Introducing ARIES:

Motivations, structure, status, networks

Mid-term Review

25 September 2019

Maurizio Vretenar, CERN, Project Coordinator

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ARIES in a nutshell

Accelerator Research and Innovation for European Science and Society

total cost 24 M€
EC contribution 10 M€
for 4 years (2017 – 21)

Integrating Activity for collaborative R&D on particle accelerators

18 workpackages
45 partners
18 EU countries

First of all people: more than 400 people working together for the progress of accelerator science and technology

From basic science to society

Only about 6% of modern accelerators are used for research, and only 0.5% are for particle physics. **Basic science** is the driving force for new developments but new drivers are appearing: **applied science** (photon and neutron science), **health and industry.**

More than 35'000 particle accelerators in operation worldwide.

Research		**6%**
	Particle Physics	0,5%
	Nuclear Physics, solid state, materials	0,2 a 0,9%
	Biology	5%
Medical Applications		**35%**
	Diagnostics/treatment with X-ray or electrons	33%
	Radio-isotope production	2%
	Proton or ion treatment	0,1%
Industrial Applications		**60%**
	Ion implantation	34%
	Cutting and welding with electron beams	16%
	Polymerization	7%
	Neutron testing	3.5%
	Non destructive testing	2,3%

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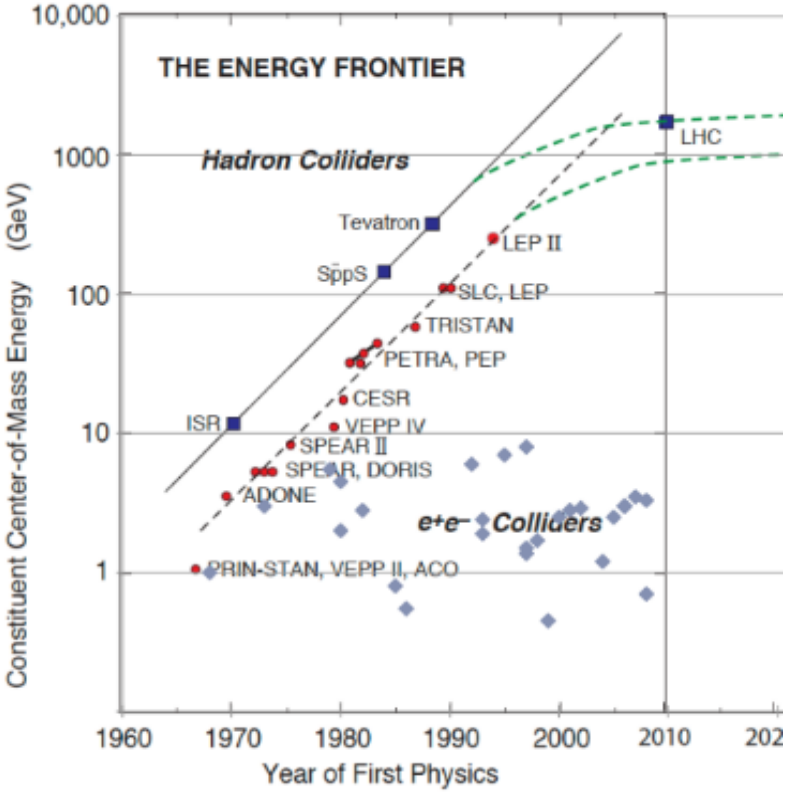
A successful technology, but…



Updated Livingstone-type chart (Wikipedia 2014, uploaded by J.Nash, Imperial College) Exponential growth (Moore's law) of accelerator energy is slowing down.

- Sustainability of accelerator-based particle physics research is at stake.
- But accelerator science is flourishing: >50 ongoing projects for upgrades or construction (2017 survey) with more than 4'000 people engaged in accelerator research in Europe.

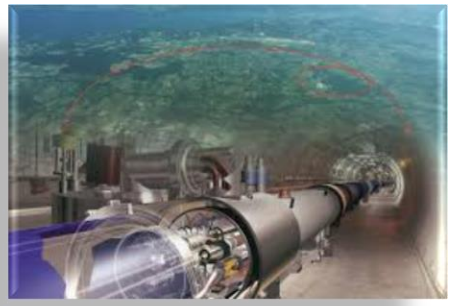
Accelerators are reaching a critical moment in their evolution:

- expectations for physics discoveries are high but requirements in terms of **size, cost, electrical power** make funding and implementation of new projects increasingly challenging → need of new possibly disruptive technologies.

- the rapidly growing use of accelerators for applied science, medicine and industry adds further demands to the **performance, reliability, cost and compactness** of accelerator designs.

Accelerators in transition – not only particle physics!

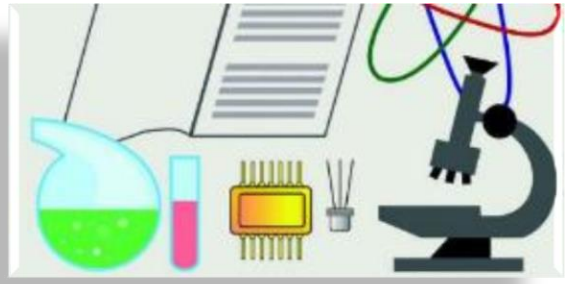
1. Transition to new more affordable and sustainable technologies for basic science
2. Transition from basic science as main technology driver to a multiple system where applied science, medicine and industry can drive accelerator development.
3. Transition from a centralised configuration based on large laboratories to a distributed scheme (project clusters of small and large laboratories and industry)



Basic science

Limitations related to size, cost, energy.

New ideas, technologies



Applied science (photon and neutron sources)

Societal applications (medicine, industry, environment, etc.)

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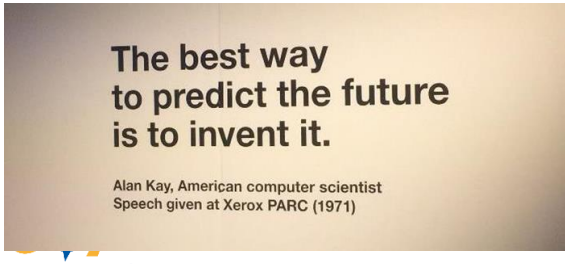
XXIst century challenges for accelerator science

Making accelerator-based particle physics research more sustainable is going to be one of the main challenges to the accelerator community for this XXIst century.

At the same time, we need to bring particle accelerators out of scientific laboratories towards society, to make society profit of our only tools able to access and modify the inner structure of matter.-

We need new ideas
We need a collaborative and creative environment for these ideas to grow



This is why we have launched ARIES

The role of ARIES

- The goal of ARIES is to accompany and favor this transition, looking at the future of accelerator science beyond the needs of ongoing projects and studies, and promoting new technologies common to different projects and accelerator types.
- In this critical step we need to promote innovation*, in terms of new ideas, new synergies, new applications, new ways of working together, etc.
- Need for a new and stronger multidisciplinary collaborative effort involving all innovation actors and promoting cross-fertilization.

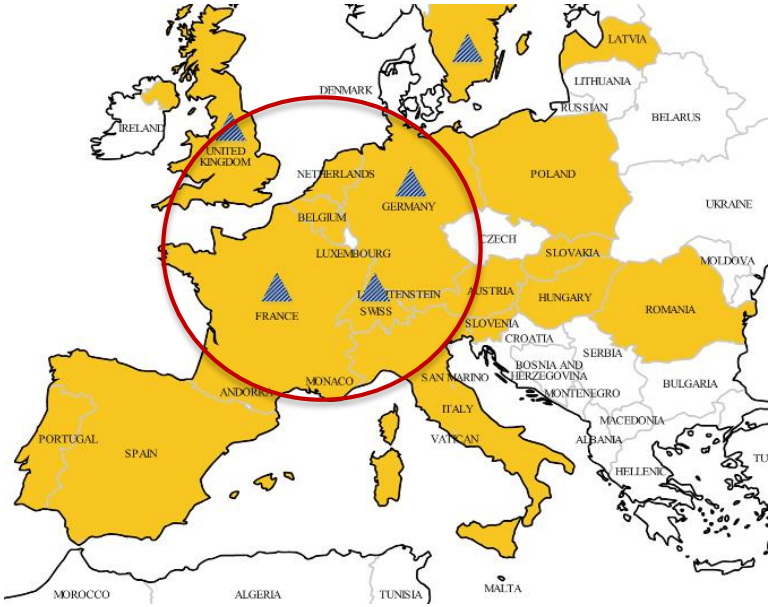
*: An ***innovation*** *is the* ***implementation*** *of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method.* *(from the Oslo Manual, Guidelines for collecting and interpreting innovation data, OECD, 2005)*

Innovation is the process of translating an idea or invention into something (object or service) that creates value.

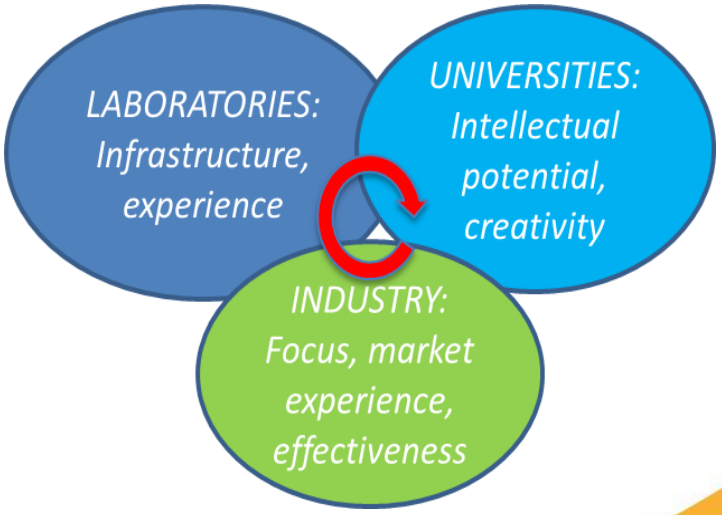
Example:
For high energy physics there are some established directions: LC, CLIC, FCC.
ARIES wants to look beyond these studies and promote alternative promising options: high-temperature superconductivity, plasma-based colliders, alternative schemes, etc.

Connecting Europe, connecting academia with industry

- 42 partners from 18 European countries
- Goals: connect the technological core of Europe with its dynamic periphery, connect the large laboratories with universities, research centers and industries.
- 12 Laboratories and research institutions, 21 Universities and research centres, 8 industries.



80% of EU Research Infrastructure is based in only 4 countries



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What is in ARIES – joining communities transversally

ARIES includes strategic accelerator developments that are:

- not covered by ongoing national – laboratory projects
- looking at the far future of the field
- with added value from collaboration
- extending the community towards new partners
- common to different accelerator platforms
- high-risk high-gain activities

	Tools 1	Tools 2	Tool 3	Tool 4	
Particle physics	accelerators	detectors			users
Nuclear physics	accelerators	separators, etc.	detectors		
Synchrotron light	accelerators	undulators	beam lines	detectors	
Neutron sciences	accelerators	targets	detectors		
Societal applications	accelerators	user interface			

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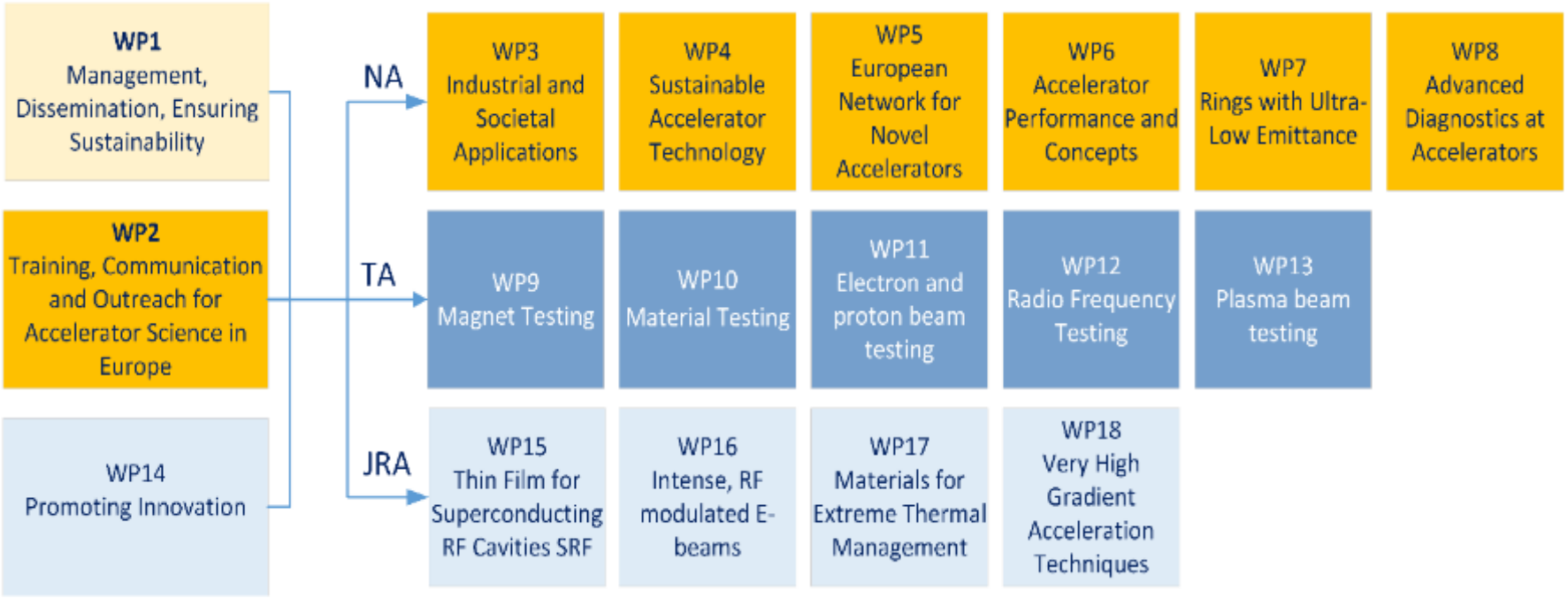
The ARIES Structure and Themes



