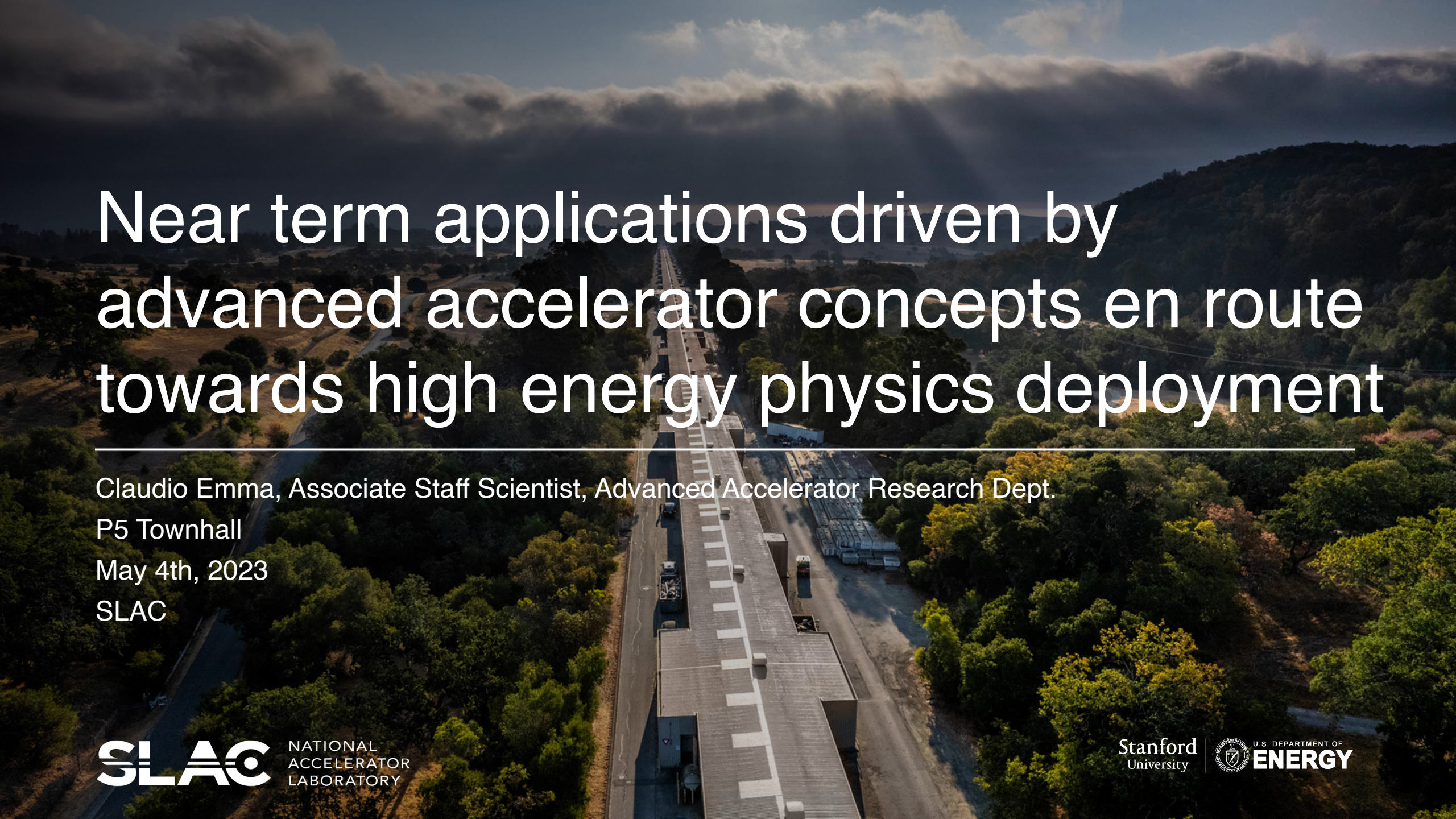


# Near term applications driven by advanced accelerator concepts en route towards high energy physics deployment

Claudio Emma, Associate Staff Scientist, Advanced Accelerator Research Dept.

