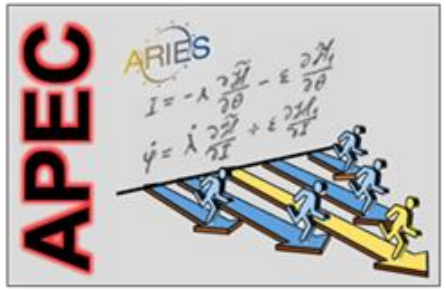
Welcome to BSW22 Valencia !

ARIES WP6 APEC & iFAST WP5.2 SMART PAF brainstorming & strategy ***in-person non-virtual*** meeting

29 March – 1 April 2022

organizers: Angeles Faus Golfe (IJCLab), Giuliano Franchetti (GSI), Frank Zimmermann (CERN)

what is/was ARIES WP6 ?



Accelerator Performance and Concepts (APEC) 2017-2021

http://aries.web.cern.ch/content/wp6

coordinators: Alessandro Drago (INFN-LNF), Giuliano Franchetti (GSI & GUF), Johannes Gutleber (CERN), Klaus Höppner (HIT), Florian Hug (JGU), Mauro Migliorati (Sapienza), Marco Zanetti (Padua) and Frank Zimmermann (CERN)

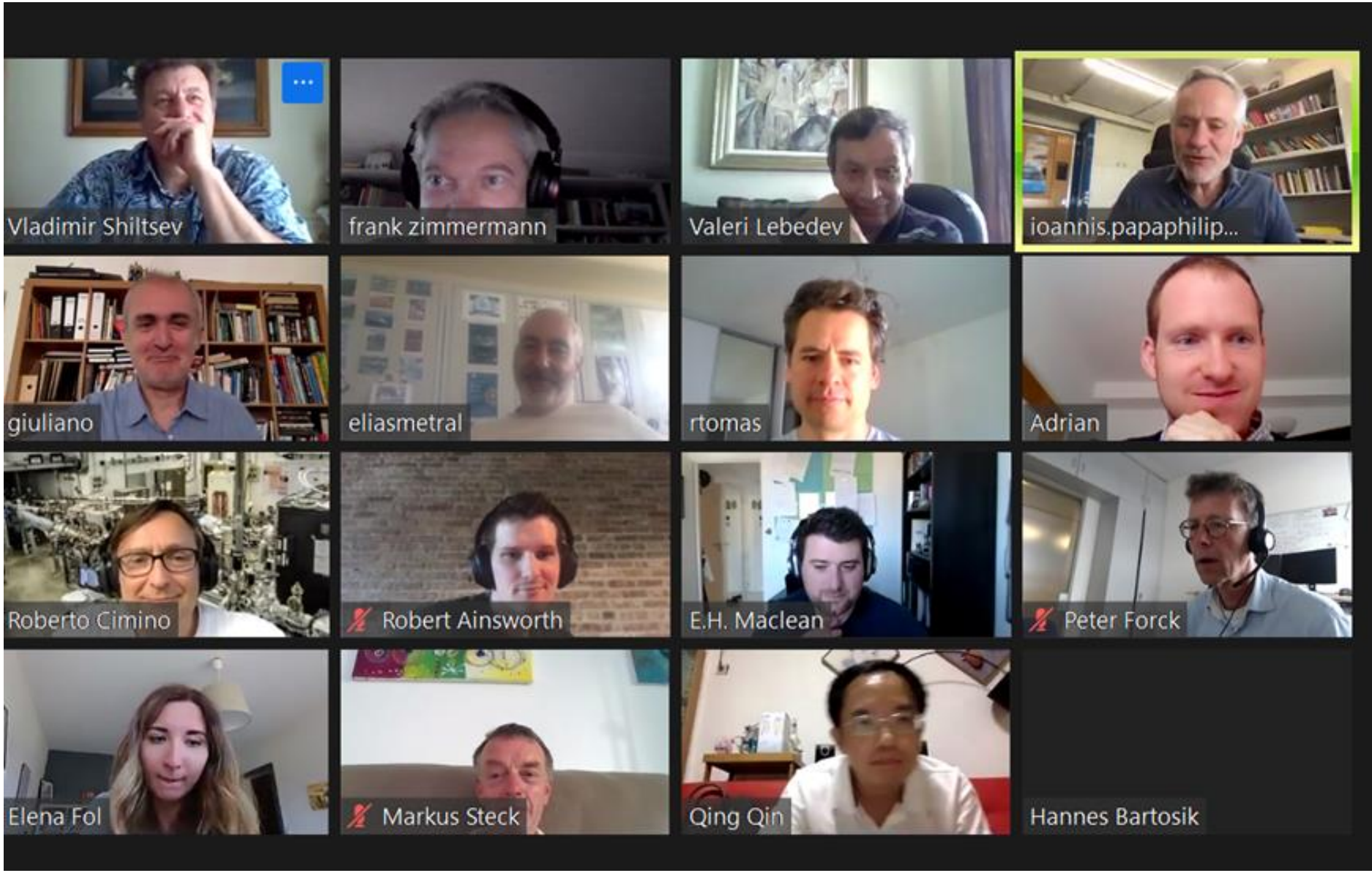
HORIZON 2020

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 730871.

