The Greek Collaboration to EuPRAXIA Consortium

Evangelos Gazis

Institute of Accelerating Systems & Applications

Institute of Accelerating Systems and Applications

National Technical University of Athens

Funded by the European Union

The Greek TEAM Contribution to XLS

Compact

IASA: E. Adamidi, Th. Xenofontos, ENG

NTUA: T. Alexopoulos, I. Kominis, M. Moniaki, E. Matsrokalou, A. Taxidi

ESS-ERIC: A. Bignami, N. Gazis, E. Trachanas

IHU-Physics Dept: D. Bantekas, N. Vordos

AUEB (ASSOE): T. Apostolopoulos, K. Pramatari, A. Karagiannaki, D. Kotsopoulos

WP1:	Co-coordination of the project	IASA/NTUA
WP3:	Laser/Photocathode (coordinator)	IASA/NTUA
	e-Gun, Injector mechanical design	ESS/NTUA
WP6:	Beam dynamics simulation and generic algorithms (ASTRA, RF-Track, GIOTTO)	NTUA/IHU
WP7:	3D Model design & Parameters List	ESS
	Solenoid shielding and Magnet design	ESS
	Cost, SWOT, Risk & Market Analysis	AUEB
	Cost to Benefit Analysis	AUEB
	Transfer Technology to industry	IASA/NTUA
	Data Management Planning	IASA/NTUA

