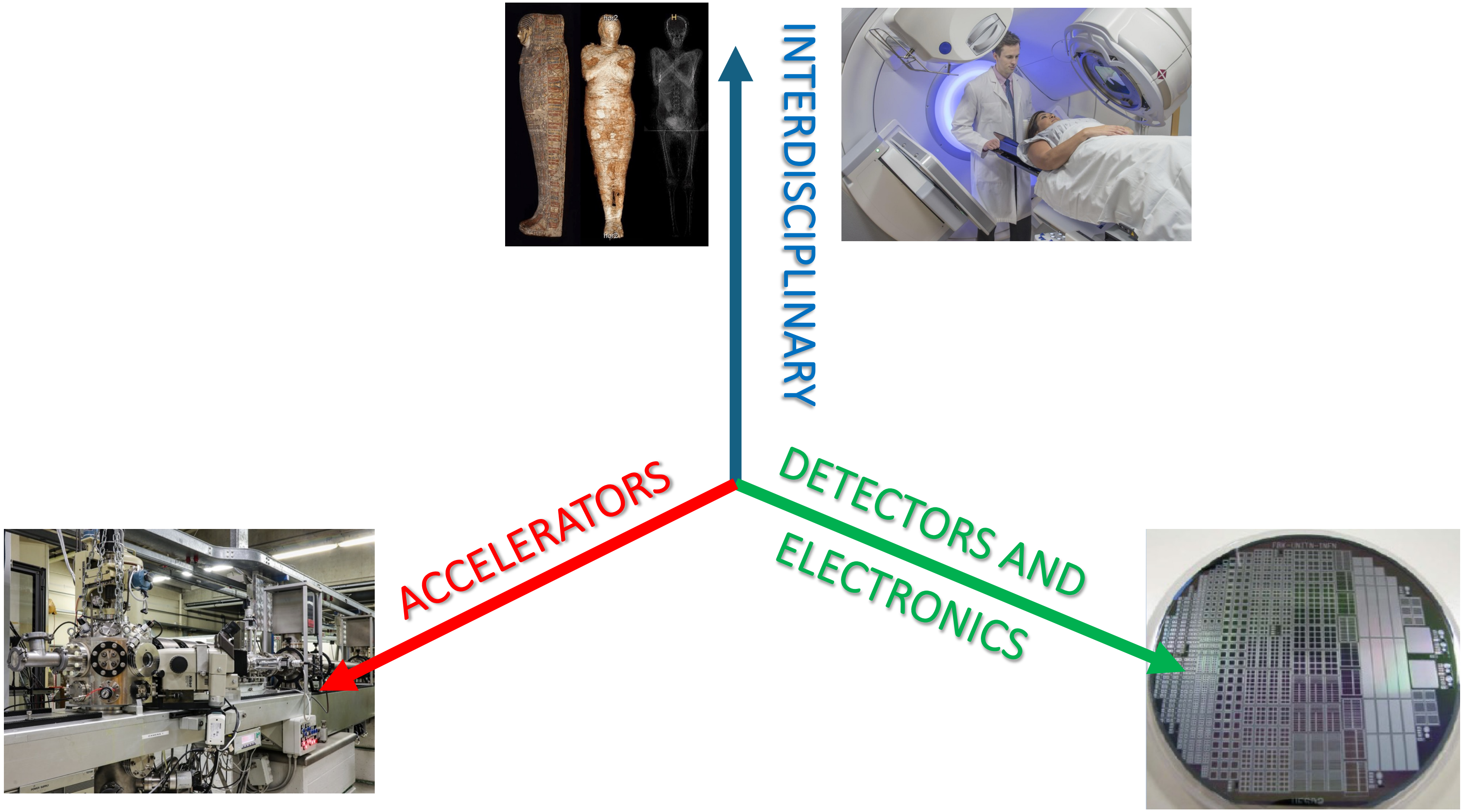
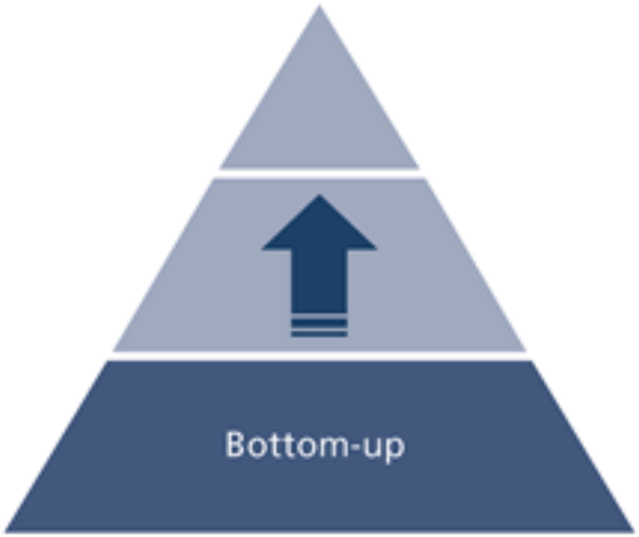
Programmi ed Esperimenti Strategici sugli Acceleleratori in CSN5

Alberto Quaranta – Cristina Vaccarezza

Linee di Ricerca in CSN5



Strategie



Selection and reviewing

Type of Projects in CSN5

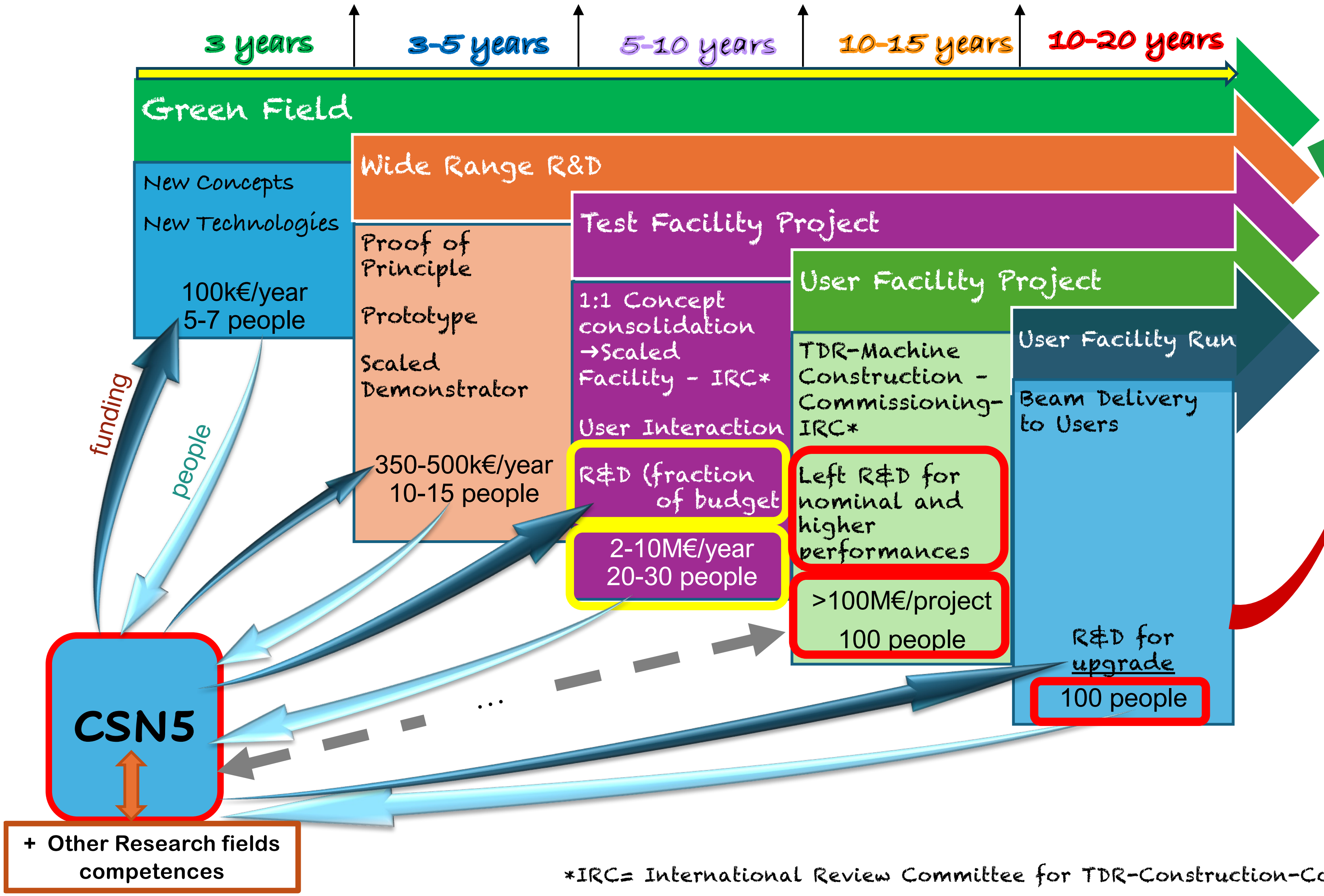
- **Standard Projects**: 2-3 years with medium-low budget (∼ 50k€/y).
  - Development of new ideas.
  - R&D activities supporting larger scale projects.
  - Road from fundamental research to interdisciplinary activities of societal interest.
- **Grants for Young Researchers**: 2 years, for young researchers (PhD ≤ 6y).
  - Competitive selection of 6 new Grants every year.
  - Funds for project (max 75 k€/y) and Grant.
  - Development of new ideas and leadership skills.
- **Call**: High budget and large networks (Max 1M€ max/3y).
  - High level competitive selection.
  - Funding of Grants supporting the activity.
  - Pushing strategic topics.
  - Preparation to larger european and international projects.

