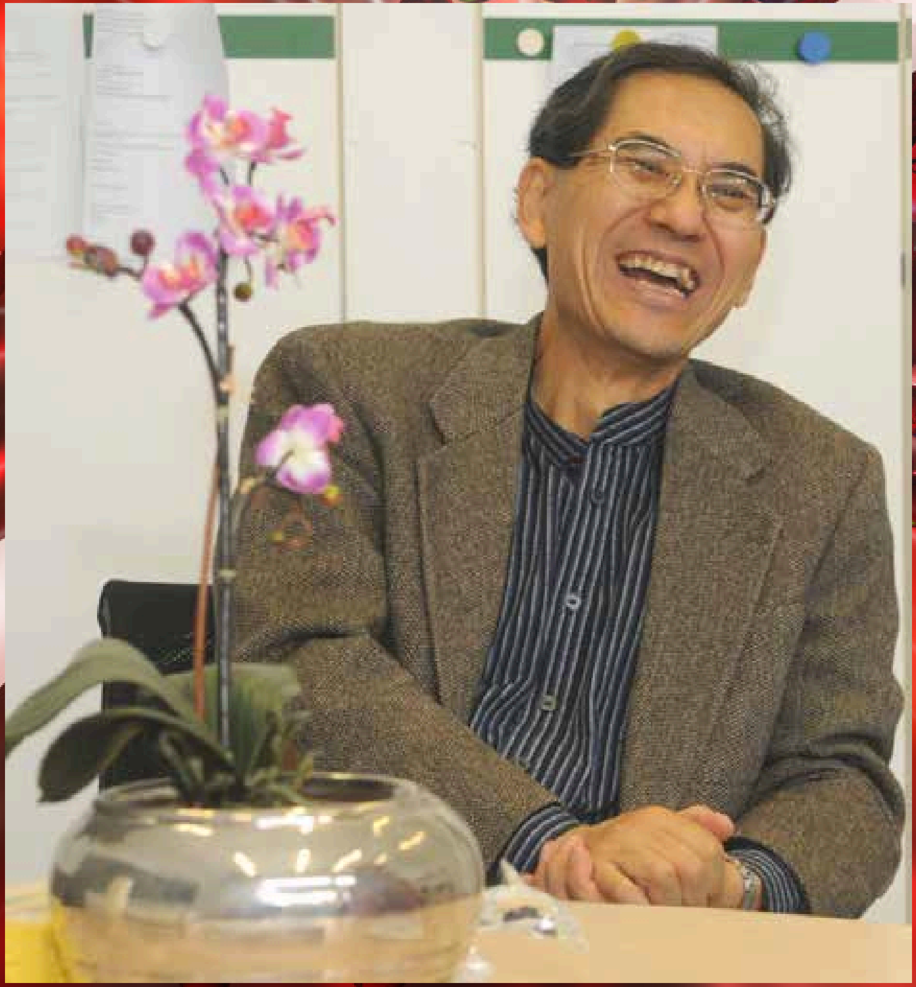
IZEST
International Zeta-Exawatt Science Technology