P5 Townhall

May 4th, 2023

SLAC

SLAC NATIONAL ACCELERATOR LABORATORY

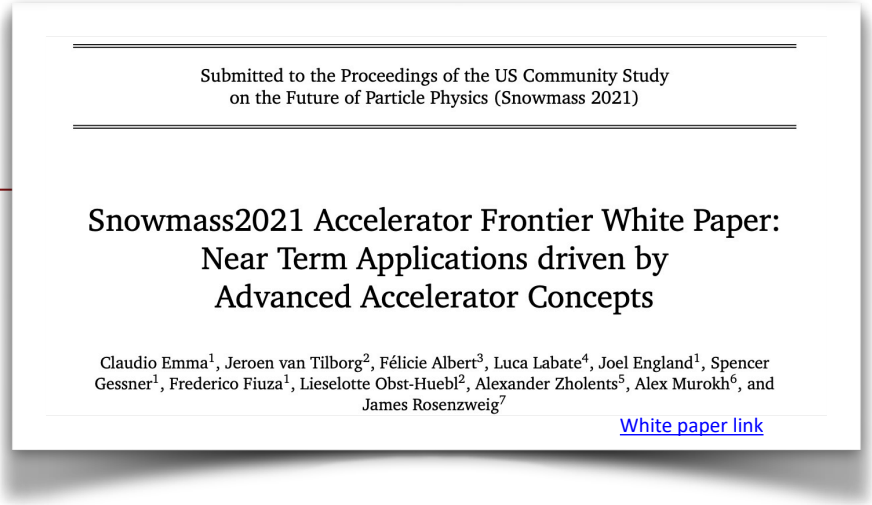
Stanford University | U.S. DEPARTMENT OF ENERGY

# Motivation for near term applications

1. Reduces cost and technical risk, improves control and reliability of AAC technology.

2. Provides important societal benefits e.g. in bringing diagnostic capabilities now only accessible in large facilities to clinical and industrial settings.

3. Increases community engagement, strengthens workforce development and recruitment/retention of early-career scientists.




A successful near-term application environment will naturally guide advanced accelerator technology to maturity

# Landscape and Recent Highlights

*High Power Laser Science and Engineering*, (2021), Vol. 9, e57, 15 pages.
doi: 10.1017/hpl.2021.39

HIGH POWER LASER SCIENCE AND ENGINEERING

REVIEW

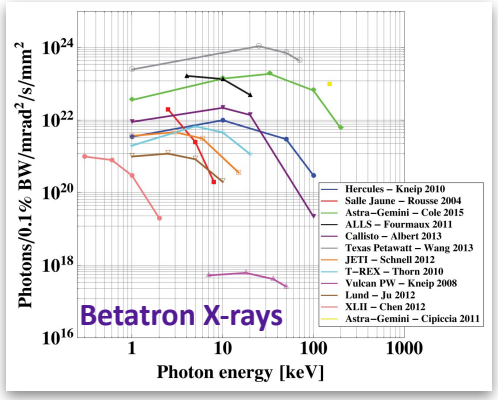
**Free electron lasers driven by plasma accelerators: status and near-term prospects**