Numero di Sigle

	2017	2018	2019	2020	2021	2022	2023
Standard Experiments	**57**	**59**	**60**	**62**	**83**	**73**	**63**
CALLs	7	6	6	6	9	12	**9**
GRANTs	12	12	12	13	19	12	12
TOT	**76**	**77**	**78**	**81**	**111**	**97**	**84**
People	**1118**	**1184**	**1162**	**1166**	**1367**	**NP**	**NP**
FTE	**567**	**597**	**564**	**550**	**606**	**600**	**602**

Budget	2021	2022	2023
Accelerators	21%	22%	22%
Detectors	48%	52%	44%
Interdisciplinary	31%	26%	34%

notes for discussion: Accelerators Landscape



Observations:
- ✓ Lost connection with CSN5 during the User Facility project....
- ✓ People resources continuity....
- ✓ The Green Field should be always alive to be ready for the new machines....
- ✓ ...

*IRC= International Review Committee for TDR-Construction-Commissioning

Sigle 2021-2023

	2021	2022	2023
FTE (Tot)	100.1(su 696.4)	88.76(su 670.23)	116.2. (su 622.9)
FTE (%)	14 %	13.2 %	18.6 %
Budget (Tot)	867 k€	865 k€	1543 k€
Budget (%)	19 %	18 %	32 %
Experiments	1. ACTIS 2. ARYA 3. ASIDI (PR) 4. ASTRACT 2021-2023 5. BISCOTTO 6. ION2NEUTRAL 7. IONS 2021-2023 8. LEMMAACC 9. LPA2 10. MOPEA 11. NUCLEAAR (PR) 12. SALVIA 2021-2022 13. SHERPA 14. SINGULARITY 15. SL_COMB2FEL 16. SL_EXIN 17. STORM 2021-2022 18. TEFEN 19. TERA 20. TRAMM 21. TUAREG	1. ACTIS (PR) 2. ARYA 3. ASTRACT 4. ETHIOPIA 2022-2024 5. GALORE 2022-2023 6. HSMDIS 2022-2024 7. IMPACT 2022-2023 8. ION2NEUTRAL 9. IONS 10. LPA2 11. MOPEA (PR) 12. SALVIA 13. SAMARA 2022-2024 14. SHERPA (PR) 15. SIG (Call) 2022-2024 16. SINGULARITY 17. SL_COMB2FEL 18. SL_EXIN 19. STORM 20. TRAMM 21. TUAREG 22. FRIDA (CALL-INT) 2022-2024	1. Alpha_DTL_BETA 2023-2025 2. ARYA 2020-2023 3. ETHIOPIA 2022-2024 4. FUSION 2023-2025 5. GALORE 2022-2024 6. H2BTF (Call) 2023-2025 7. HISOL 2023-2024 8. HSMDIS 2022-2024 9. IMPACT 2022-2023 10. ION2NEUTRAL 2020-2023 11. IONS 2021-2023 12. MICRON 2022-2024 13. PBT 2022-2024 14. SAMARA 2022-2024 15. SIG (Call) 2022-2024 16. SINGULARITY 2020-2022 17. SL_COMB2FEL 2019-2023 18. TUAREG 2020-2022 19. FRIDA (CALL-INT) 2022-2024

Situazione 2024

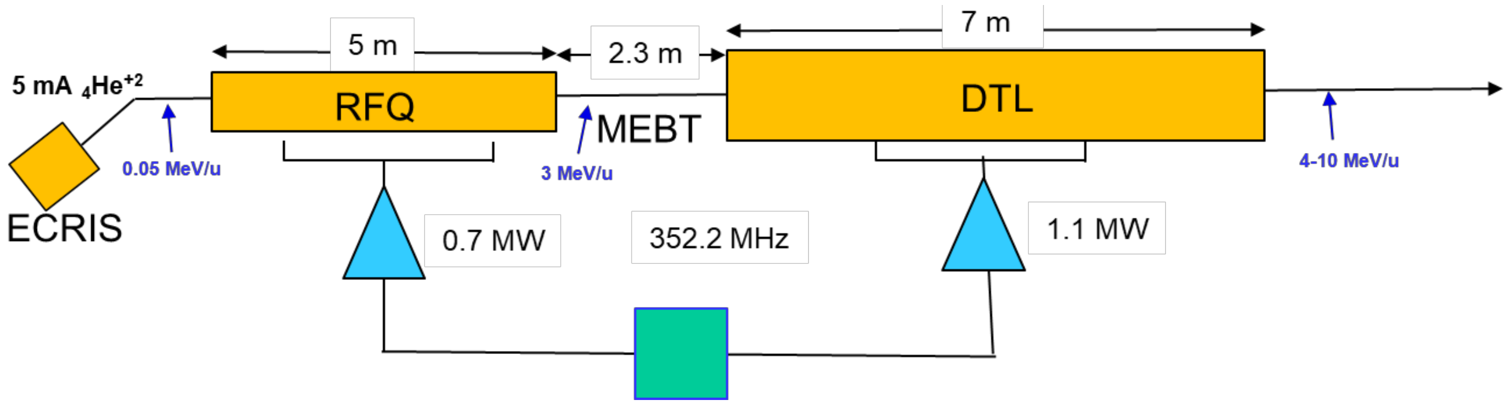
2024	
FTE (Tot)	95.7 (su 587.17)
FTE (%)	16.3 % (↓ 2.3)
Budget (Tot)	1075.5 k€ (over 4521 k€)
Budget (%)	23.8 % (↓ 8.2)
Experiments	1. Alpha_DTL_BETA 2023-2025 2. ASTRACT 2021-2024 3. CROWN 2024-2026 4. ETHIOPIA 2022-2024 5. FUSION 2023-2025 6. H2BTF (Call) 2023-2025 7. HISOL 2023-2024 8. HSMDIS 2022-2024 9. IONS 2021-2024 10. MICRON 2022-2024 11. PLASMA4BEAM2 2024-2026 12. PBT 2022-2024 13. SAMARA 2022-2024 14. SL_BETATEST 2024-2026 15. SIG (Call) 2022-2024

Tematiche Principali

- Innovation and improvement for «traditional» acceleration technologies.
  - High gradient/current accelerators.
  - Targets and materials for RF technologies.
- Innovative acceleration technologies and methods.
  - Laser based methods.
  - Miniaturization.
  - Plasma acceleration.
- Applications of acceleration technologies.
  - Accelerators for innovative medical treatments.
  - Accelerator technologies for energy (fusion).

ALPHA_DTL

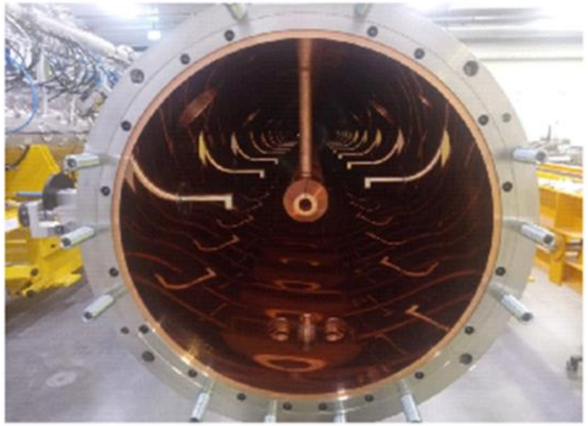
PI: Francesco Grespan

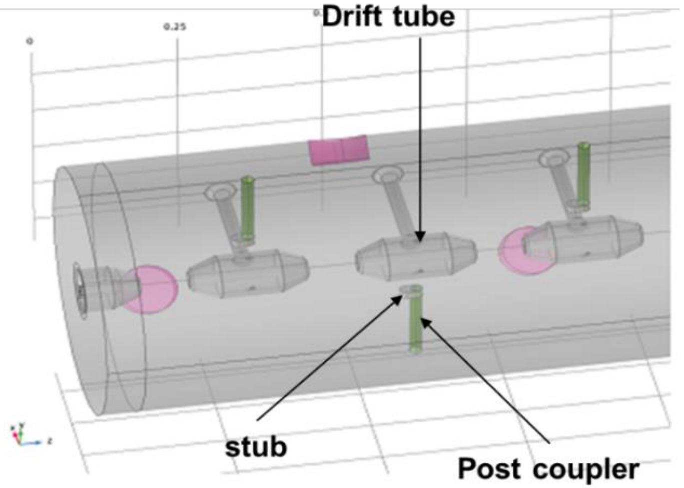


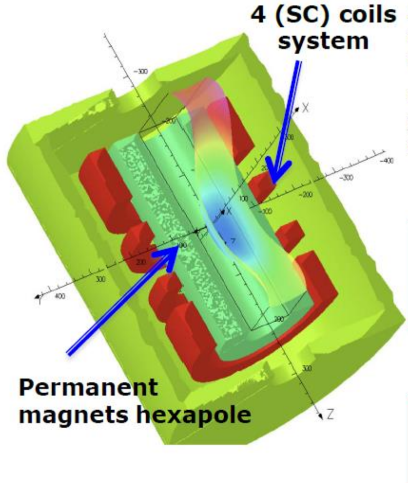
- High duty cicle LINAC.
- Alpha particles 0.5 mA at variable energy up to 40 MeV.
- Only 2 stages: RFQ – DTL.
- (Total cost 15M€ + infrastructures).

ALPHA_DTL

PI: Francesco Grespan







- Key: vacuum modulating post-couplers (simulations and design of motors and controllers).
- He2+ source from AISHA.
- RF sources adapting kylstrons from ESS (re-optimization).

