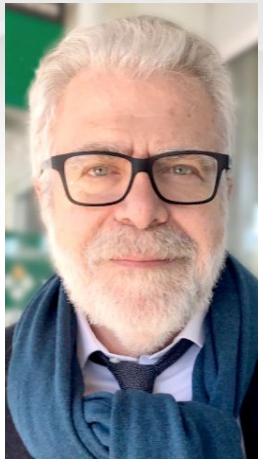
Panel members - BREAKTHROUGH IDEAS

Dimitris Charalambidis
Professor Emeritus of the Physics Department of the University of Crete, head of the attosecond S&T laboratory of FORTH-IESL in Heraklion, Crete and Chief Scientific Advisor of ELI-ALPS,

Rapporteur : Antonia Morabito

Sergei Bulanov
Department head at ELI-Beamlines in Czech Republic



Luis Roso
Director (founding) of CLPU & promotor of its creation.

Luís O. Silva
Professor of Physics at IST, University of Lisbon

IMPULSE is funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871161

Questions for Panel - BREAKTHROUGH IDEAS

- Which are the most exciting scientific/technological challenges to be tackled by high pulse energy, short pulse duration, high repetition rate laser and secondary sources operating at ELI?
- Which scientific disciplines are served best by high pulse energy, short pulse duration, high repetition rate laser and secondary sources?
- What are the near future developments that will promote high peak power, high repetition rate technologies beyond the current state of the art?

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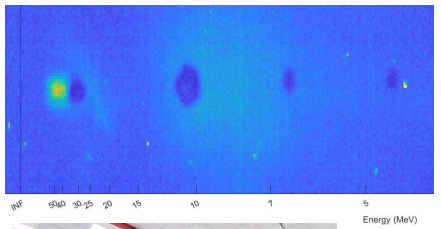
Breakthrough ideas from the ELI-BL Development of facilities, Experiment, Theoretical Physics for Applications and Fundamental Science

- LUIS: Laser accelerated electron based compact XFEL;
  L2 DUHA laser
- ELI-ELBA: Electron–Laser Collider for Fundamental Science; (GEV-L3: PW-10 Hz)
- ALFA: kHz Electron Acceleration with L1-ALLEGRA
- P3: plasma physics

XFEL (SACLA) Conception of tabletop XFEL

Eupraxia ESFRI

Fish eye picture of ELI-ELBA all-optical collider at ELI-Beamlines



Energy spectrum of 40 MeV electrons at 1 kHz. For material science & radiotherapy

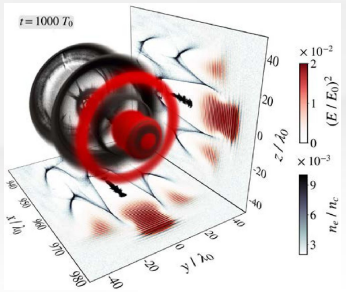
Warm dense matter

……

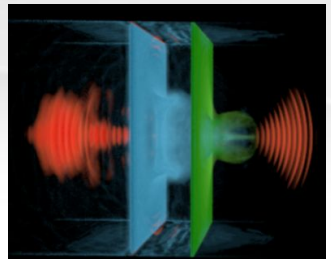
Gamma flash generation

Theoretical Physics & Astrophysics

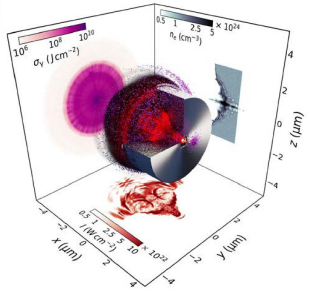
- LWFA: high energy electrons 10 – 100 GeV