5 Networks on strategic themes: applications, sustainability, new concepts, extreme designs and instrumentation

5 Pools of testing facilities to prove new concepts

5 Joint Research Activities for experimental valiadation of selected technologies

Budget (4 years): 15 M€ from the partners, 10 M€ from the European Commission

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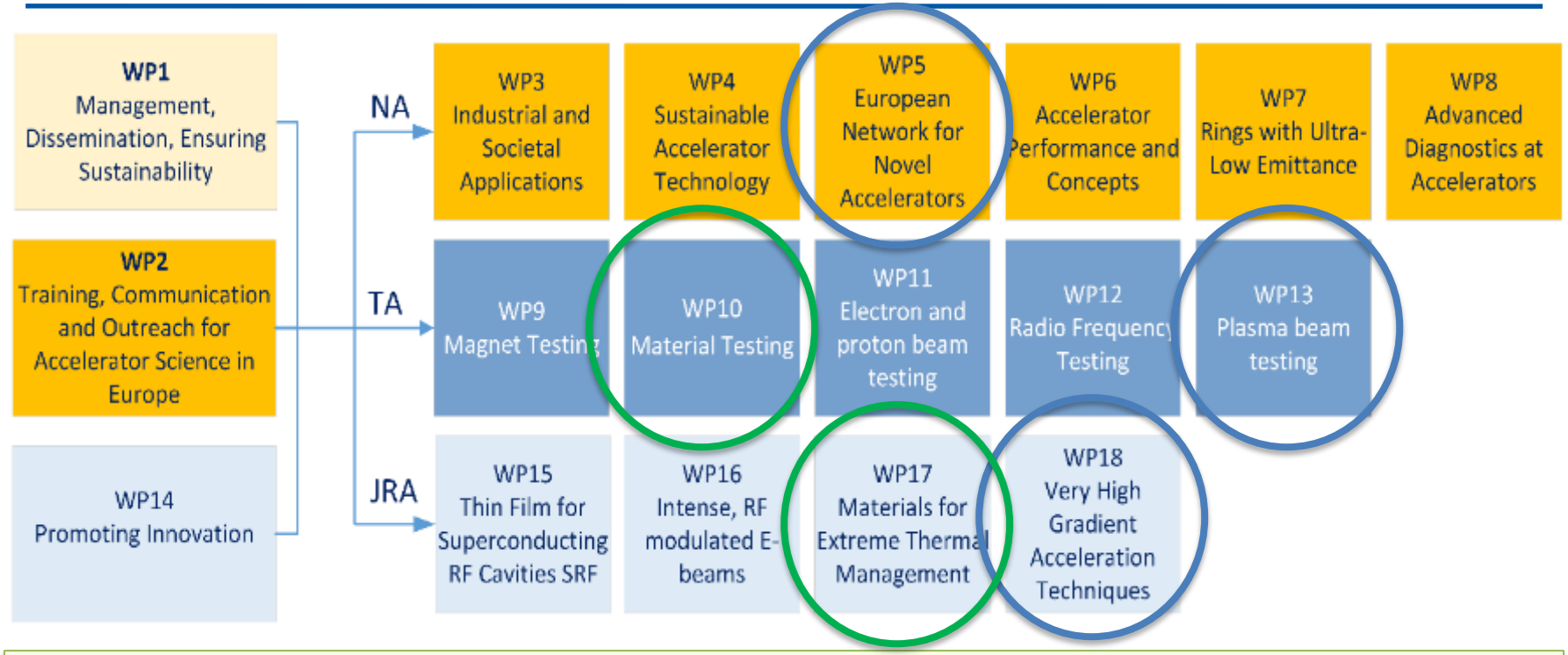
Today's programme



A light review without mobilising all 18 WP Coordinators.
Presentation by the Coordinator, and by 2 WP Coordinators covering 3 strategic themes including Networks, TA, JRA:

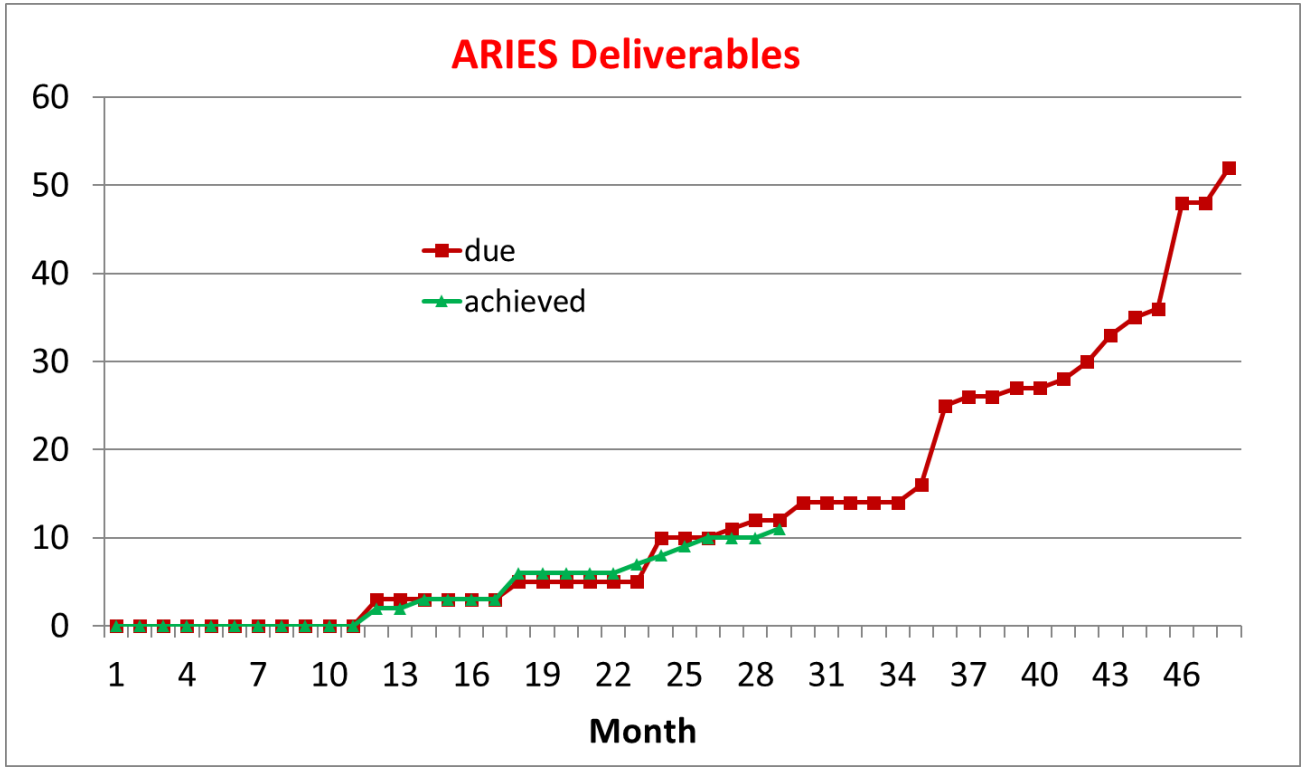
Novel Acceleration techniques, Brigitte Cros, for WP5, WP13, WP18

New materials for accelerators, Alessandro Bertarelli, for WP10, WP17

All the rest (13 WPs) will be covered by the Coordinator – with my apologies if I will not be able to answer too detailed technical questions.

ARIES Progress – measurable indicators

ARIES Deliverables



51 deliverables (total)

11/12 delivered

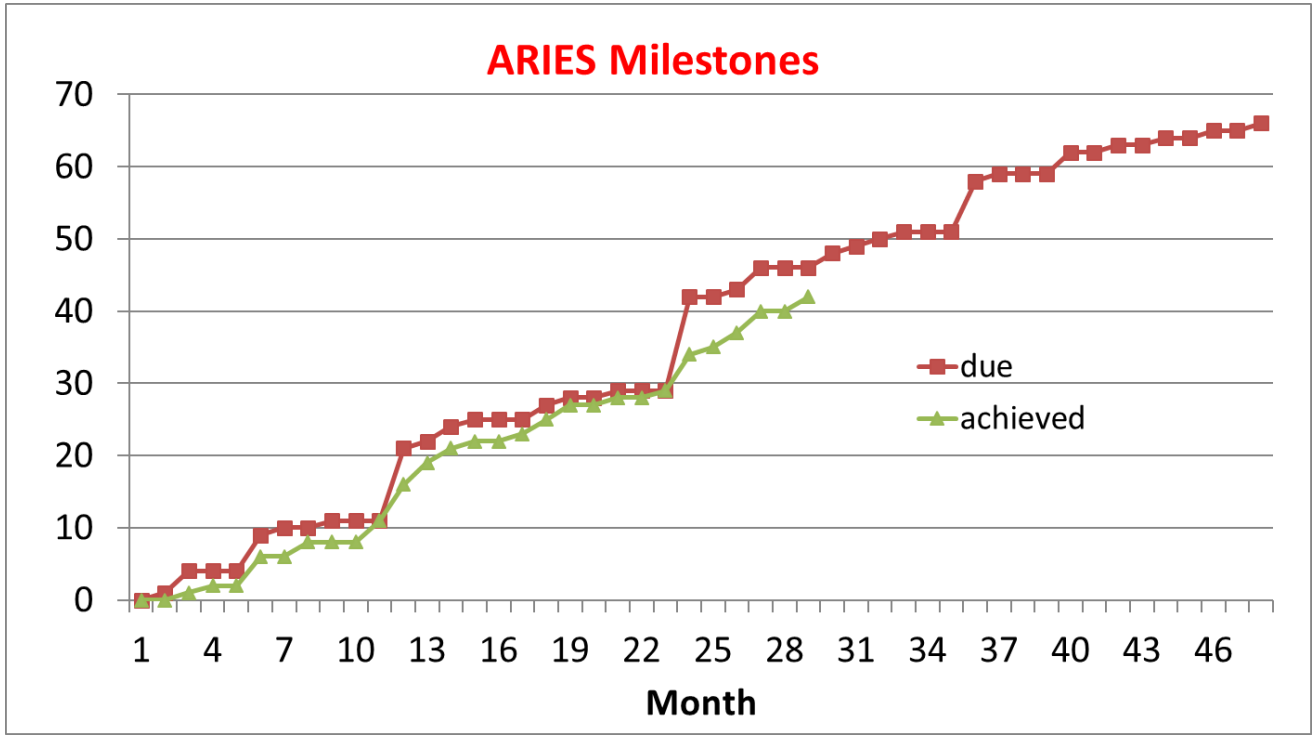
1 delayed (WP16) for justified reasons

3 in preparation

Deliverable production procedure (managed by EDMS tool at CERN):

- Report ready 2 months before deadline
- Commented and approved by WP Coordinator
- Commented and approved by 1 or 2 Reviewers from Steering Committee
- Commented and approved by Coordinator
- Submitted to H2020 Portal

ARIES Milestones



42 / 46 achieved

4 late Milestones – to be achieved in the next 2/3 months:

MS5 Sustainability
MS12 Training
MS54 Test stand
MS 7 Mid-term review

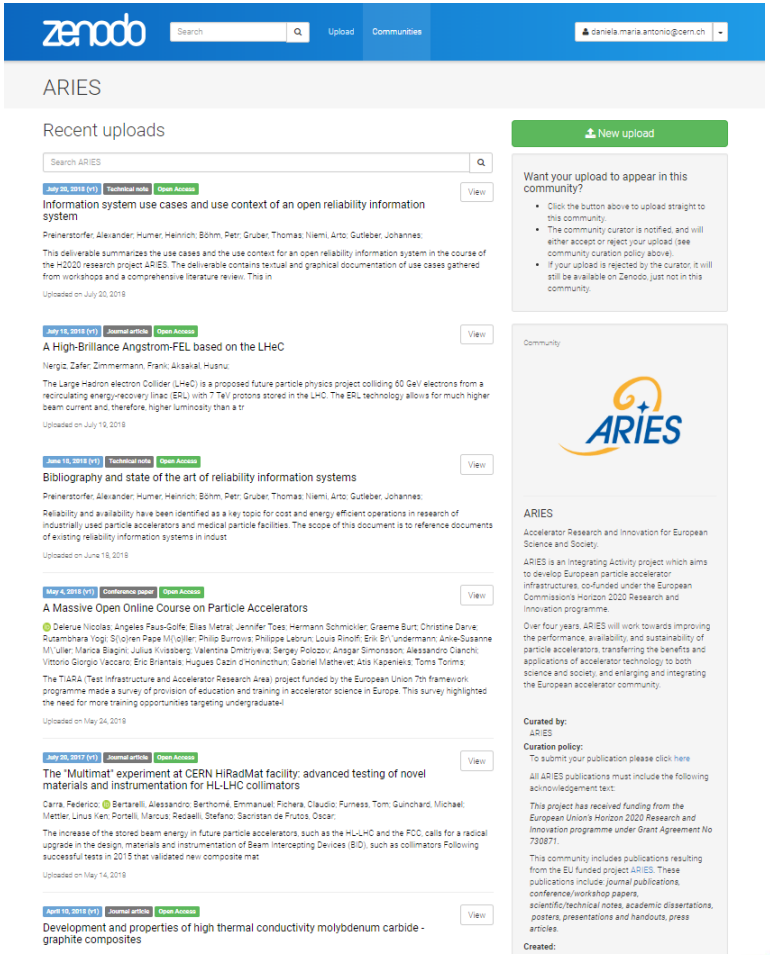
Milestone production procedure managed by EDMS tool at CERN

- Milestone available or justification for delay
- Periodic reassessment by Coordinator

Publications

From 7 publications in September 2018 to 42 publications in April 2019.