IMPACT					
Very High (16)	HIGH (16)	HIGH (32)	VERY HIGH (64)	VERY HIGH (128)	VERY HIGH (256)
High (8)	MEDIUM (8)	HIGH (16)	HIGH (32)	VERY HIGH (64)	VERY HIGH (128)
Medium (4)	MEDIUM (4)	MEDIUM (8)	HIGH (16)	HIGH (32)	VERY HIGH (64)
Low (2)	LOW (2)	MEDIUM (4)	MEDIUM (8)	HIGH (16)	HIGH (32)
Negligible (1)	LOW (1)	LOW (2)	MEDIUM (4)	MEDIUM (8)	HIGH (16)
	Not Credible (1)	Unlikely (2)	Not Likely (4)	Likely (8)	Highly Likely (16)

LIKELIHOOD

ALPHA_DTL

PI: Francesco Grespan

WP1	Movable Post coupler prototyping	
MS# or DLV#	Description	Months from T0
MS2.1.a	Mech. Design of motorized post coupler	6
MS2.1.b	Production of 1 motorized post coupler and vacuum chamber	18
MS2.1.c	Test in vacuum of 1 motorized post coupler	24
DLV2.1	Report of test in vacuum of a motorized PC	24

WP1	Movable Post coupler prototyping	2022	2023	Tot
		kEuro	kEuro	kEuro
consumables	Motorized post coupler mech.design	5	0	5
equipment	Motorized post coupler production	25	10	35
consumables	Test motorized PC in vacuum chamber	0	10	10
Tot		30	20	50

WP2	RF system development	
MS# or DLV#	Description	Months from T0
MS2.2.a	Set up development program with ESS-RF group	6
MS2.2.b	Technical specifications of a modulator and RF system compliant with alpha-Linac requirements	15
DLV2.2	Preliminary Design of Modulator and RF system for apha-DTL	24

WP2	RF system developemnt	2022	2023	Tot
		kEuro	kEuro	kEuro
services	Modulator technical design	0	10	10
Tot		0	10	10

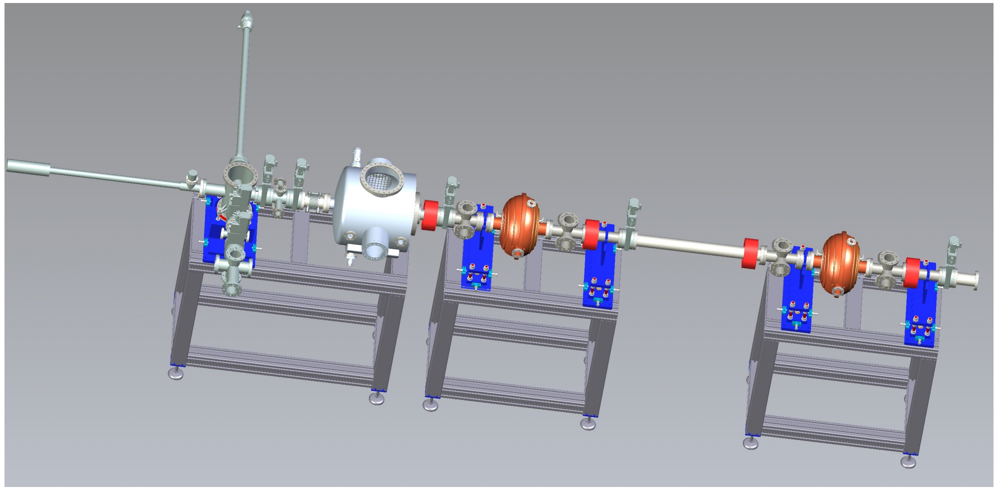
Ion Source	
Description	Time from T0
He2+ production by applying the frequency tuning	6
He2+ production with the optimized frequency at different extraction voltages	12
Simulation of plasma dynamics in AISHA	12
He2+ production with an Al liner at the optimized frequency and extraction voltage	18
Simulation of beam extraction in experimental conditions	18
Report on AISHA characterization in single frequency heating	24

WP3	Ion Source	2022	2023	Tot
		kEuro	kEuro	kEuro
travels	Experiment at AISHA LNS	10	10	20
consumable	Experiment at AISHALNS	5	5	10
Tot		15	15	30

HB2TF (Call)

High Brightness Beam Test Facility

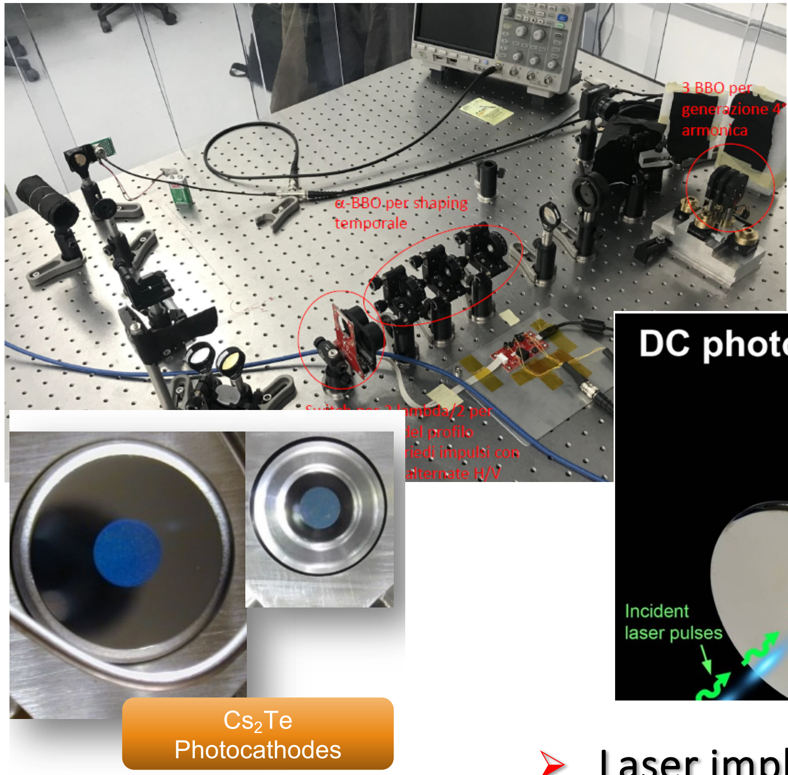
PI: Dario Giove

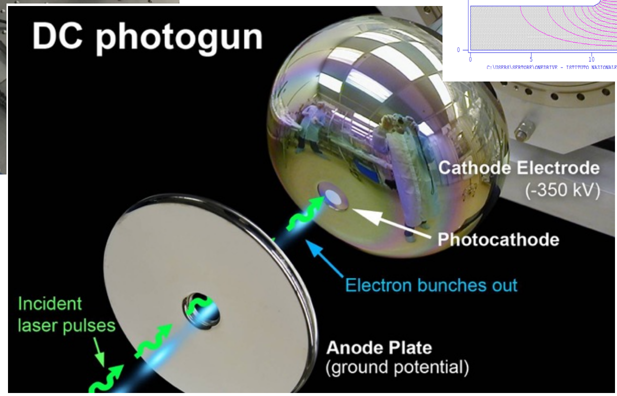


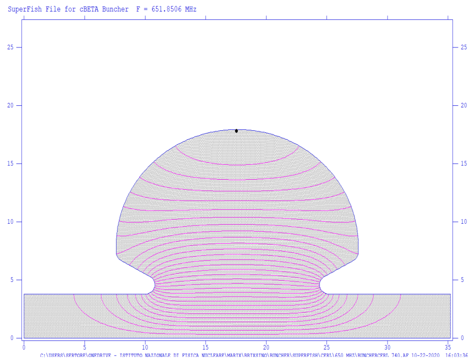
- Injector for high power and high brightness CW ERL electron beams (mAs for FEL).
- Photocathode gun.
- Pulsed laser excitation.

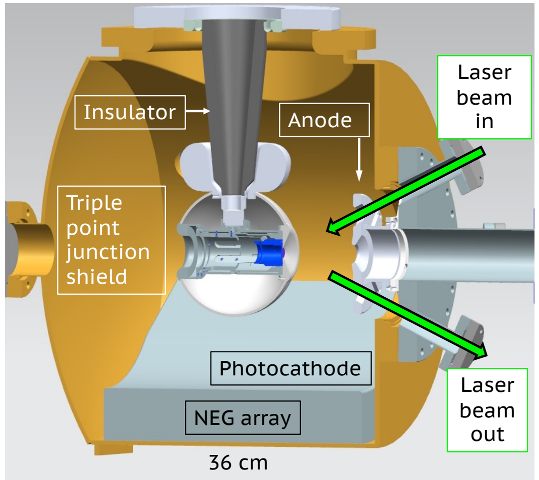
HB2TF (Call)

PI: Dario Giove







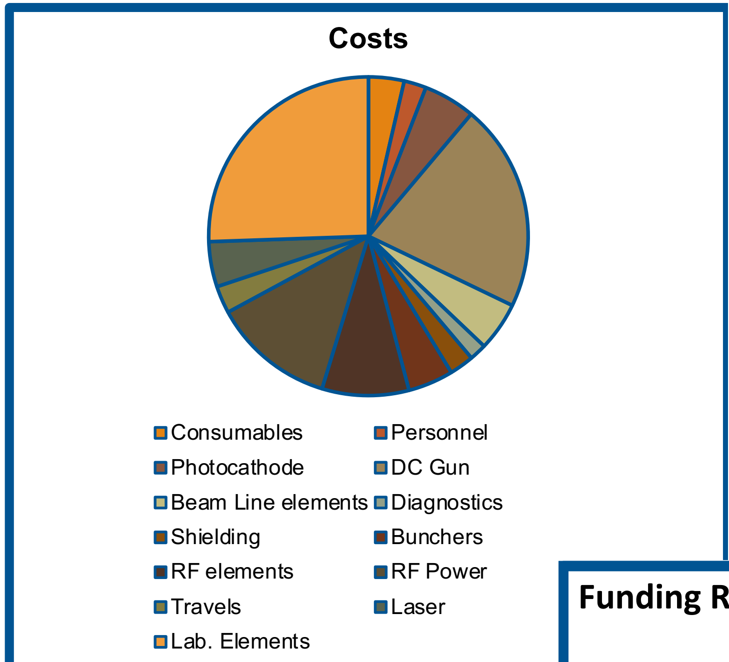


- Laser implementation (present and partially funded by CSN5).
- Photocathode expertise at LASA (long life and vacuum stability).
- RF design (electron bunch shaping).