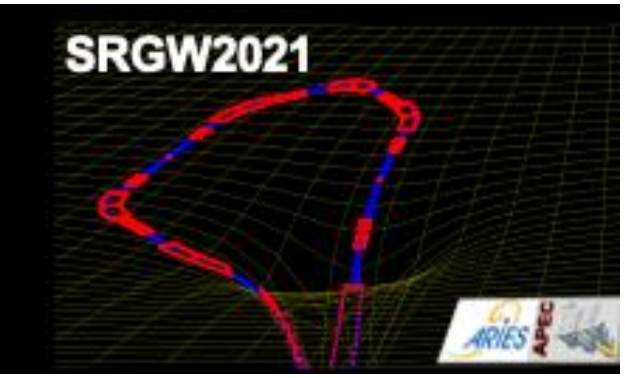
ARIES-APEC workshop on "**Mitigation Approaches for Hadron Storage Rings and Synchrotrons**" (Mitigations2020) was held, during the covid-19 pandemic, from 22 June to 1 July in a safe virtual space; chaired by G. Franchetti and F. Zimmermann

summary report from scientific secretaries (Alexander Engeda, Elena Fol, Michael Hofer, Annemarie Lauterbach, Giulia Russo, Tirsi Prebiba) + **survey on SC mitigation**

118 participants



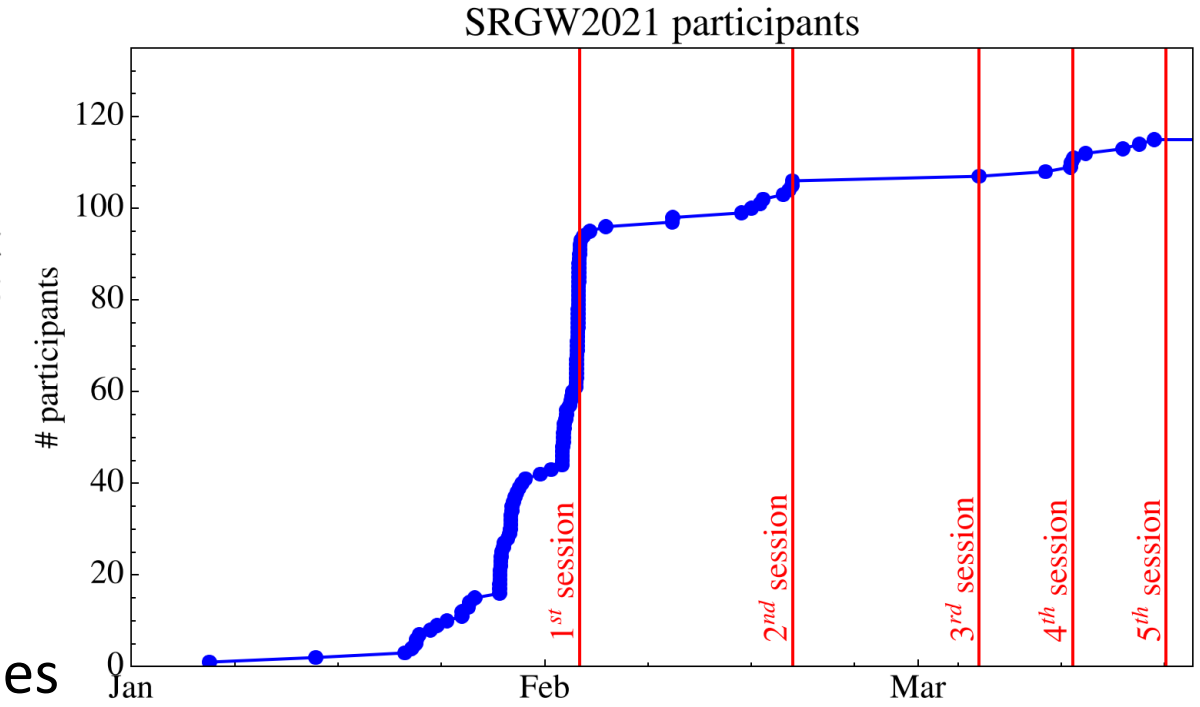
ARIES Workshop on Storage Rings and Gravitational Waves (SRGW2021), virtual space, 2 February -18 March 2021 ; chaired by G. Franchetti, Marco Zanetti, and F. Zimmermann