Review paper link

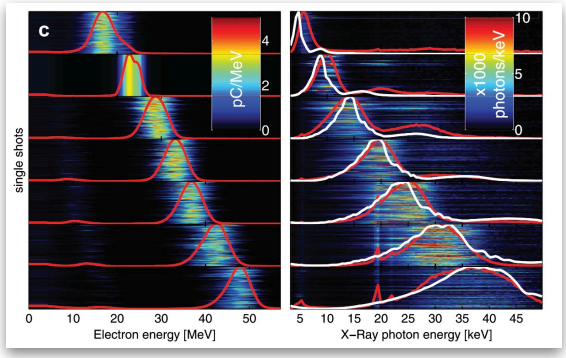
C. Emma[1], J. Van Tilborg[2], R. Assmann[3], S. Barber[2], A. Cianchi[4], S. Corde[5], M. E. Couprie[6], R. D'Arcy[3], M. Ferrario[4], A. F. Habib[7], B. Hidding[7], M. J. Hogan[1], C. B. Schroeder[2], A. Marinelli[1], M. Labat[6], R. Li[8], J. Liu[8], A. Loulergue[6], J. Osterhoff[3], A. R. Maier[3], B. W. J. McNeil[9,10], and W. Wang[8]

## *Light Sources*

F. Albert, A. Thomas, PPCF (2022)



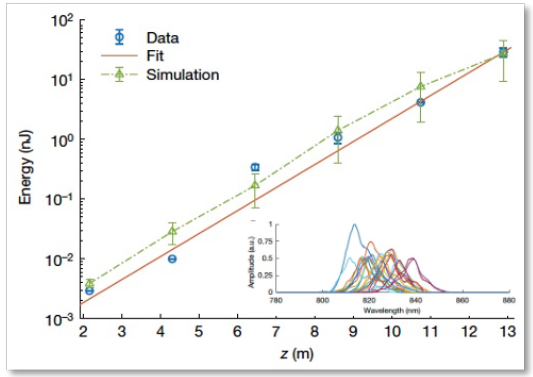

### LWFA-driven Compton Scattering



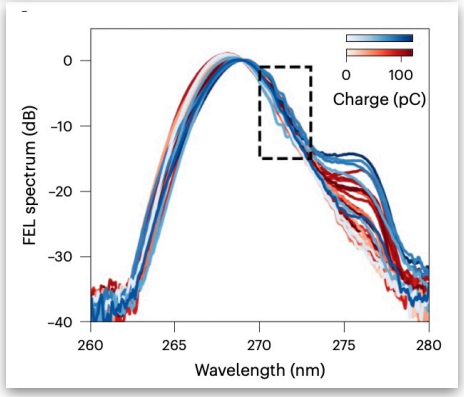

**e.g. Gamma-ray radiography of cargo**

### FEL demonstrations


W. Wang et al., Nature (2022)



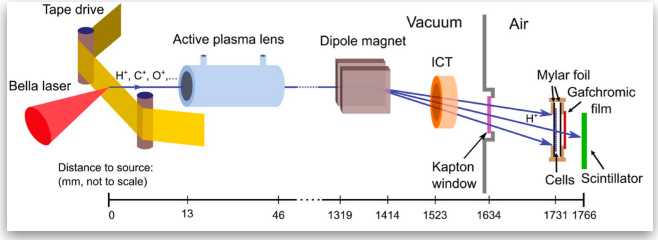

R. Pompili et al., Nature (2022)




M. Labat et al., Nature Photonics (2022)

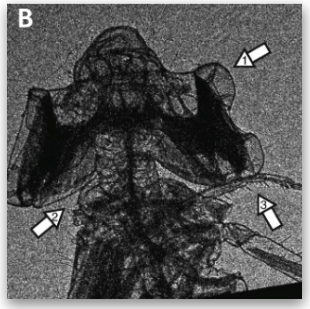
## *Bio-Medical Applications*

### Ion beams for cancer therapy (e.g. FLASH) at BELLA



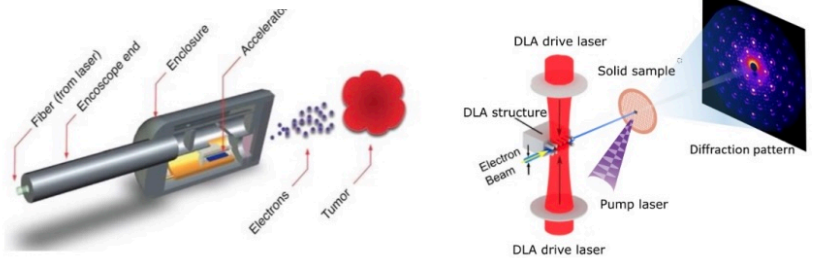

J.Bin et al., Scientific Reports (2022)

