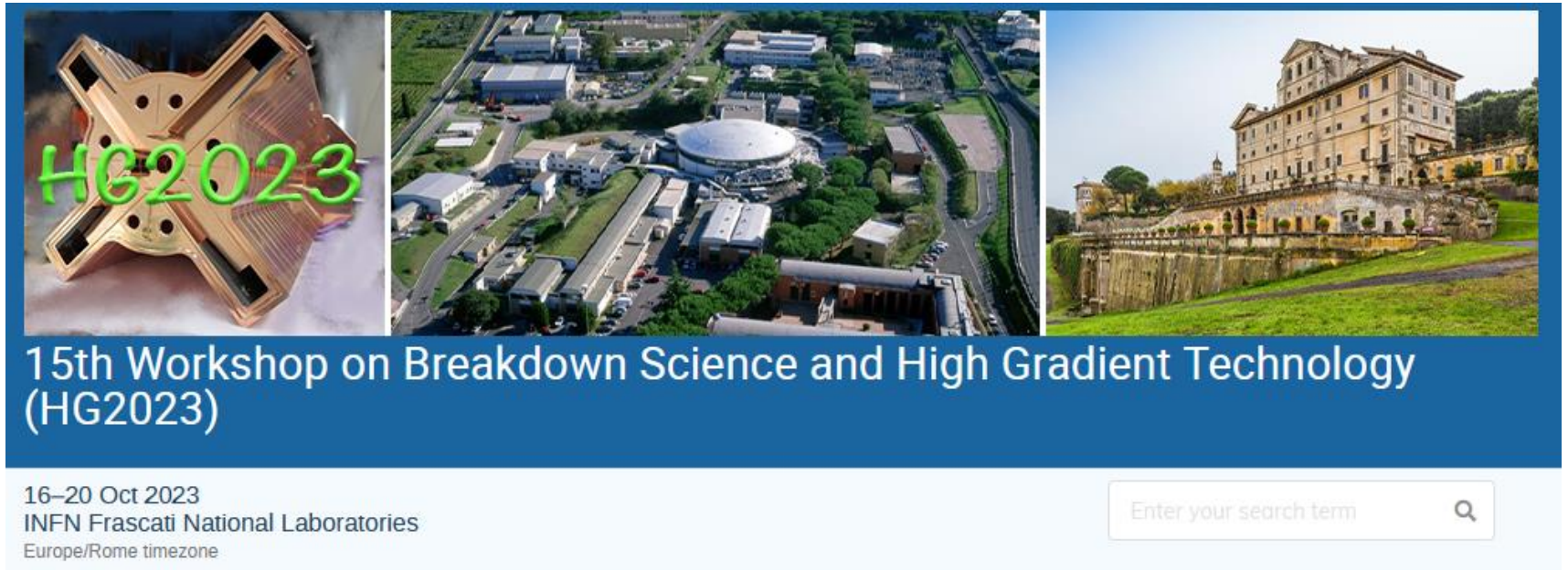
Report from HG2023



https://agenda.infn.it/event/34253/

HG2023 context

Nearly-annual workshop dedicated to rf technology for advanced linacs – including high gradient, high frequency, compact applications, energy and performance upgrades.

Started out in 2007 focused on breakdown and the CLIC rf main linac rf system, also on maintaining a community for ex-NLC/JLC.

Dedicated breakdown workshop series MeVArc split off and started in 2010.

HG2023 was the 15th edition!

Hosted by INFN Frascati. They are on their way to having the largest X-band installation.

Main themes

Things	Attributes

• Projects
  • Compact facilities
  • Energy upgrades
  • Ring injectors
• Test stands
• Accelerating structures
• Deflectors
• Photoinjectors
• Components
• Power sources
	• High-gradient
	• DC (gun and experiments)
	• S-band
	• C-band
	• X-band
	• Ka, mm and THz
	• Dielectric
	• Cryogenic
	• Short pulse
	• External magnetic field

Selected examples

Now I will present a very few selected highlights, that do not include those being presented at this project meeting (hence the bias towards US and China).

