This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.

EuroNNAc Special Topics Workshop

IFAST - WP6 Novel Particle Accelerators Concepts and Technologies

19 – 26 September 2022, Elba, Italy

Ralph Assmann, DESY & LNF/INFN

Massimo Ferrario, LNF/INFN

iFAST

EuroNNAc – A Success Story for our Community since 2011 (Europe Teaming Up)

- Founded within the **EuCARD** European project in **2011** with special CERN funding (thanks to J.P. Koutchouk and R. Heuer): Coordinator: RA, CERN
- Continued in **EuCARD2** (coord. J.P. Koutchouk) with EU funding: **2013 – 2017**. Coord: RA, DESY
- Continued in **ARIES** (coord: M. Vretenar) with EU funding: **2017 – 2021**. Coord: RA, DESY
- Continued in **I-FAST** (coord: M. Vretenar) with EU funding**: 2021 – 2025**. Coord: RA, DESY/INFN & Massimo Ferrario, INFN. >60 institutes in Europe, Asia, US.
- Our work **considered a great success**. Final 2022 review of ARIES by EU commission mentions our work as one of several highlights: «They have also explored and **foster plasma and laser-based acceleration**, contributing to the integration of EuPRAXIA plasma-based Free Electron Laser in the ESFRI Roadmap.».

Tasks of WP6 – Novel Particle Accelerators Concepts and Technologies

- Task 1 (RA + M. Ferrario): **Novel Particle Accelerators Concepts and Technologies** (NPACT – EuroNNAc4) M1 – M48

  Sub-task leaders: ***B. Holzer*** *(CERN),* ***P. Nghie*** *(CEA),* ***A. Specka*** *(CNRS),* ***R. Walczak*** *(Oxford)*

- Task 2 (Leo Gizzi): **Lasers for Plasma Acceleration** (LASPLA) M1 – M48
- Task 3 (Cedric Thaury): **Multi-scale Innovative targets for laser-plasma accelerators** (MILPAT) M1 – M32
- Task 4 (Francois Mathieu): **Laser focal Spot Stabilization Systems** (L3S) M1 – M36

WP6 Milestones

May 2023

- MS21: Report on the novel accelerator landscape in Europe, facilities, projects and capabilities at the beginning of the 2020's. Lead – DESY, M24, Publication, website (task 6.1)
- MS22: LASPLA Workshop/School. Lead – CNR, M30, Report (task 6.2)
- MS23 Target manufacturing and characterization. Lead – CNRS, M12 Report (task 6.3)
- MS24: Hypothesis on the causes of the instabilities of the focal spot profile. Lead – CNRS, M24 Publication (task 6.4)

This Special Topics workshop will **prepare the milestone MS21**.
Thanks to all **session organizers** and **participants** for your help!

WP6 Deliverables

Nov 2024

Deliverables related to WP6	
D6.1: EAAC workshops and strategies. *Report on the EAAC workshops as strategic forums for international accelerator R&D and resulting strategies*	M42
D6.2: LASPLA Strategy. *Report on a strategy for laser drivers for plasma accelerators.*	M46
D6.2: Electron acceleration experiments with new targets. *Report on electron acceleration with micro-scale target at a kHz repetition rate, and with long targets at the multi-Joule level.*	M24
D6.4: Improvement of the laser intensity stability on target. *Report showing the stability on two laser facilities before and after improvement.*	M36

2011: The Start of Our Network

EuCARD, EuroNNAc Workshop, 3 - 6 May'11

3.–6. Mai 2011
CERN
Europe/Zurich Zeitzone

Geben Sie Ihren Suchbegriff ei

EuroNNAc - European Network for Novel Accelerators - Looking at the Next Generation of Novel Electron Accelerators

- HOME
- Programme
- Registration
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- Access to WIFI
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- Upload of Presentations
- Beitragsliste
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- Links

HOME

The first workshop will form the network and define the work towards a significant FP8 proposal for novel accelerator facilities in Europe.

To request an invitation letter please Click here (send e-mail to euronnac.coordination@cern.ch)

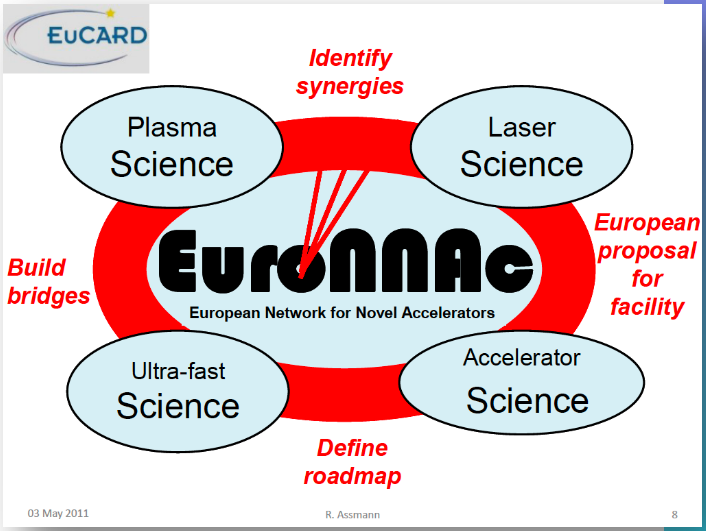
Dates: **3rd May'11 08:30 - 6th May'11 15:00**