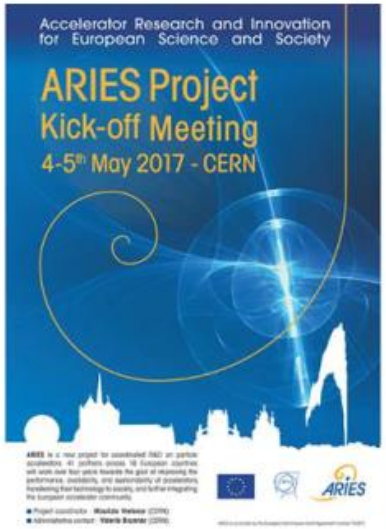
- ✓ Article (22)
- ✓ Report (7)
- ✓ Conferencepaper (4)
- ✓ Technicalnote (4)
- ✓ Other (2)
- ✓ Thesis (2)

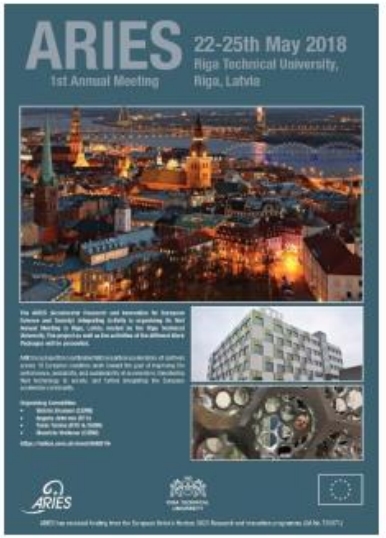


WP 1 – Management, Dissemination, Ensuring sustainability

Management

- No particular issues during the 1st period.
- All committees formed and meeting regularly.
- Only minor internal budget adjustments.
- 1st Annual Meeting in Riga (Latvia): 113 participants (20.3% F), 17 countries.
- 2nd Annual Meeting in Budapest (Hungary): 128 participants (21% F), 16 countries



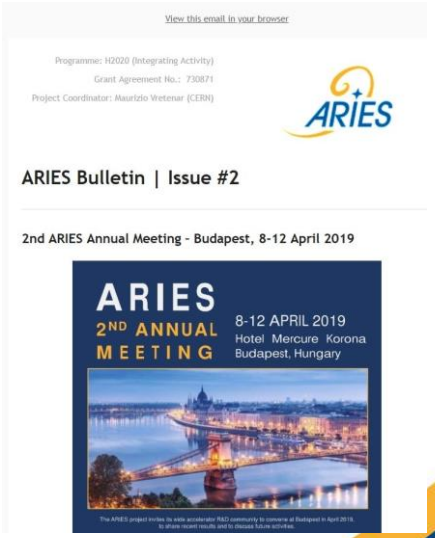


Scientific Advisory Committee	
Europe	Pantaleo Raimondi (ESRF)
Asia	Akira Yamamoto (KEK)
America	Tor Raubenheimer (SLAC)

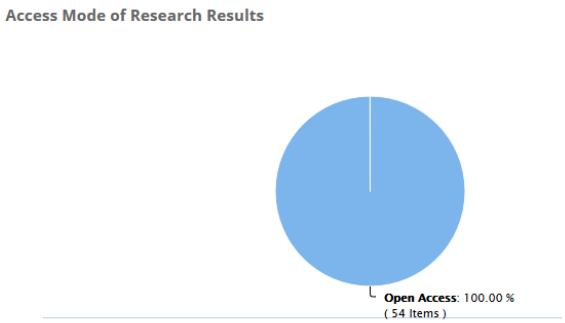
Industry Advisory Board		
France	SigmaPhi/PIGES	J.L. Lancelot
Spain	Elytt	J. Lucas
UK	Elekta	J. Allen
Scandinavia	GE	T. Eriksson
Germany	Research Instruments	M. Peiniger

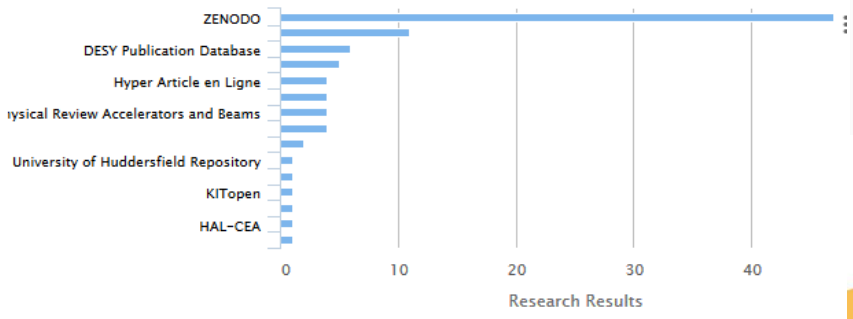
Dissemination and scientific publications

- Choice of Zenodo as open source platform (introduced to participants in meetings and via a tutorial video) – currently 42 publications.
- ARIES Bulletin published 3-4 times/year.
- Six «monographs» (Editorial Series on Accelerator Science) produced so far (reference scientific material, valuable PhD thesis).



Open access ARIES (from https://explore.openaire.eu)





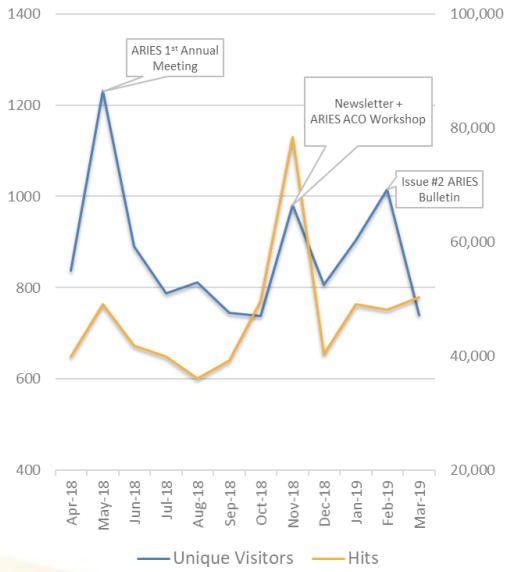
Sustainability (of accelerator research in Europe)

- Increase involvement of European industry in supporting and orienting accelerator research, join efforts with other accelerator R&D projects– Workshop in February 2018.
- ARIES/TIARA/Industry Committee has defined the procedure to set-up the new Innovation Pilot project for accelerators (INFRAINNOV-04-2020)
- Common work with FuSuMaTech to define the rules for co-innovation initiatives with industry, in particular for co-financing.
- Long-term goal: reinforcing the structures of the accelerator community (following the LEAPS model?), starting from the present TIARA Committee.

WP2 – Training, Communication and Outreach for Accelerator Science

ARIES website and video

29,689 unique website visitors
946,371 total website hits



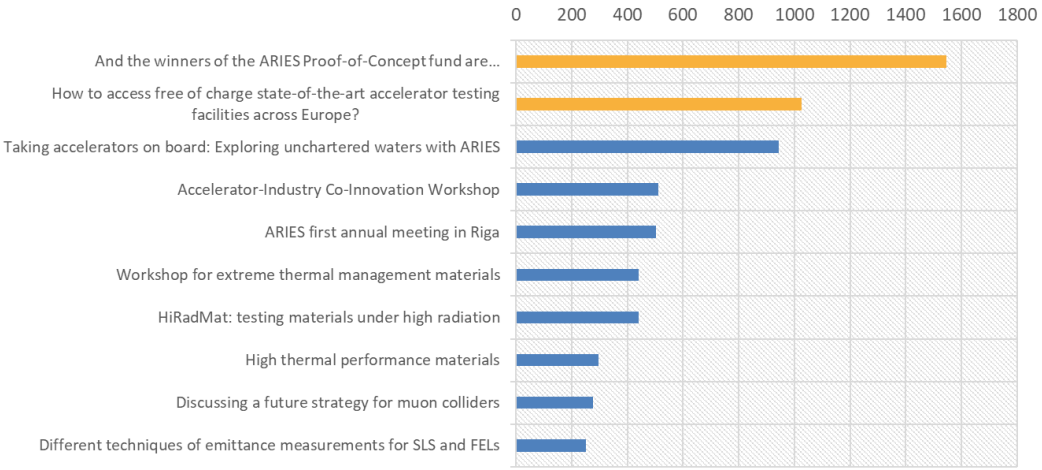
ARIES Introduction Video

2 versions, long for reference (4'51") and short for social media (2'13").
Revised version for DG-RTD communication services
Posted on 15 February 2018:
CERN Facebook and Twitter, YouTube, ARIES Facebook and website
22'400 views from CERN FaceBook with engagement rate 5.5%

Accelerating News

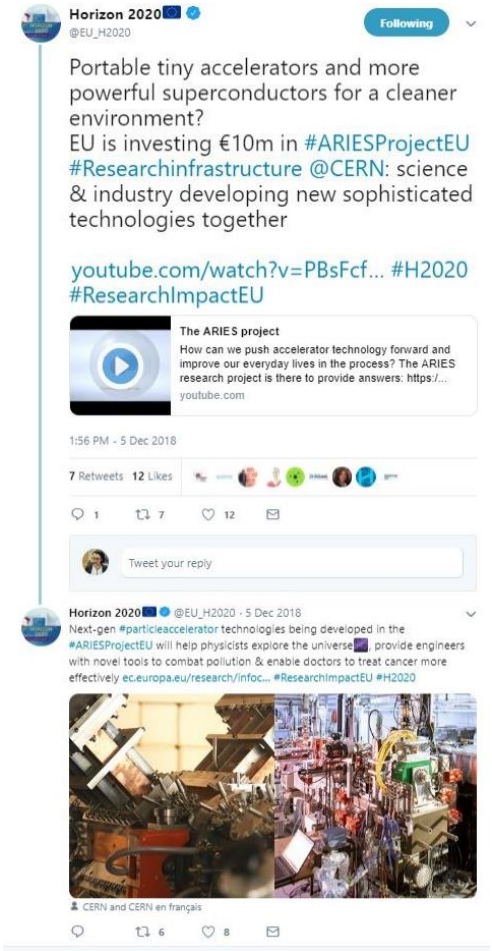
Web based bulletin for the particle accelerator community

- 1’441 subscribers
- 17 ARIES articles in 2 years



ARIES featured @ H2020 Twitter

Article published in H2020 website, linked in Twitter
https://twitter.com/EU_H2020/status/1070316103832870912

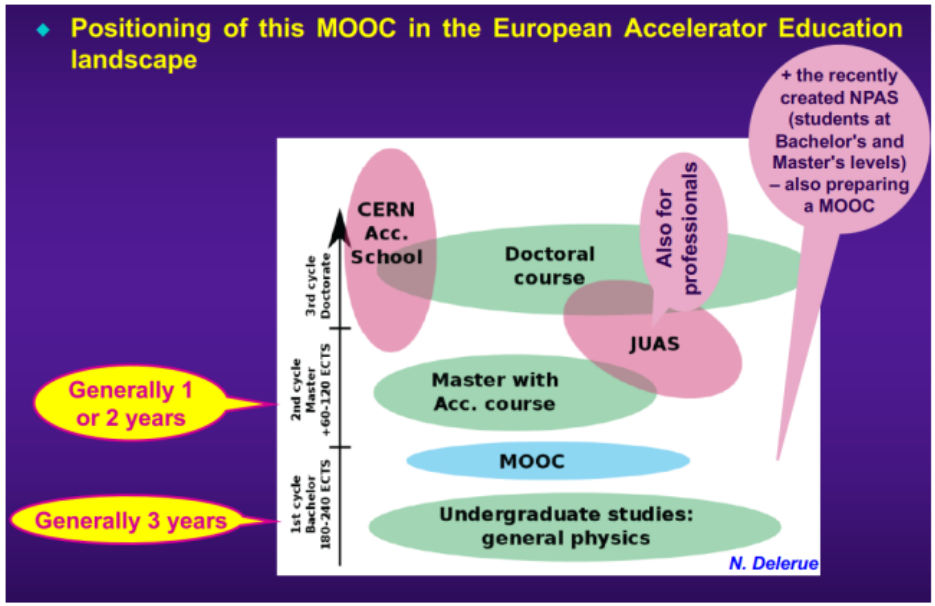


Impressions	7,686
Media views	1
Total engagements	59
Detail expands	31
Likes	12
Retweets	7

Impressions	5,324
Total engagements	66
Detail expands	29
Link clicks	9
Media engagements	8
Likes	8
Retweets	6

Training coordination and e-learning course

- Few University courses exist on accelerators, some schools organised by laboratories and consortia aim at providing accelerator training.
- Goal of ARIES is: a) to provide information on future training needs; b) to promote exchange of information and some coordination between schools; c) to produce a MOOC (Massive Online Open Course) on accelerators .