Rather arbitrary choice, not at all comprehensive!

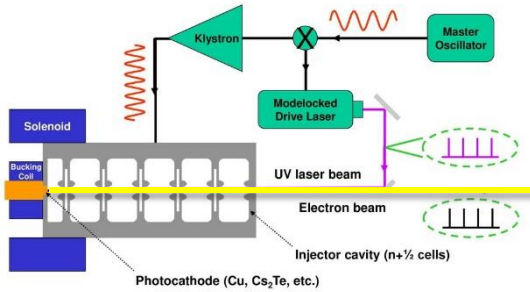
AWA RESEARCH THEMES

Timeless research themes

APPLICATION

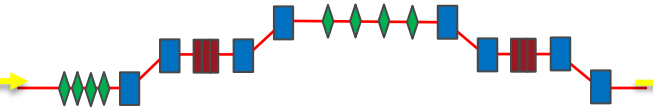
THEME 1 — **Beam Production** → **THEME 2** — **Beam Manipulation** → **THEME 3** — **Advanced Acceleration** → ★

e.g. RF Photoinjector



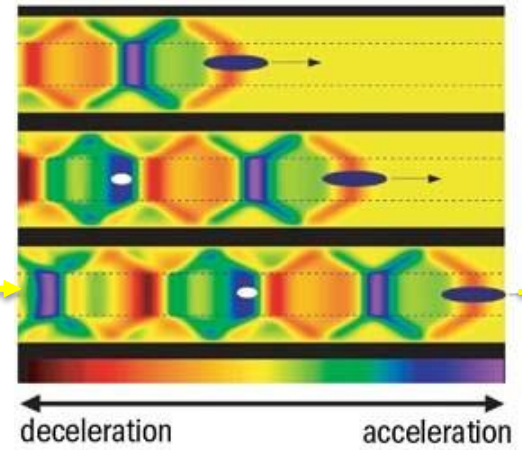
- High-brightness sources
- High-charge sources
- Novel cathodes

e.g. Double Emittance Exchange



- Beam manipulation and control.
- Beam Diagnostics.

e.g. SWFA



- Structure Wakefield Acceleration
- Two beam acceleration
- Collinear wakefield acceleration
- Plasma Wakefield Acceleration

- 10 TeV Linear Collider
- 10 GeV Compact XFEL
- 10 MeV UED
- ⋮
- not exhaustive

The Argonne Wakefield Accelerator (AWA) Facility

Beam Test Facility to enable novel acceleration

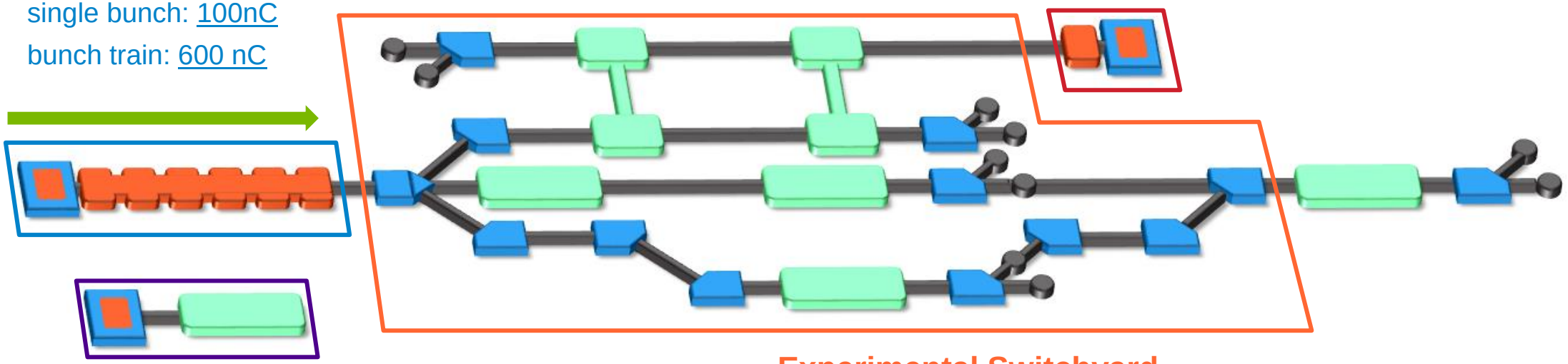
https://www.anl.gov/awa

Witness RF photoinjector (15 MeV)