Location: **Geneva, Switzerland**
CERN, (Kjell Johnsen Aud. 30-7-018)

Registration: **4th April 2011: CLOSED !!**

List of registrants

93 Teilnehmer



2011 Goals

Draft Mandate/Mission I

1. Develop goals from photon science and particle physics for advanced e-beam accelerators, including timeline. 5y, 10y, 20y goals and perspectives.
2. Describe coherent program for research on novel e-beam accelerators. What are the main components of this program?
3. Define reference measurements to qualify facilities for photon science and/or particle physics, including definition of standards.
4. Produce white-paper summarizing European efforts/goals with comments on world efforts.

03 May 2011 R. Assmann 6

Draft Mandate/Mission II

5. Create framework for open facilities. EuroNNAc to describe and further develop coherent network of test facilities, document capabilities, review requests, discuss work share. "Distributed accelerator test facility for synchrotron science and particle physics"
6. Each facility to propose its main speciality (1-2) on what they want to offer for collaboration.
7. Ask FP7/8 support for such a "distributed open test facility", including support for beam/laser time for users. Use also LaserLab opportunities.

03 May 2011 R. Assmann 7

2011 Goals

EuCARD — Draft Mandate/Mission III

9. Foster transfer of technology between communities and with industry.
10. Propose adequate funding mechanisms to support university-based accelerator research with long-term scientific benefits.
11. Creation of a "European School: From Conventional to Novel Accelerators", linked to CAS or other series.
12. Support training of students and specialists.
13. Organize a European Advanced Accelerator Conference every second year.

03 May 2011 R. Assmann 8

EuCARD — Draft Mandate/Mission III

14. Vision on the time-scale of one or few centralized "big" facilities, beyond present projects.
    - From "distributed test facility" to a "pilot e-beam facility".
    - Pilot facility runs 24h 7/7 to produce agreed e-beam.
    - What does "big" mean? Beam parameters? How many?
    - How to split beam time for synchrotron radiation, medical applications and High Energy Physics applications?
15. Prepare significant FP8 proposal for pilot facility(ies), beyond present projects. Time scale?
16. *Foster inter-disciplinary work on theory and simulations.*

03 May 2011 R. Assmann 9

This network organizes EAAC, applies for EU funding and supports the students with this funding.

iFAST

EAAC 2013


EAAC2013
SUPPORTED BY EU via EuCARD-2, GA 312453
LA BIODOLA - ISOLA d'ELBA - FROM 2 TO 7 JUNE 2013
© vinicio.tullio@lnf.infn.it

EAAC 2015 (258 participants)

EAAC 2017

EAAC 2019

- Number of participants: 267 (> 70 applications not accepted)

EAAC 2021

European

Advanced

Accelerator

Concepts

Workshop

5th Edition

Hybrid

iFAST

2011: 10 Year Technical Goals

Summary "Brainstorming: European and World Plans"

06.05.2011, 11:20
20m
30/7-018 - Kjell Johnsen Auditorium (CERN)

Sprecher

Henri Videau (Laboratoire Leprince...
Jens Osterhoff (University of Hambur...

EuCARD — Draft Collection Goals

- What are the top goals of the field (10y ahead)?
  - Demonstrate working plasma-based FEL at realistic frequencies
  - Reliable 24/7 operation of plasma-based accelerators at 1 GeV
  - Staging
  - High beam quality at 10 GeV from plasma accelerators
  - GV/m positron acceleration with plasma devices while preserving emittance
  - Demonstrate proton drivers for wake acceleration

Discussion

- What are the top goals of the field (10y ahead)?
  - Demonstrate working plasma-based FEL at realistic frequencies
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  - Staging
  - High beam quality at 10 GeV from plasma accelerators
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2011: 10 Year Technical Goals – Achieved?

Summary "Brainstorming: European and World Plans"

06.05.2011, 11:20
20m
30/7-018 - Kjell Johnsen Auditorium (CERN)

Sprecher

Henri Videau (Laboratoire Leprince...
Jens Osterhoff (University of Hambur...

Not perfect, but also not bad at all.

Of course, more work to be done.

ST sessions will tell us much more.

Discussion

- What are the top goals of the field (10y ahead)?
  - Demonstrate working plasma-based FEL at realistic frequencies ✅
  - Reliable 24/7 operation of plasma-based accelerators at ~~1 GeV~~ 0.2 GeV ✅
  - Staging ✅
  - ~~High beam quality~~ at ~~10~~ 8 GeV from plasma accelerators ✅
  - GV/m positron acceleration with plasma devices while ~~preserving emittance~~ ✅
  - Demonstrate proton drivers for wake acceleration ✅

2011 Goals

EuCARD Draft Mandate/Mission III

9. Foster transfer of technology between communities and with industry.
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03 May 2011 R. Assmann 8

EuCARD Draft Mandate/Mission III

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15. Prepare significant FP8 proposal for pilot facility(ies), beyond present projects. Time scale?
16. *Foster inter-disciplinary work on theory and simulations.*

03 May 2011 R. Assmann 9

This network created a proposal for a common European facility as backbone of our community („**EuPRAXIA**“).