HB2TF (Call)

PI: Dario Giove

Description of risk	Subsystems involved and time schedule	Foreseen risk mitigation measures
Organization: the coordination activities of each subsystem working group should be guaranteed	All, always	A co-leadership has been foreseen in each working group
Organization: the coordination activity of PI should be guaranteed	All, always	A steering board (composed of the subsystems working group leaders) has been foreseen to coordinate all the activities and to take general decisions. In case the PI is not in condition to operate the Steering board will drive the project for the time necessary with the same prerogative of the PI
Technical: DC Gun performances	DC Gun Subsystem	The design and the technological challenges related to the DC Gun are one of the major areas of risk in the project. We faced these aspects starting the analysis as soon as we could and signing a joint development program with the people of the JLAB laboratory.
Technical: photocathode performances at very high repetition rates	Photocathode Subsystem	Photocathodes constitute one of the more relevant area of expertise in our group. People working on this subsystem are well recognized in the worldwide scenario as pioneers and still act as a reference in providing these components for a lot of laboratories.
Technical: laser performance	Laser Subsystem	The laser subsystem is in advance phase of realization as a result of other activities. In any case a considerable support may be obtained from experts at the University of Paris Saclay.
Technical: Injector buncher and booster	The RF system	The people involved in these subsystems have more than 20 years' experience in designing, constructing, and testing cavities for several worldwide laboratories. Buncher cavities and RF power supplies will be developed starting from a well known situation and taking experience from the internal expertise and collaboration with KEK (Japan), Raja Ramanna Centre for Advanced Technology (India) laboratories and at least by a private company in Italy.



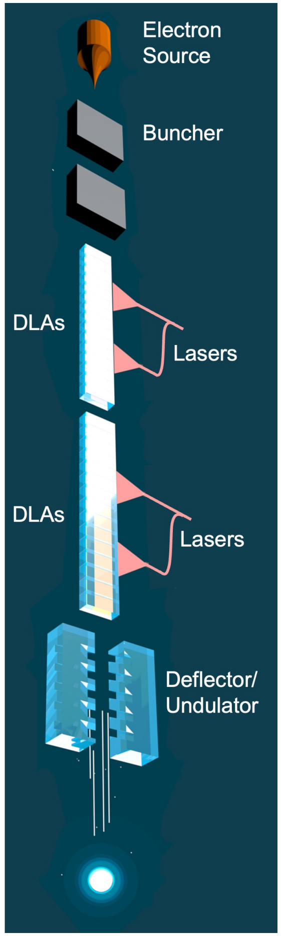
Funding Request

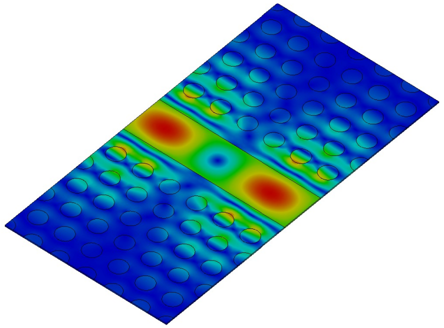
2023	Euro 333.100
2024	Euro 412.000
2025	Euro 254.600
Total	**Euro 999.700**

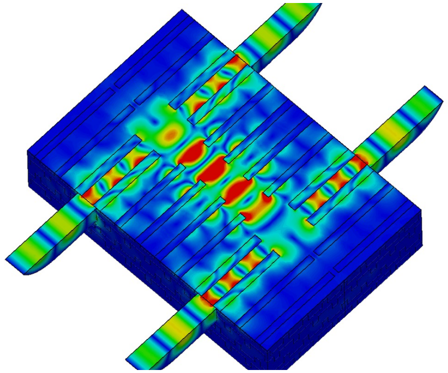
MICRON

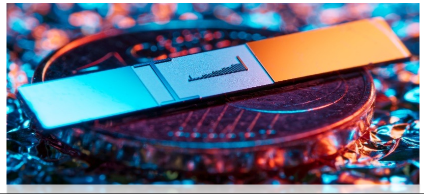
MIniaturised aCceleRatOrs Network

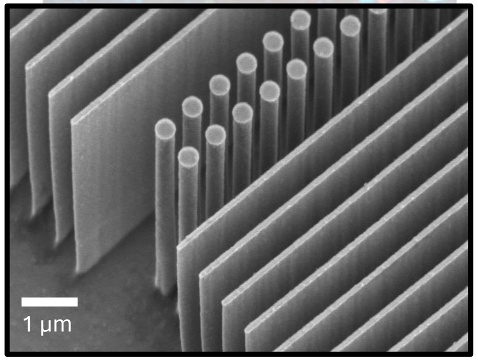
PI: Giuseppe Torrisi







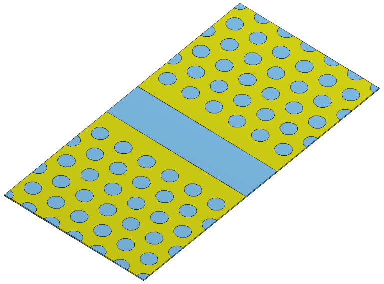


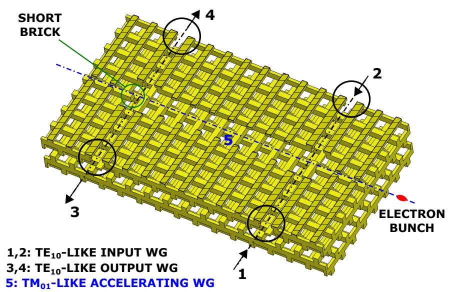


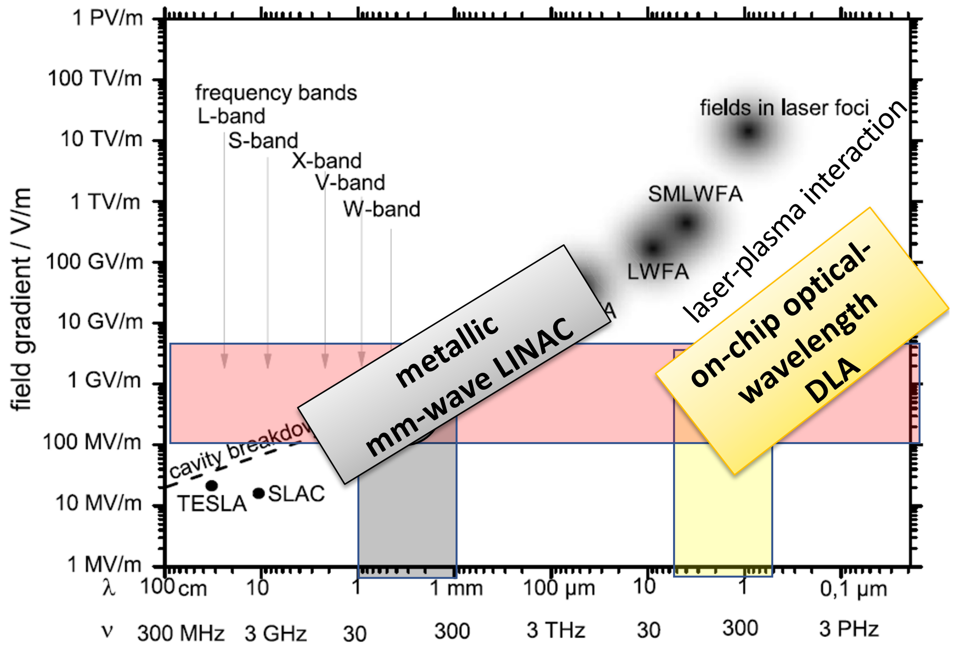
- On chip Dielectric based Linear Accelerators (DLA) for FEL, medical applications, electron microscopy.
- High accelerating gradients (01-2 GV/m) enabling miniaturized accelerators.
- Design of both metallic and dielectric structures.