Status:

- Survey ready to be launched: : https://www.surveymonkey.com/r/T2NYF93
- MOOC: syllabus defined (4 hours introductory, 3 x 6 hours advanced), lecturers selected, contract for recording launched, initial recording starts at CERN next week.

The ARIES Networks

WP3 – Industrial and Societal Applications

Task 3.1. Coordination and communication
Task 3.2. Low energy electron beam applications: new technology development
Task 3.3. Low energy electron beam applications: new applications
Task 3.4. Medium energy electron beams
Task 3.5. Radioisotope production

Task 3.3, examples year 1:

- *development of polymeric materials with new properties,*
- *reduction in the environmental pollution by degradation of toxic compounds in air, water and soil,*
- *cracking crude oil to increase the yield of lighter compounds (most valuable products),*
- *increased sale of irradiated foods to reduce the use of toxic chemicals to control insects,*
- *radiation degradation of natural polymers, such as chitosan, starch and carrageenan to produce plant growth promoters and super-water absorbents for improving agriculture*

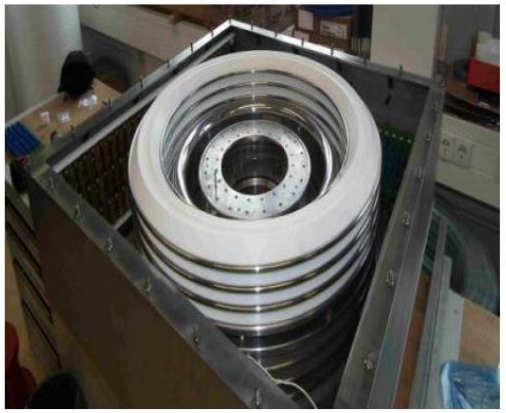
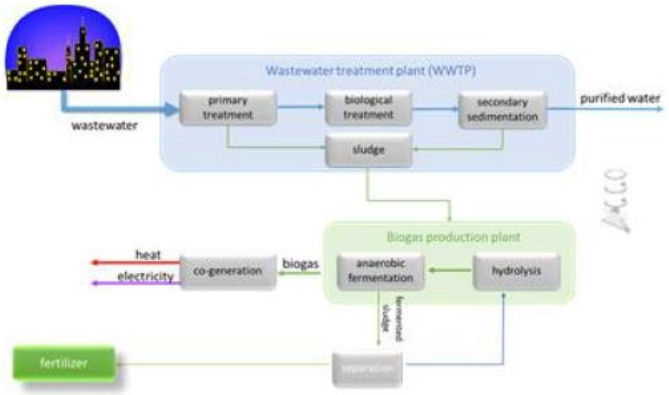


Figure 9: Prototype toroidal accelerator built by Fraunhofer FEP



Task 3.3, examples year 2:

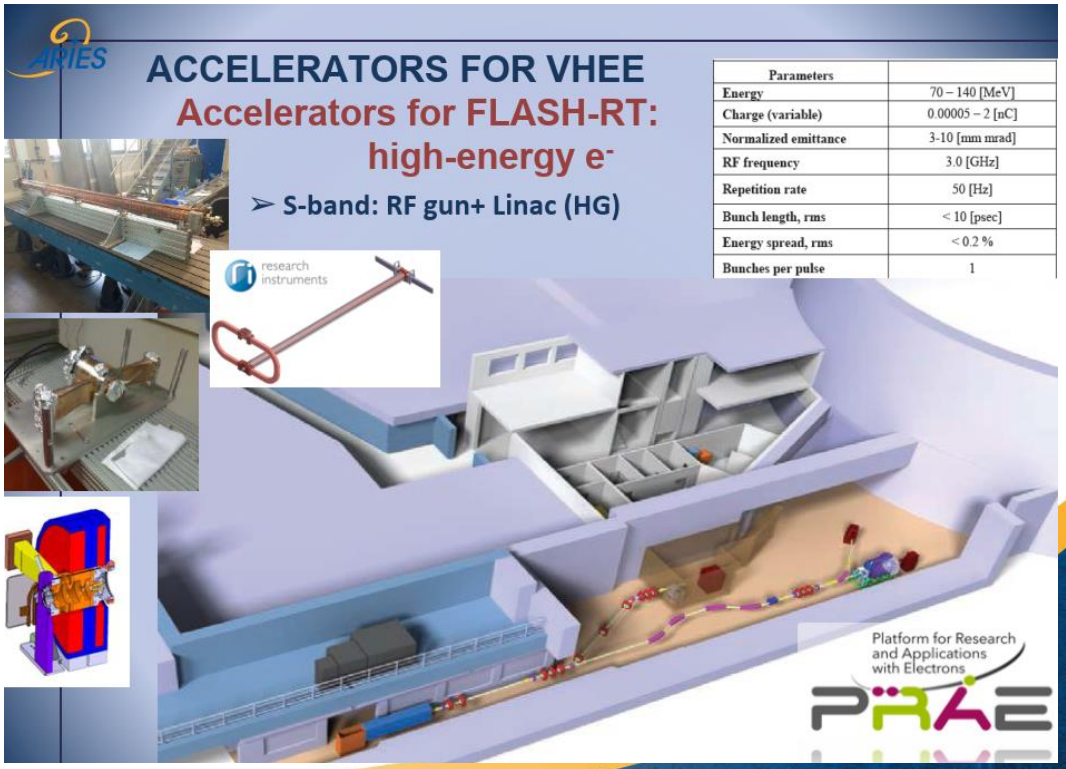
- Synthesis of grafted copolymers
- Optimisation of EB cross-linking
- Elimination of plant pathogens from ornamental bulbs
- Preservation of water-damaged paper products
- Production of polymer matrix composites
- Harmonisation of quality control procedures and dosimetry
- Development of low energy food treatment technology

Medium energy electron beams

- Focus is on the design of a linac (PRAE) for:
  - Minibeam radiotherapy (Very High Energy Electrons):
    - use a grid rather than treating full tumour
    - spot size 400-700 µm
    - small beam divergence: >70 MeV electrons
  - FLASH RT:
    - short treatment time: <500 ms
    - high dose rate: 60-200 Gy/s

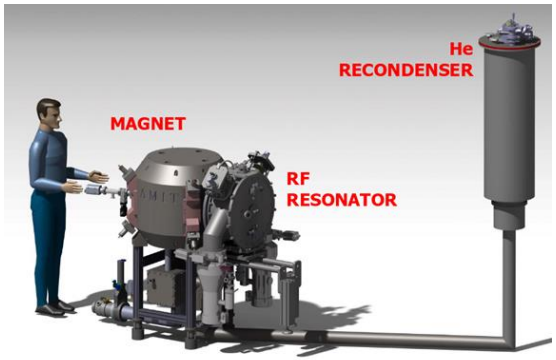
PRAE:
Multidisciplinary R&D facility on the CNRS Orsay campus

RESULTS:
- Beam simulations completed
- Identification of user community
- Definition of initial set of experiements

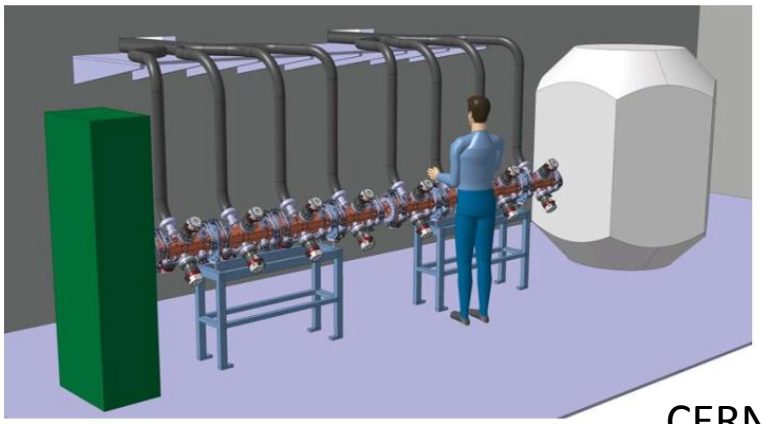


Radioisotope production with compact accelerators

- Construction and testing of 4T AMIT cyclotron (CIEMAT)
- Design of linac for PET isotope production (CERN)
  - Re-parameterisation underway to reduce costs
- Design of a very high current FFAG for ^{99m}Tc and ^{211}At
  - Optics design done and thesis written



Initial assembly completed at CIEMAT

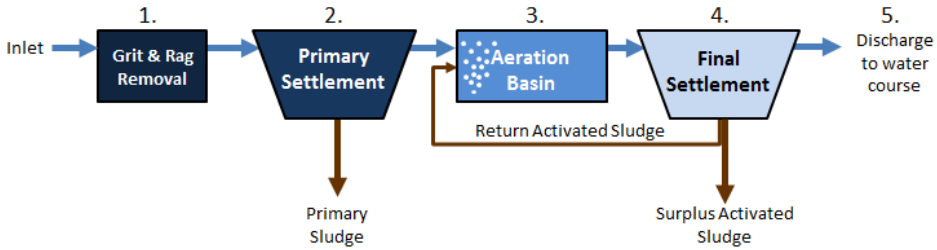


CERN concept, reoptimisation ongoing

WP3 Success Stories

- Treating of ship exhaust gases – will be presented in detail in the «innovation» part
- PHOEBe – Production of High-quality Organic fertiliser using Electron Beams proposal (joint EU-China programme, aims at building 3 pilot plants in EU and China).

Sewage sludge can be used as fertilizer if parasites and bacteria are eliminated. Current chemical treatments have limited power and related risks, sterilisation by low-energy electron beams can open new perspectives

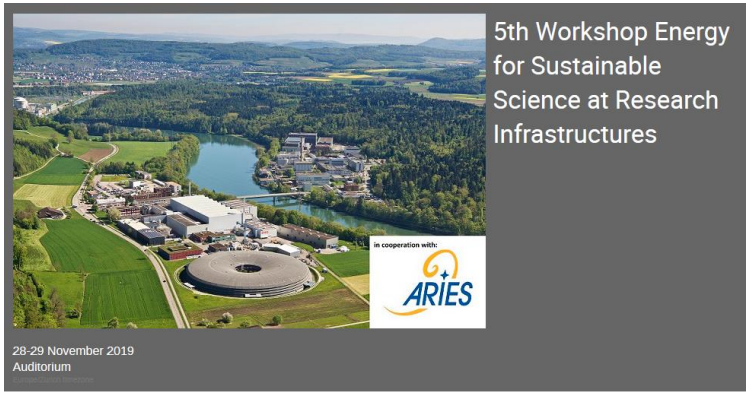


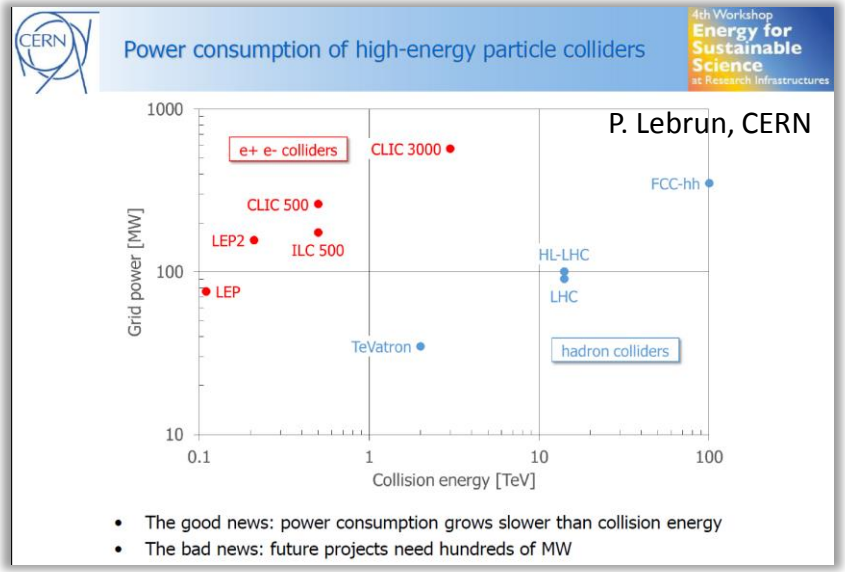
- New ideas: microplastic removing from water (encouraging experiments ongoing).

WP4 – Efficient Energy Management

Structure and workplan

Task 4.1. Coordination and communication
Task 4.2. High Efficiency RF Power Sources
Task 4.3. Increasing energy efficiency of the spallation target station
Task 4.4. High Efficiency SRF power conversion
Task 4.5. Efficient operation of pulsed magnets





Energy management is a priority to ensure sustainability of large accelerator facilities

Network acting at 2 levels:

- Contribute to the ongoing international effort (sessions at the Energy for Sustainable science workshops)
- Promote the development of some specific technical solutions to improve efficiency.