IFAST WP6/NPACT – Strategy

- EuPRAXIA:
  - World-wide 1st conceptual design report of the accelerator facility based on plasma accelerators
  - Consortium grown since 2015 to > 50 institutes, 17 countries
  - Only new accelerator project on ESFRI roadmap since 2016 and 1st preparatory phase project since Hi-Lumi LHC.
- Plasma accelerators for particle physics:
  - Follow-up to European strategy for particle physics
  - Part of European accelerator R&D program

European Plasma Research Accelerator with eXcellence In Applications

European High-Tech Project on Accelerator Innovation

New kind of **C O M P A C T** Distributed Research Infrastructure Involving 50 Institutes from **15 Countries** – see full CDR published in 2020

Selected for 2021 Update **ESFRI Roadmap** *as first ever plasma acc. project, first accelerator project since HiLumi LHC*

569 M€ total cost: ~150 M€ already financed

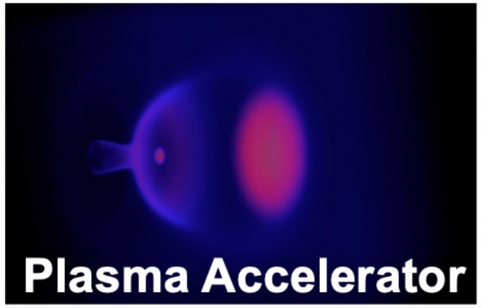
EU Preparatory Phase project 11/2022 – 2026 to define full implementation: financial, legal, technical

Will serve users (FEL, e+, e-) in biology, health, physics, materials, … at end of decade

LNF-INFN
Frascati, Rome, Italy:

1st construction site & Headquarter in progress

2nd construction site in Europe for a laser-driven plasma accelerator facility to be decided in June 2024