- Provides two-beam capability
- Bright beams for low-energy experiments

Drive RF Photoinjector (65 MeV)

- single bunch: 100nC
- bunch train: 600 nC



Argonne Cathode Test Stand (2-4 MeV)

- Cathode research and diagnostics
- Physics of high-gradient breakdown

Experimental Switchyard

- Highly reconfigurable
- 6D phase space manipulation

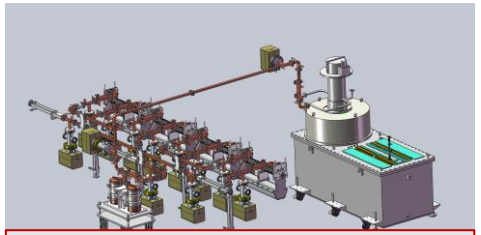
Laser

- 100 mJ (IR), 10 mJ (UV),
- 300 fs – 6 ps (UV)
- temporal shaping

Research and development of MW team

Project

SSRF
SXFEL
SHINE



X-band deflector on SHINE

Satisfy the operation of SSRF and SXFEL, and construction of SHINE normal conducting rf system, including several S-band and X-band deflectors

Normal conducting RF system

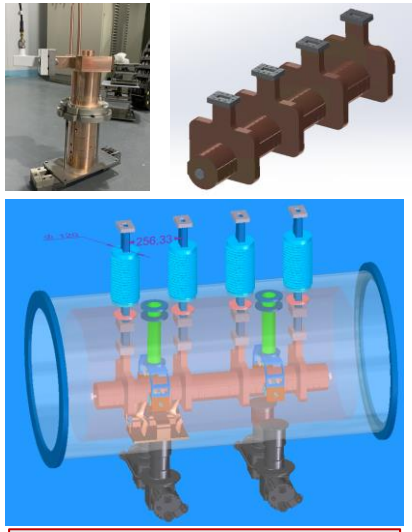
X-band accelerating structure
X-band deflecting structure
Dual-mode deflecting structure
S-band accelerating structure for proton therapy

X-band RF system on SXFEL

Responsible for high gradient technology research, such as X-band accelerating structures and deflecting structures, new technology about two modes operation deflecting structure, we begin cryogenic RF structures and systems development in recent years.

Cryogenic RF system

Cryogenic RF structures and system



Cryogenic RF system

Technology Application

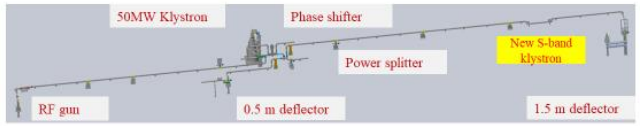
S/C/X-band RF system, including accelerating structure, deflecting structure, pulse compressor on different facility or application

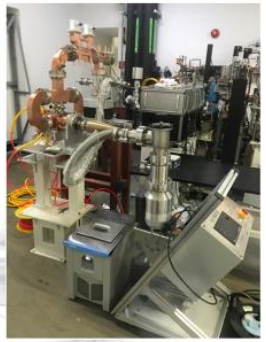
C-band RF system on SXFEL

Responsible for mature technology application, including S-band and C-band accelerating structures, deflecting structures, pulse compressor and waveguide components.