High Efficiency RF sources

Radio-frequency sources (e.g. klystrons) have efficiency around 50% (in the conversion between HV and RF)

Goal of ongoing studies is to increase efficiency >70 %

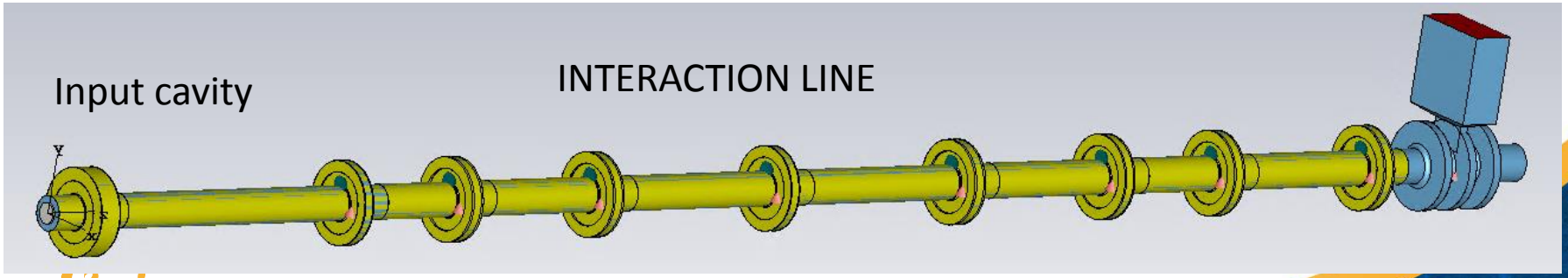
ARIES WP4 will

- Organise workshops and meetings to identify promising ideas and technologies
- develop the design of a 12 GHz high-efficiency klystron, in a collaboration Thales-CEA.

Results:

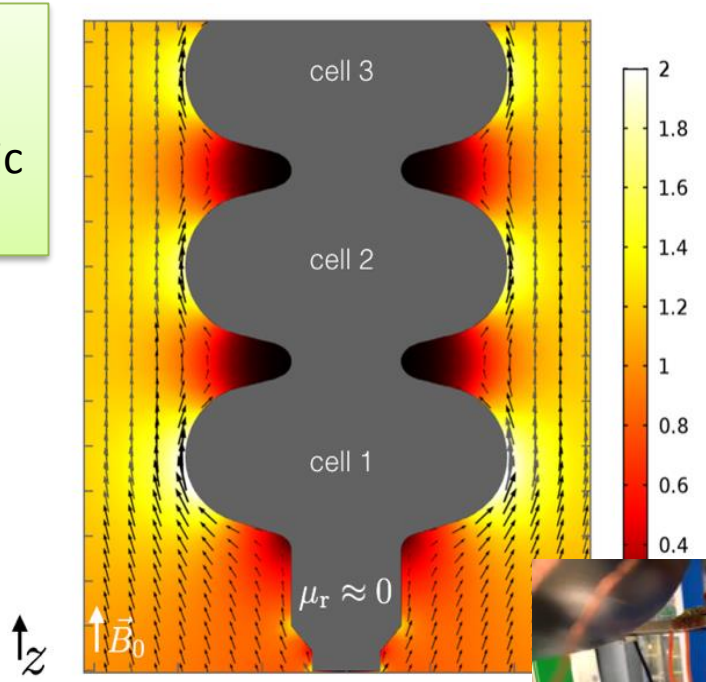
Klystron design completed, computed efficiency 70%

3 cells output cavity



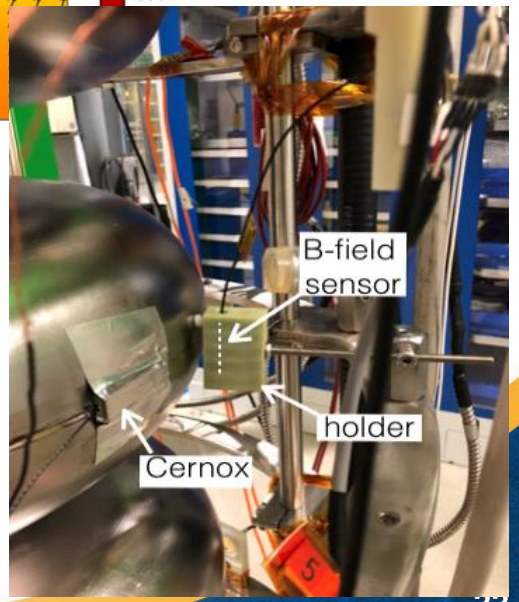
Efficiency of SRF power conversion

Residual resistance in SC cavities related to trapped magnetic field during cool down (e.g. earth magnetic field) → need to improve shielding



Simulation of flux expulsion on multicell bulk Nb cavity

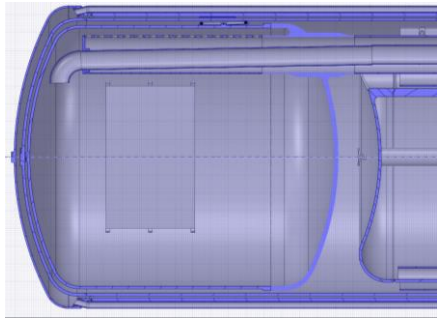
- May 2017 – Jan 2018: studies on improved magnetic shielding for an existing vacuum vessel with ARIES supported PostDoc. Measurement report: CERN-ACC-NOTE-2018-0045.
- May 2018 – today: experimental and theoretical studies on flux trapping in superconducting cavities with ARIES supported PostDoc.

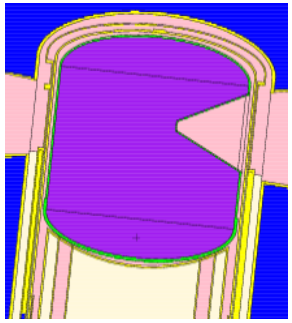


Experimental set-up to measure flux expulsion during cool-down.

Efficiency of accelerator neutron sources and pulsed magnets

Liquid deuterium moderator, current design, side view.





New design for the deuterium moderator, top view.

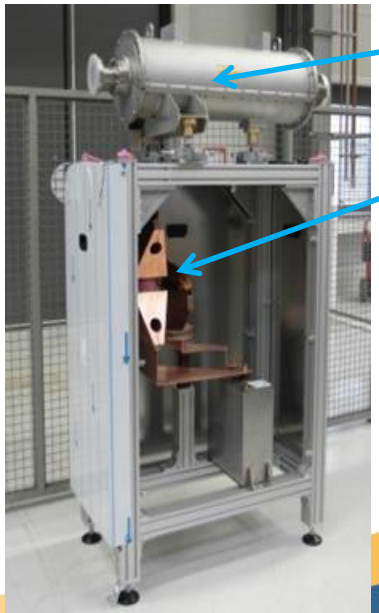
A new moderator design for neutron sources will provide 1.3 – 1.6 increase in cold neutron flux

- Ongoing: numerical modelling of fluid and heat flows to understand the limitations of the current design
- Planned: hydro-thermo-mechanical analysis of the new design to assess feasability

Pulsed iron-free quadrupole magnet prototype with high efficiency

up to 400 kA, up to 25 kV 75 T/m

Assembled, to be tested at GSI (D)



WP6 – Accelerator Performance and Concepts

Task 6.1. Coordination and communication
Task 6.2. Beam Quality Control in Hadron Storage Rings and Synchrotrons
Task 6.3. Reliability and Availability of Particle Accelerators
Task 6.4. Improved Beam Stabilization
Task 6.5. Beam Quality Control in Linacs and Energy Recovery Linacs
Task 6.6. Far Future Concepts & Feasibility

The «think tank» of ARIES
In this WP the most advanced accelerator ideas are presented and discussed. Long list of Workshops, with enough flexibility to direct the exploration in the directions that are considered as the most promising.

Europe-wide Network managed by two efficient coordinators and with many connections outside Europe (US, Japan)

Giuliano Franchetti, GSI; Frank Zimmermann, CERN, with input from Alessandro Drago, INFN Frascati; Johannes Gutleber, CERN; Klaus Hoeppner, HIT; Florian Hug, JGU Mainz; Mauro Migliorati, Sapienza Roma; Arto Niemi, CERN; and Marco Zanetti, INFN & U. Padua

WP6 is the largest producer of ARIES publications

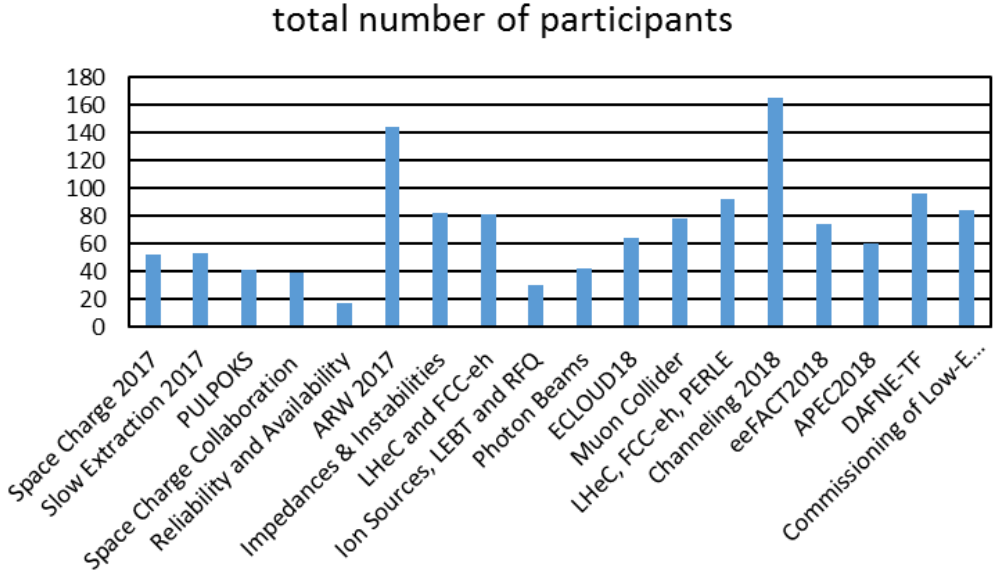
APEC workshops in year 1

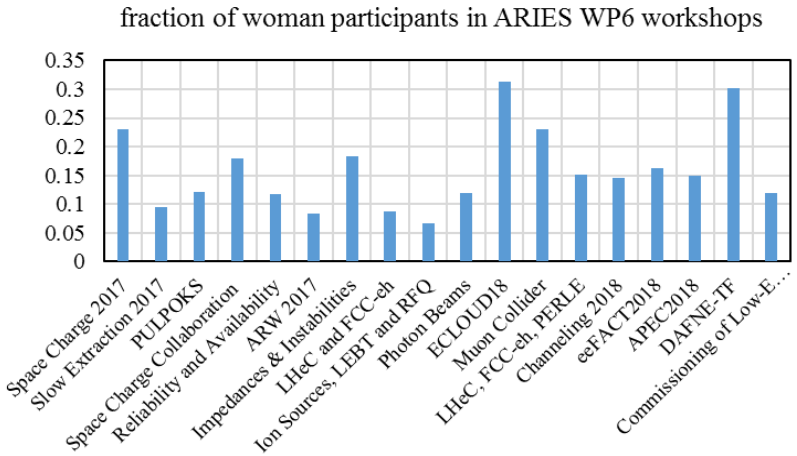
1. **LHeC/FCC-eh** Workshop, CERN, 11-13 Sep. 2017 (6.5)
2. **Mini-workshop on Reliability and Availability**, CERN, 18–21 Sept. 2017 (6.3)
3. **Impedances and Beam Instabilities in Particle Accelerators** , Benevento, Italy, 18-22 September 2017 (6.4)
4. **Space Charge 2017** workshop, Darmstadt, 4-6 Oct. 2017 (6.2)
5. **Accelerator Reliability Workshop 2017** , Versailles, 15-20 Oct.'17 (6.3)
6. **Slow Extraction** workshop, CERN, 9-11 Nov. 2017 (6.2)
7. **Photon Beams** workshop, Padova, 27-28 Nov. 2017 (6.6)
8. **Ion Sources and Low Energy Beam Transport into RF Linacs**, 28 Feb – 2 Mar 2018 (6.5)
9. **Pulsed Power for Kicker Systems** (PULPOKS), CERN, 12-14 March 2018 (6.2)
10. **2nd Space Charge Collaboration** meeting, CERN, 12-14 March 2018 (6.2)
11. **FCC Week 2018**, Amsterdam, 9-13 April 2018 (6.2)

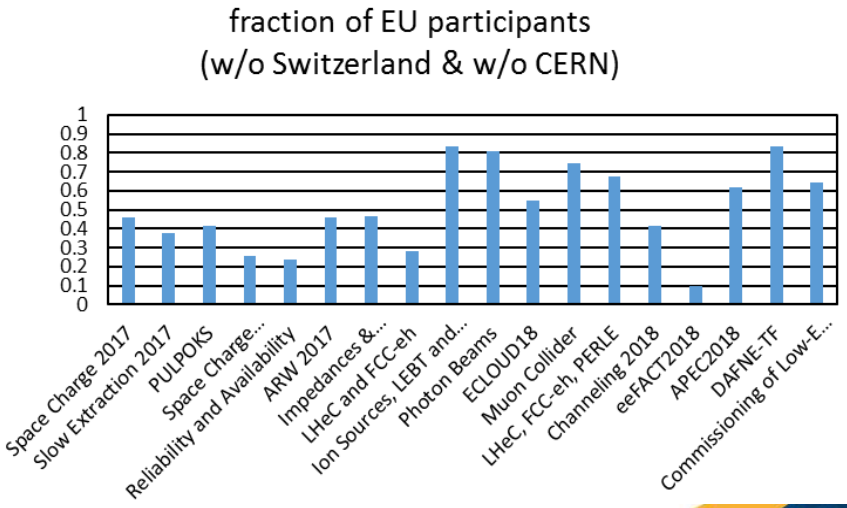
APEC workshops in year 2

1. **Electron Cloud Effects in Accelerators** (ECLOUD'18), La Biodola, Italy, 6-7 Jun 2018 (6.2, 6.4, ICFA)
2. **Electrons for the LHC – LHeC, FCC-eh and PERLE**, LAL Orsay, France, 27-29 Jun 2018 (6.5)
3. **Muon Collider** workshop, Padua, Italy, 2-3 July 2018 (6.6)
4. **Channeling 2018** conference and workshop, Ischia, Italy, September 2018 (6.6)
5. **eeFACT2018**, HKUST Hong Kong, 24.-27.09.2018, with ICFA (6.2, 6.3, 6.4)
6. **APEC2018** workshop, Frankfurt am Main, Germany, 10-12 December 2018 (6.2, 6.3, 6.4, 6.5)
7. **DAFNE as Open Accelerator Test Facility**, Frascati, 17 Dec'18 (6.2, 6.4, ICFA)
8. **Beam Tests and Commissioning of Low Emittance Rings**, KIT, 18-20 Feb'19 (6.2, WPs 7, 11) ARIES
9. **High Intensity RFQ meets Reality**, Heidelberg, 15-16 April 2019 (6.2, 6.5)