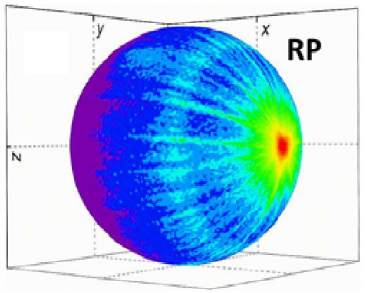


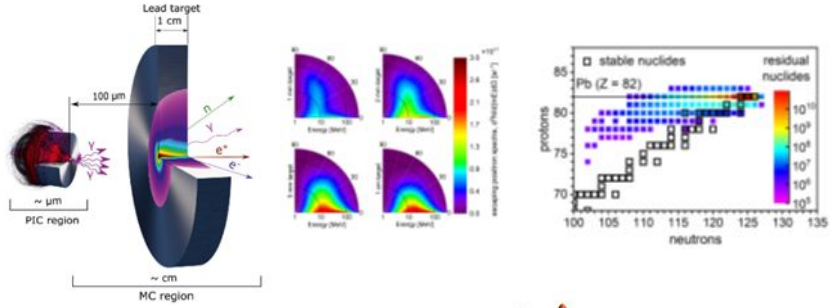
- RPA: high energy ions L4: 1 GeV



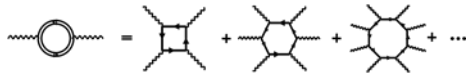
- GAMMA RAY FLASH: high γ-photon and el.-pos. conversion efficiency. Photo-nuclear reactions