Scientific Programme Committee

William A. Barletta	MIT
Pisin Chen	NTU
Raffaele-Tito D'Agnolo	IPHT
Raffaele Flaminio	LAPP
Giuliano Franchetti (co-chair)	GSI
Shyh-Yuan Lee	Indiana U
Katsunobu Oide	CERN & KEK
Qing Qin	ESRF & U. Peking
Jorg Wenninger	CERN
Marco Zanetti (co-chair)	U. Padova
Frank Zimmermann (co-chair)	CERN

115 registered participants



main focus: detection and/or generation of gravitational waves or other gravity effects using storage rings & accelerator technologies

Sessions:

2/2/2021, **Introduction to Gravitational Waves and their effects,** chair: *Pisin Chen / NTU Taiwan*
18/2/2021, **Measurements and sensitivity,** chair**:** *Shyh-Yuan Lee / Indiana U*
4/3/2021, **Proposals and Schemes**, chair*: Jörg Wenninger / CERN*
11/3/2021, **Gravitational wave generation and detection,** chair: *Frank Zimmermann / CERN*
18/3/2021, **Ground motion and final discussion,** chairs: *Giuliano Franchetti/GSI; John Ellis/CERN*

ARIES WP6 milestones and deliverables

a job well done

White List of Ranked Far-Future Accelerator Options

April 2021

ARIES D6.5

Time scale	Priority and focus
10-15 years	Energy recovery Crystal bending Gamma Factory
15-30 years	Proton based muon collider Plasma acceleration Positron based muon collider Crystal and nanostructure acceleration Gravitational wave detection using storage rings
	Low or no priority
	Photon collider Crystalline beams “Moessbauer acceleration” using photon entanglement Gravitational wave generation using accelerators Non-electromagnetic acceleration or focusing mechanisms

key results from WP6 APEC

- **ERL R&D guidelines** [D6.4]

(1) test facilities, (2) beam dynamics & diagnostics, (3) electron sources & injectors, (4) SRF: high loaded Q cavity operation; HOMs, HOM damping & high current operation; high Q_0 cavity performance

- **optimal RAMS characteristics for accelerators** [D6.2]

availability critical systems and availability model (FCC-ee); measures to improve reliability of power converters, RF system, and electrical distribution (lead causes of unavailability for CERN's normal conducting machines); operations modelling platform (FCC-hh) for allocating availability goals to different sub-machines, fault-tolerant system design

- **performance limitations in hadron synchrotrons** [D6.1]

beam loss, single-bunch instabilities, & nonlinearities prominent

- **mitigation measures** [MS31, D6.3]

Landau octupoles, bunch-by-bunch feedback, optimised tunes, and tailored slippage factor; novel techniques emerging ; for Space Charge: reduced the peak intensity (CERN, PSB, JPARC),resonance compensation, optimized lattice & working point; future e-lenses ; Impedance: mechanical design optimization, feedback systems, advanced coatings (HTS,…)

- **ranking of (far-)future accelerator options** [D6.5]

(1) **energy recovery linacs**, crystal bending, **Gamma Factory**

(2) **muon collider(s),** plasma & **crystal & nanostr. acceleration, gravitational wave detection**

what is iFAST WP5?

