Near Term Applications of Advanced Accelerators

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White paper status

- View-only link: https://www.overleaf.com/read/jrtfpjfzgdxp
- Divided into 3 sections with relevant experts:
  - Light source applications - FEL, betatron, Compton, gamma ray
    - Multiple FEL groups, F. Albert, A. Murokh
  - Medical applications - laser ion acceleration, DLAs, VHEE radiation therapy
    - L. Obst-Huebl, J. England, L. Labate
  - Fundamental applications - beamdump experiments, astrophysical plasmas
    - S. Gessner, F. Fiuza
- Incorporated all contributions into a completed draft, sent to authors for feedback
- Finalizing executive summary, including connections to other topical groups/frontiers e.g. AF7 Accelerator Technology & Community Engagement Frontier

	Source	Example application	Status	Readiness in 5-10 years
Light Source	Plasma-based FEL [8]	Single-shot high-res imaging, non-linear excitation	Experimental feasibility demonstrated, two high-impact papers in 2021	Realistic at higher flux and photon energy in < 5 years
	Dielectric-structure FEL [9]	Medical imaging	Conceptual Development	Technology to be explored
	Cryo-cooled Copper FEL [10]	Ultrafast Imaging, Attosecond Science	Conceptual Design	Technology to be explored
	Betatron X-rays [11, 12]	Single-shot phase-contrast imaging of micro-structures	Extensive demonstrations	Ready now
	Compton-scattered X-rays [11, 12]	Compact dose-reduced medical imaging, HED dynamics	Proof-of-principle demonstrations	Tunable and mono-energetic in < 5 years
Medical (Particle Source)	Advanced gamma ray sources [13–16]	Security, efficient imaging at reduced dose	Experimental demonstrations (plasma based). Conceptual Development (non-plasma based)	Plasma-based ready now. Non-plasma based technology to be explored
	VHEE [17–19]	Low dose radiotherapy	Well established	Ready now
	Laser-solid ions [20]	Medical imaging, FLASH therapy, HED diagnostic	Extensive demonstrations in TNSA regime	Ready now, >100 MeV protons in <5 years
Fundamental	High-energy particle beams []	Beam-dump explorations, astro-physical plasmas	Initial experiments planned	Results from initial experiments expected in $\sim$5 years

Table 1: High-level summary of near term applications of advanced accelerators described in the manuscript. References, example applications, status and readiness in 5-10 years is included for each source.

Key Points from the Executive Summary

- Motivation for near term applications of AAC emphasized by previous community reports e.g. BRNs from 2020 on “Transformative Manufacturing” and “Microelectronics” and 2016 Advanced Accelerator Development strategy report
- Relevance of near-term applications **only** discussed in terms of communication/awareness among general public in Snowmass 2013
- International competition leading to concrete investment has emerged from language in the European Particle Physics report.
  - The EuPraxia project is explicitly pointed to as a concrete example
  - Major milestone plasma-based FEL results from Shanghai (laser-driven) and Frascati (beam-driven)
- We emphasize:
  - Development of near term applications drives improvements in stability, reliability,tunability which in turn accelerates road map to particle colliders
  - The need for investment in application-oriented facilities, and dedicated access to beamtime at existing facilities to optimize and render proof-of-principle technologies mature.

Plasma FEL “pre-white paper” publication

- “Free electron lasers driven by plasma accelerators: status and near-term prospects” published 09/10/2021 in HPLSE
  - https://www.cambridge.org/core/journals/high-power-laser-science-and-engineering/article/free-electron-lasers-driven-by-plasma-accelerators-status-and-nearterm-prospects/22B853D363AF76B5CD795558626638CC
- 8 Plasma FEL groups represented:
  - 4 LWFA: COXINEL, DESY-LUX, SIOM, LBNL-BELLA
  - 4 PWFA: SLAC FACET-II, DESY FlashForward, Strathclyde, EuPRAXIA
- Similar ~1-page contributions to be used in each section of white paper