600+ page CDR,
240 scientists contributed

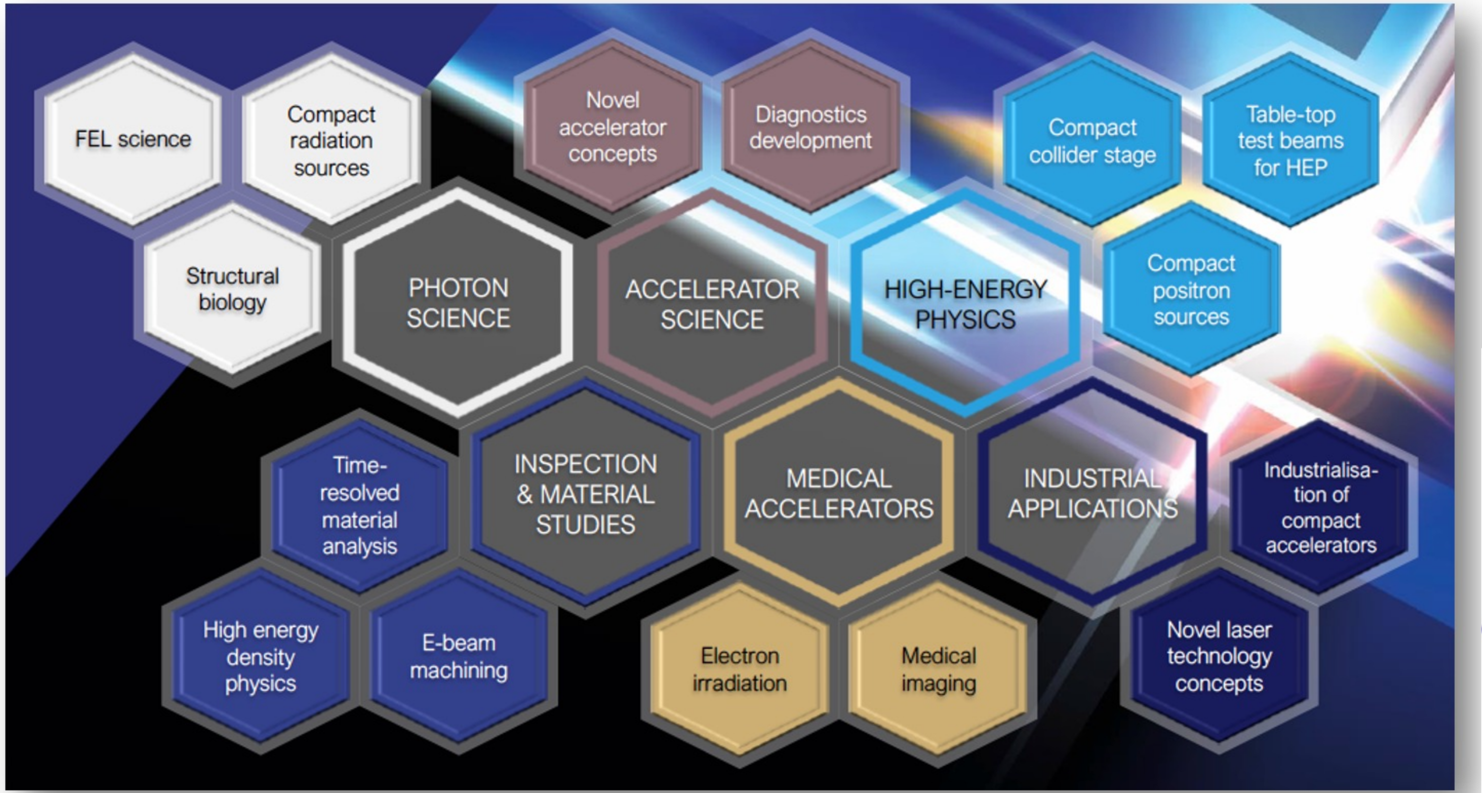
ESFRI

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 653782.

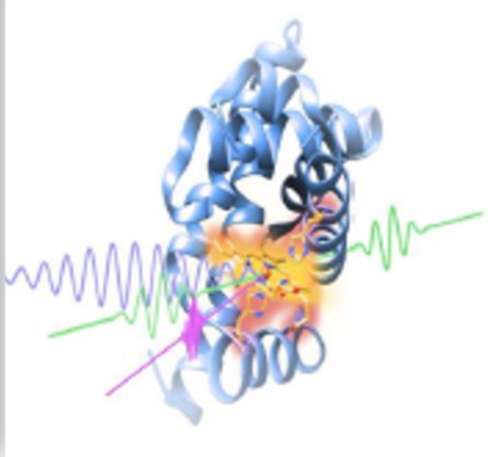
EuPRAXIA

European Plasma Research Accelerator with eXcellence In Applications

Versatile – Designed for Users in Multiple Science Fields



EuPRAXIA delivers:
Ultra-short pulses of X rays, up to 5 GeV electrons, high energy positrons



proteins, viruses, bacteria, cells, metals, semiconductors, superconductors, magnetic materials, organic molecules

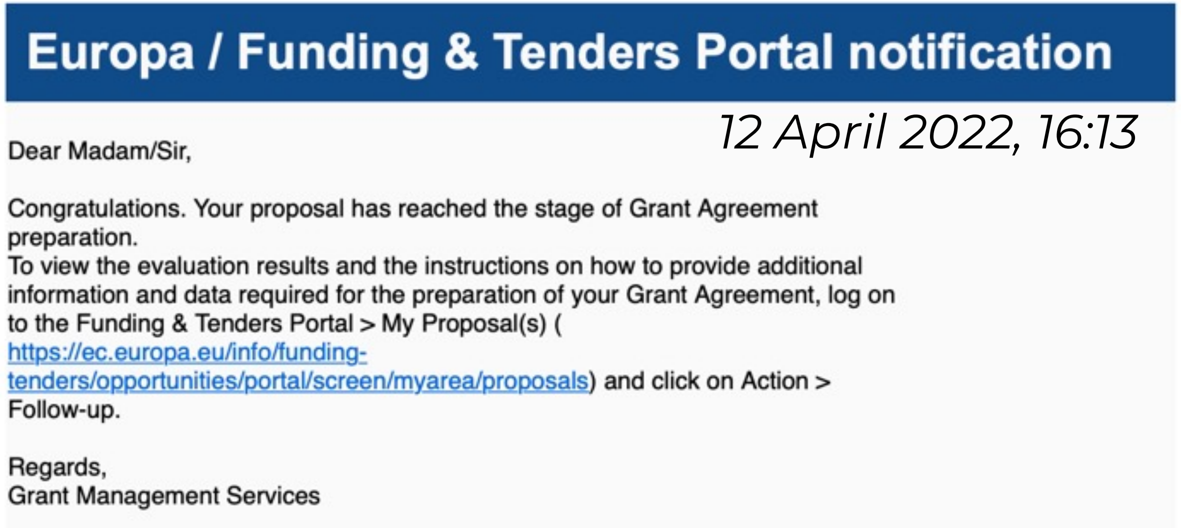
Launch of 2021 Update of ESFRI Roadmap | EuPRAXIA Consortium

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 653782.

EuPRAXIA

Two new EuPRAXIA projects approved by EU

EuPRAXIA Preparatory Phase Project
(Nov 2022 – Nov 2026)



Europa / Funding & Tenders Portal notification

12 April 2022, 16:13

Dear Madam/Sir,

Congratulations. Your proposal has reached the stage of Grant Agreement preparation.
To view the evaluation results and the instructions on how to provide additional information and data required for the preparation of your Grant Agreement, log on to the Funding & Tenders Portal > My Proposal(s) (https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/myarea/proposals) and click on Action > Follow-up.

Regards,
Grant Management Services

3 M€ EU funding, total value: 8.3 M€
Coordinated by INFN (R. Assmann, M. Ferrario)
Will formally establish a "**Board of Financial Sponsors**" with representatives of funding agencies. So far ~ 25% of total (569 M€) M&P funding secured.