WP5: Strategies and Milestones for Accelerator Research and Technologies (SMART)

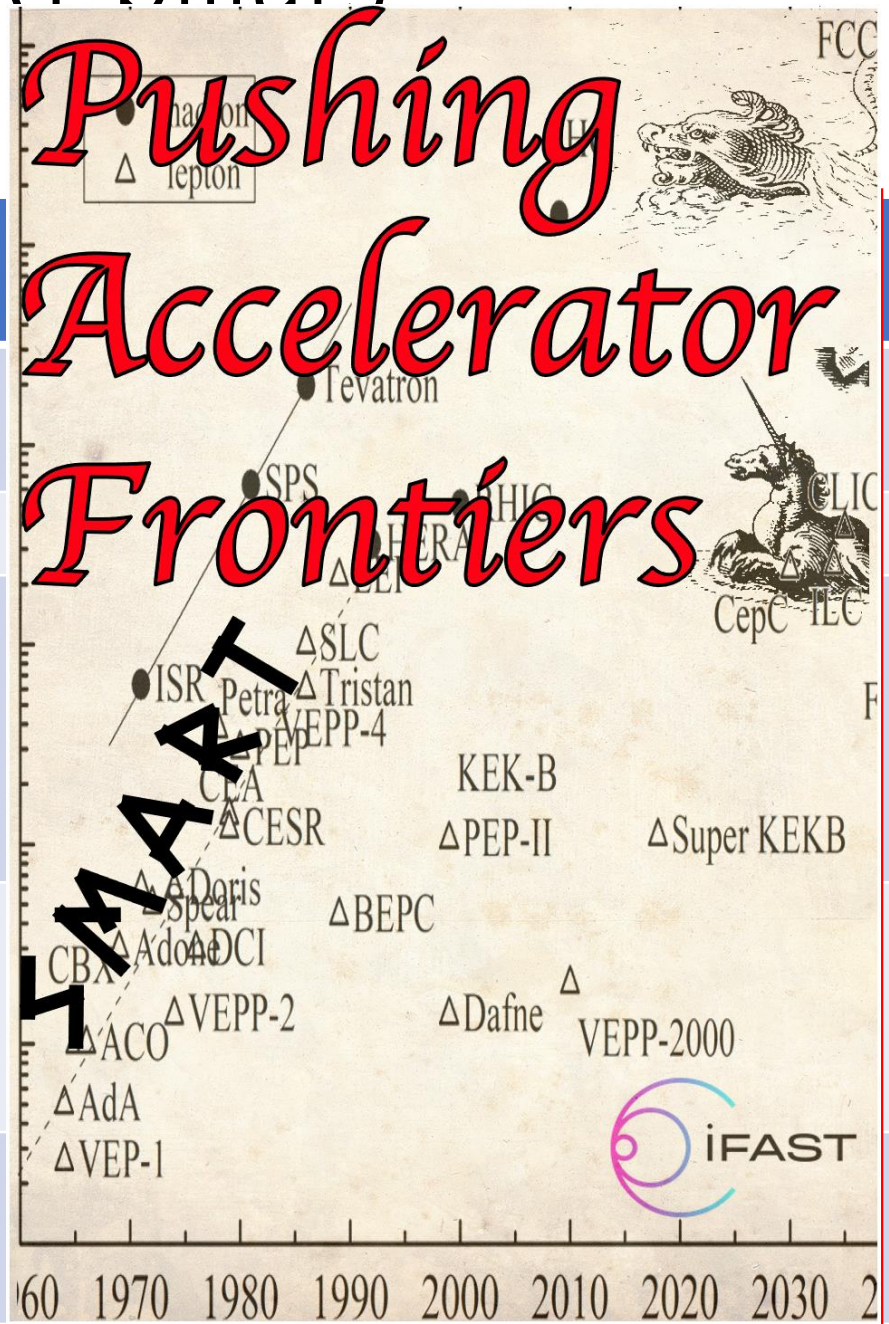
Peter Forck (GSI), Giuliano Franchetti (GSI), Nadia Pastrone (INFN),
Frank Zimmermann (CERN)