Workshops statistics







Accelerator Performance and Concept Workshop 2018

Accelerator Performance & Concepts Workshop

Chairs
G. Franchetti, F. Zimmermann

Secretariat
P. Lindenberg, p.lindenberg@gsi.de
L. Birli, l.birli@gsi.de
Tel. +49 (0)6159 71 1550

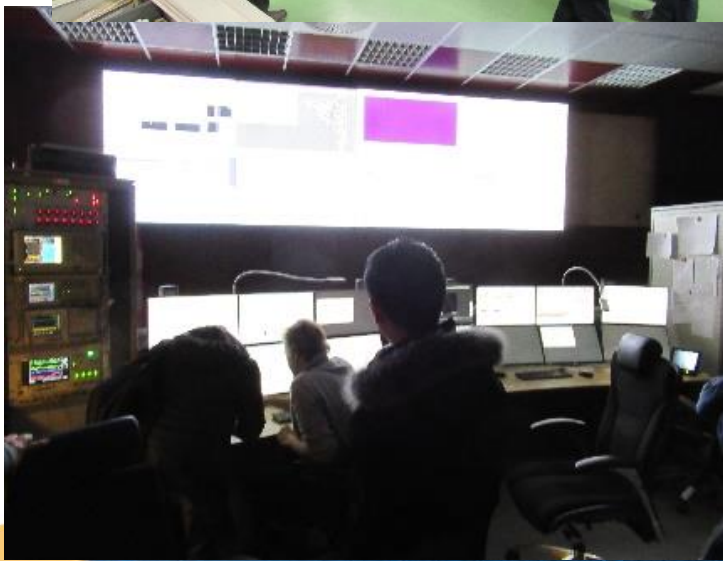
Fleming Hotel
Frankfurt am Main, Germany
December 10-12, 2018

https://indico.gsi.de/event/7510/

International Advisory Committee

M. Bai	GSI
J-L. Biarrotte	IN2P3
Y-H. Chin	KEK
S. Cousineau	SNS
A. Drago	INFN
W. Fischer	BNL
R. Garoby	ESS
J. Gutleber	CERN
K. Hoeppner	HIT
F. Hug	JGU
V. Lebedev	FNAL
S. Machida	RAL/ISIS
M. Migliorati	INFN
Q. Qin	IHEP
P. Spiller	GSI
M. Steck	GSI

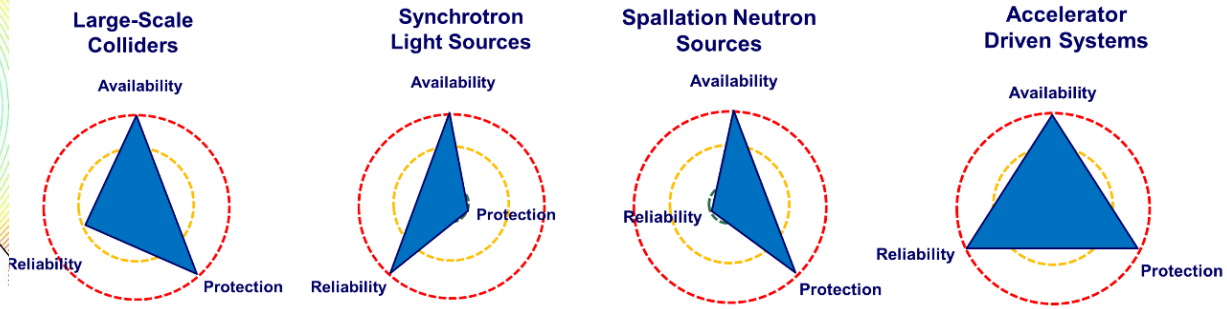
<u>60 participants</u> :
Austria: 2,
Belgium: 1,
China: 7,
Finland: 1,
France: 3,
Germany: 23,
Italy: 3,
Sweden: 2,
Switzerland: 8,
United Kingdom: 2,
United States: 8
of these:
9 women,
8 students



Note: ARIES budget only for conference room and for inviting some overseas speakers

APEC2018 highlights

“RASP” charts → demands in reliability, availability, safety / protection



post-workshop Community Survey

Ranking of performance degrading mechanisms for hadron storage rings and synchrotrons

This form is a survey of the relevant mechanisms affecting the accelerator performance. The survey was suggested at the APEC Workshop held in Frankfurt am Main on 10-12/12/2018. The survey asks you to rank the importance of a list of mechanisms:

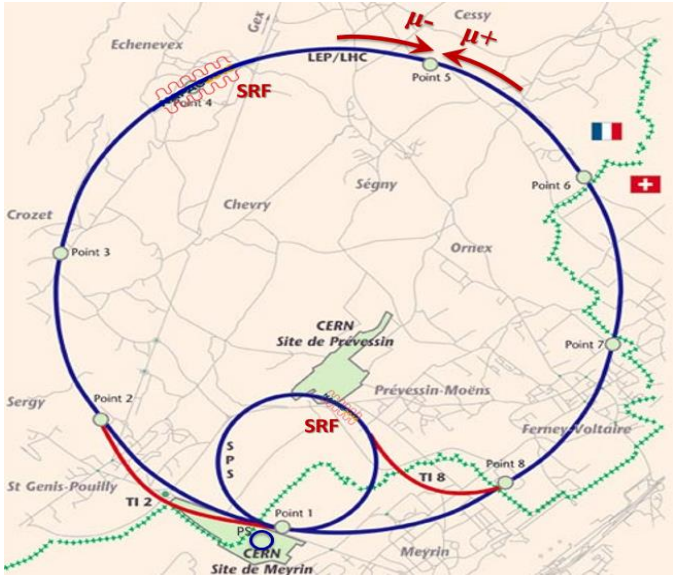
1 = "LOWEST IMPACT", 5 = "HIGHEST IMPACT".

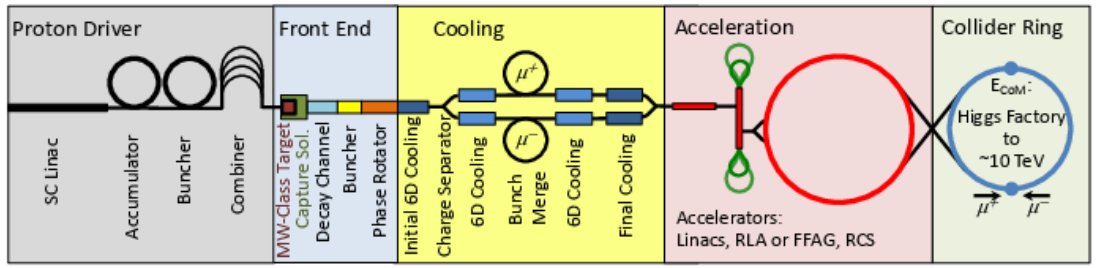
In case some relevant mechanism is missing please let us know. Giuliano Franchetti and Frank Zimmermann (g.franchetti@gsi.de, frank.zimmermann@cern.ch)

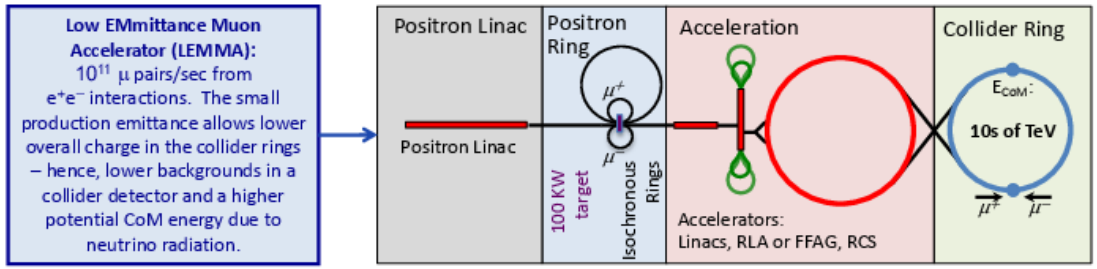
still ongoing

Exploring new directions – the Muon Collider

The revival of the muon collider as a possible alternative to large-size high energy project owes a lot to the prompt and strong support from ARIES.
ARIES is now helping in structuring and organising the community and in collecting support from the main European laboratories for a Conceptual Design Study.





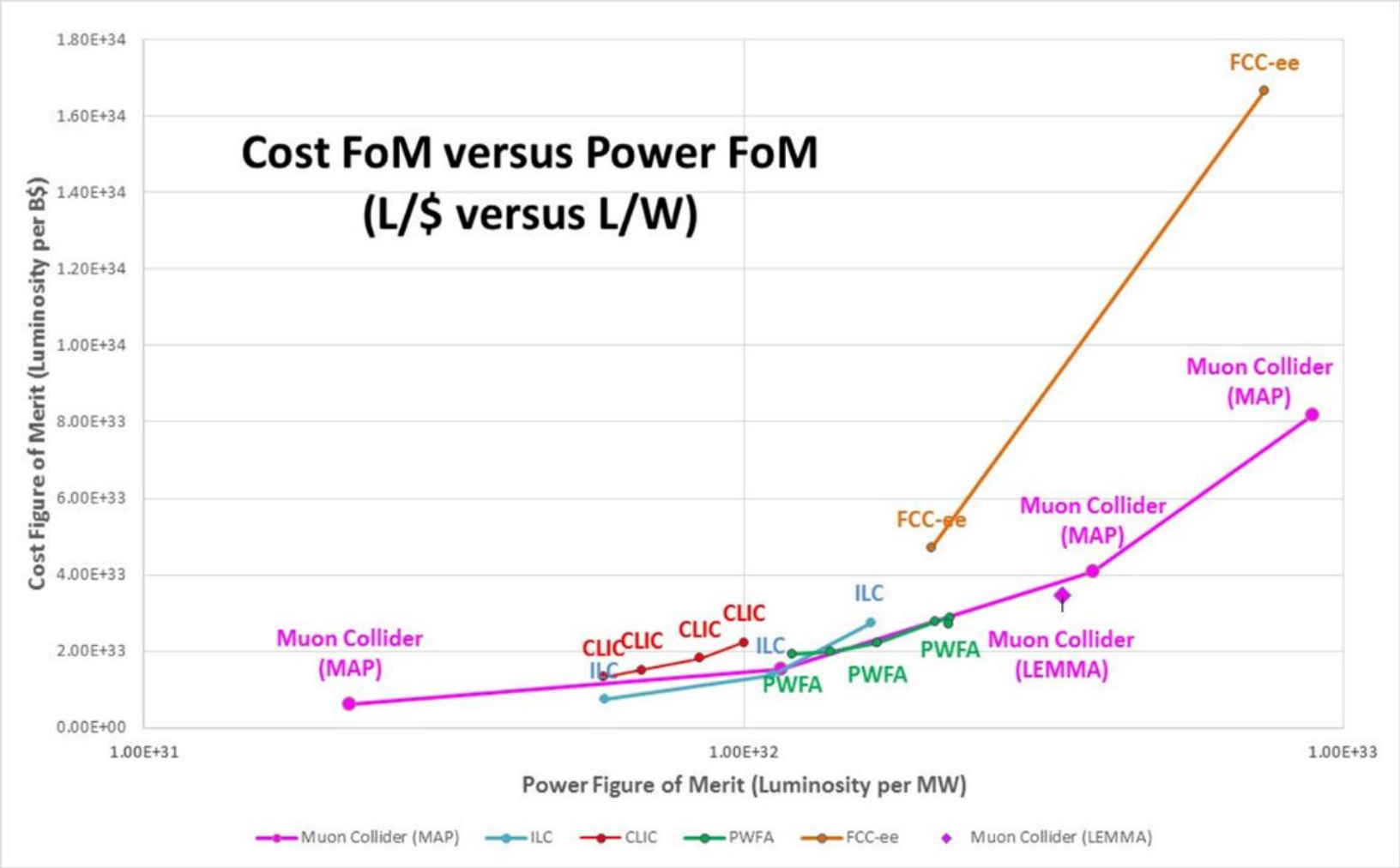


A 14 TeV muon collider in the LHC tunnel (D. Neuffer and V. Shiltsev).