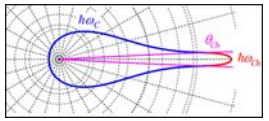


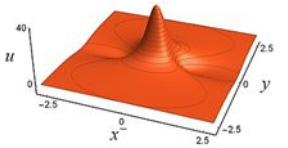




- LWFA electron – laser collision: QED vacuum polarization, el.-pos. creation



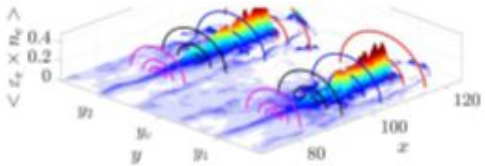


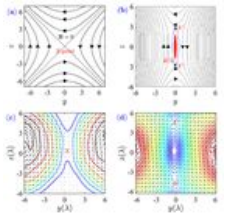


photon-photon scattering; Cherenkov radiation; nonlinear EM waves

- Space accelerator of cosmic rays: gamma ray flash

Magnetic reconnection
Charged particle acceleration
Gamma flash





Breakthrough ideas for laser acceleration

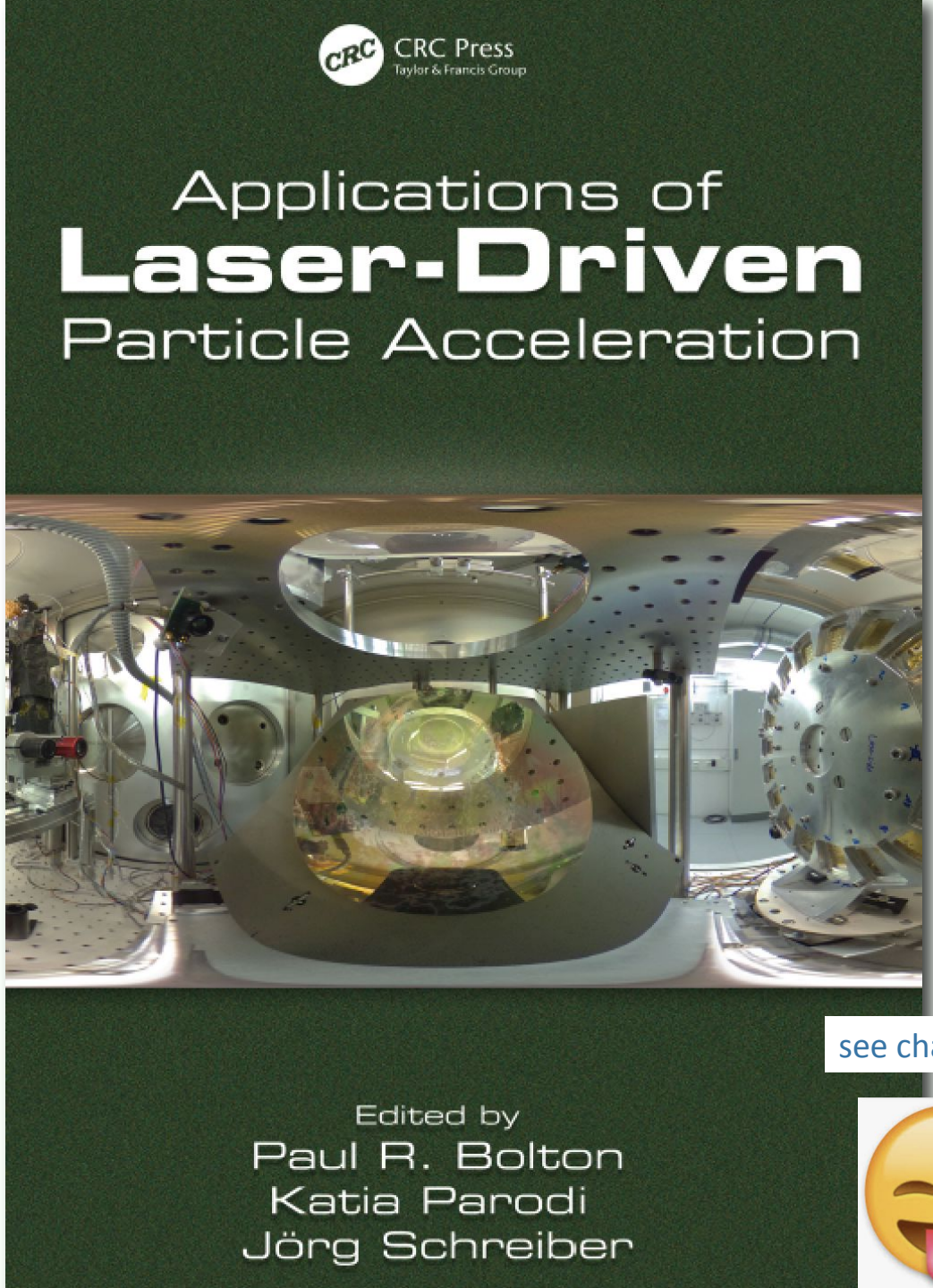
Community under construction

Future laser accelerators with fields of **GeV/cm**
... and possible **Megatesla magnetic fields**

However, they are violent accelerators,
- do not try to reuse it as soft accelerators (CERN, Synchrotrons, XFELs, ...)
- need to find advantages for such violent accelerators in emerging fields, such as
  Medicine: FLASH radiotherapy (protons and electrons)
  Weather control: Lightning guided discharges
  Space: Orbital debris
  Energy: New schemes for laser induced fusion

Novel X ray sources:
Betatron ... Phase contrast imaging,
High Harmonics ... Attoscience, molecular dynamics control!!!

Novel neutron sources for civil engineering, homeland security.

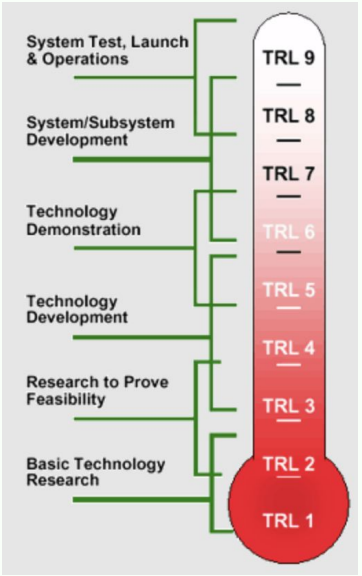


see chapter 13!