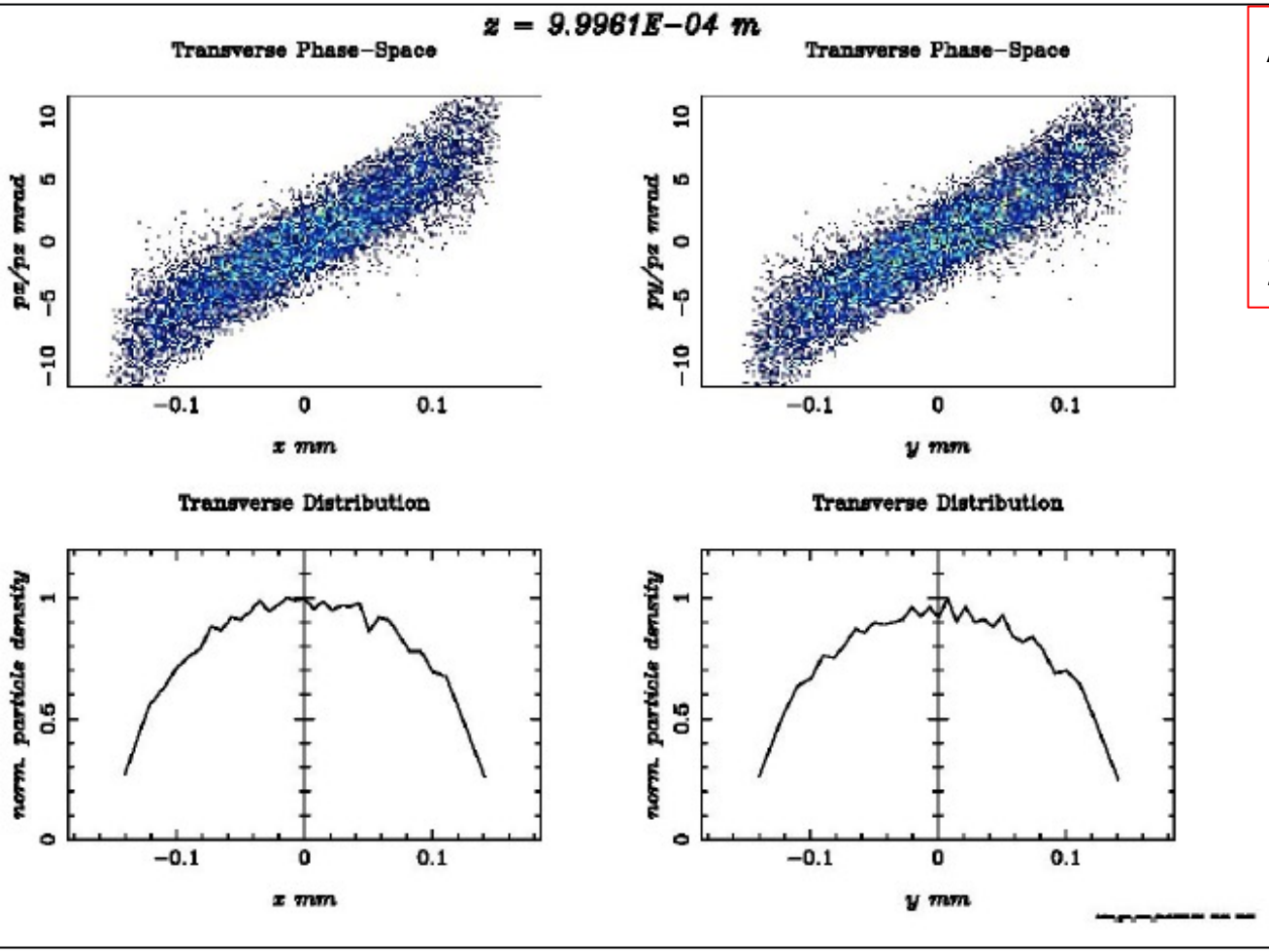
Funded by the European Union

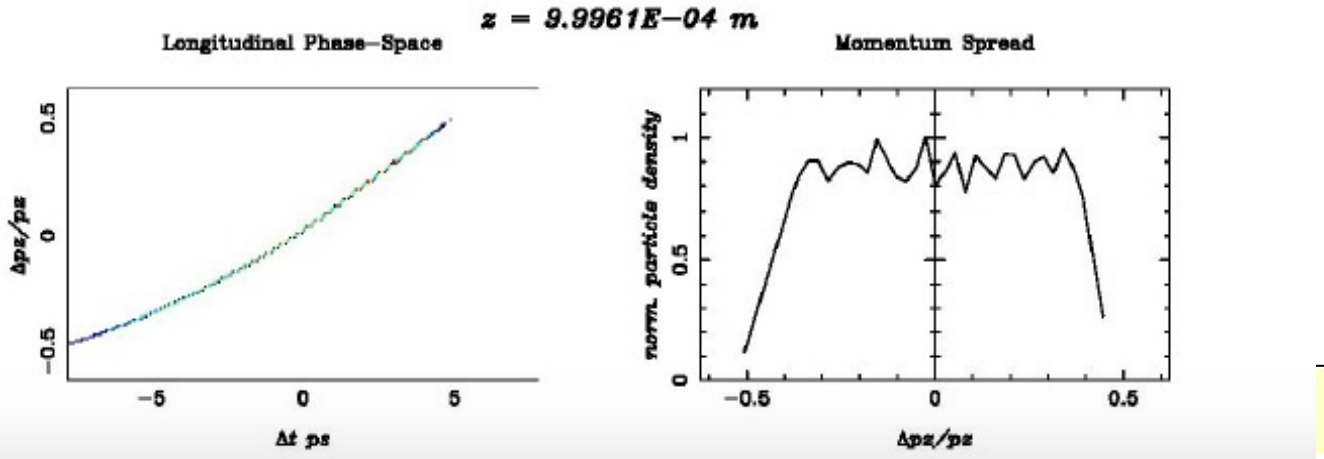
The NTUA/IHU/AUTH team

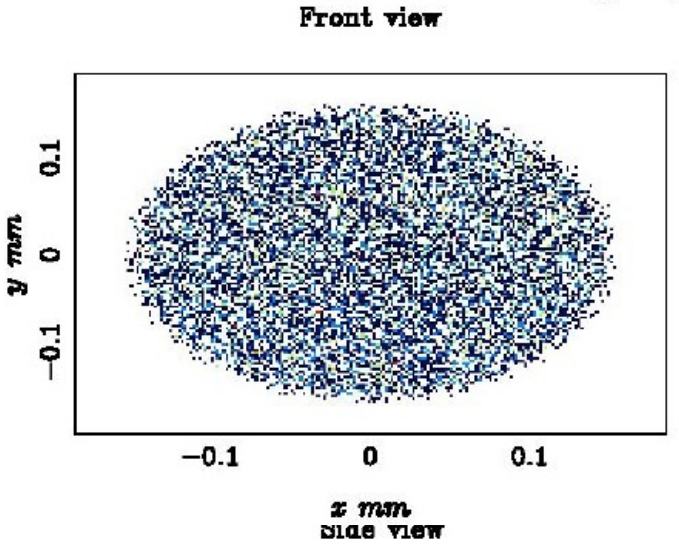
Compact

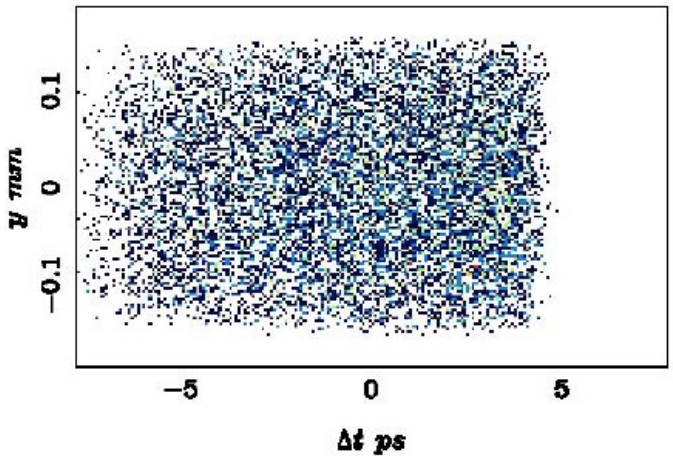
ASTRA code

1. the electron beam distribution very close to the cathode at z=0.002m
2. the electron beam density









Laser spot size (mm)	0.08
Phase (degrees)	9.31
Solenoid field maximum (T)	0.1898
Solenoid position (m)	0.2939

Final Results

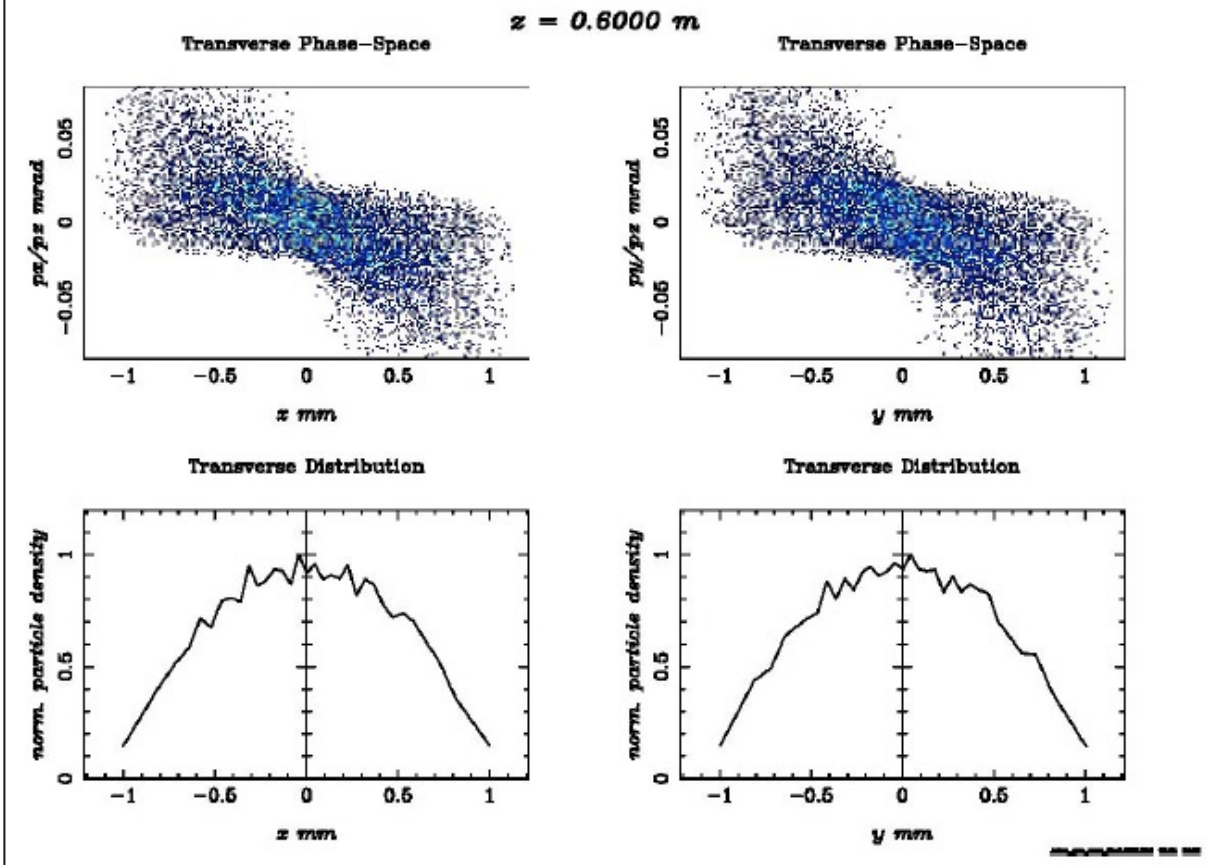


Figure A5: Transverse phase space

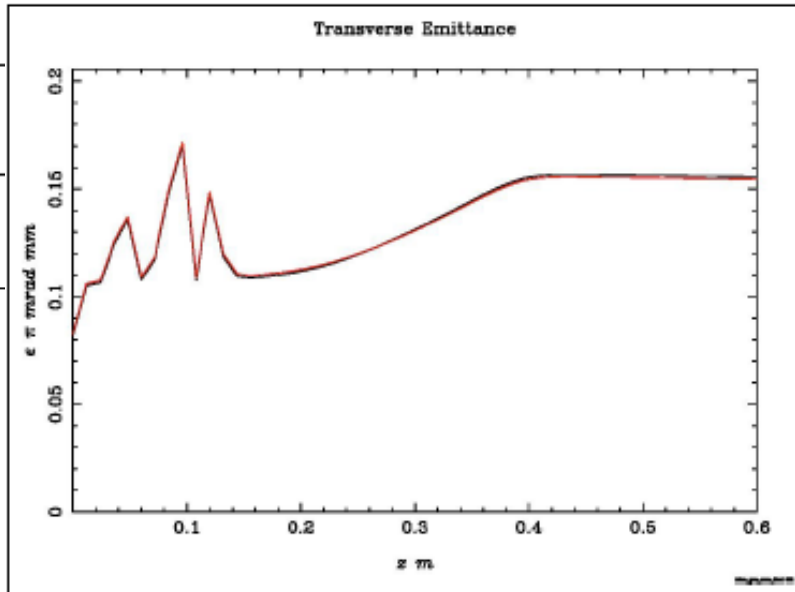
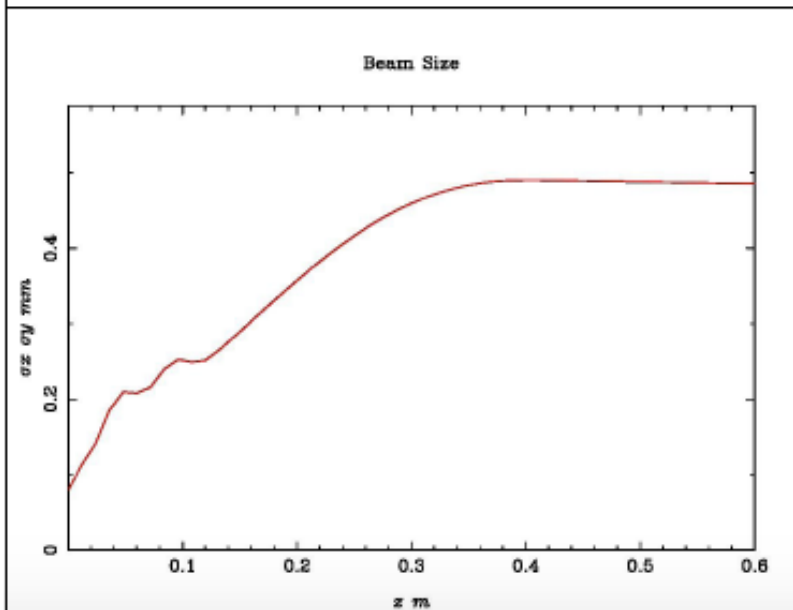
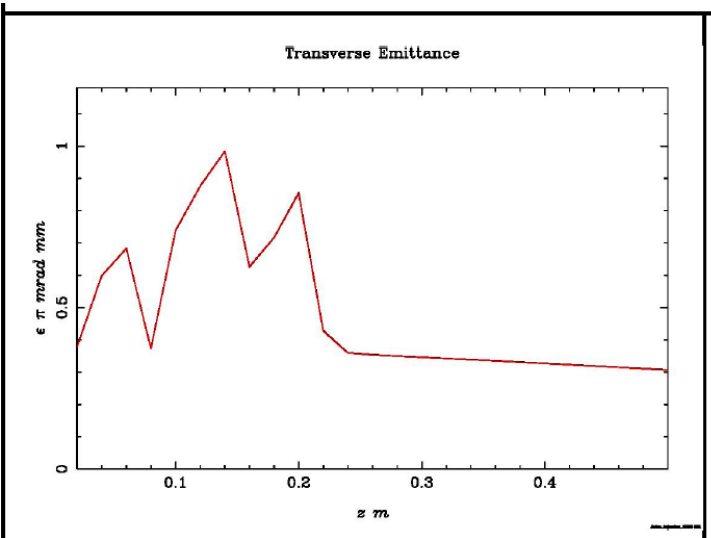