Muon Collider schemes, Padua, July 2018

Parametric ionization cooling (C. Rubbia), LEMMA concept (P. Raimondi, M. Boscolo et al.), e^+ target design, self-amplification of e^+ (F. Collamati), Gamma Factory (W. Krasny), PoP demonstration facility / facilities , …

lepton collider performance, Padua, 2018



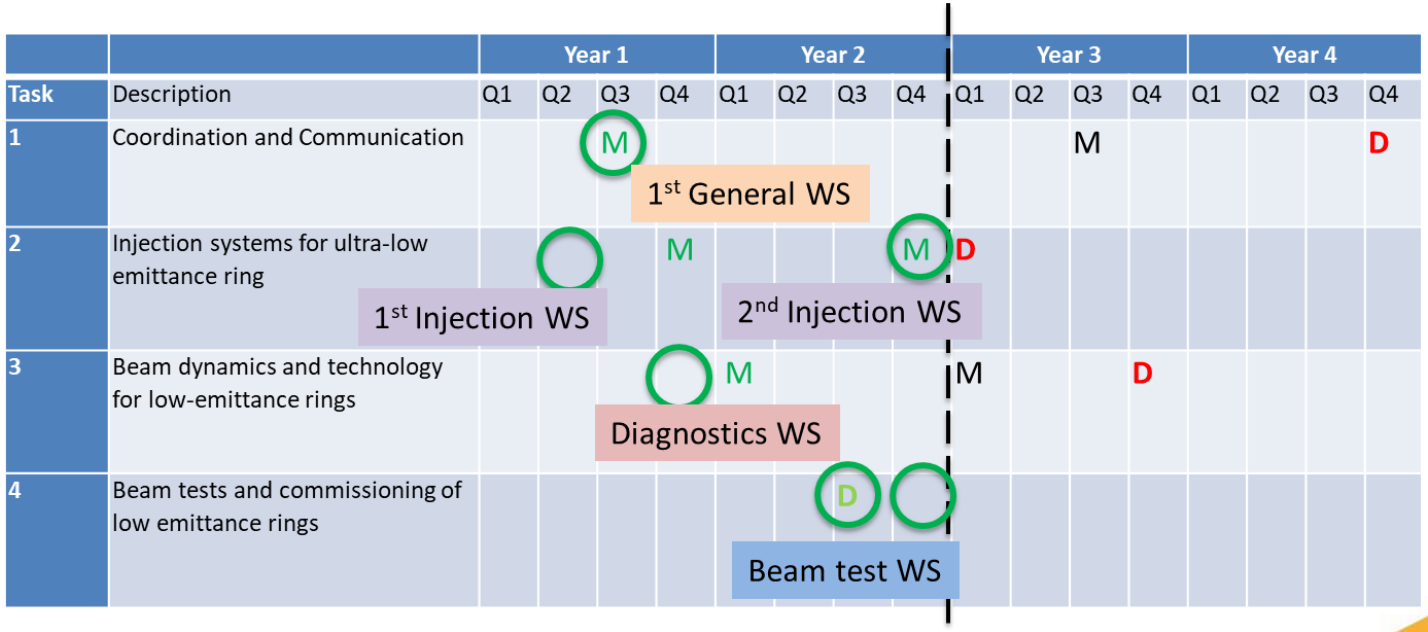
Cost-figure-of-merit versus power-figure-of-merit for future lepton colliders (Jean-Pierre Delahaye).

WP7 – Rings with Ultra-Low Emittance

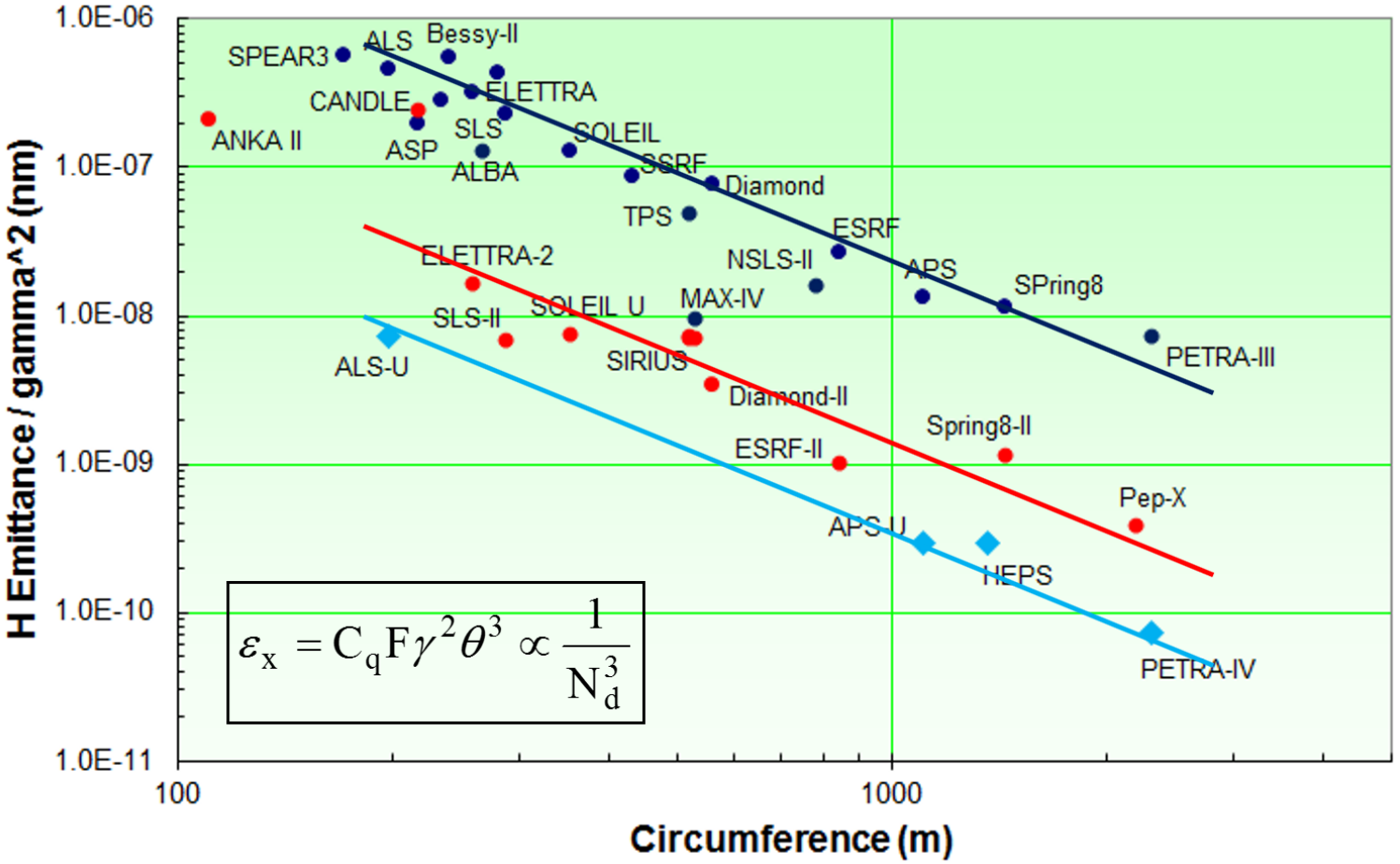
WP7 – Rings with ultra-low emittance

Fostering **networking** activities, exchange of ideas and staff in the accelerator community involved in **design, construction and operation of ultra-low emittance rings** (light sources, HEP: damping rings and colliders)

- Task 7.1. Coordination and Communication (R. Bartolini, UOXF)
- Task 7.2. Injection Systems for U-LER (R. Bartolini, UOXF, M. Boege, PSI)
- Task 7.3. Technology for ultra low emittance rings
  (Y. Papaphilippou, CERN, M. Biagini, INFN, R. Nagaoka, SOLEIL)
- Task 7.4. Beam tests and commissioning of U-LER (A.S. Mueller, KIT-ANKA)



WP7 RULε: present landscape



DBA/DTA

MBA + technology

On-axis inj. + technology

WP7 RULε: 2nd injection workshop (PSI)

2nd Topical Workshop on **Injection and Injection Systems** (PSI, Villigen, 1-3 April 2019) – 35 participants

Main goals:
Injection in **small apertures** (6D, DA, MA), for **transparent top-up** (injection transient), with **high injection efficiency** (reduce losses for low radiation dose and PM demagnetisation)

Study of novel injection schemes:

Off axis injection with anti-septum: SLS-II, Diamond-II

allows ~ 3mm separation of injected and stored beam; but nonzero transient

Off axis injection with NLK: Bessy-II, MAX-IV)

ok at MAX IV – heating issues – difficult to build

On axis longitudinal injection schemes: off-energy (SLS-II, SOLEIL, HEPS, …)

an impressively large number of variants (see later on beam tests)

Swap out injection: APS-U, ALS-U, HEPS, Petra-IV, …

allows extremely pushed lattices – need fast kickers and demanding injector

Hardware development:

New kickers (MIK) and fast kicker pulsers: e.g. 20 kV- 10 ns;
New boosters for low emittance or Linac injectors
Accumulators rings for swap-out injection: injection of full charge per bunch

Task.7.4: beam tests and commissioning

Topical workshop on **beam tests and commissioning of LER**
(KIT, Karlsruhe, 18-20 February 2019)
81 participants

Review the commissioning experience:
MAX IV experience – still the first and only LER - lesson learned P. Tavares
Main commissioning issues were relate to simple problems that risked to slow down progress rather than fundamental issues

- polarity inversion
- short circuited pole face stripes – poor isolations
- misplaced thermal switches on coils – no temperature information (ILK)
- misaligned vacuum chamber
- chamber hot spot

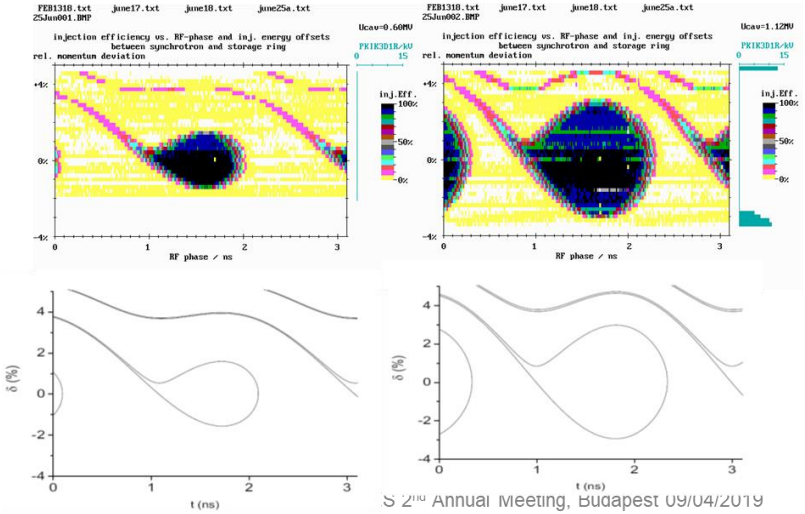
All emphasised the need for adequate preparation:
High level software and diagnostics readiness

Subsystem testing:
use final control system for commission and be ready with the relevant software

Do not want surprises when you start the commissioning …but one cannot foresee everything.

beam tests: off energy injection at BESSY-II

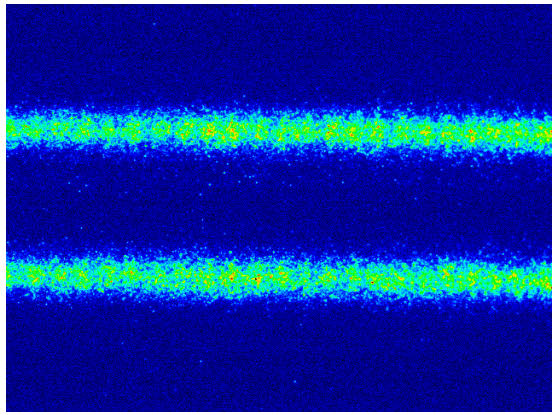
Two machine shifts were performed at the BESSY-II Feb and Jun 2018



Injection efficiency as a function of off energy and off phase creates a golf club structure that is well replicated by the numerical simulations

Poor injection efficiency in the golf club due to long bunches from bessy booster

beam tests: with (large) negative alpha



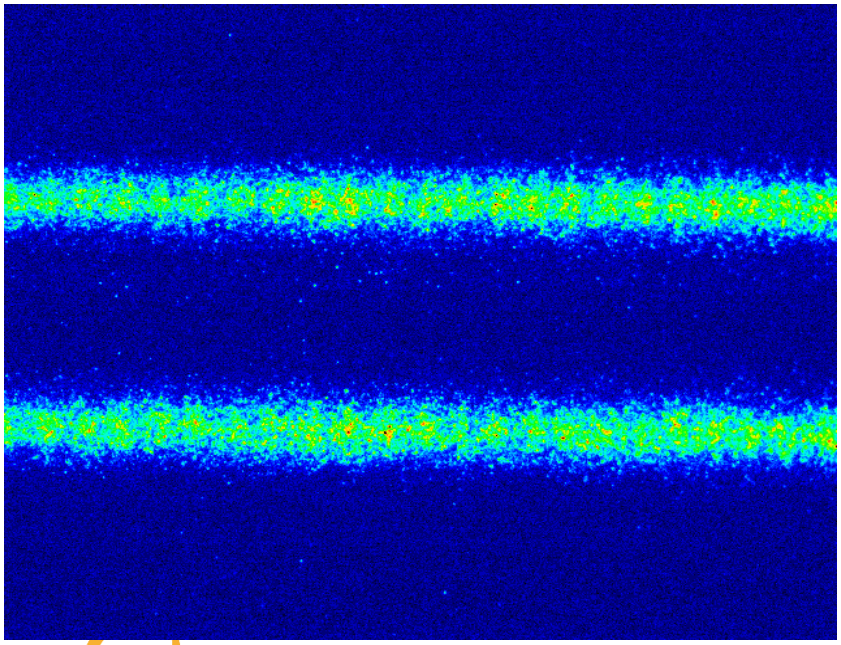
streak camera of first beam injection in negative alpha