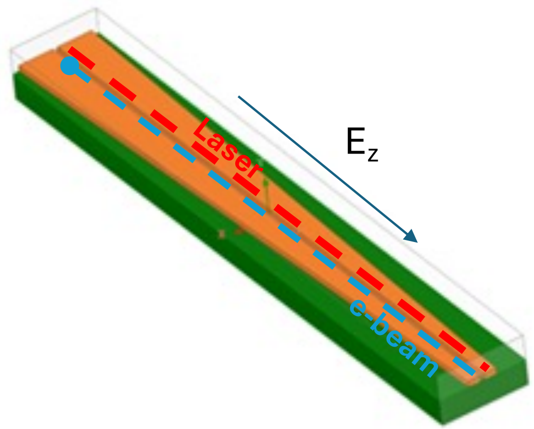
MICRON

PI: Giuseppe Torrisi





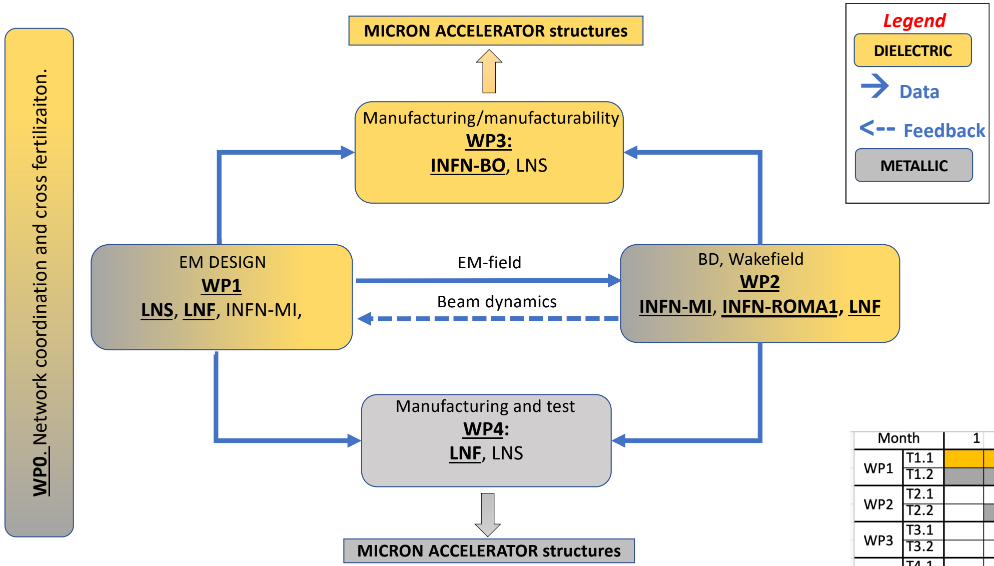




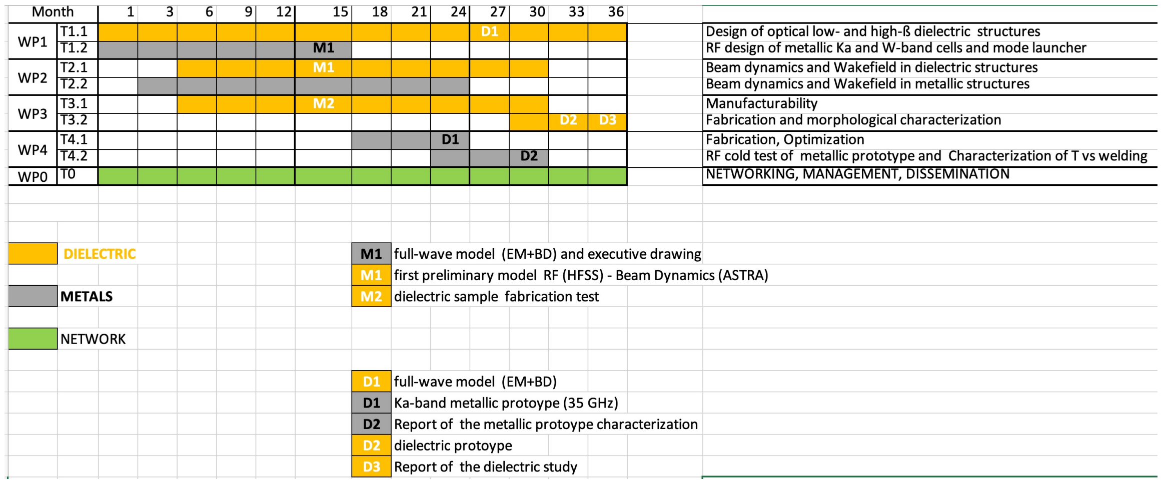
- Collinear coprapagation of laser and particle beams.
- Metallic structure from Ka to W-band (35-200 GHz, mm-WL) – modeling and prototyping.
- DLA structures at optical WL (1-5 µm) – test of fabrication technologies.

MICRON

PI: Giuseppe Torrisi



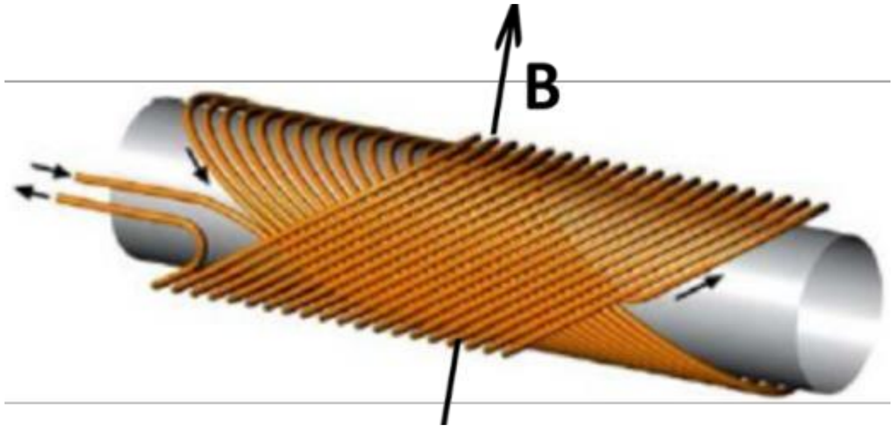
ANNO	MISSIONI	CONSUMO	INVENTARIO	LICENZE-SW	TOTAL
2022	20	20	56,5	0	**96,5**
2023	20	20	0	0	40
2024	20	36	0	15	71
TOT	60	76	56,5	15	**207,5**

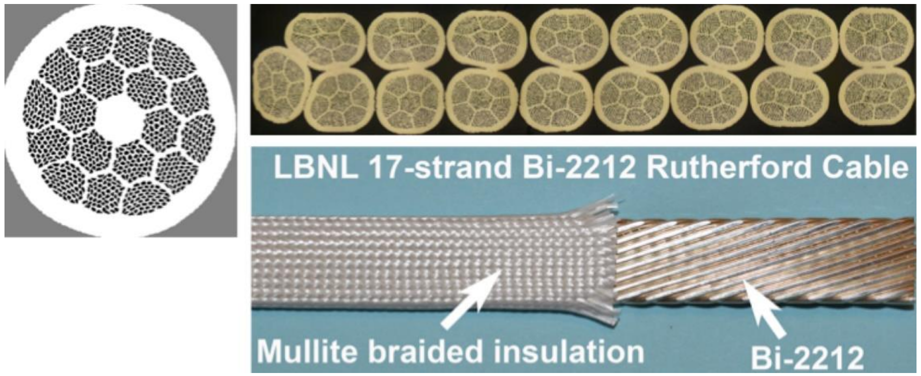


ASTRACT

Analysis of STRain Affected CharacTeristics of brittle SC cables

PI: Stefania Farinon – Riccardo Musenich

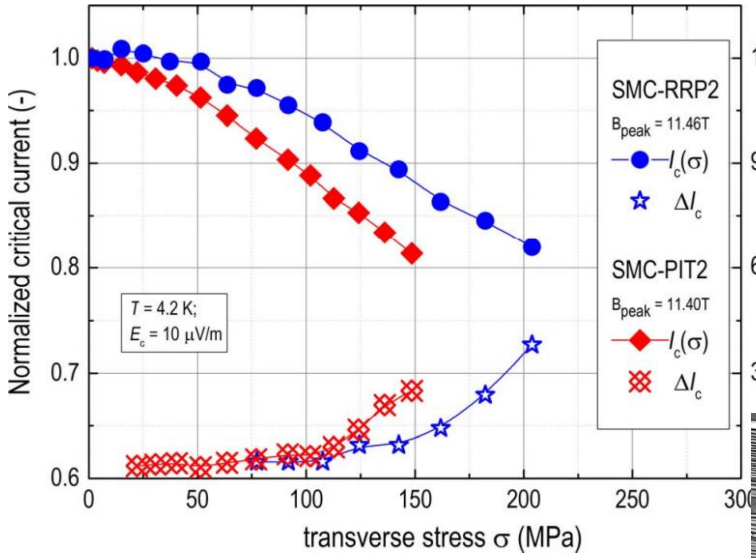


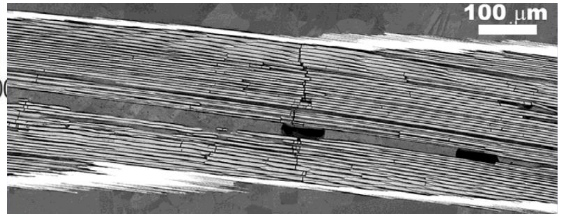


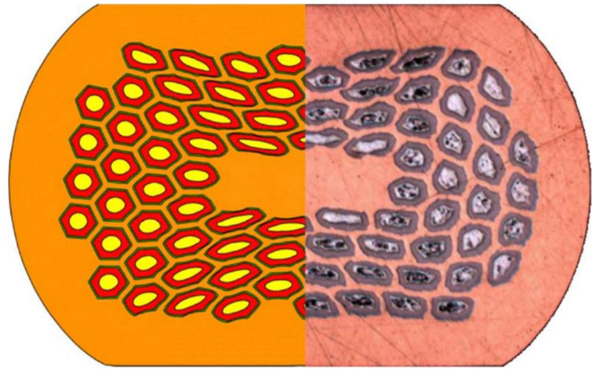
- High multipolar magnetic fields through superconductors.
- High Jc (Nb3Sn) and Tc superconducting materials for cables.
- Wires of precursors wired to form cables and thermally treated for the formation of the SC compound.

ASTRACT

PI: Stefania Farinon – Riccardo Musenich



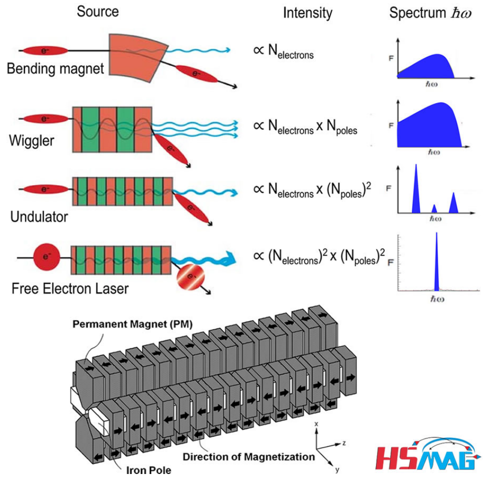


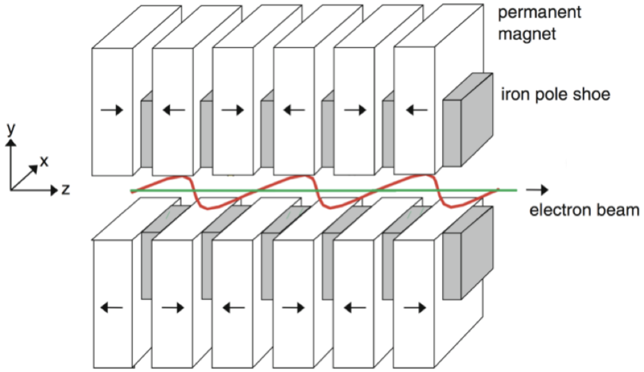


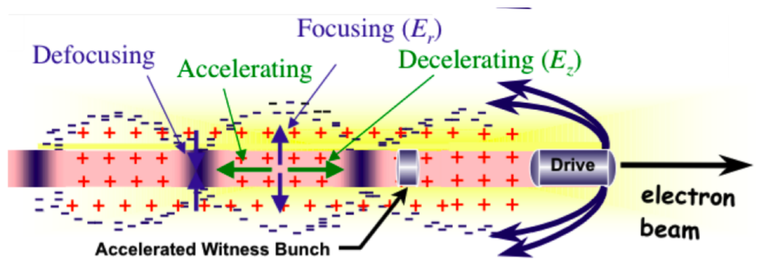
- Study of the behaviour after plastic deformations.
- Study of the behaviour after thermal and (not) recovered deformations.
- Experimental method for measuring tension and strain during the test.