Participating Institutes:
INFN, CERN, CEA, CNRS, KIT, PSI, United Kingdom Research and Innovation, GSI, Bergoz Instrumentation, Barthel HF-Technik GmbH, HIT Heidelberg + JGU Mainz

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

the three SMART pillars



Task 5.1 MUon colliders STrategy network (MUST)	Task 5.3 Improvement of Resonant slow EXtraction spill quality (REX)
Coord.: Nadia Pastrone (INFN)	Coord.: Peter Forck (GSI)
INFN, CERN, CEA, CNRS, KIT, PSI, UKRI	*GSI, BI, BT, CERN, HIT*
Support the effort to design a muon collider and to project and plan the required R&D.	Mitigate intensity fluctuations of slowly extracted beam from synchrotrons by means of detailed parameter simulations, related experimental verifications, and active beam control
Consolidate the community devoted to developing an international future facility.	Produce a prototype of improved hardware for power supply control to achieve a current stability in the range of $\Delta I / I < 10^{-6}$.
Prepare the platform to disseminate the information	Design and produce a high-performance RF-amplifier with versatile control for knock-out extraction.

Task 5.2 Pushing Accelerator Frontiers (PAF)

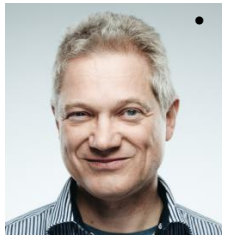
- **Main tools:** **topical workshops and dedicated prospective studies**

- **Overriding goal:** survey **frontiers of classical accelerators and develop long-term strategies** for boosting the performance of **future facilities** and for **overcoming limitations**

- **Thrust 1:** networking on **novel intense positron sources**, providing a **"condensation point" for the worldwide positron-source community** (**CNRS – Iryna Chaikovska**)

  - different methods of e^+ production, both classical techniques & especially novel/exotic ones

- **Thrust 2:** **survey extreme beams and ultimate limits**, and examine **approaches to overcome the present limits on beam brightness** (**CERN – Frank Zimmermann, GSI – Giuliano Franchetti**)



F. Zimmermann, R. Assmann, M. Bai, G. Franchetti, ***Review of Accelerator Limitations and Routes to Ultimate Beams***, IPAC'21

  - **space-charge compensation or cooling, crystalline beams,..**
  - review the ultimate limits on **high-gradient acceleration, high-field bending, beam size, beam density, and luminosity**

- IPAC'21 paper

Task 5.2 Pushing Accelerator Frontiers (PAF) – cont'd

- **Thrust 3:** **artificial intelligence for accelerators,** exploring applications of **machine learning, deep learning, advanced optimization algorithms and neural networks**, for accelerator control and design (**PSI – Rasmus Ischebeck**)

- **Thrust 4:** **accelerators for "dark sector"& precision physics**

  (**CERN – Christian Carli, GSI – Bernd Lorentz**)

  - accelerator/beam requirements for dark-sector searches in fixed-target experiments
  - investigating current precision frontier accelerator developments, such as EDM ring designs

focus of the Valencia meeting !