Figure A1 3: Transverse emittance

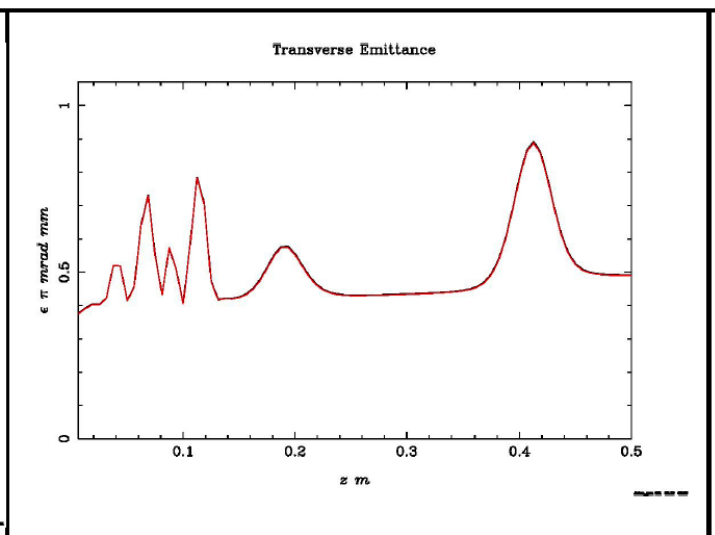


Emmitance evolution inside e-gun for **Cu-photocathode**



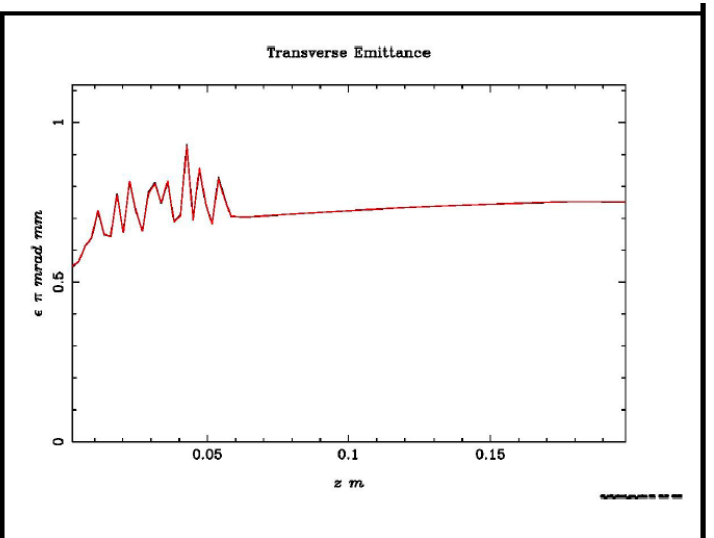
(I)

1.5 cells S-band gun
Cu photocathode
Solenoid F.9.5



(II)

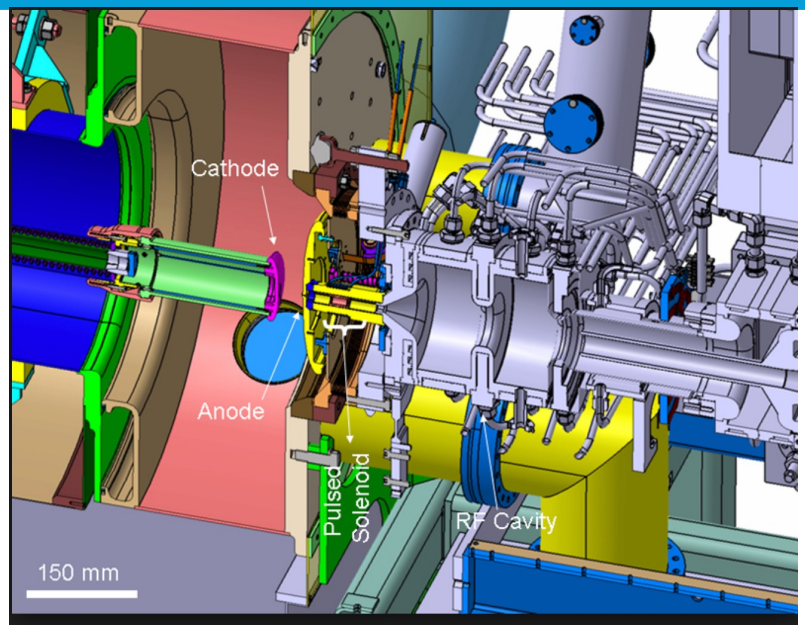
2.5 cells S-band gun
Cu photocathode
Solenoid No3 of Chapter 10
Table 10.2

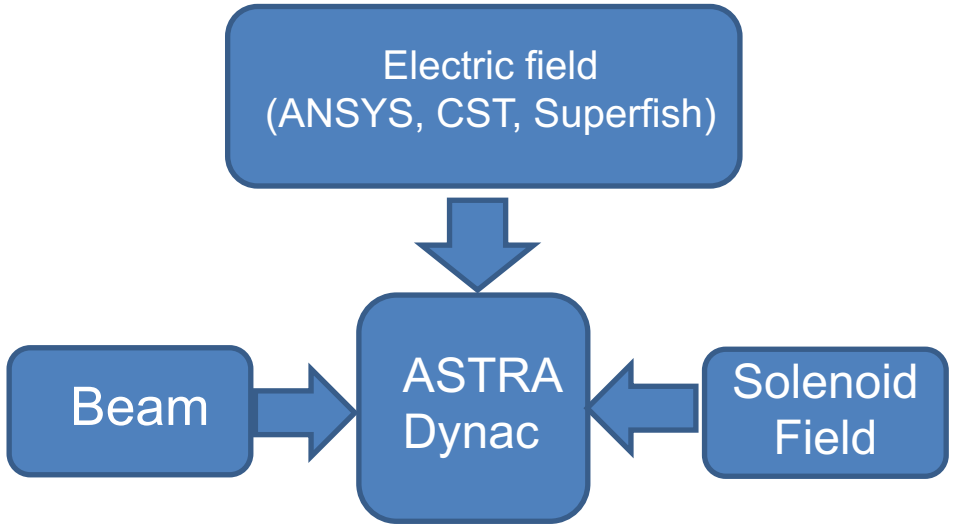


(III)