EuPRAXIA Doctoral Network
(2023 – 2027)

2.6 M€ EU funding, 10 MSCA Fellows
Coordinated by University Liverpool (C. Welsch)
Start date: 1 Jan 2023

Expert Panel: European Particle Physics Roadmap for High-Gradient Novel Accelerators

Expert Panel – Panel chairs:
Chair: Ralph Assmann (DESY/INFN)
Deputy Chair: Edda Gschwendtner (CERN)

Panel members:
Kevin Cassou (IN2P3/IJCLab), Sebastien Corde (IP Paris), Laura Corner (Liverpool), Brigitte Cros (CNRS UPSay), Massimo Ferarrio (INFN), Simon Hooker (Oxford), Rasmus Ischebeck (PSI), Andrea Latina (CERN), Olle Lundh (Lund), Patric Muggli (MPI Munich), Phi Nghiem (CEA/IRFU), Jens Osterhoff (DESY), Tor Raubenheimer (SLAC), Arnd Specka (IN2PR/LLR), Jorge Vieira (IST), Matthew Wing (UCL).

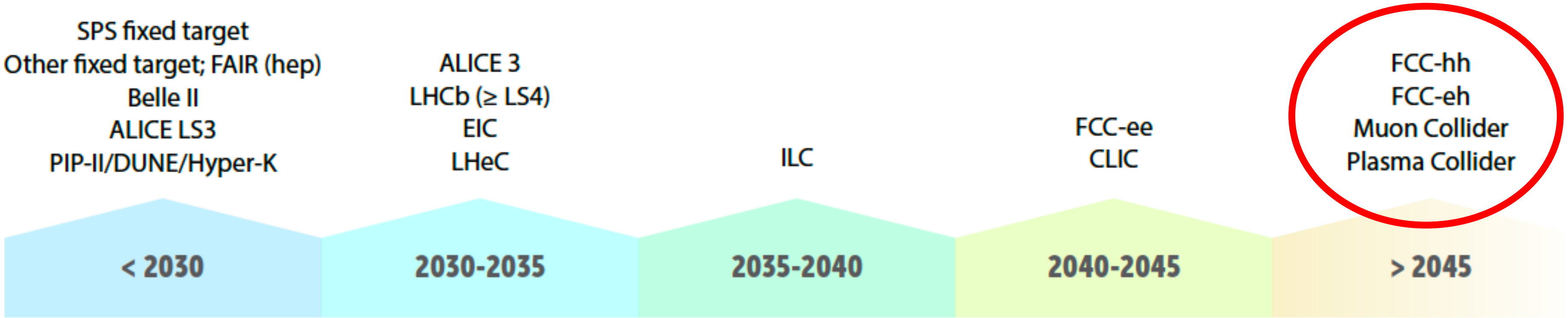
Panel associated members:
Cameron Geddes (LBNL), Mark Hogan (SLAC), Wei Lu (Tsinghua U.) , Pietro Musumeci (UCLA)

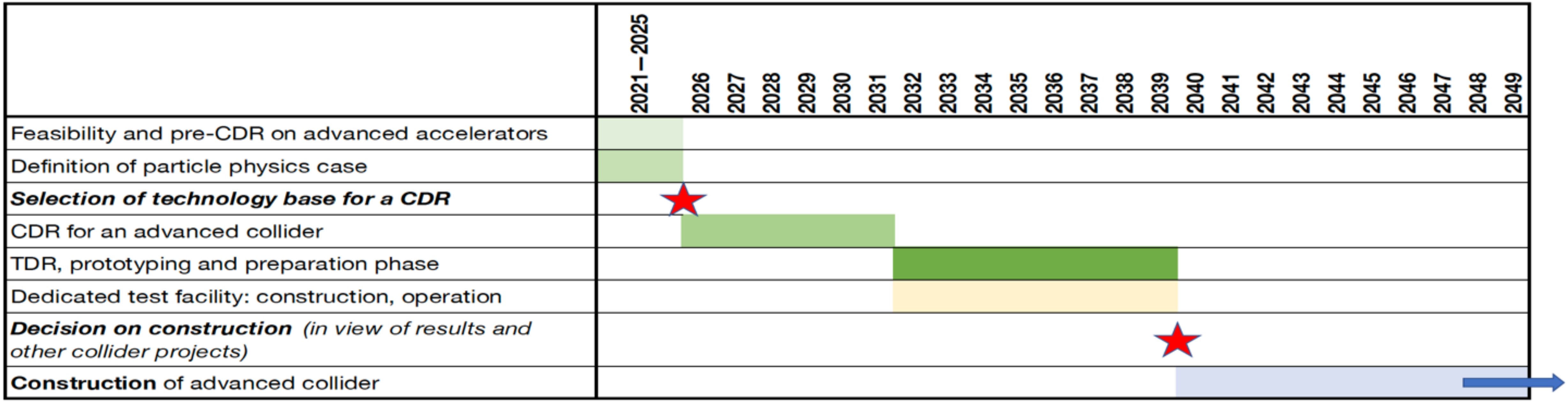
Work performed: Jan 2021 – Feb 2022
Final report: Yellow Report CERN-2022-001

Panel work is completed with report publication. Implementation in next years followed up by Wim Leemans.