SL_BetaTest

PI: Enrica Chiadroni





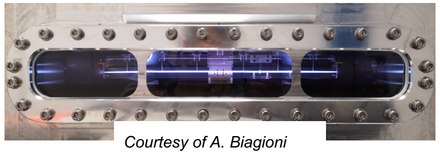


➔ Plasma undulator towards a whole plasma-based facility

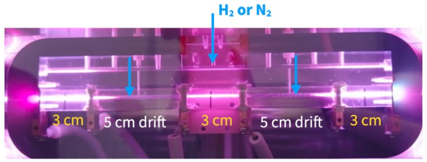
- 4y proposal (2024-2027).
- Physics and R&D case: Generation of betatron radiation from beam-driven PWFA at SPARC_LAB.
- Betatron motion of electrons in an ion-channel to emulate an undulator – compact device.

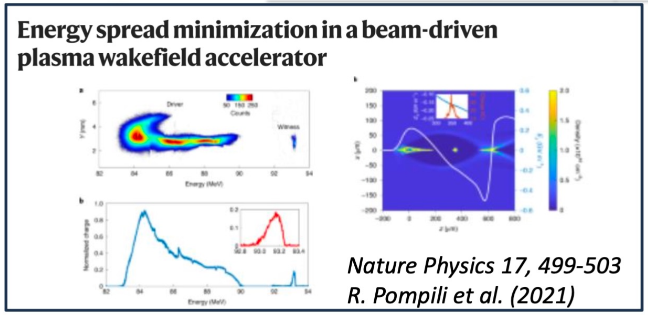
SL_COMB2FEL

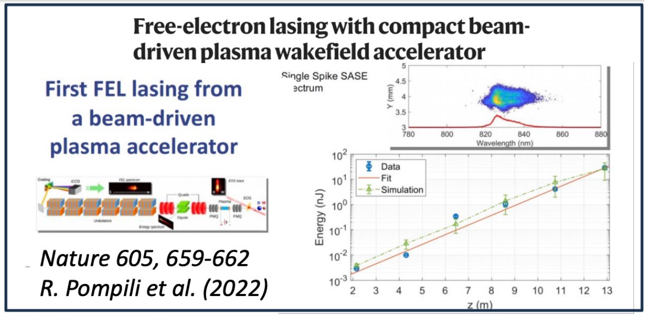
PI: Enrica Chiadroni

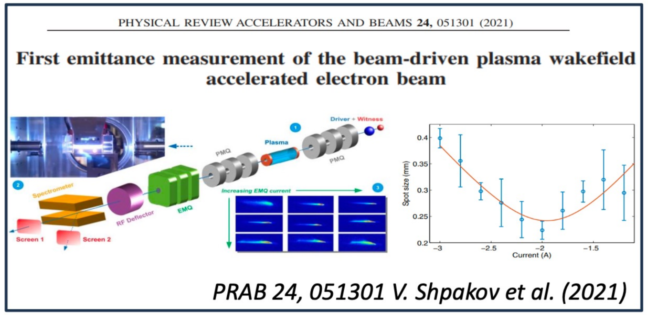


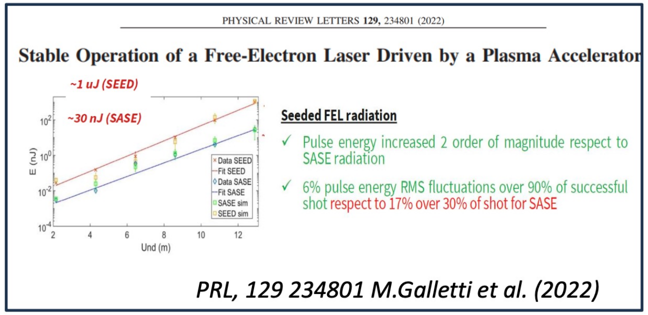
Courtesy of A. Biagioni











- 5y activity (2019-2023).
- First experimental observation of the gain growth of a plasma-driven FEL both in Self Amplified Spontaneous Emission (SASE-FEL) and in Seeded configuration.
- First EuPRAXIA plasma source enabling 1.1 GeV (1.5 GV/m) in 40 cm length capillary (n = 10^{16} cm^{-3})
- Active Plasma Lenses (APL) based final focus and extraction line.

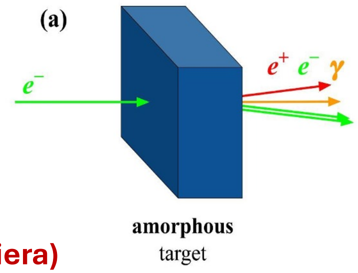
STORM

STtrOng cRystalline electroMagnetic fields

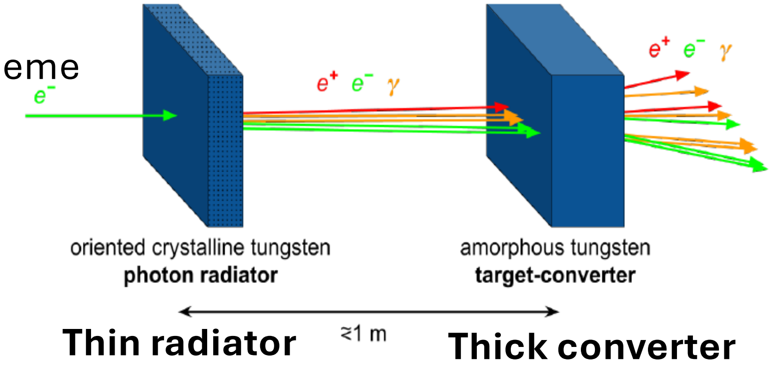
PI: Laura Bandiera

Funded by the European Union
NextGenerationEU

Conventional



Hybrid scheme



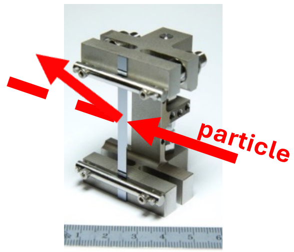
Bando PRIN 2022

e+BOOST
(PI L. Bandiera)
PRIN2022-2022Y87K7X

- Intense positron sources for future colliders based on crystal channeling.
- Intense axial Channeling Radiation in a thin tungsten crystal results in higher e+ rate, with less deposited energy in the converter.
- Enhancement of photon generation in crystals in channeling conditions and reduction of the Peak Energy Deposition Density (PEDD) in the target material.

Bent Crystals for Beam Steering

Collimation & Extraction



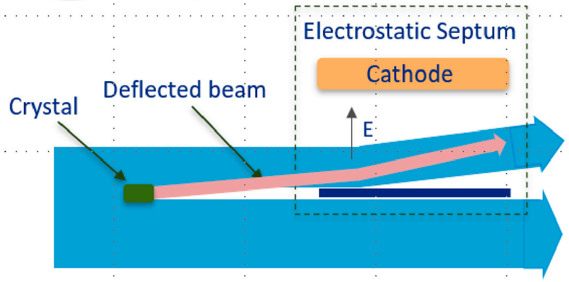
Bent Si crystal – 4 mm long

Ferrara bent crystals have been installed in the LHC and are currently under test for the HI-LUMI ion beam collimation

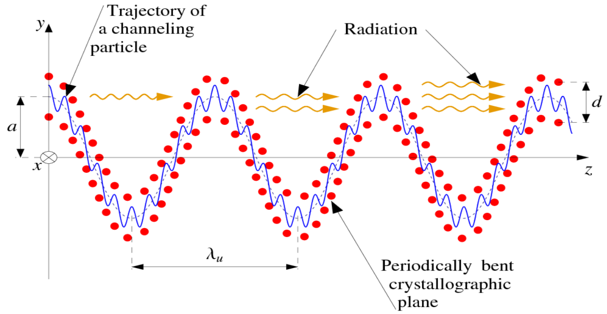
HiLumi HL-LHC PROJECT

Mu2e

Fermilab



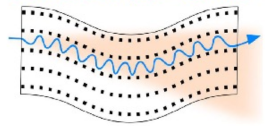
Extraction of protons from Fermilab's Delivery Ring, which are used to produce muons to search for the rare decay $\mu \to e\gamma$:
with a bent crystal, the beam losses can be decreased **-> increases the proton beam intensity and therefore the muon beam intensity**