4.6 cells X-band gun
Cu photocathode
Solenoid Table 11.2

Simulation Methodology and Strategy for the e-Gun beam dynamics



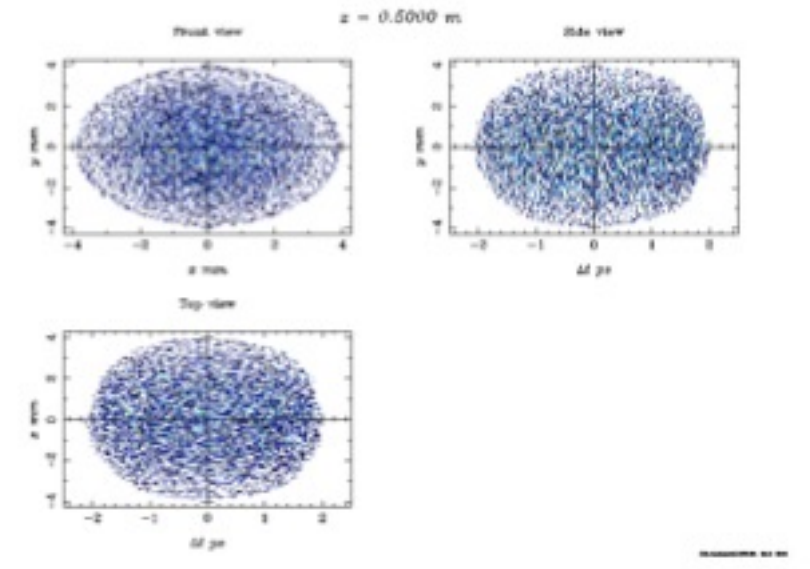


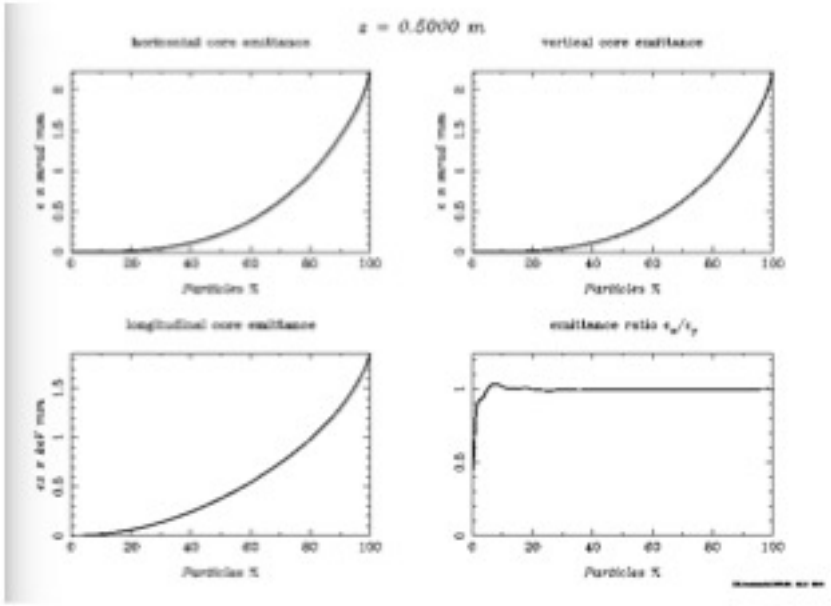
Material Science: Non-Destructive Tests to Materials
Beams: INFN Beam, SwissFEL Beam (Created from IASA/NTUA team)
E-Gun Electric Fields: 1.5 Cell from INFN , SwissFEL 2.5 cell
Solenoids: INFN, SwissFEL

All the possible combinations with respect to the material have been investigated

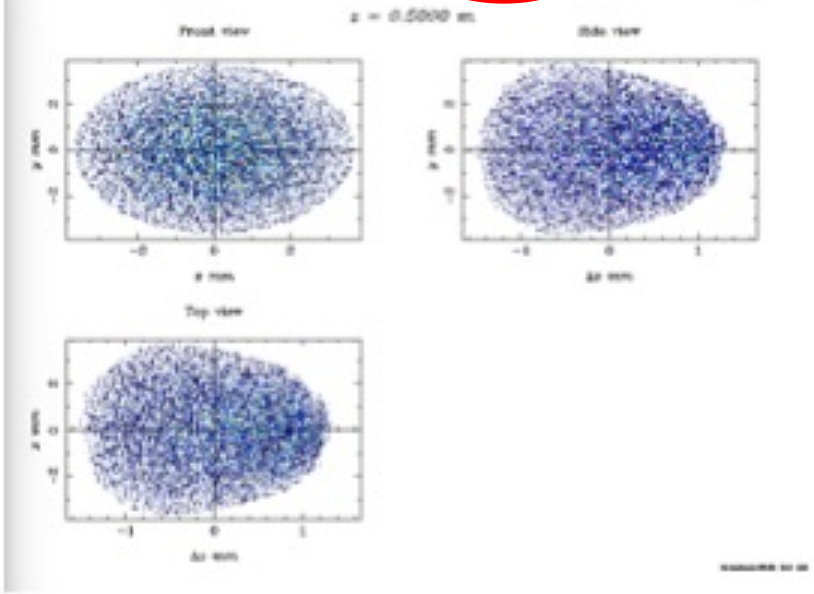
The Greek TEAM participation - ESS

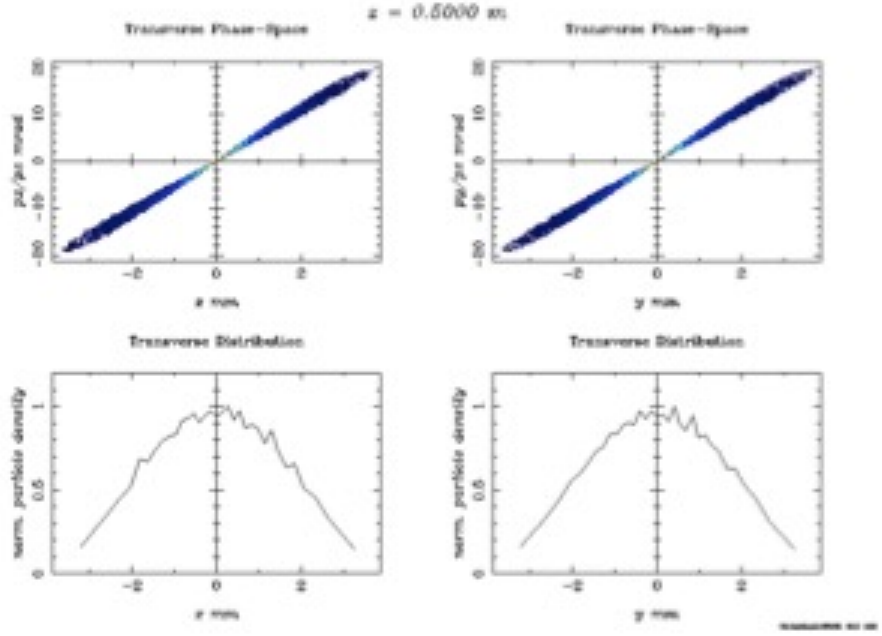
Scenario I : INFN Beam , 1.5 cell, INFN Solenoid