The Steps Towards an Advanced Collider

See expert panel report on European Accelerator R&D for Particle Physics





Three Pillars of Plasma R&D Roadmap

See expert panel report on European Accelerator R&D for Particle Physics

FEASIBILITY, PRE-CDR STUDY

Scope: 1st international, coordinated study for self-consistent analysis of novel technologies and their particle physics reach, intermediate HEP steps, collider feasibility, performance, quantitative cost-size-benefit analysis

Concept: Comparative paper study (main concepts included)

Milestones: Report high energy e^- and e^+ linac module case studies, report physics case(s)

Deliverable: Feasibility and pre-CDR report in 2025 for European, national decision makers

TECHNICAL DEMONSTRATION

Scope: Demonstration of critical feasibility parameters for e^+e^- collider and 1st HEP applications

Concept: Prioritised list of R&D that can be performed at existing, planned R&D infrastructures in national, European, international landscape

Milestones: High-rep rate plasma module, high-efficiency module with high beam quality, scaling of DLA/THz accelerators

Deliverable: Technical readiness level (TRL) report in 2025 for European, national decision makers

INTEGRATION & OUTREACH

Synergy and Integration: Benefits for and synergy with other science fields (e.g. structural biology, materials, lasers, health) and projects (e.g. EuPRAXIA, …)

Access: Establishing framework for well-defined access to distributed accelerator R&D landscape

Innovation: Compact accelerator and laser technology spin-offs and synergies with industry

Training: Involvement and education of next generation engineers and scientists

Case Study: High Energy Accelerator Module e^- & e^+

See expert panel report on European Accelerator R&D for Particle Physics

Table 4.2: Specification for an advanced high energy accelerator module, compatible with CLIC [87]. Additional CLIC design values are listed for reference in the second part of the table.

Parameter	Unit	Specification
Beam energy (entry into module)	GeV	**175**
Beam energy (exit from module)	GeV	**190**
Number of accelerating structures in module	-	≥ 2
Efficiency wall-plug to beam (includes drivers)	%	≥ 10
Bunch charge	pC	833
Relative energy spread (entry/exit)	%	≤ 0.35
Bunch length (entry/exit)	µm	≤ 70
Convoluted normalised emittance ($\gamma\sqrt{\epsilon_h \epsilon_v}$)	nm	≤ 135
Emittance growth budget	nm	$\leq$ **3.5**
Polarisation	%	80 (for e^-)
Normalised emittance h/v (exit)	nm	900/20
Bunch separation	ns	0.5
Number of bunches per train	-	352
Repetition rate of train	Hz	50
Beamline length (175 to 190 GeV)	m	**250**
Efficiency: wall-plug to drive beam	%	58
Efficiency: drive beam to main beam	%	22
Luminosity	$10^{34}\text{cm}^{-2}\text{s}^{-1}$	1.5

Possible intermediate steps at lower energies for experiments in Particle Physics

Table 4.3: Specification for an electron beam for fixed-target (FT) experiments, generated by a dielectric laser accelerator (inspired by the eSPS specifications [88]) as well as for electron bunches from plasma accelerators for PEPIC [91–93], a low-luminosity LHeC-like collider [89] and for the LUXE experiment [90]. Such bunches (for PEPIC and LUXE) can also be used for a beam-dump experiment to search for dark photons. Note that the number of bunches per train in the European XFEL is 2700, but for LUXE only one is used.

Parameter	Unit	single e FT	PEPIC	LUXE
Bunch charge	pC	few e	800	250
Final energy	GeV	20	70	16.5
Relative energy spread	%	< 1	2–3	0.1
Bunch length	µm	-	30	30–50
Normalised emittance	µm	100	10	1.4
Number of bunches per train	-	1	320	1
Repetition rate	-	1 GHz	0.025 Hz	10 Hz
Luminosity	10^{27} cm^{-2} s^{-1}	-	1.5	-

The Advanced Accelerator R&D Project Plan

See expert panel report on European Accelerator R&D for Particle Physics

Table 4.4: Work packages and tasks in the minimal plan.

