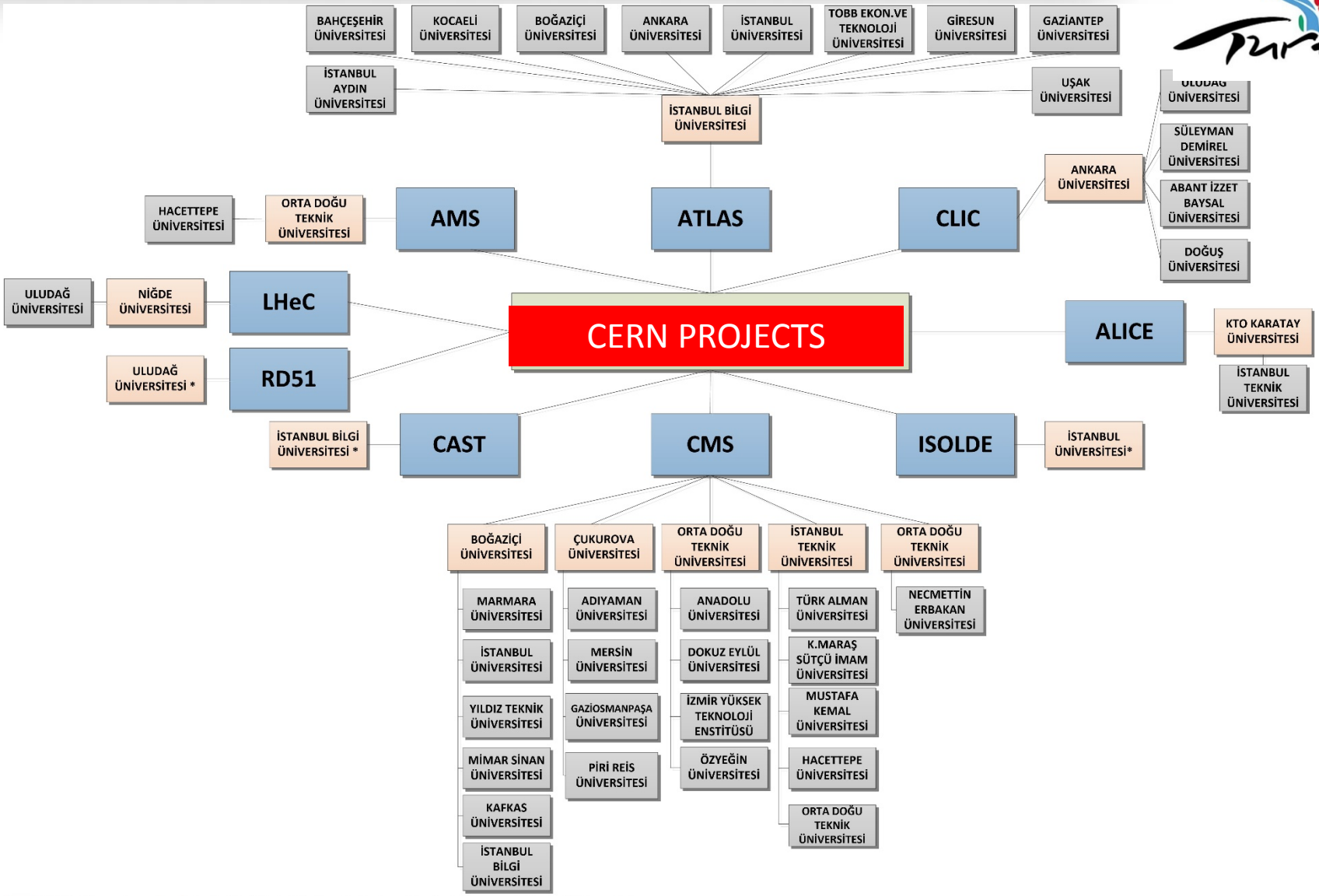
Parameter	Positron beam	Electron beam
Beam energy (GeV)	3.56	1
Number of particles per bunch (10^{11})	2	0.2
Beta functions at IP β_x/β_y (mm)	80/5	80/5
Normalized emittance $\varepsilon_x^N/\varepsilon_y^N$ (μm rad)	111/0.36	31/0.1
σ_x/σ_y (μm)	36/0.5	36/0.5
σ_z (mm)	5	5
Number of bunches	300	
Circumference (m)	600	
Luminosity ($cm^{-2}s^{-1}$)	$1.4x10^{35}$	

e^+-e^- Colliders: Past, Present and Future



TR Participation to CERN Projects

Accelerator R&D in Turkey



* İlgili CERN Çalışması kapsamında desteklenen son proje olup halihazırda devam eden proje bulunmamaktadır.

http://www.taek.gov.tr/egitim-arastirma/cern-tr.html

TAC-ISAC Meetings



Ankara University (2009)



Boğaziçi University (2010)



Ankara University (2011)



Istanbul University (2012)



Ankara University (2013)



Istanbul University (2014)