

# X-Band Linac Based X-FEL Facility Proposal of Turkey

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Workshop on X-Band technology for FELs  
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# SASE FEL Proposal of TAC

SASE-FEL based on 1 GeV linac proposal was the second FEL project of TAC after TARLA.

It has been preliminary studied based on SC linac similar to FLASH.

The new idea is using X - Band linac for TAC SASE FEL project proposed by CERN CLIC team by end of 2012

## The benefits of the collaboration;

- CERN will have the opportunity to demonstrate the performance of the CLIC accelerating structures in a realistic operational environment as a user facility.
  - ▶ Using RF sources instead of using CLIC Drive beam..
- Turkey will have opportunity to transfer new technology to Turkish accelerator community and industry, and will have SASE FEL with huge support of CERN
  - ▶ Know-how, training, infrastructure, development..


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



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## 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 Tanrikut** (TAEK, Turkey),

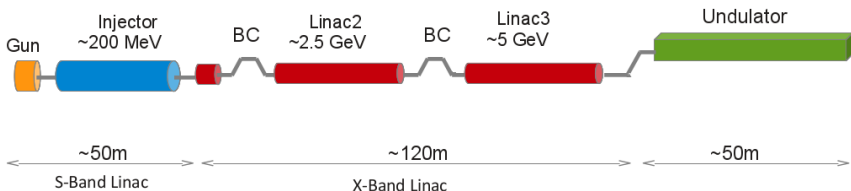
CERN: **Steinar Stapnes** (Linear Collider Study Leader), **Daniel Schulte**

TR Ministry of Science, Technology and Industry: **Mecit Yaman**

TR Ministry of Development: **Mustafa Alpaslan**

Turkish Atomic Energy Authority (TAEK): **Irfan Koca**

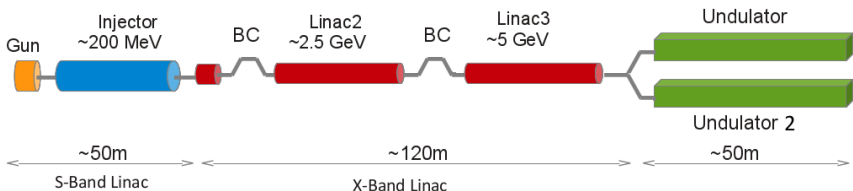
# Layout of proposed SASE FEL



Facility consists of

- 200 MeV injector based on S band linac
- 2 stages of main accelerating section based on X-band up to 5 GeV
- Lasing section: several undulators or single undulator
- Expected FEL range  $1\text{\AA} - 100\text{\AA}$

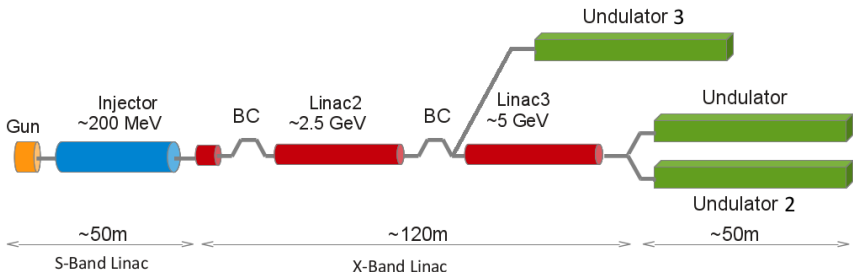
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## Main Linac Parameter

Parameter	Unit	Value
Beam Energy	GeV	5
Linac frequency	GHz	12
Accelerating Gradient	MV/m	~ 70
Bunch Charge	pC	250
Normalized Emittance	mm.mrad	<1
Bunch Length	fs	30
Energy spread (rms)	%	0.02
Rf pulse length	ns	150
Number of pulses per train	#	??
Bunch repetition rate	MHz	??
Pulse repetition rate	Hz	??
Klystron power	MW	??
Number of klystron	#	??