SSRF (SARI)

S-band high power test platform



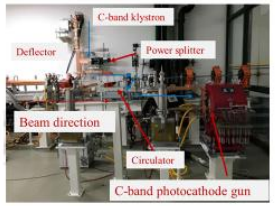


Now SXFEL facility has completed the national acceptance, we have plenty of time and space to do more research.
Right now, the power source is still use Toshiba 50 MW klystron, the power is divided into three structures, including the rf gun, short s-band deflector in the end of injector and long deflector in the down stream of X-band linearizer system by power splitter and phase shifter.
The waveguides is too complicated and long, recently, we have ordered a new klystron from a China company, it will be installed near the long deflector, part of the power will be used for S-band deflector, while meeting the high power test the s-band rf structures.

SSRF

C-band high power test platform

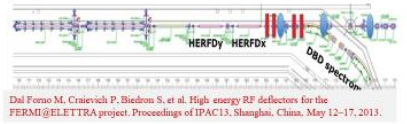
In the end of the linac, c-band deflector is powered by a Mitsubishi 50 MW klystron, and it is not need to operation all the time.
Separated from c-band deflector's klystron by a power splitter, and it will not influence the operation of SXFEL.
High power test of C-band photocathode gun has finished, and the maximum gradient is 180 MV/m.
A new klystron from Institute of Electrics of CAS has been installed, the maximum power is 50 MW.
Cryogenic RF gun has completed cold test and installation, and preparing to test when klystron is ready.
The structures to be tested is not on the beam line.



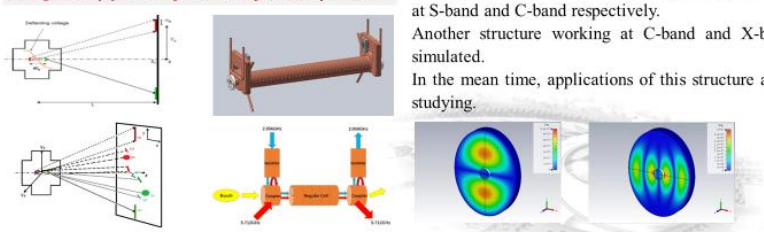
SSRF

New C-band klystron made by Institute of Electrics, CAS

Dual mode deflecting structure



Dal Forno M, Craievich P, Biedron S, et al. High energy RF deflectors for the FERMI@ELETTRA project. Proceedings of IPAC13, Shanghai, China, May 12–17, 2013.



Two fixed polarization plane deflectors were used to measure the beam distortion.
One structure with two or more polarization planes.
The design of dual mode deflector working at HEM_{11} and HEM_{12} mode has completed, corresponding to the frequencies at S-band and C-band respectively.
Another structure working at C-band and X-band is being simulated.
In the mean time, applications of this structure are also under studying.

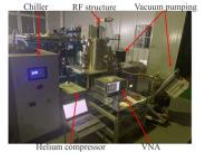
NUCL SCI TECH (2015) https://doi.org/10.13538/j.1001-8042/nst.26.040102
This work was supported by the National Natural Science Foundation of China (No.12175292)

SSRF

Presentation by Hanyu Gong

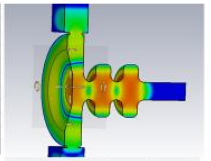
Cryogenic RF gun

Cryogenic RF gun

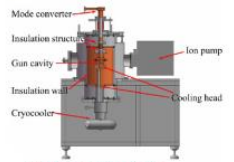


Prototype test in cryogenic platform

	Room temp.	Cryo temp.	
π mode	5692.9	5712	MHz
1/2π mode	5674.5	5693.6	MHz
0 mode	5647	5666	MHz
Q0	9852.46	54000	
Esmax/Ec	0.914		
Shunt impendance	6.285	34.455	Mohm
Target gradient	200		MV/m
Peak RF power	16.773	3.07	MW
RF pulse	2		μs
Peak temperature rise	75.45	7.8	K



New TM02 mode coupler gun



Layout of cryogenic platform

Cryogenic rf structure is a hotspot field in recent years.
The first prototype of cryogenic RF gun and platform for high power test are completed, and preparing to do high power test in a few months later.
A new cryogenic RF gun with TM02 mode coupler design has finished, and getting ready to fabricate.
The first prototype of cryogenic platform is only used for high power test.