### X-ray imaging (diagnostics)



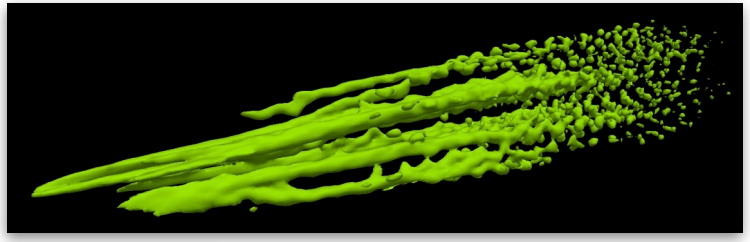

Kneip et al., Appl. Phys. Lett (2011)

### DLAs for RT and MeV UED



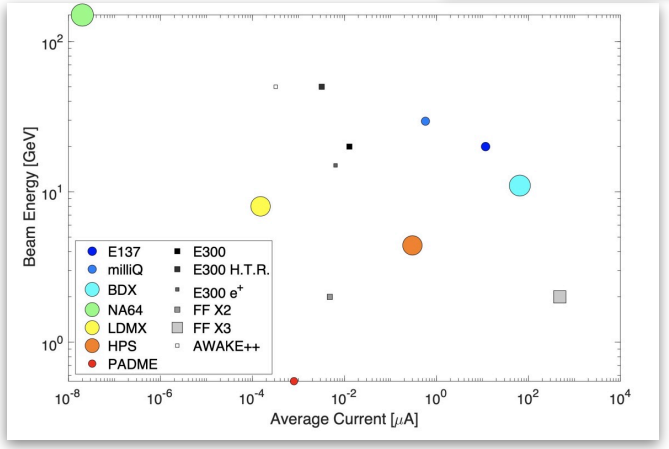

J. England et. al., Rev. Mod. Phys (2014)

## *Fundamental Applications*



S. Gessner et al., LOI to Snowmass 2021

S. Corde et al., FACET-II Science Workshop 2019




**Beam-plasma interactions relevant for astrophysical processes**

**Beamdump Experiments - searches for rare interactions and dark matter particles**

# Near-term application experiments at FACET-II

**E338 - Plasma-driven attosecond X-ray source**

C. Emma et al., APL Photonics (2021)

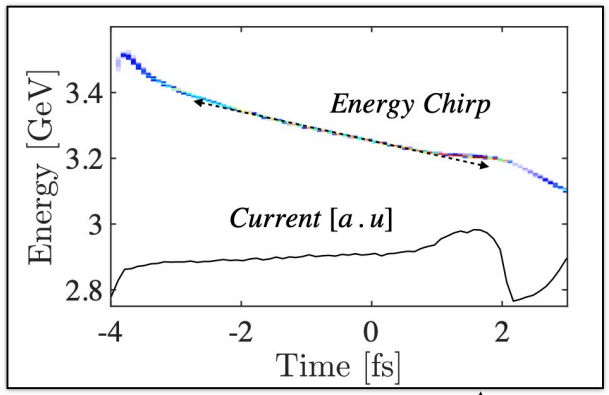
Large plasma fields impart large energy chirp