Task 5.2 Pushing Accelerator Frontiers (PAF) – cont'd

Thrust 5: **green accelerators, sustainable accelerator concepts, e.g. energy recovery, energy efficiency, and possibly particle (e.g. positron) recycling** (**CERN, GSI, CNRS, PSI, + JGU – Florian Hug**)

WP5 - **Task 5.2 PAF synergies:**
with Task 5.1 MUST: positron sources, ultimate limits, and particle recycling ..
with the Task 5.3 REX: dark sector fixed-target experiments and machine learning …

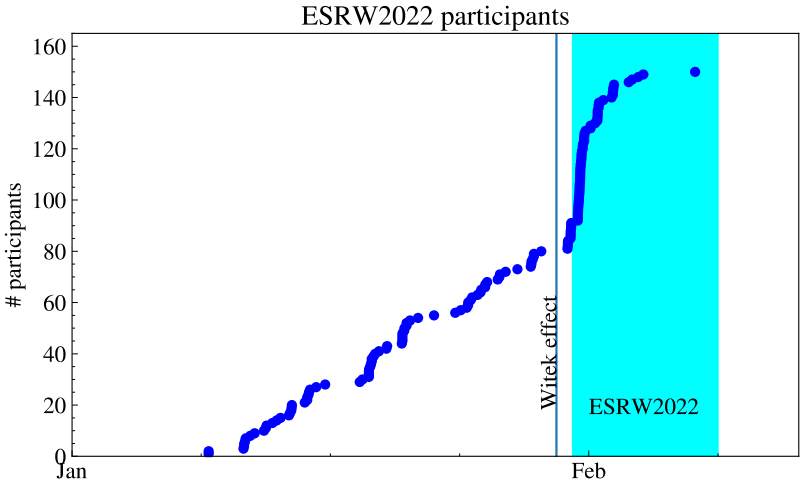
→ PAF will develop a coherent landscape for future accelerators and issue targeted R&D recommendations

PAF workshops so far

- ***Extreme Storage Rings Workshop (ESRW22)*** – virtual – 31 January to 8 February 2022, see next page

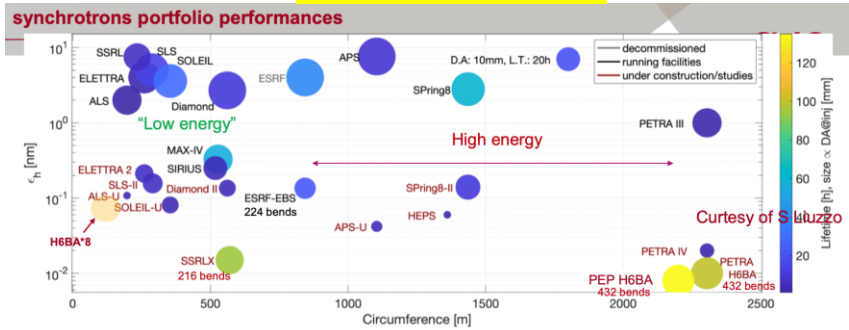
- Cross-boundary subjects with added value from collaboration and sharing of resources.
- Collaborative schemes involving laboratories, university and industry.
- Priority to longer-term high-risk high-gain R&D.