Toshi Tajima's Gifts to Science and Society



International Year of Light 2015

Toshi Tajima

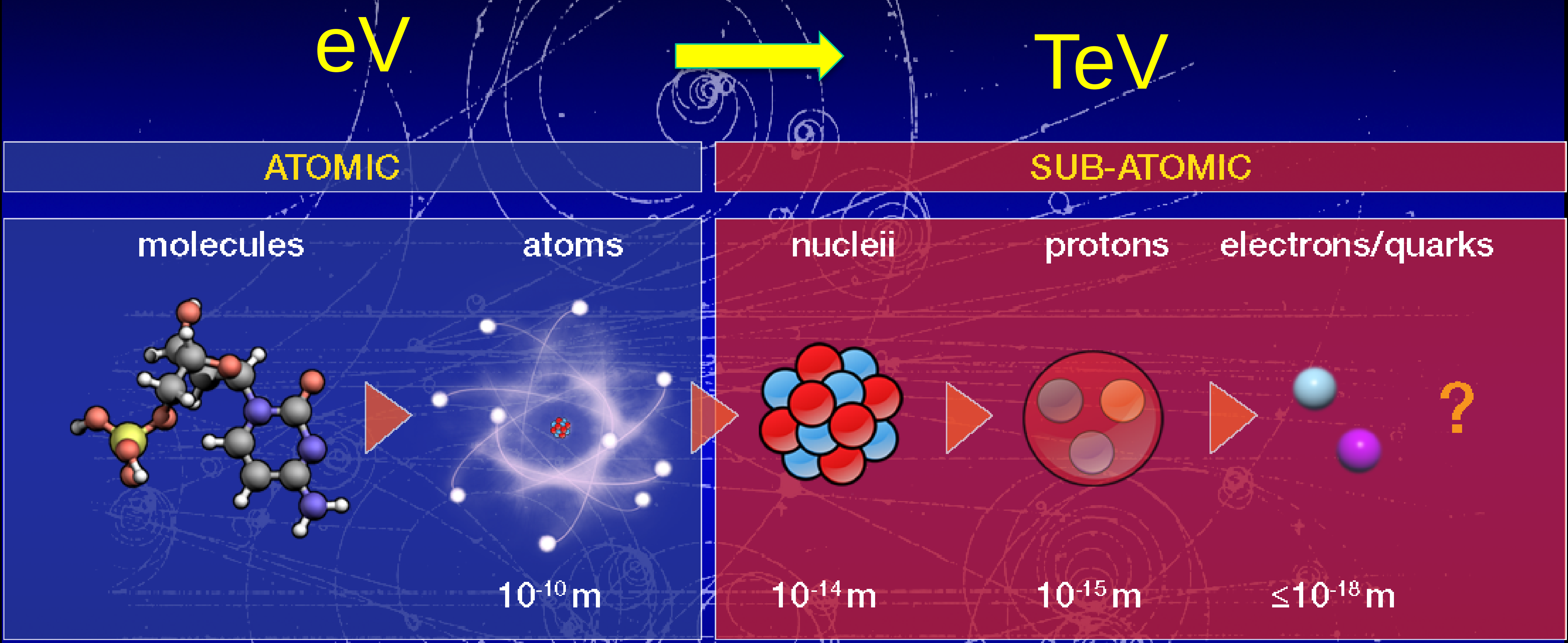
1.Toshi Tajima is the inventor with John Dawson(1979) of the particle acceleration technique known as Laser Wake Field Acceleration.

2. With gradients 10^3 to 10^6 greater than traditional RF technology. LWA is the lynch pin of High Field Science and Technology.

3. It has been Extended to particle beam driven: e-SLAC and p-CERN by P. Chen, JM Dawson, RW Huff, T Katsouleas (1985)

4. It bridged the atomic and subatomic domains and revolutionized Laser Science and establish the foundation of HighField Science and Technology.

LWA Unifies Optics with Nuclear, High Energy particle TeV Physics



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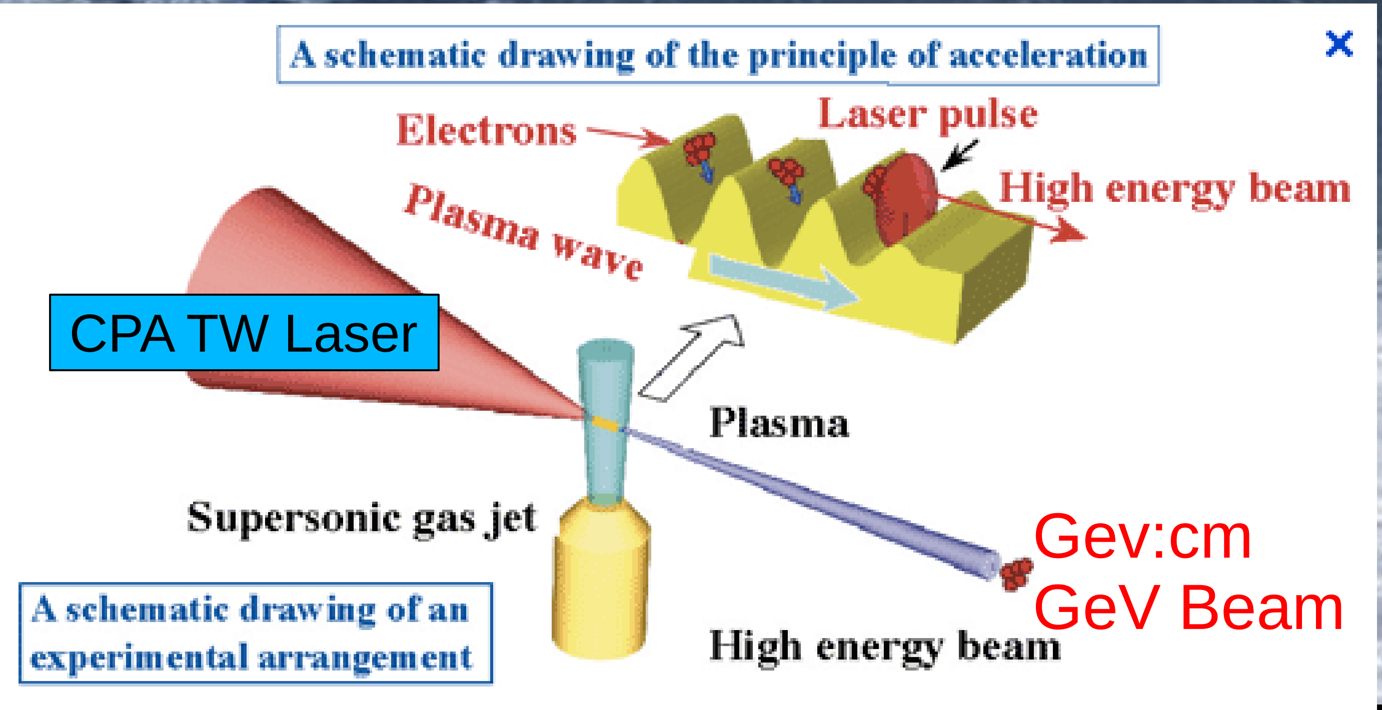
Laser Wake Field Acceleration: Concept