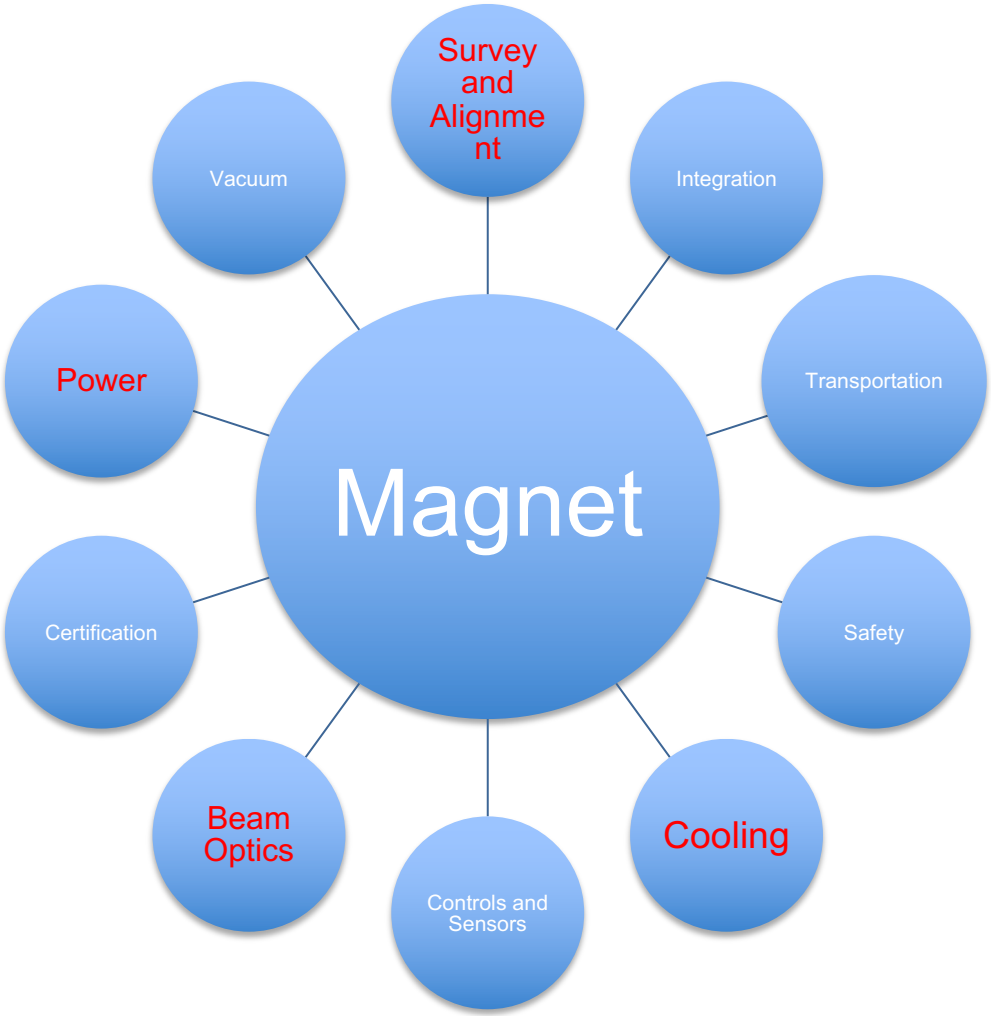


Scenario II:INFN BEAM, 2.5 Cell- SwissFEL , INFN solenoid





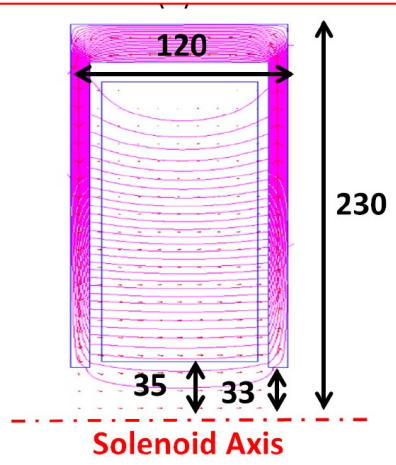
Methodology to mechanical & electrical design of the injector solenoid

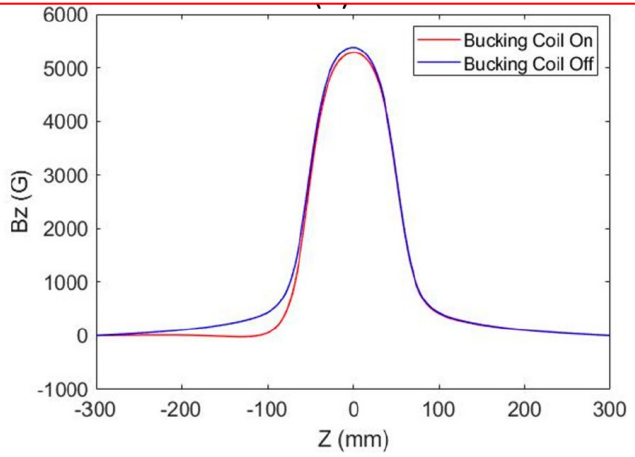


- **Field Strength/Gradient**
- **Mechanical Length**
- **Integrated Field Strength/ Gradient**
- **Aperture and Field Region**
- **Field Quality (Field Homogeneity, Maximum allowed Multipoles- error and Tolerances, Time Constant)**
- **Operation Mode**
- **Supporting & transportation systems design**
- **General mechanical tolerances**
- **Electrical Parameters: Ampere Turns, Current**
- **Magnet Topology Bucking Coil, Steerer Coil**
- **Coil Design : Number of Coils and Cross Section, Material, Cross Section, Insulation Epoxy Impregnation,**
- **Cooling Circuit and Sensors, Hydraulic Connections, Integration to accelerator cooling system**
- **Temperature and Sensors**
- **Power Distribution : Power Supply, Cabling , Protection**
- **Integration of Sensors to Control System**
- **Alignment targets Adjustment tables Support jacks**
- **Magnetic measurement devices: Pick-up, hall probes**

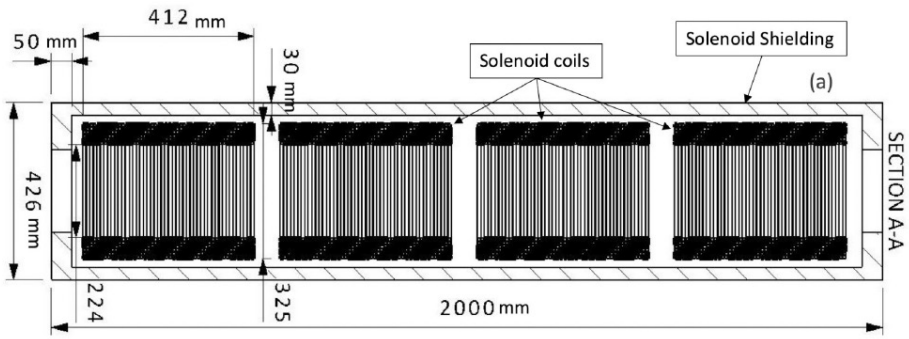
Solenoid Parameter Design

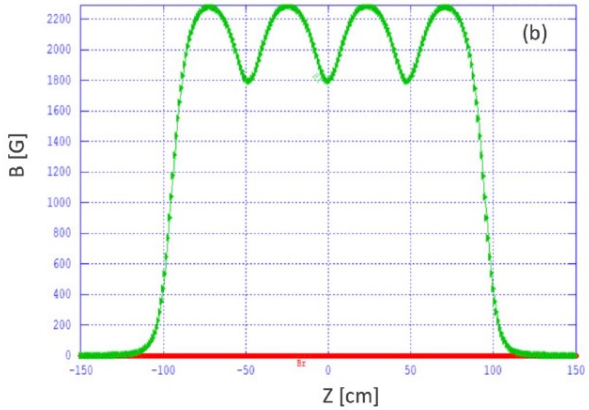
Solenoid simulated by the code Poisson and magnetic field profile on axis