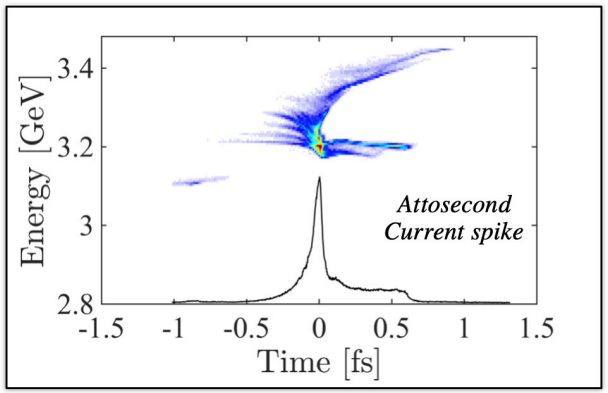
↓

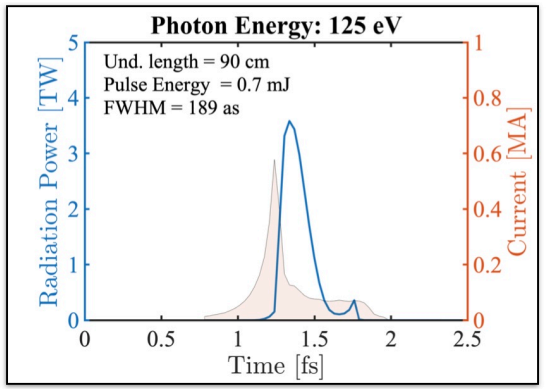
Weak chicane compresses e-beam to as-duration

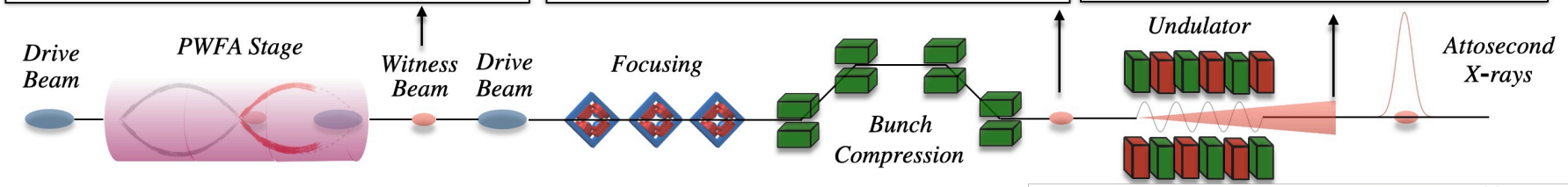
↓

Beam radiates soft X-rays in m-length undulator

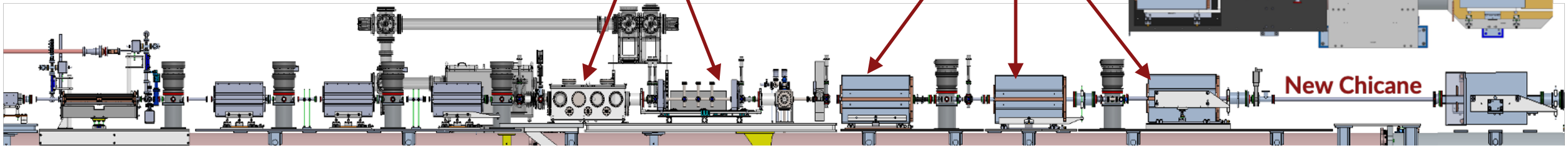



**FACET-II beamline layout**




Plasma-accelerated beams enable new attosecond light sources performance beyond what is possible with conventional accelerators + exploration of MA compression relevant for ABP thrust/short-bunch colliders