## Module Parameters based on 50 MW klystron

Parameter	Unit	Value		
Structures per RF unit		12	16	10
Klystrons per RF unit		2	2	2
Structure length	m	0.23	0.23	0.75
a/lambda		0.145	0.145	0.125
Allowed gradient	MV/m	100	100	80+
Operating gradient	MV/m	77	67.5	65
Energy gain per RF unit	MV	213	248	488
RF units needed		27	20	10
Total klystrons		54	40	20
Linac active length	m	74	75	78
Cost estimate	a.u.	76.2	71.5	51.7

D.Schulte

# Road Map

The preparation phase, including

- The Conceptual Design Report phase ( $\sim 1$  Year)
- The Technical Design Report phase including demonstrations ( $\sim 4$  Years)
  - ▶ Development of RF gun
  - ▶ Development of pulse compression scheme
  - ▶ High rep-rate Klystron (if necessary)
  - ▶ 12 GHz test stand
- Construction phases
  - ▶ Phase 1 ( $\sim 2+2+1$  Years) ;
    - Injector and first stage of accelerator
    - Undulator beamline based on 2.5 GeV beam energy
  - ▶ Phase 2 ( $\sim 2+2$  Years) ;
    - Second stage of accelerator
    - Undulator(s) beamline based on 5 GeV beam energy

# Road map for CDR

- Available budget for CDR 40 k€+ 20 k€
- Available staff
  - ▶ Beam Physics and Diagnostics (2 Staff + 1 Student)
  - ▶ FEL (2 Staffs)
  - ▶ Structure (1 Staff)

## Near future

- Meeting with users from existing FEL facility to define beam timing parameters (beginning of 2014)
- Studying cost optimization in terms of RF structure and RF sources according to user requirements, decision on parameters.

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## Near future

- Meeting with users from existing FEL facility to define beam timing parameters (beginning of 2014)
- Studying cost optimization in terms of RF structure and RF sources according to user requirements, decision on parameters.
- Completing draft version of CDR by the mid of 2014 and representing it to ISAC
- Finalizing the CDR by the end of 2014

# Table of Contents of CDR (draft)

## 1. Summary

- 1.1 FEL Project goals and CDR objectives
- 1.2 Accelerator, FEL design and Technical Highlights
- 1.3 Scientific case
- 1.4 Project Schedule

## 2. Design and parameter choice

- 2.1 Design parameters
- 2.2 Simulation tools
- 2.3 Accelerator Simulations (gun, injector, main linac)
- 2.4 Undulator lines and simulations

## 3. Electron beam line components

- 3.1 RF Systems (gun, injector, main linac)
- 3.2 Magnets
- 3.3 Electron beam Diagnostic
- 3.4 Vacuum
- 3.5 Mechanical support systems and alignment tools
- 3.6 Control and timing systems

## 4. Test Stands

- 4.1 Gun test stand
- 4.2 RF test stand
- 4.3 Power combination & compression
- 4.4 Klystron modulator

## 5. TDR plan

- 5.1 Time schedule
- 5.2 Budget, human sources
- 5.3 Human sources
- 5.4 Infrastructure requirements.

# TDR Plan

- Review of CDR and being sure about user requirements
- Development of
  - ▶ A gun test stand (2 men)
  - ▶ RF module test stand (3 men)
  - ▶ RF pulse compressor and power combination test stand (2 men)
  - ▶ Klystron modulator (depending on beam requirements (2 men)
  - ▶ LLRF system (2 men)
  - ▶ Control systems for the items above (2 men)
- Designing the injector, accelerator and FEL beamlines (3 men)
- the FEL related subjects (3 men)
- Designing the building and infrastructure civil engineering (3 men)
- Turkey plans to hire about 20 staff..
- Expected budget for TDR is about 10 M€

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- Turkey plans to hire about 20 staff..
- Expected budget for TDR is about 10 M€
- During the TDR can all development stands be installed at CERN ??
- During the TDR can CERN take the technical co-ordination responsibility??

## Conclusion and Discussion

- In order to start TDR by the beginning of 2015 we should submit the project by the mid of 2014.
- The budget requirements for TDR and its steps should be clarified before CDR completed.
- Turkey has less number of employee to complete the CDR in short time.. Collaboration with other facilities would help us..
- During the meeting the subjects and responsibilities should be defined and deadlines shall be clarified
- Clarification of CERN's support for this project will help us to convince the government for the next step.