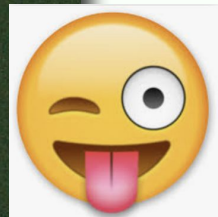
A long journey

from the concept (Low TRL)

to the application (High TRL)



ELI-ERIC is the tool to get this tech ready Through ELI you have early access to that



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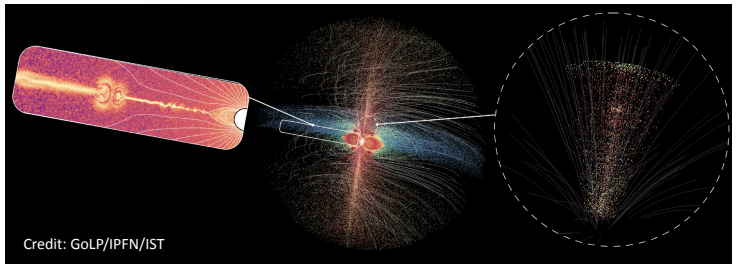
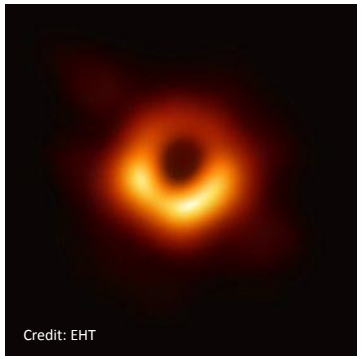
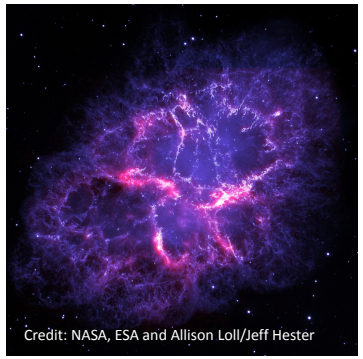
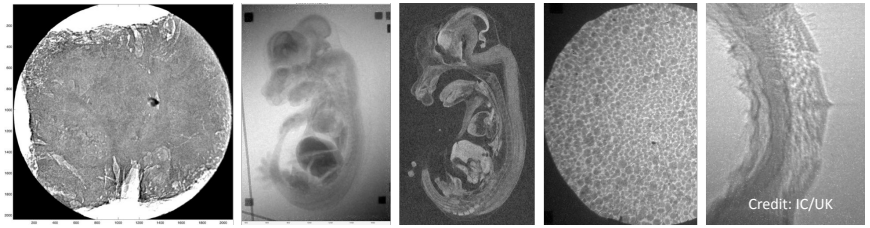
Breakthrough Discovery Science and Innovation

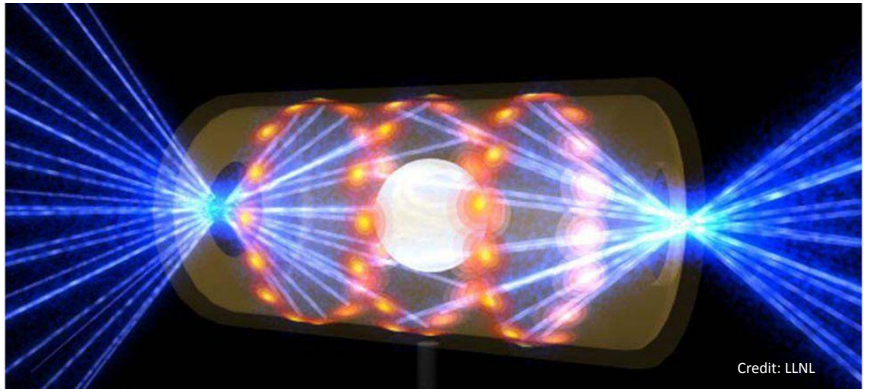
- What are the fundamental processes operating at the most extreme astrophysical objects and responsible for the radiation/particles reaching us?
- Can we tame plasmas for novel radiation and particle sources for medical and biological applications and for fusion energy?
- What are the fundamental properties of light and matter at extreme intensities and fields, and on the transition to quantum behavior?