# Near-term application experiments at FACET-II

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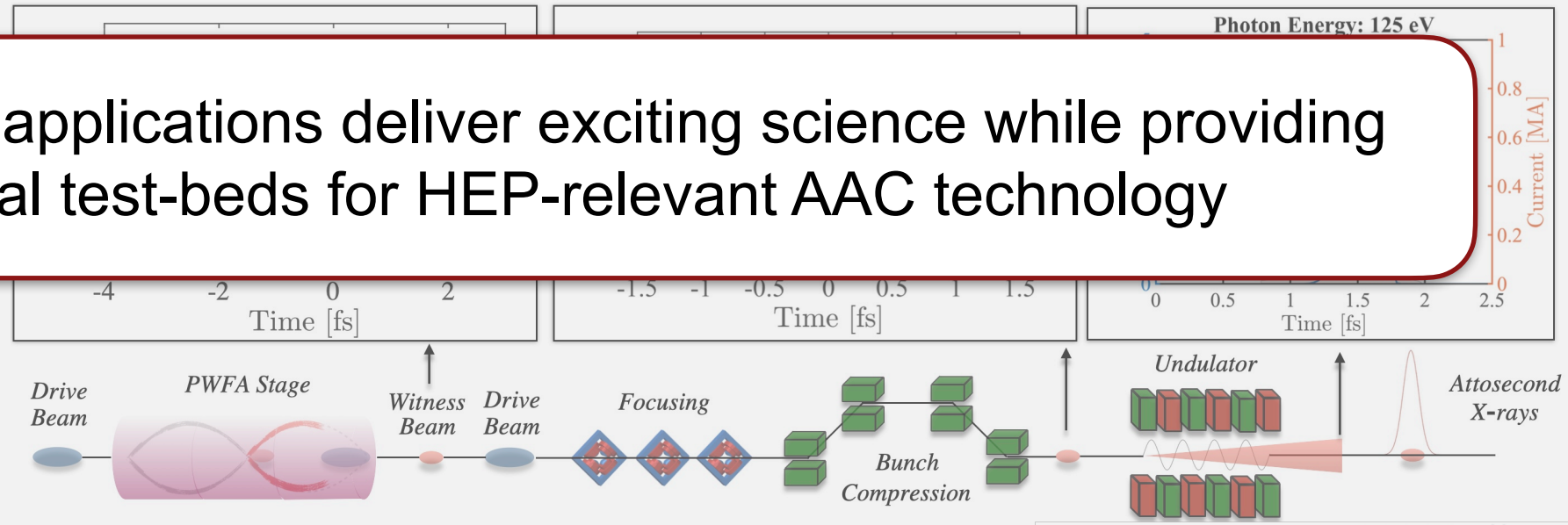
C. Emma et al., APL Photonics (2021)

Large … impart …

Weak ch… beam to … duration

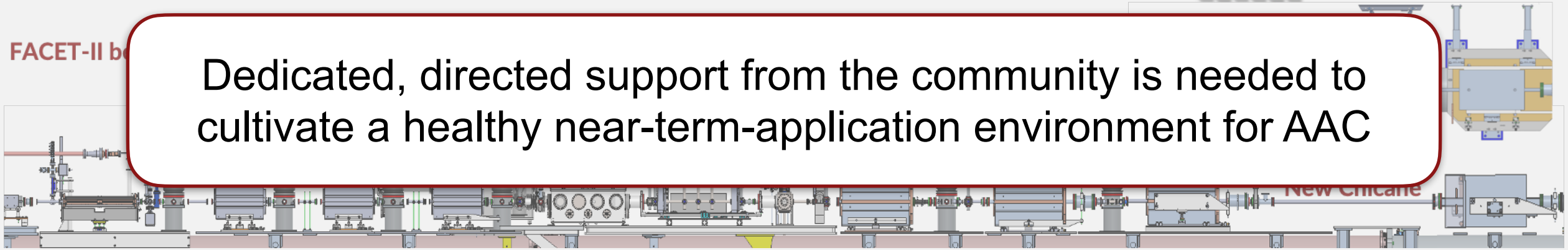
Beam radiates soft X-rays in m-length undulator




Near-term applications deliver exciting science while providing critical test-beds for HEP-relevant AAC technology

Dedicated, directed support from the community is needed to cultivate a healthy near-term-application environment for AAC

FACET-II b…

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