Maurizio Vretenar

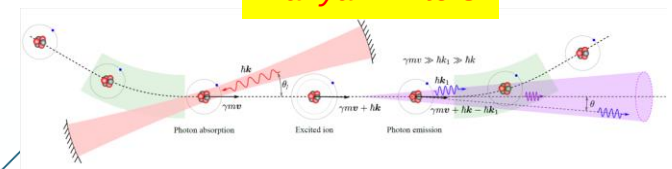


https://indico.cern.ch/event/1096767/

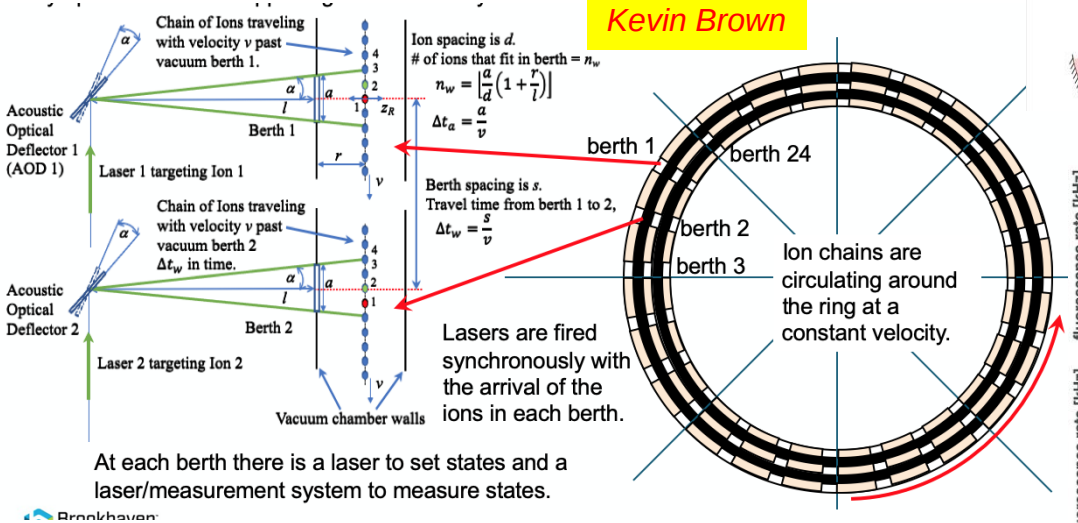
Pantaleo Raimondi



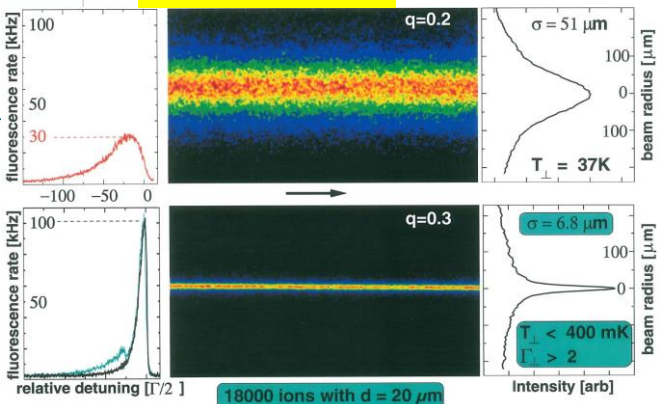
Danyal Winters



Kevin Brown



Tobias Schaetz



Dima Budker

WP5 deliverables

D5.1: International collaboration plans towards a multi-TeV muon collider Report on established collaboration and results disseminated by the action [MUST]	M46
D5.2: Roadmap for future accelerators **Strategy for intense positron sources; R&D plan towards ultimate beams; State of the art and possible directions for crystalline beams; Strategy and requirements for EDM ring or other precision experiments; Roadmap for accelerator AI; State of the art and future roadmap for green accelerators [PAF]**	**M42**
D5.3: Ripple mitigation for slow extraction beam quality improvement Simulation results for improvements including their experimental verifications, and design considerations of the accelerator control with related hardware. [REX]	M46

WP5 milestones

MS15	International workshop on muon source design	5.1	M18
MS17	**Beam requirements for dark-sector searches**	**5.2**	**M18 Oct. 22**
MS18	**Present and future AI accelerator applications**	**5.2**	**M24 May 23**
MS20	Engineering design of improved power supply current measurement and RF-amplifier layout	5.3	M24
MS16	International workshop to define R&D plans	5.1	M36
MS19	**Ultimate hadron-beam brightness**	**5.2**	**M48**

PAF workshops so far

- ***Extreme Storage Rings Workshop (ESRW22)*** – virtual – 31 January to 8 February 2022, see next page

- ***PAF brainstorming & strategy workshop***, in 30 March – 1 April, 2022 (departure 2 April) – ***this event !!***
  - <u>topics:</u>
    (1) present and future AI accelerator applications
    (2) beam requirements and accelerators for the dark sector

different from a zoom meeting

but be careful in shady streets (brazen thefts !)

already three results from last night

- Gamma Factory inevitable
- question marks on AWAKE and LHeC
- solution for powering the FCC

today we will start with the dark sector

in recent years more and more ideas and proposals :

- SHIP, FASER,… subsequent generations, … g-2, EDM…
- DASEL, eSPS,… what exactly is needed ?
- can advanced accelerator concepts find a purpose here?

- intra-workshop theme :

  might machine learning help the dark sector accelerator searches?