WP	Task	Short description	Invest Personnel
COOR		Coordination Plasma and Laser Accelerators for Particle Physics	—
FEAS		Feasibility and pre-CDR Study on Plasma and Laser Accelerators for Particle Physics	300 kCHF 75 FTEy
	FEAS.1	Coordination	
	FEAS.2	Plasma Theory and Numerical Tools	
	FEAS.3	Accelerator Design, Layout and Costing	
	FEAS.4	Electron Beam Performance Reach of Advanced Technologies (Simulation Results - Comparisons)	
	FEAS.5	Positron Beam Performance Reach of Advanced Technologies (Simulation Results - Comparisons)	
	FEAS.6	Spin Polarisation Reach with Advanced Accelerators	
	FEAS.7	Collider Interaction Point Issues and Opportunities with Advanced Accelerators	
	FEAS.8	Reach in Yearly Integrated Luminosity with Advanced Accelerators	
	FEAS.9	Intermediate steps, early particle physics experiments and test facilities	
	FEAS.10	Study WG: Particle Physics with Advanced Accelerators	
HRRP		Experimental demonstration: High-Repetition Rate Plasma Accelerator Module	1200 kCHF 30 FTEy
HEFP		Experimental demonstration: High-Efficiency, Electron-Driven Plasma Accelerator Module with High beam Quality	800 kCHF 10 FTEy
DLTA		Experimental demonstration: Scaling of DLA/THz Accelerators	500 kCHF 16 FTEy
SPIN		Experimental demonstration: Spin-Polarised Beams in Plasma Accelerators	350 kCHF 16 FTEy
LIAI		Liaison to Ongoing Advanced Accelerator Projects, Facilities, Other Science Fields	—

DEL3.1	12/25	High-Repetition Rate Plasma Accelerator Module	Demonstrates: at least 1 kHz characterised; robust lifetime ($> 10^9$ shots); only the plasma cell; without full repetition rate beam test but including cooling and power handling assessment. Long-term goal: 15 kHz repetition rate.
DEL4.1	12/25	High-Efficiency, Electron-Driven Plasma Accelerator Module with High Beam Quality	Beam demonstration of high efficiency PWFA module. 40% transfer efficiency from driver beam stored energy to witness beam stored energy
DEL5.1	12/25	Scaling of DLA/THz Accelerators	Staged dielectric laser or THz accelerator with 10 MeV energy gain, transverse and longitudinal focusing and at least two stages. Long-term goal: Massively scale-able design printed on a chip.
DEL6.1	12/25	Spin-Polarised Beams in Plasma Accelerators	Demonstration of polarised electron beams from plasma with 10–20% polarisation fraction. Long-term goal: Polarisation 85%.

Technical deliverables (above) point to high priority activities: high repetition rate, efficiency (power), scaling to high energy, spin polarization, …

Next step: Implementation & secure some funding for the particle physics R&D project

2022: EuroNNAc Special Topics

- It is not an EAAC
- Following up on EU tasks that we promised but are more easily done in workshop atmosphere with lot‘s of discussions.
- Limited to 150 participants
- Only one common plenary session, no parallel sessions.

EuroNNAc 10 Years Later & 10 Years in the Future

- The wisdom of the many: **ideas that convince in common discussion**, brainstorming, **bottom up science** drive our field – 150 brains have more power than a few brains – well prepared ideas win in physics.
- 2011: bringing us together created **realistic 10 year goals, more or less achieved**, new unifying concepts attracted **funding** support (EAAC, students, prizes, plasma acc. facilities AWAKE-EuPRAXIA-…)
- Use the unique Elba retreat atmosphere for an iteration:
  What are our **common goals (ambitious but realistic) for the next 10 years** – in strategy, facility and in technical terms?
- Special topics will focus discussion on specific challenges – use coffee, lunch, dinner and the beach to keep discussing and brainstorming.

iFAST

SUMMARIES

	Towards milestone report MS21 for EuroNNAc in May 2023 *Sala Maria Luisa - Hotel Hermitage*	*Ralph Assmann et al.* 17:50 - 18:00
18:00	**Summary - Beam-driven Plasma Accelerators with focus on proton-driven** *Sala Maria Luisa - Hotel Hermitage*	*Edda Gschwendtner et al.* 18:00 - 18:07
	Summary - Simulation tools and roadmap *Sala Maria Luisa - Hotel Hermitage*	*Jorge Vieira et al.* 18:07 - 18:14
	Summary - Laser Technology and LWFA Results (e-, p+, ion) *Sala Maria Luisa - Hotel Hermitage*	*Leonida Antonio Gizzi et al.* 18:14 - 18:21
	Summary - Distributed Plasma Accelerator Landscape in Europe and Technical Progress towards Applications (EuPRA… *Enrica Chiadroni et al.*	
	Summary - Talks and discussion on plasma-based FEL experiments *Sala Maria Luisa - Hotel Hermitage*	*Arie Irman* 18:28 - 18:35
	Summary - Particle physics plasma test facility (multi-stage, 10`s of GeV) *Sala Maria Luisa - Hotel Hermitage*	*Carl Schroeder* 18:35 - 18:42
	Summary - EuroNNAc Student and Young Researher Program - Posters, prizes, ... *Sala Maria Luisa - Hotel Hermitage*	*Bernhard Holzer et al.* 18:42 - 18:49
	Summary - International Landscape: Facilities, projects, initiatives *Sala Maria Luisa - Hotel Hermitage*	*Mark Hogan et al.* 18:49 - 18:56
19:00	**Summary - Structure-based accelerators (e.g. ACHIP) and advanced radiation generation schemes** *Sala Maria Luisa - Hotel Hermitage*	*Rasmus Ischebeck* 18:56 - 19:03
	Workshop Closure *Sala Maria Luisa - Hotel Hermitage*	*Massimo Ferrario et al.* 19:03 - 19:13

WP6 Milestones

May 2023

- MS21: Report on the novel accelerator landscape in Europe, facilities, projects and capabilities at the beginning of the 2020's. Lead – DESY, M24, Publication, website (task 6.1)
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- MS23 Target manufacturing and characterization. Lead – CNRS, M12 Report (task 6.3)
- MS24: Hypothesis on the causes of the instabilities of the focal spot profile. Lead – CNRS, M24 Publication (task 6.4)

This Special Topics workshop will **prepare the milestone MS21**. Thanks to all **session organizers** and **participants** for your help!