Nuclear Inst. and Methods in Physics Research, A 1010 (2021) 165488
NUCL SCI TECH (2021) 32:97 https://doi.org/10.1007/s41365-021-00925-8

SSRF

Thursday presentation by Cheng Wang

Soon-to-be largest X-band installation

NSFC 清華大學 Tsinghua University

Progress of the VIGAS Project in Tsinghua University

VIGAS: **V**ery compact **I**nverse-compton-scattering **GA**mma-ray **S**ource

Jiaru Shi
on behalf of VIGAS team in THU
2023.10.18

INTRODUCTION

Design parameters of accelerator system for VIGAS

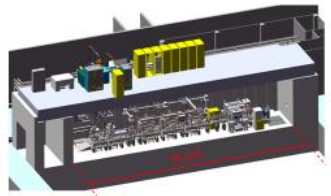
Properties	Value
Electron energy	50-350 MeV tunable
Charge	>= 200 pC
Normalized emittance	< 0.6 mm mrad
RMS bunch length	< 2 ps
RMS energy spread	< 0.3 %
RMS beam size at interaction point	< 20 um
Repetition	10 Hz

7

PROGRESS

Bunker is under construction

- Coming Soon…
  - Modules move in as sealed.
  - Alignment of the beam line.
  - Klystrons install (Canon S OK, CPI X Feb/24)
  - Waveguide connection and cabling…



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SUMMARY

- VIGAS as a compact ICS source, total length ~13.5m, up to 350MeV beam energy, 4.8MeV photon
- Accelerator Design finalized
- RF components, Pulse compressor, magnets, pipes, Sband structures… READY
- X-band HG structure:
  - CI prototype (XC72) tested at 80MV/m
  - CG testing soon (XT72#1)
- Module installation started.
- Bunker ready in November.
- Hope to start commissioning in the first quarter of 2024

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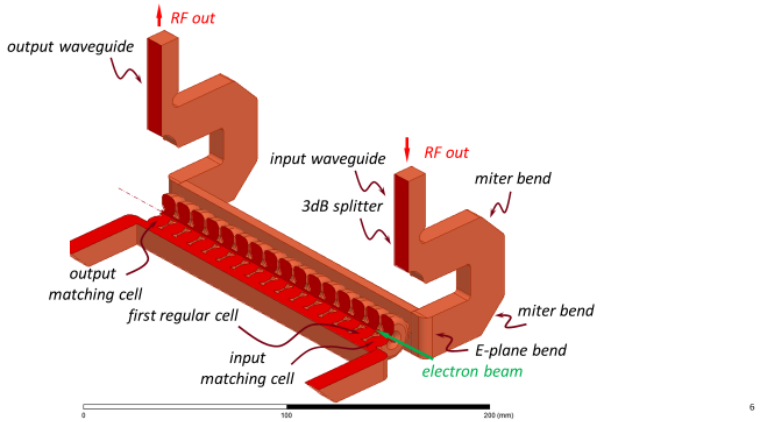
10 MeV linac, Arizona State University

High Efficiency X-band Traveling Wave Linac with Pulse-To-Pulse Tunable Energy

Valery Dolgashev, SLAC

15th Workshop on Breakdown Science and High Gradient Technology,
INFN Frascati National Laboratories, Frascati, Italy, 16–20 October 2023

Traveling Wave Linac Concept



Funding and Team

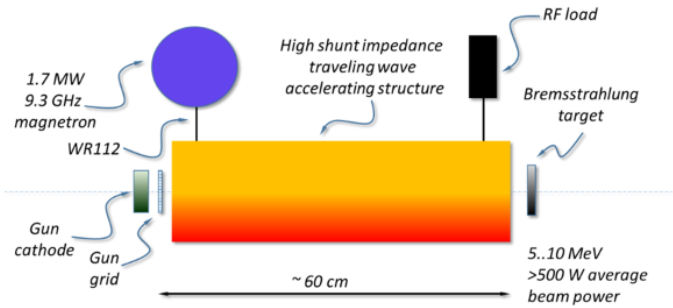
U.S. DEPARTMENT OF ENERGY | Office of Science