Crystalline undulator->
Hard X-rays and gamma rays (100 keV - 10 MeV)
λ_u < mm

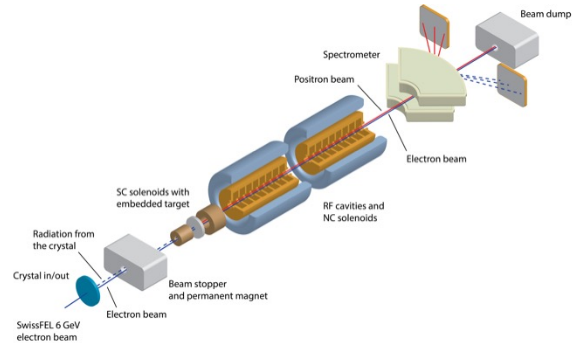
G.A. 101046458

TECHNO-CLS



PAUL SCHERRER INSTITUT PSI

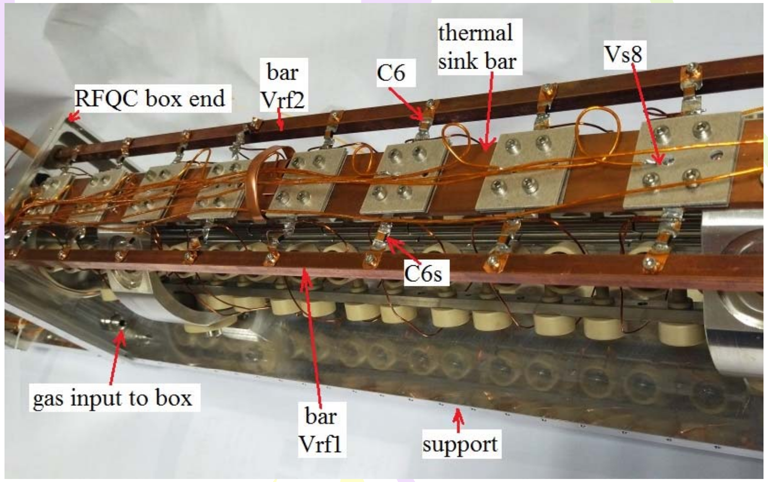
CHART
Swiss Accelerator Research and Technology



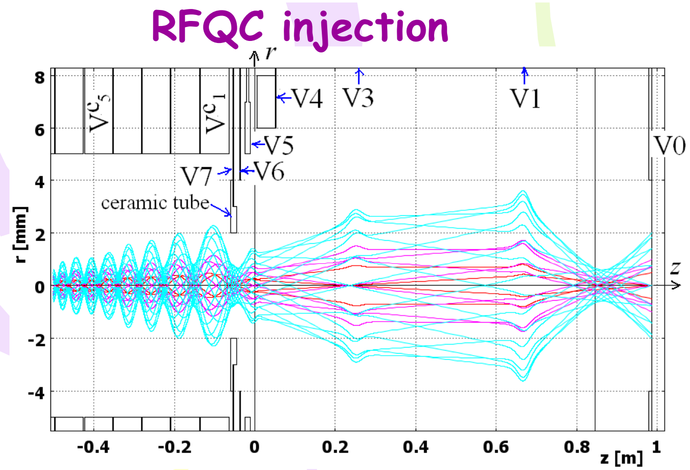
Collaboration with the **FCC-ee Injector Studies Group** (I. Chaikovska, IJCLab)
MoU signed between INFN Ferrara and IJLab in Sept. 2022

PLASMA4BEAM2

PI: Marco Cavenago



Front view of RFQC prototype

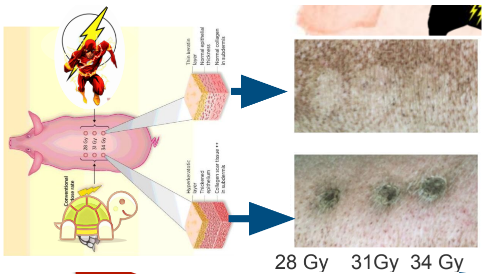


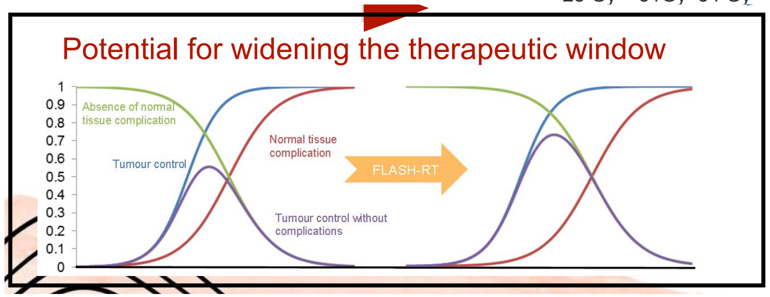
- Study of ion, plasma and gas collision physics for transport of beams into collisional media (RFQC cooler), negative ion beams (NIO1) relevant to fusion and photon detectors (GEM) for High Voltage breakdown survey.
- Beam and plasma manipulation.
- High intensity beams for fusion and Neutral Beam Injectors.
- Beam-Plasma Interaction modelling.

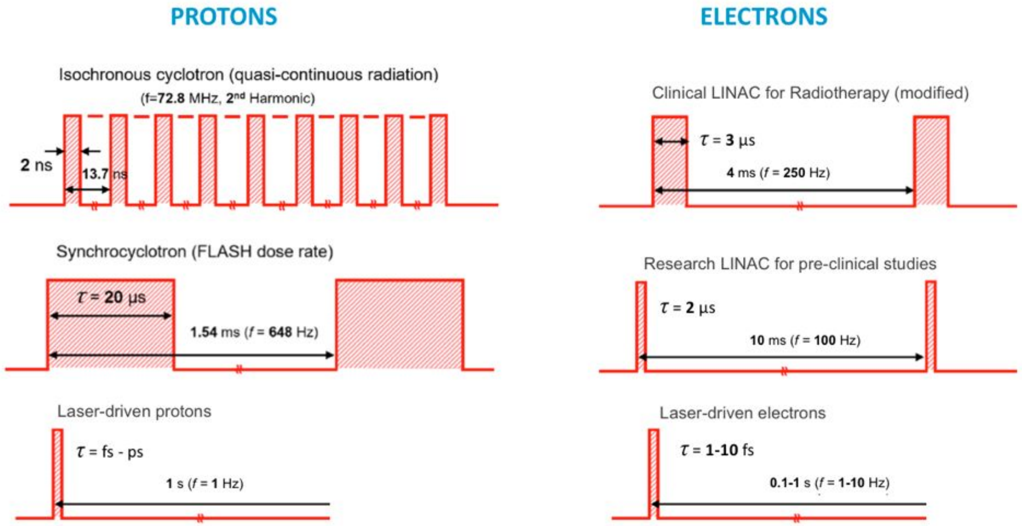
FRIDA

FLASH Radiotherapy with hIgh Dose-rate particle beAms

PI: Alessio Sarti



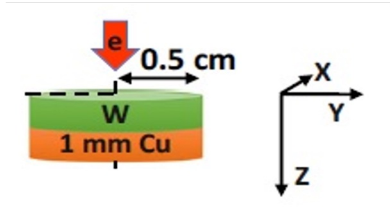


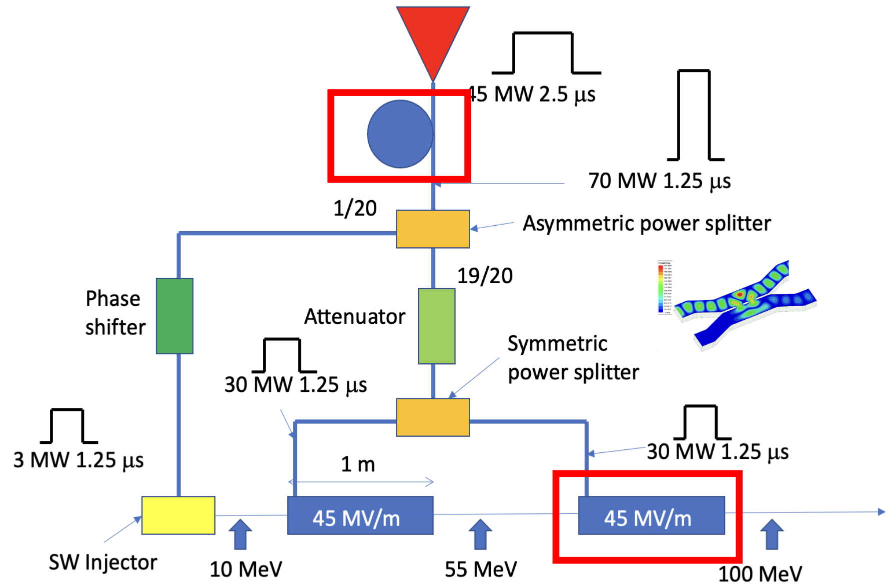


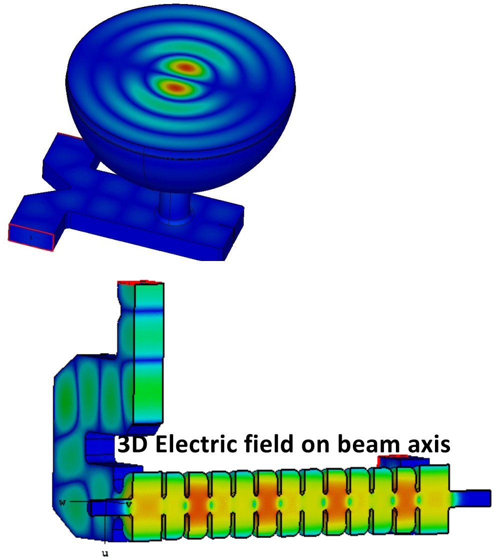
- Evidences that sort pulses at ultra-high dose rates decrease the damage of normal tissue.
- Study of production, dosimetry and biological effects of high dose pulses.