Parameter	Unit	Value
B_{max}	T	0.53
Bore radius	mm	33
Solenoid length	mm	120
Yoke Material		Low Carbon Steel
Integrated field	Tmm	59.4
Good field region radius	mm	10 mm
Integrated Field variation		3×10^{-5}
Number of Turns		336
Conductor dimension	mm	5.6×5.6/bore 3.6
Nominal Current	A	164
Nominal Voltage	V	40

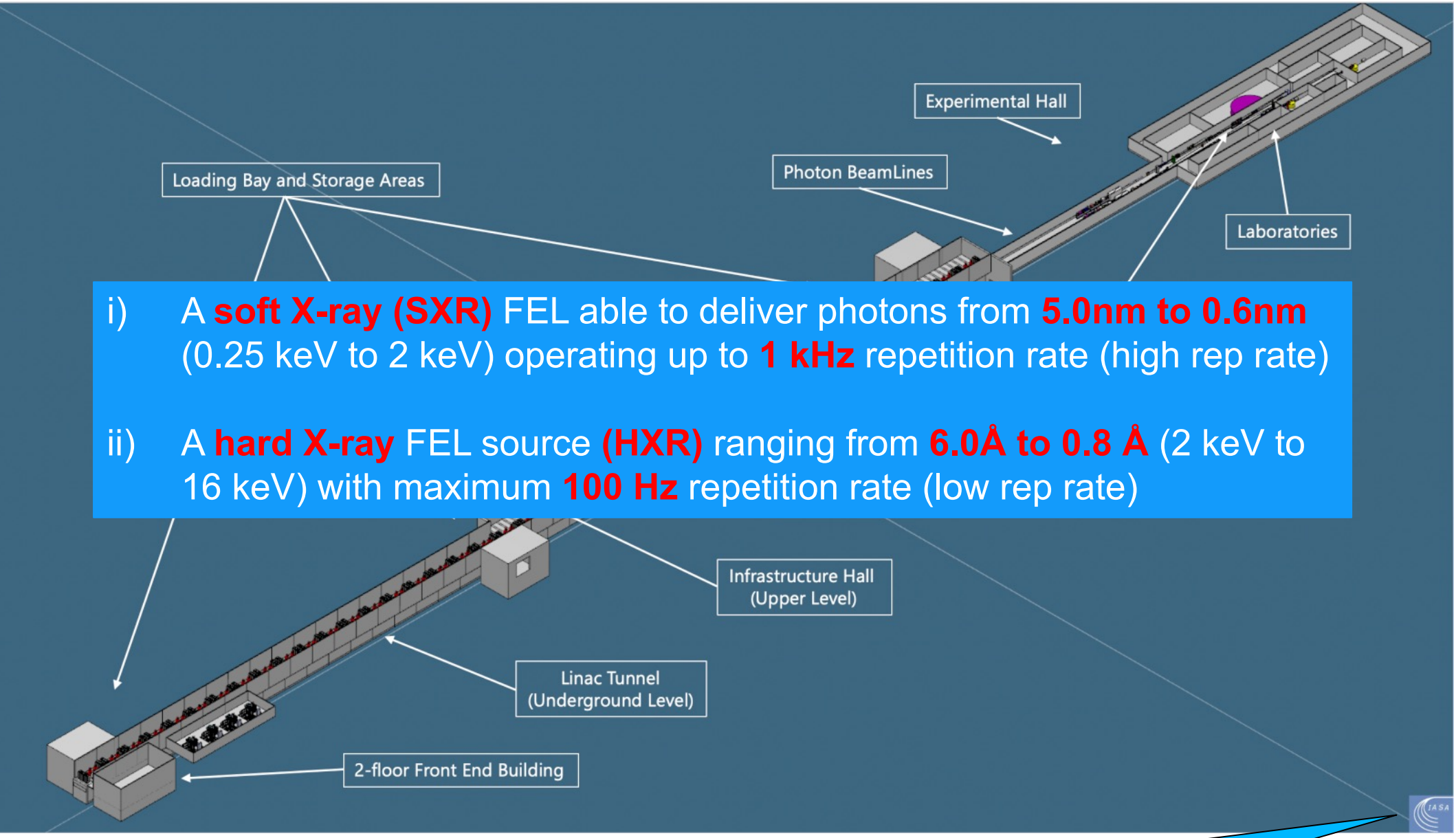




Geometry of the C-band solenoid simulated with Poisson-Superfish

Longitudinal magnetic field on axis

Compact Light facility, length **480m**



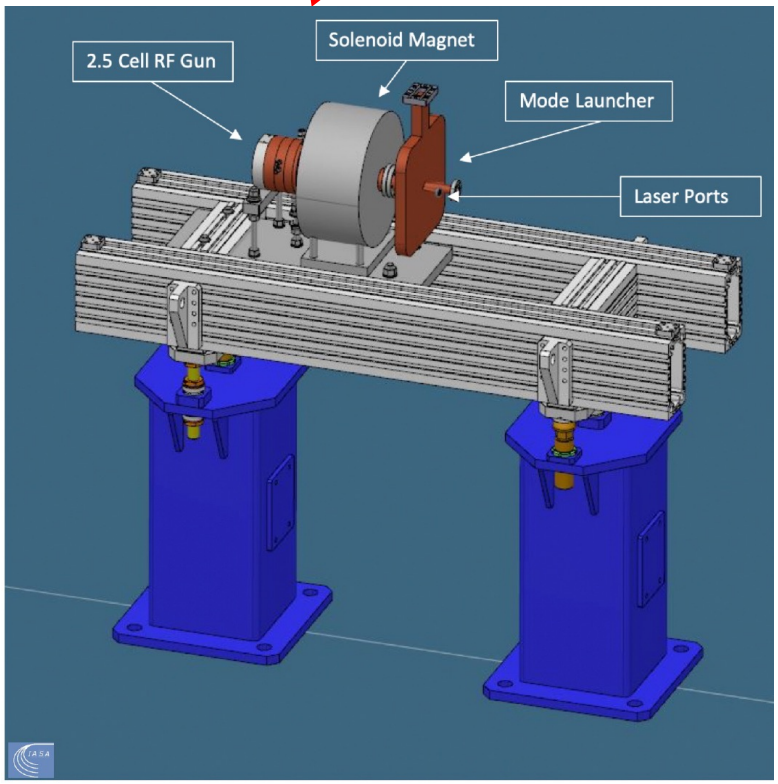
i) A **soft X-ray (SXR)** FEL able to deliver photons from **5.0nm to 0.6nm** (0.25 keV to 2 keV) operating up to **1 kHz** repetition rate (high rep rate)

ii) A **hard X-ray** FEL source **(HXR)** ranging from **6.0Å to 0.8 Å** (2 keV to 16 keV) with maximum **100 Hz** repetition rate (low rep rate)