NPACT/EuroNNAc Meeting Saturday

- Saturday will discuss EAAC2023, propsoal of a new Bob Siemann prize, how to make our facilities and projects a full success, …
- Let us know your proposals for the future of the field.

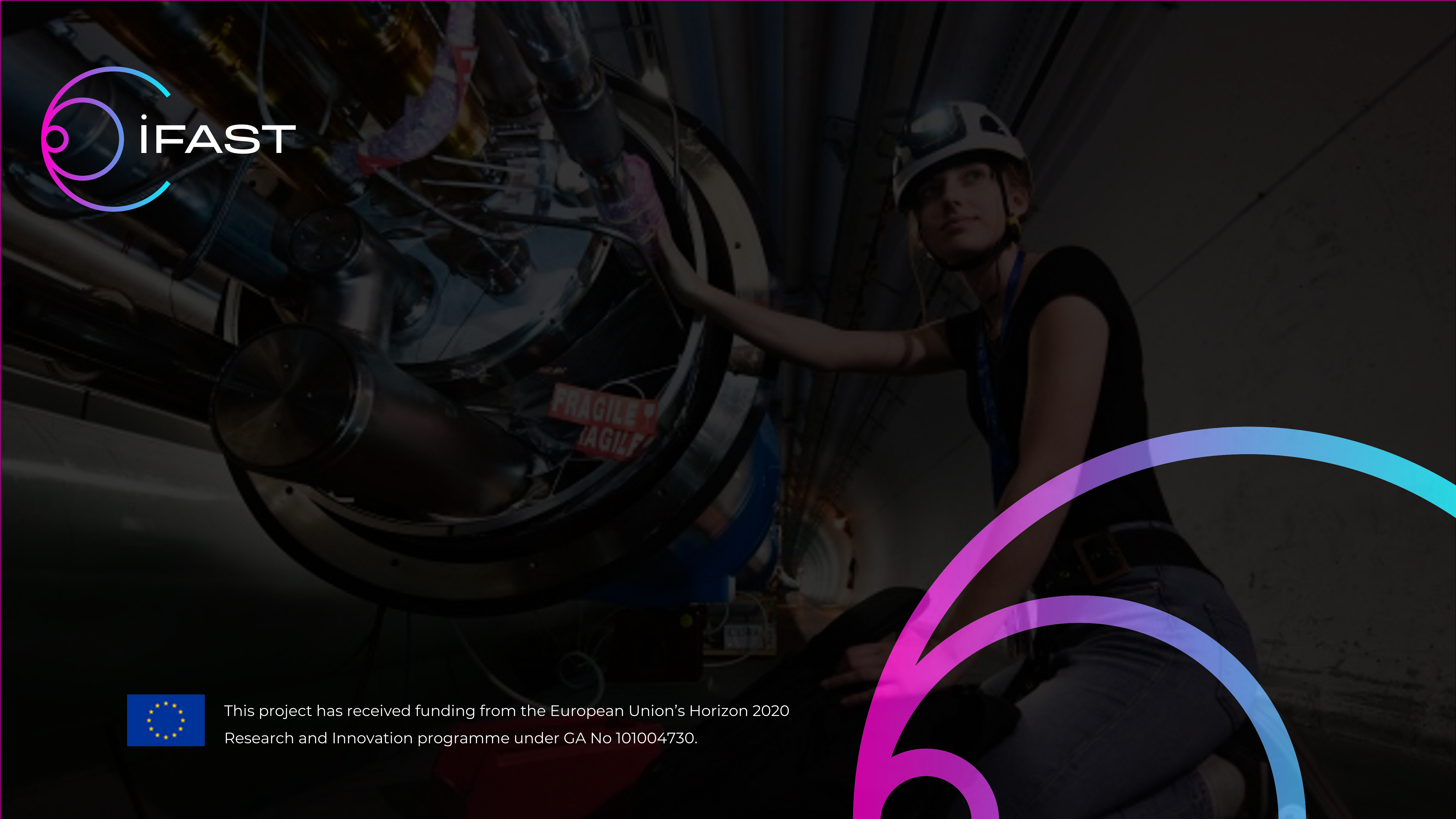
Meetings Overview (see also 2023)

-EuroNNAc Special Topics Workshop: 18-24 September 2022

Program includes the **Simon van der Meer Early Career Award in Novel Accelerators** , Student sessions and the **Poster Prize**

-AAC 2022 takes place in the US (6-11 November 2022)

-EAAC 2023, 17-23 September 2023



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