Accelerator Stewardship and Accelerator Development Programs

Team

- Agustin Romero, Anatoly Krasnykh, *SLAC*;
- Sergey Kuzikov, Roman Kostin, *Euclid Techlabs LLC*;
- Philipp Borchard, *Dymenso LLC*;
- Drew Packard, *General Atomics*;
- Sergey Kutsaev, *Radiabeam;*
- Douglas Boyd, *TeleSecurity Sciences Inc and Imatrex Inc.*;
- Mark Holl, William Graves, *Arizona State University*.

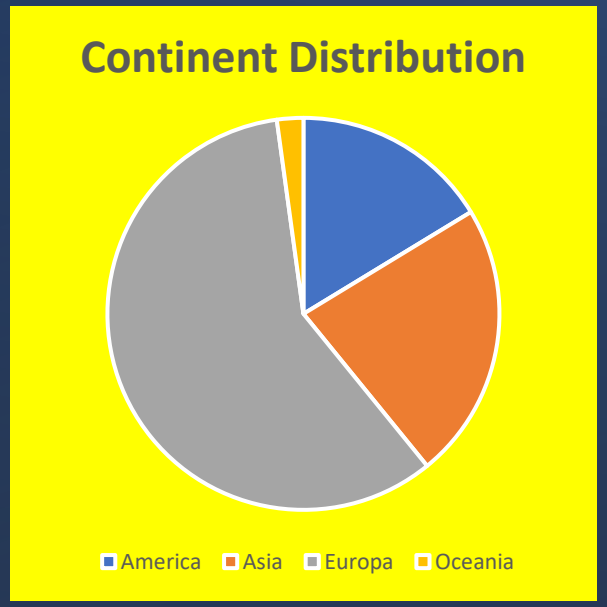
Concept Traveling Wave Linac with Pulse-To-Pulse Tunable Energy