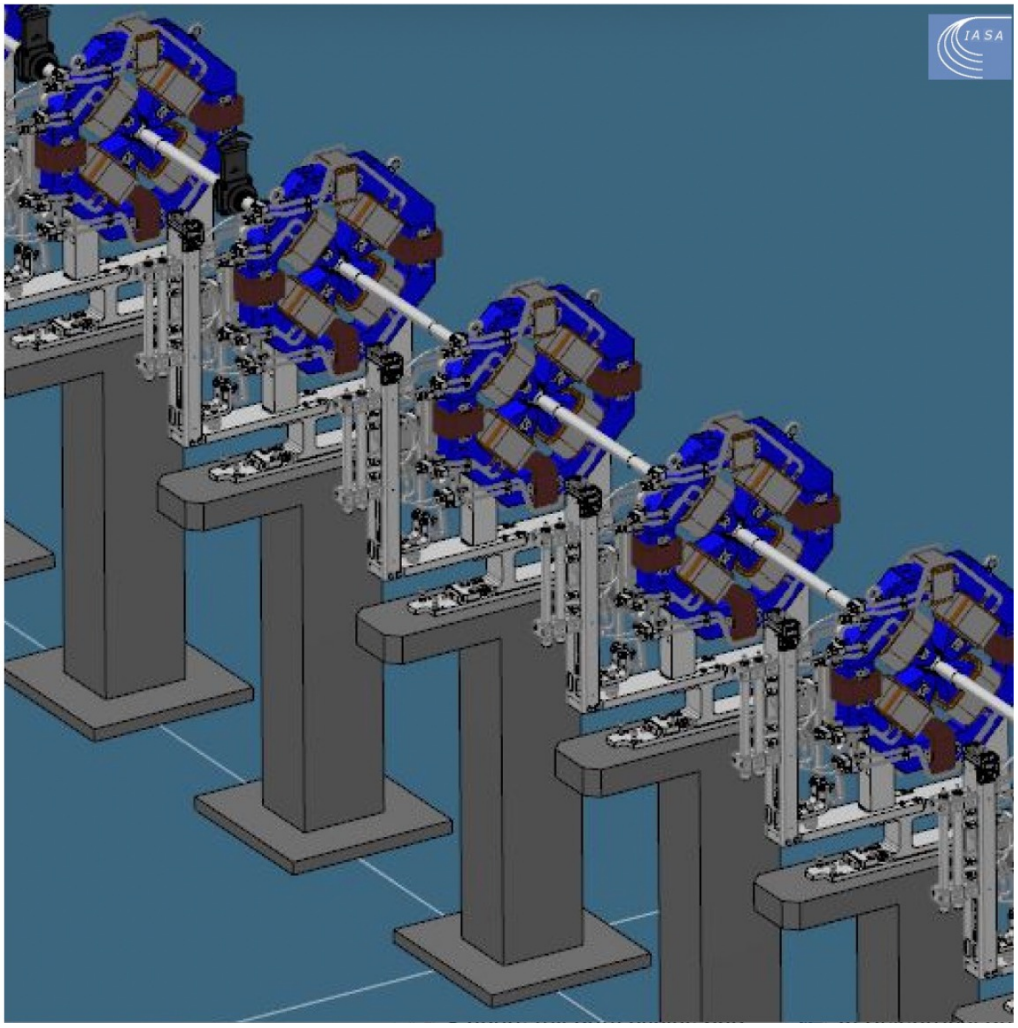
IASA/ESS 3D design

The Greek TEAM participation – IASA/ESS

Cell C-band gun parameters and **3D design**, with **solenoid**, **mode launcher**, **laser ports**

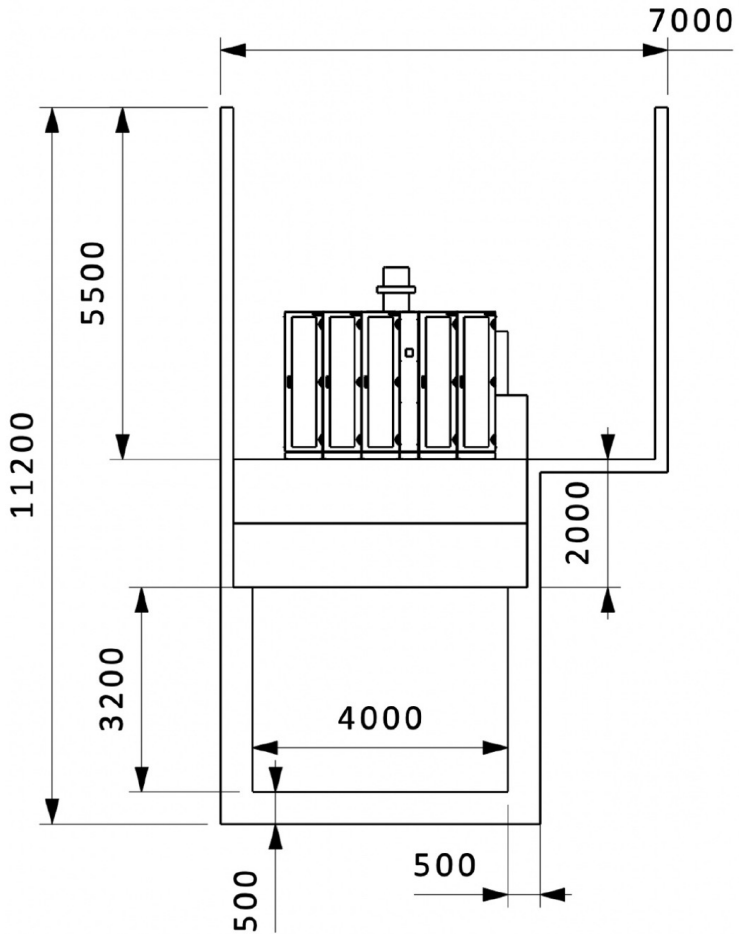


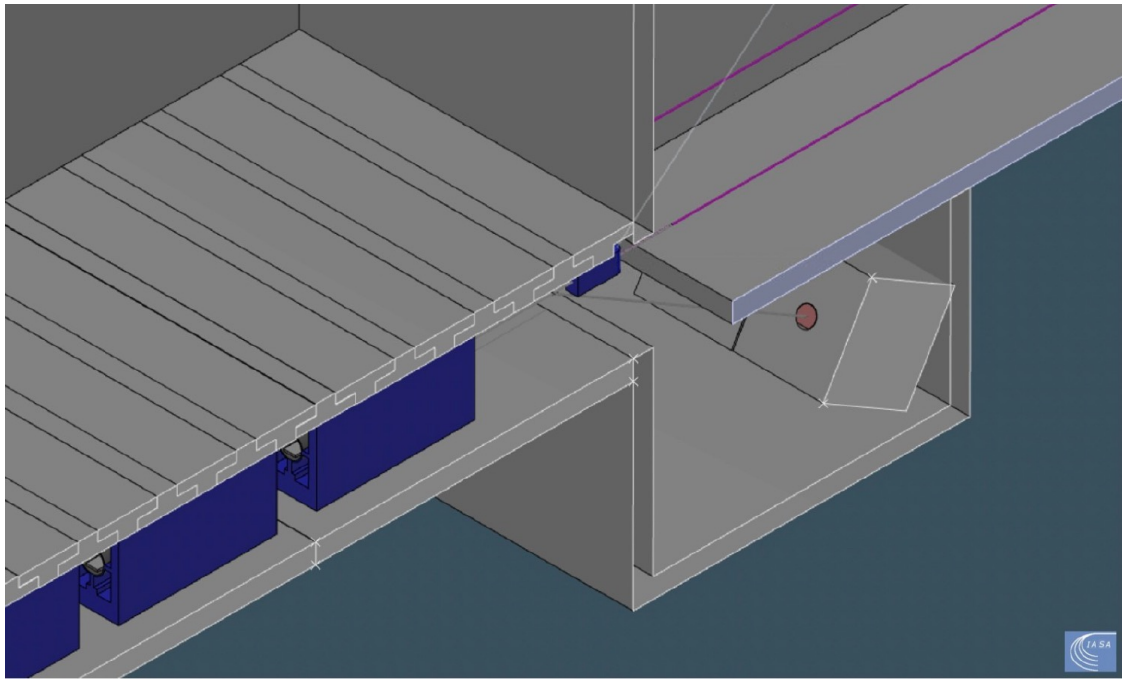
Close up view of the **quadrupoles** with **embedded steerers**