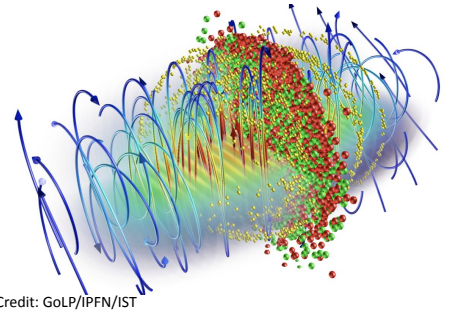

Credit: GoLP/IPFN/IST

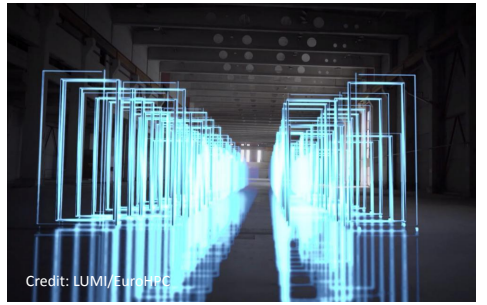

Credit: EHT


Credit: NASA, ESA and Allison Loll/Jeff Hester


Credit: IC/UK


Credit: LLNL

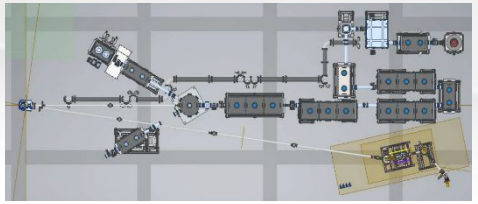

Credit: GoLP/IPFN/IST


Credit: LUMI/EuroHPC

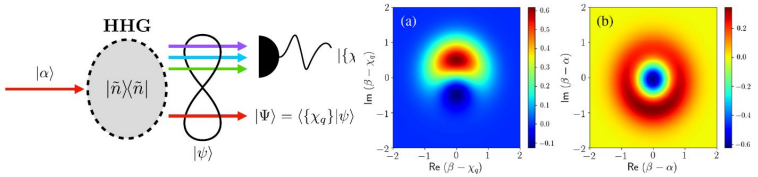
Breakthrough ideas @ ELI-ALPS

Exploiting high rep rate, energetic, short pulse, lasers & SeSos

- 1kHz atto + ReMi. Kinematicaly complete experiments of ultrafast dynamics. *The He DDI holy grail.*

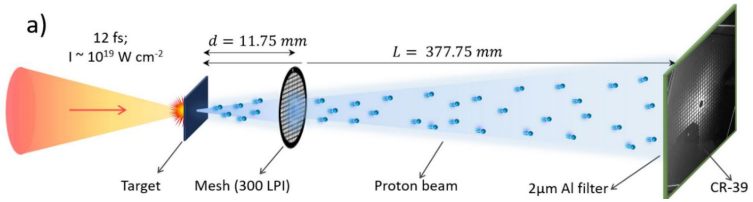


- MIR: Development of novel quantum light sources



- 1kHz betatron source

- Transmutation of nuclear waste

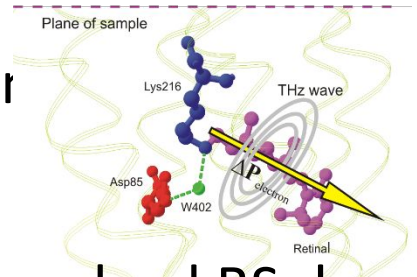


scientific reports

OPEN **Low divergent MeV-class proton beam with micrometer source size driven by a few-cycle laser pulse**

Prashant K. Singh[1✉], Parvin Varmazyar[1], Bence Nagy[1], Joon-Gon Son[1], Sargis Ter-Avetisyan[1] & Karoly Osvay[1,2✉]

- Photosynthetic dynamics using THz radiation



- 100kHz+ NanoEsca: Ultrafsat energy & spin resolved BS dynamics