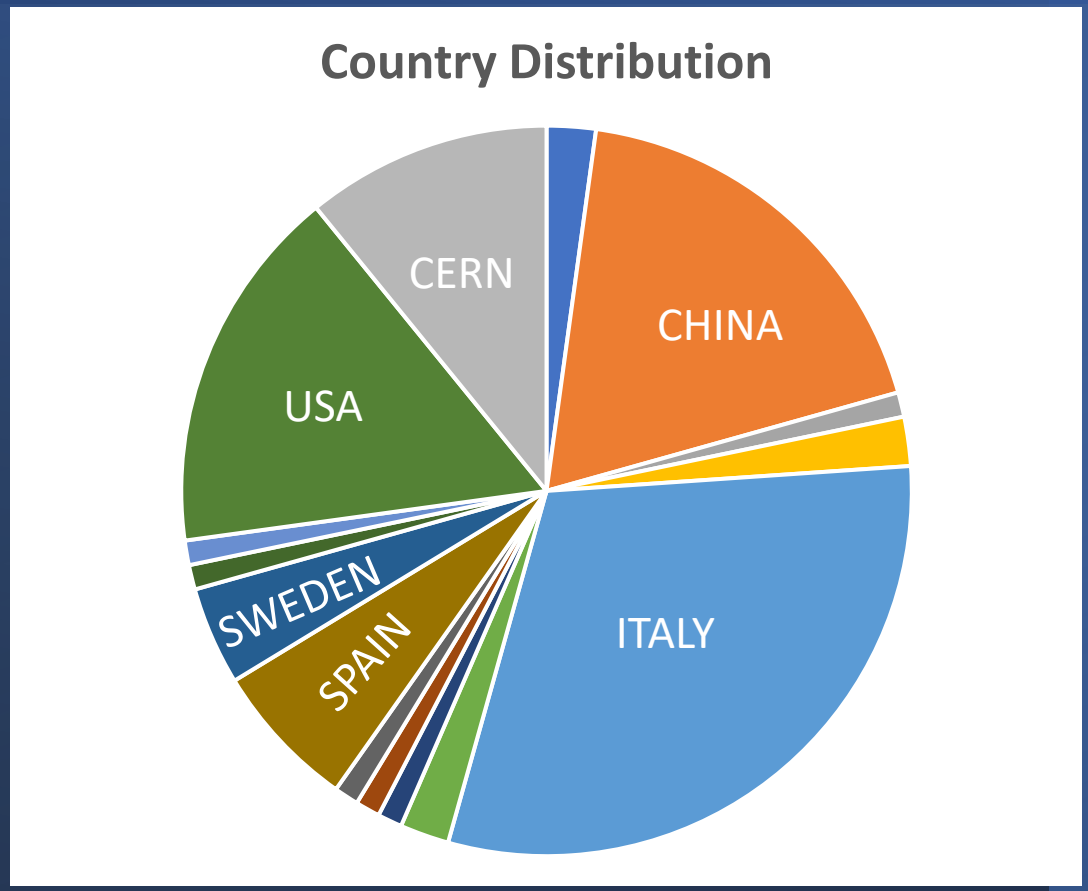


A schematic of a compact X-band linac with tunable output energy based on the high shunt impedance travelling wave accelerating structure. The linac does not need a circulator to protect magnetron.

HG2023 in numbers

- 92 registered participants
  - ✓ from 28 scientific institutions + 7 companies;
  - ✓ from 14 countries + CERN;
  - ✓ from 4 continents

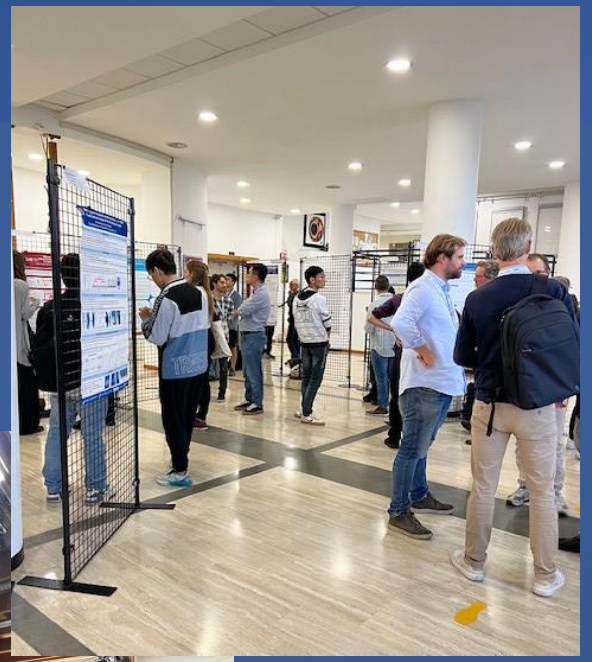




Australia	2
China	17
France	1
Iran	2
Italy	28
Japan	2
Nederland	1
Norway	1
Slovenia	1
Spain	6
Sweden	4
Switzerland	1
United Kingdom	1
USA	15
CERN	10

HG2023 in numbers

- 11 Plenary Sessions;
- 56 Oral presentations;
- 21 Posters;
- 3 Industrial Exhibitors



HG2023 in numbers

- 15 students supported by grants

We are especially proud of them!

About **20%** of the whole audience

Contrary to the statistical trend for the general audience, **none of them is Italian!**

CONCLUDING REMARKS

Alessandro Gallo – INFN Frascati

INFN LNF
Istituto Nazionale di Fisica Nucleare

and thanks to all of you for the kind and alive participation to HG2023!

Next

We’re going to keep going. Next will be HG2025. Location under discussion.

Some of you may also be interested in MeVArc2024
https://indico.cern.ch/event/1298949/overview.
Hosted by Sandia Laboratory and held in Lake Tahoe. Registration is open.