The building, cross section of the tunnel, the dogleg area and the beam dump

Name	Length (m)	Width (m)	Height (m)
Linac Tunnel/Undulator Hall	329	4.0/8.5	3.2
Infrastructure Hall	329	7.0/11.0	5.5
Experimental Hall	154.6	5.9/24.9	4.0
Total:	483.6		





1. Data Management Plan

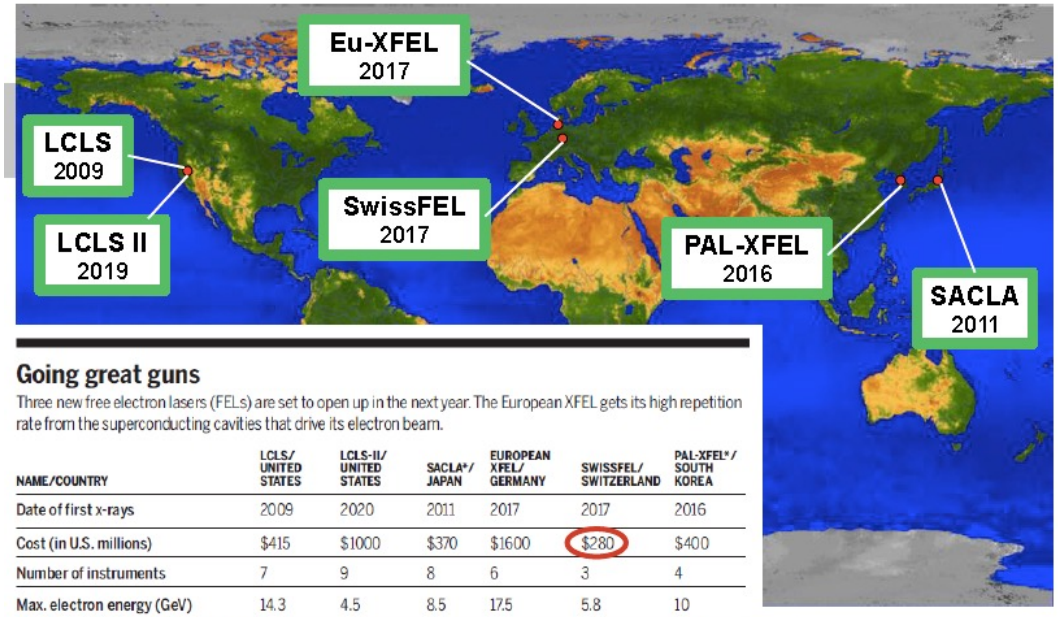
It is a formal document that outlines how data are to be handled both during a research project, and after the project is completed.

1st project deliverable by Greek Team**: D1.2: XLS Data Management Plan v1.0, 30 June 2018**

2. Cost, SWOT, Risk Model (risk table) and Market Analysis

Sub-Systems	Rough Distribution %
• RF-Gun	6
• Injector	9
• LINACS	16
• Klystrons	25
• Bunch Compressors	10
• Magnets	5
• Undulator	25
• Controls & Operation	4

PAUL SCHERRER INSTITUT PSI X-FELs worldwide



Going great guns

Three new free electron lasers (FELs) are set to open up in the next year. The European XFEL gets its high repetition rate from the superconducting cavities that drive its electron beam.

NAME/COUNTRY	LCLS/ UNITED STATES	LCLS-II/ UNITED STATES	SACLA*/ JAPAN	EUROPEAN XFEL/ GERMANY	SWISSFEL/ SWITZERLAND	PAL-XFEL*/ SOUTH KOREA
Date of first x-rays	2009	2020	2011	2017	2017	2016
Cost (in U.S. millions)	$415	$1000	$370	$1600	$280	$400
Number of instruments	7	9	8	6	3	4
Max. electron energy (GeV)	14.3	4.5	8.5	17.5	5.8	10
Min. pulse duration (femtoseconds)	15	15	10	5	2	30
Pulses per second	120	1,000,000	60	27,000	100	60

*SACLA is the Spring-8 Angstrom Compact free electron Laser and PAL-XFEL is the Pohang Accelerator Laboratory X-ray Free Electron Laser

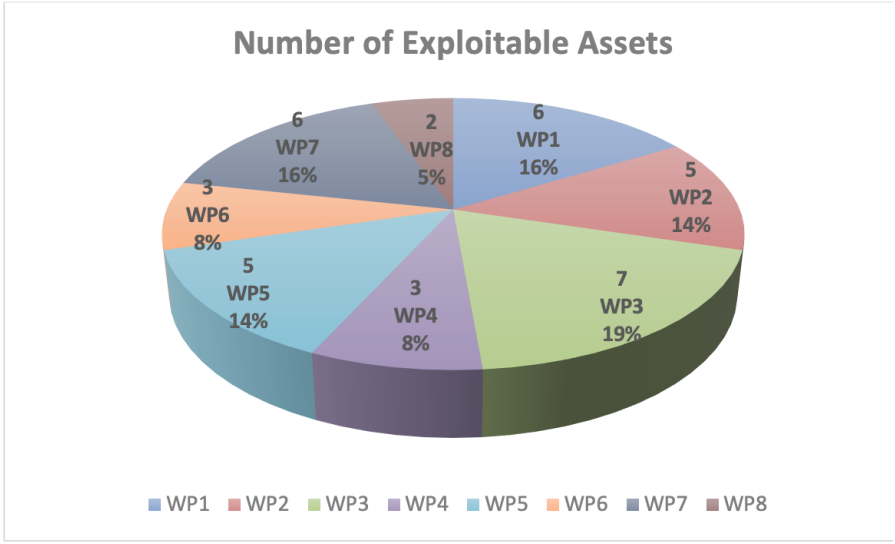
3. Transfer Technology

Advanced Applications
Advanced XFEL Components
Intellectual Property

Compact Light construction & installation cost: **76.74 MEuros**

4. Innovative Assets Exploitation

About **43 exploitable assets** have been identified among the WP1 – WP7 results, for dissemination to research units, industry and society



5. Cost to Benefit Analysis - CBA

The benefits stemming from research is tremendously wide, including:

- Knowledge creation and dissemination
- Technological development
- Human capital creation (papers, MSc/PhD theses, etc.)
- Employment effects
- Social capital creation
- Others

EuPRAXIA Kick-off meeting 24-25 Nov 2022

Staff effort per participant

Grant Preparation (Work packages - Effort screen) — Enter the info.

Participant	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	WP10	Total Person-Months
20 - CERN				2.00					2.00		6.00
21 - IASA		8.00	8.00	8.00					8.00		56.00

WP2 - Dissemination and Public Relations
C. Welsch, U Liverpool
S. Bertellii, INFN

Greek Contr.: Dissemination/Outreach to society & industry

WP3 - Organization and Rules
A. Specka, CNRS
A. Ghigo, INFN

Greek Contr.: Organization & Rules to consortium

WP4 - Financial & Legal Model. Economic Impact
A. Falone, INFN

Greek Contr.: Market-/Risk-/CostToBenefit- Analysis

WP9 - RF, Magnets & Beamline Components
S. Antipov, DESY
F. Nguyen, ENEA

Greek Contr.: Photocathode/RF/Magnets study & Design, HV Power Supplies?

WP7 - E-Needs and Data Policy
R. Fonseca, IST
S. Pioli, INFN

Greek Contr.: Data Management Plan

WP11 - Applications
G. Sarri, U Belfast
E. Chiadroni,U Sapienza

Greek Contr.: Medical & Cultural Applications

Summary

1.Our IASA team has extensive experience since we have already done similar work (for CLIC, HL-LHC, CompactLight, etc.)

2. Our IASA team has access to an even larger pool of experts, besides the existing teams, that can deliver even more work to Eupraxia, feeling grateful that Massimo, Federico and all the management team has welcomed IASA to Eupraxia

3. Our teams currently are:

- IASA engineering team
- IASA physics team
- IASA economics/financial team
- IASA knowledge transfer