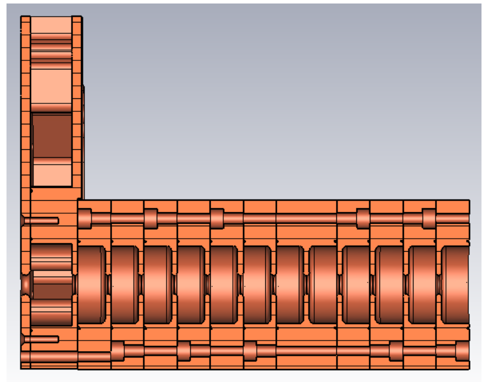
FRIDA

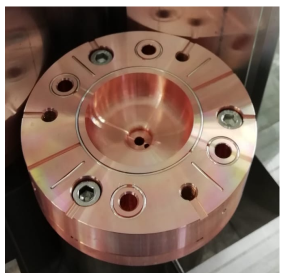
PI: Alessio Sarti

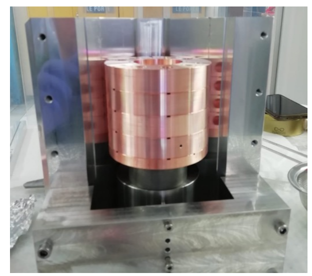










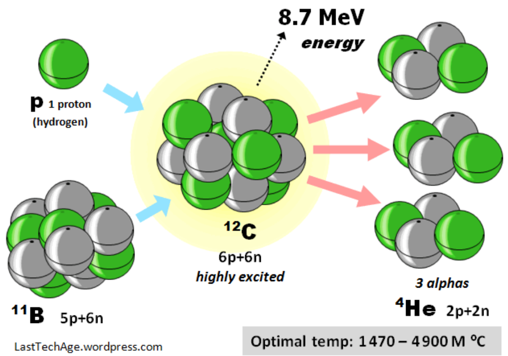


- Design of a RF structure for electron pulses (160 MeV).
- Design of pulse compressor.
- Design of ICT + quadrupole laser-matter interaction & transport.
- W anode suitable for high currents to produce high intensity photon beams via bremsstrahlung.
- Collimation systems.

FUSION

FUsion Studies of prOton Boron Neutron less radiation in laser-generated plasmas

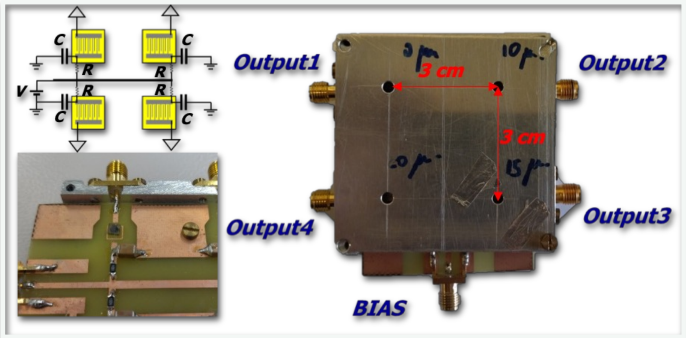
PI: Pablo Cirrone – Fabrizio Consoli



- p-^{11}B reaction study for applications in plasma energy processes.
- Efficiency maximization of the reaction and alpha particle production.

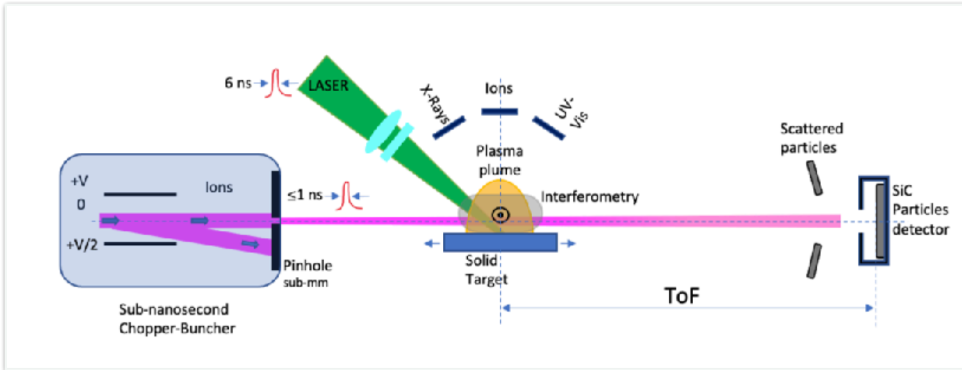
FUSION

PI: Pablo Cirrone – Fabrizio Consoli



New detectors

New borated targets

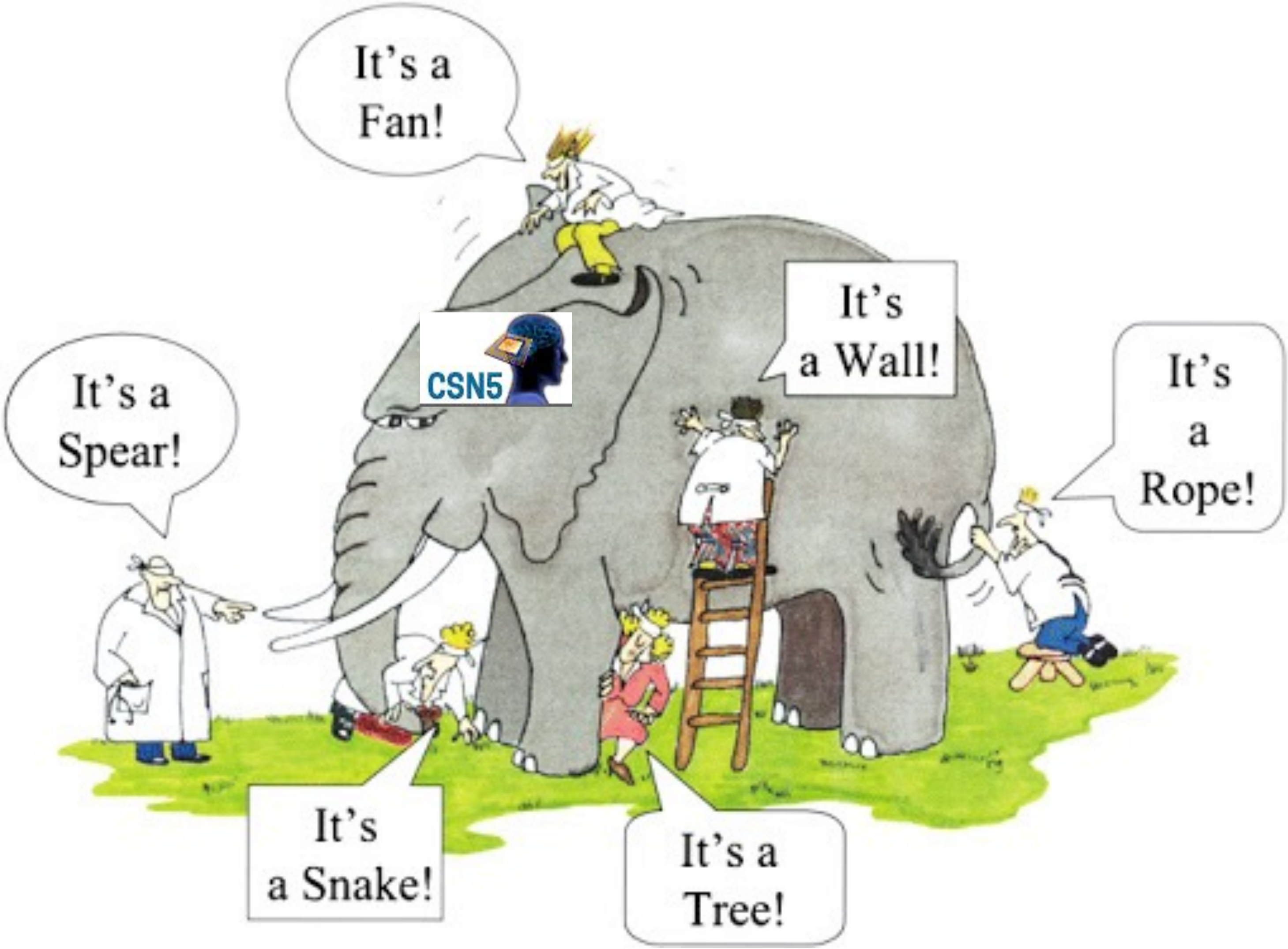


Stopping Power Measurements

- WP1: Study of the laser triggered interaction.
- WP2: measuring the stopping power in plasma.
- WP3: development and simulation for new targets.
- WP4: plasma and radiation diagnostics.

Summary

- Advantages of CSN5 projects.
  - Allow to explore new ideas.
  - Give scientific validation to ideas and teams.
  - Foreseen budget is necessary.
  - Strenghten collaborations and proposal for larger scale applications..
  - Short timelines allow to set measurable goals and deliverables step by step.
  - Visibility of groups and researchers.
- Drawbacks.
  - No funds for large apparatuses.
  - Deadlines for purchasing or tests may extend the project timeline.
  - Foreseen budget is necessary.


It's a Fan!
CSN5
It's a Wall!
It's a Spear!
It's a Rope!
It's a Snake!
It's a Tree!

Proposal Submission

- Every year there is an open call for the submission of new proposals (20-30 new proposals).
- The proposal has to fit a template.
- Project management approaches are required only for Calls.
- Proposals (as written) are ranked during the July meeting:
  - Project motivations. Scientific/technical Impact. Clarity in explaining novelty and advancements over the state of the art. Relevance to INFN and CSN5 mission. (1-10)
  - Clarity in explanation of methodologies and expected results. Methods for evaluating the activity progress. Risk analysis and mitigation. (1-10)
  - Experiment sustainability. Consistency and justification of financial requests. Consistency of engaged personnel with the planned activities. Competence of the proponents regarding the proposal topic. (1-10).

Final Steps

- If the ranking is sufficient (total ≥ 18) 2-3 referees are assigned to the project (at least one among the Coordinators).
- A meeting between referees and proponents before the September meeting setting milestones, personel and costs.
- CSN5 meeting in september: the PI gives a seminar to the whole CSN5 and after questions and discussion a new final ranking is formulated.
- Taking into account of both the ranking and the economical availability the projects are approved and funded by the Commission.
- Referees follow the project along its whole life helping the proponents to set the milestones and to overcome problems along the road.