Work Package Description

Blue = Guidelines for filling out the sections

Title of the Workpackage

Strategies and Milestones for Accelerator Research and Technologies (SMART)

General Description *(4 lines)*

(Describe your Workpackage in maximum 4 lines)

WP5 (NA) Strategies and Milestones for Accelerator Research and Technologies (SMART): Fostering international collaborations, this NA will chart the future accelerator landscape and identify associated R&D priorities, in the areas of intense particle sources, advanced cooling techniques, extreme beams, ultimate limits, high-quality slow extraction, dark-sector accelerators, green and novel approaches.

Excellence *(1/2 page)*

Task 5.1 (MUST) will prepare the ground for a future high-energy muon collider by comparing several alternative options for muon production and cooling, by developing a baseline collider scenario, and by devising the optimum test facilities to prove the feasibility of such a collider. It will also serve as the common ground for a growing international muon-collider collaboration. The MUST effort will be unique, exploiting the results of the previous studies in the US and in Europe. At CERN a working group was established in 2017, to review the prospects of a muon collider as input to the European Strategy process. A joint exploratory workshop, held in the frame of ARIES Task 6.6 in 2018, allowed to discuss all the studies with a larger community. Other workshops followed, organised by the working group to develop a timeline and future plans, and to start coordinating the ongoing efforts by the international community. The recent revived interest in muon collider physics calls for a coherent effort to further build and support a collaboration able to cope with the challenges pertaining to an efficient and potentially low emittance muon source, and to a possible future muon collider. The ambition of Task 5.2 (PAF) is to improve long-term accelerator performance and to exploit novel opportunities, by leveraging the unique expertise of key partner institutes, and by building upon the results of ARIES WP6. Specifically, PAF will study novel schemes for positron production, e.g. by use of micro/nano-undulators, crystal undulators, or high-power lasers. It will boost hadron beam brightness, by space-charge compensation and various types of cooling, and by exploring the potential of crystalline beams. It will survey fundamental limits for extreme beams and conceive ultimate scenarios. PAF will also explore applications of artificial intelligence to accelerator control and accelerator design, which is a rapidly evolving field, where coordinated European efforts have so far been missing or lagging. It will, further, develop optimum accelerator configurations for dark-sector searches in fixed-target experiments, and review precision-frontier accelerator developments, including EDM rings. Building on other preparatory activities in ARIES (WP4 and WP6.5), PAF will, finally, advance sustainable accelerator concepts, by developing schemes for energy recovery, energy efficiency, and possibly particle (e.g. positron) recycling. Responding to an increasing strong demand from the accelerator users, and motivated by three past slow-extraction workshops partly organized in

the frames of EuCARD-2 and ARIES, Task 5.3 (REX) will improve the spill quality during resonant slow beam extraction by a multi-pronged approach, namely by developing feedback/feedforward system to cancel the effect of power supply ripple, by exploring new methods for controlling spill structure and extraction efficiency through quadrupole excitation or optimised knock-out waveform, and by monitoring the spill improvement over a large dynamic range of beam intensities with suitable new diagnostics. The improved spill structure will significantly reduce the beam time required per application.

(Explain in ½ page the excellence of your Workpackage with reference to present state-of-the-art, and the extent to which the proposed work is ambitious. Highlight the novelty of the proposed work in relation to other EU funded projects)

[Text]

Impact *(1/2 page)*

WP5 SMART will develop a coherent landscape for future accelerators and issue targeted R&D recommendations. By exploring new directions and fostering synergies between its different tasks and sub-tasks, it will identify and advance novel promising directions for the next- and next-next generation of high-energy accelerators. SMART will have a great impact on many different types of accelerator: lower energy consumption, accelerator control and optimization by artificial intelligence, more intense and possibly novel particle sources, higher-gradient/compact acceleration, brighter beams, higher-quality spills, etc. could be important on any scale and for a wide number of applications. Specifically:

Task 5.1 MUST will establish an international collaboration and develop an optimised R&D roadmap towards a future muon collider, including the definition of optimum test facilities and possible intermediate steps.

Task 5.2 PAF will deliver long-term strategies for future accelerator facilities and for overcoming existing limitations. Schemes for novel intense positron sources and, in general, brighter beams will boost accelerator performance and support numerous applications, in particle physics and beyond. Advanced accelerator precision, the targeted deployment of artificial intelligence, and greener accelerator technologies may lead to transformational changes in the accelerator field

Task 5.3 REX will significantly boost the operational performance of present and future accelerator facilities utilizing slow extraction, e.g. for medical applications, for GSI/FAIR facilities, and non-collider particle-physics programmes at CERN.

Table: Key exploitable results expected from I-FAST

Outline some of the main exploitable results expected from I-FAST.

Description of exploitable foreground	I-FAST deliver-able, month	How the foreground may be exploited	IPR measures foreseen	Further R&D (if needed)	Sector(s) of application or end user(s)	Potential/expect ed impact

Roadmap for future accelerators	D5.1 M42	Advertise at scientific conferences and industrial events; disseminate plan to policy makers	Open	Further improvements and prototypes possible	Accelerator Design and Operation	Higher-performance lepton and hadron accelerators; input to strategic decisions by policy makers
International collaboration plans towards a multi-TeV muon collider	D5.2 M46	Advertise at scientific conferences and industrial events; disseminate plan to policy makers	Open	Test facility and conceptual design study. New material tests possible	Particle Physics and Accelerator Design	Future energy-efficient, higher-energy muon collider
Ripple mitigation for slow extraction beam quality improvement	D5.3 M46	Advertise at scientific conferences and industrial events; implementation at existing facility	Open, see note	Further improvements and prototypes possible	Accelerator Operation, Hadron Therapy	Increased number of therapy patients treated per unit time; higher average event rates for other applications
Note: For the hardware produced by the industrial partners, the detailed technical designs might not be fully published, but might be a subject of patents.						