Energy	500 MeV
Alpha	- few 1e-3
Bunch length	~ 50ps FWHM
stored current	2 mA now

beam tests: with (large) negative alpha

In the past, studies of **low alpha** dynamics were intentionally pursued in the light source storage ring community in the attempt to produce short bunches and CSR, rather than to lower the emittance (**“large” negative alpha** required)

Experiments are needed to investigate the “large” negative alpha operation. The operation might suffers from significant coherent instability, reducing significantly the stored current.



streak camera of first beam injection in negative alpha

Energy	500 MeV
Alpha	- few 1e-3
Bunch length	~ 50ps FWHM
stored current	2 mA now

More tests foreseen in April 19
WP11 transnational access in KARA

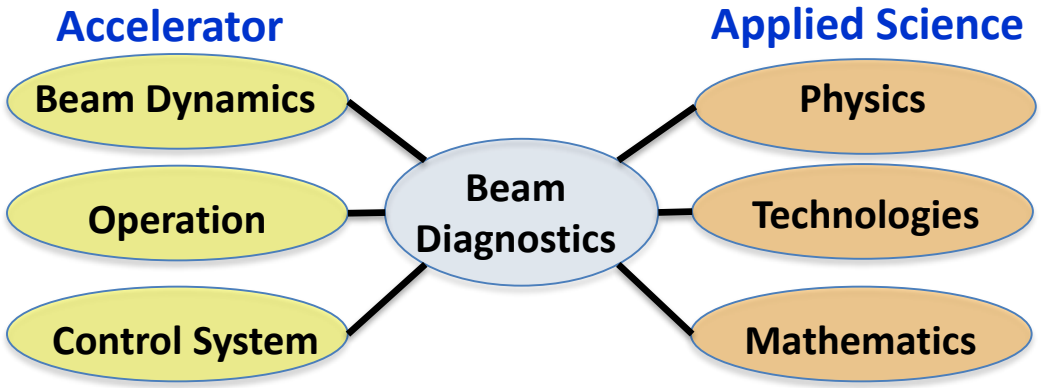
WP8 – Advanced Diagnostics at Accelerators

A Network on Beam Diagnostics

Task 8.1. Coordination and communication
Task 8.2. Advanced instrumentation for hadron LINACs
Task 8.3. Advanced instrumentation for hadron synchrotrons
Task 8.4. Advanced instrumentation for 3rd generation light sources
Task 8.5. Advanced instrumentation for FELs

Requirements for beam diagnostics at novel accelerators:

- Commissioning & enhanced operation of adequate diagnostics
- Instruments are based on different physics and techniques
- Design of diagnostics for novel accelerators



Goal of topical workshops → Focusing of activities at different labs:

- Discussion of requirements, improvements and novel methods of **one** subject
- Meeting of physicists, engineers, technicians from acc. labs, universities & industry
- Inclusion expertise from experts on other fields
- Documentation of state-of-the-art knowledge and realizations
- Envisaged number of participants is 30 to 50 (or even more...)

ARIES Topical Workshops up to Present and Plans for 2019

#	Date	Org. & location	Title of workshop	Part.	Task
1	May 22-24, 2017	GSI Darmstadt	Simulation, Design & Operation of Ionization Profile Monitors	33	2 & 3
2	Jan. 29-30, 2018	ALBA Barcelona	Emittance Measurements for Light Sources and FELs	37	4 & 5
3	May 14-16, 2018	CERN Geneva	Extracting Information from electro-magnetic monitors in Hadron Accelerators	32	3
4	June 25-27, 2018	DESY Hamburg	Longitudinal Diagnostics at FELs (co-sponsoring)	45	5
5 & 6	Nov. 12-14, 2018	ALBA Barcelona	Next Generation Beam Position Acquisition and Feedback Systems Two in one event: hadron - common - electron	84	3 & 4
7	April 1-3, 2019	GSI Krakow	Scintillation Screens and Optical Technology for transverse Profile Measurements	49	2, 4 & 5
8	June 3-5, 2019	ALBA & ESRF Grenoble	Diagnostics Experts of European Light Sources (DEELS) (co-sponsoring)		4
9	Nov. 2019	CERN Geneva or Oxford	Novel materials & mechanical methods for instrumentation		2 & 3

Workshop Scintillation Screens: Profile Measurement versus Detector Appl.

Difference to traditional applications in high energy physics, medical imaging & security:

Parameter	Physics, Medical	Hadron acc.	Electron acc.
Application	Secondary part.	Primary beam transverse profile	
Particle rate	Low	High	Very high
Energy	Up to 10 GeV	10 keV...100 GeV	100 keV...10 GeV
Spot size	10...100 mm	1...50 mm	0.01...1 mm
Spatial resolution	1 mm	100 µm	10 µm
Deposited dose	Low	Very high	Medium
Saturation	None	Expected	Possible
Radiation damage	Low	Very high	High

Corutesy B. Walasek-Höhne GSI, G. Kube DESY

Accelerators:

- Some time same material used e.g. YAG:Ce for electron beams
- Sometimes different requirements e.g. ceramic Al $_2O_3$:Cr (Chromox ‘)
- Quite different demands....

Scintillation Screens and Optical Technology for transverse Profile Measurements

Workshop on 1st to 3rd of April 2019 in Krakow

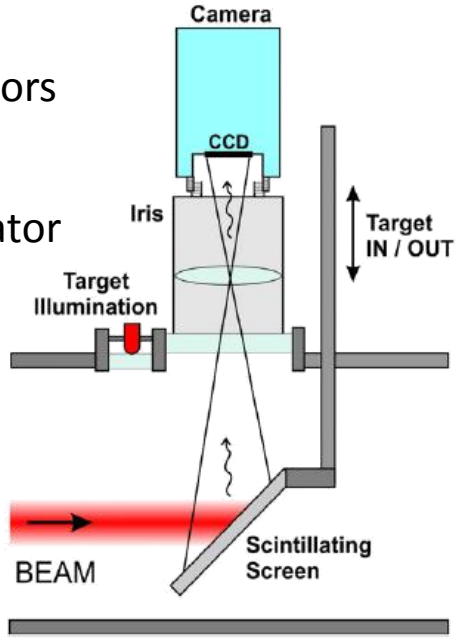
see indico.cern.ch/event/765975/

49 participants

incl. material research, laser acceleration, industry

- Physics and production techniques of scintillators
- Optics and cameras
- Experiences at hadron accelerators
  → mainly radiation hardness
- Experiences at electron accelerator
  → mainly resolution limits
- Three talks by industry

Simple set-up,
but non-trivial physics



Workshop Scintillation Screens: Topic 1 - Physics of Scintillation

Talks on scintillation process by experts

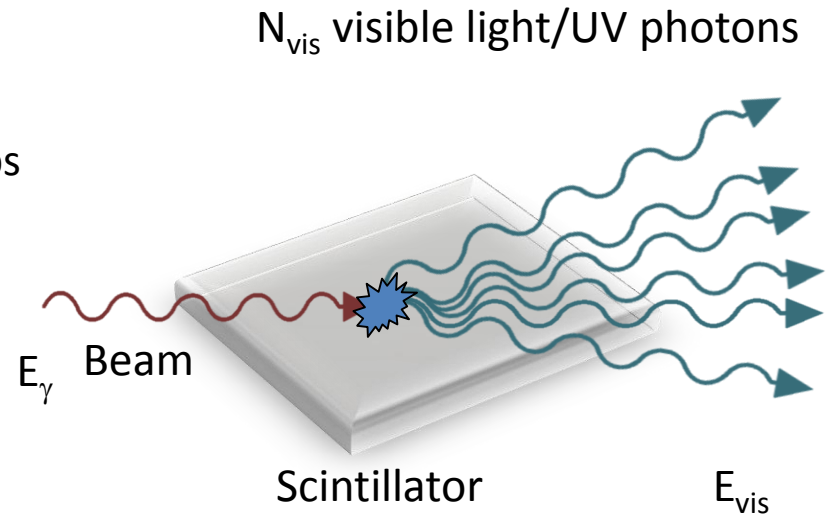
- Liberation of fast electrons by beam particle
- Thermalization within conducting band within ≈ ps
- Trapping at imperfection or dopants ≈ ns
- Light emission ≈ 100 ns

⇒ Material dependent

⇒ Controllable by matrix and dopant

Accelerators: Large energy loss in small volume

→ Informal collaboration established



Courtesy W. Wolszczak TU-Delft & E. Auffray CERN

Talks inorganic scintillator production by industry

- Extensive production method
- Detailed quality assurance required

Accelerators:

- Demands for high energy deposition
- Mechanical stability
- Vacuum capability

⇒ Intensive discussion on material choice

Courtesy J. Parizek CRYTUR

Workshop Scintillation Screens: Topic 2 – Optics & Cameras

Optics: Old principles & recent realization

- Scheimpflug criterion & tele-centric lens
  ⇒ no image deformation
- Appropriate camera sensor technology
- Camera digital interface
- Camera cauterization by fixed norm

Accelerators:

⇒ Improved installation at some facilities

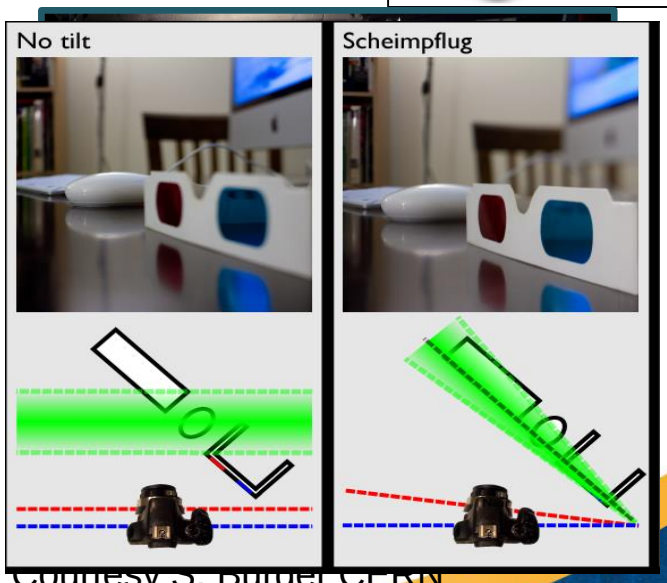
Radiation hardness tests

- Radiation hardness
  e.g. at CERN CHARM with 24 GeV protons
  Result: Digital interface failure of few shots
  Image sensor still acceptable after 500 Gy
- Fibre bundle versus telescope

Accelerators:

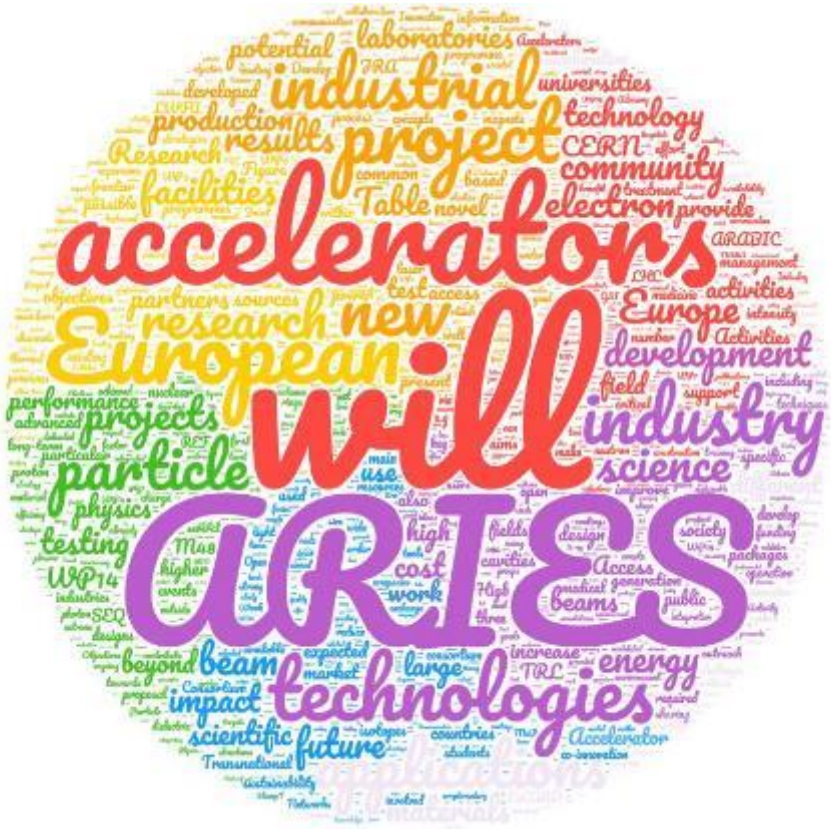
⇒ Requirement for radiation-hard digital cameras!

Courtesy S. Gibson RHUL, M. Veronese ELETTRA



Courtesy S. Burger CERN

Thank you for your attention (to this 1st presentation)



The ARIES word cloud