Tajima et Dawson (1979) and

Chirped Pulse Amplification

Mourou et Strickland (1985)



1988, Eric Esarey, established the connection betwen CPA and LWFA.

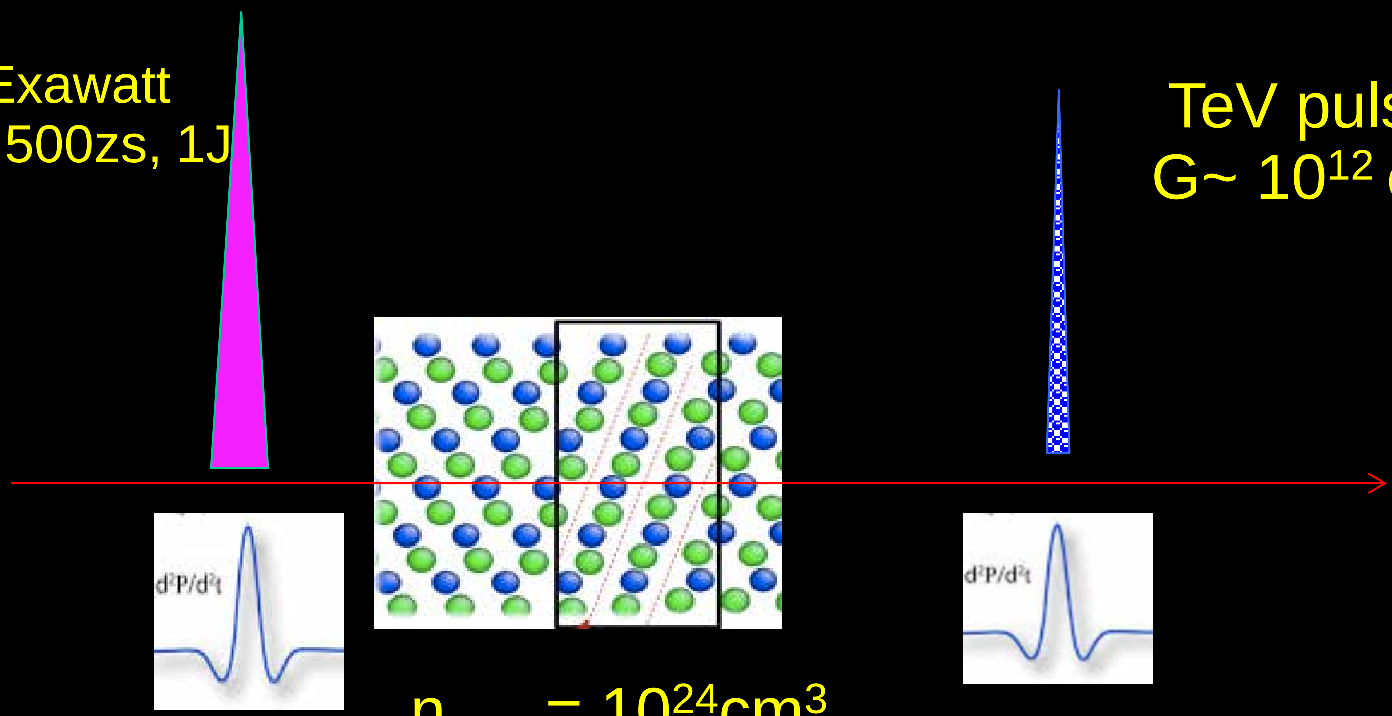
Next Step the TeV/cm level

Laser Wake Field in Crystal
in the single cycle regime

Atto-zepto, X-ray Driver, Solid, *Tajima et Cavenago 1987*

Drive pulse, Exawatt
X-Ray pulse 500zs, 1J

TeV pulse
G~ 10^{12} eV/cm



$n_{solid} = 10^{24}cm^3$

Channeling lower the emittance
Valid for electrons, muons, heavy ions

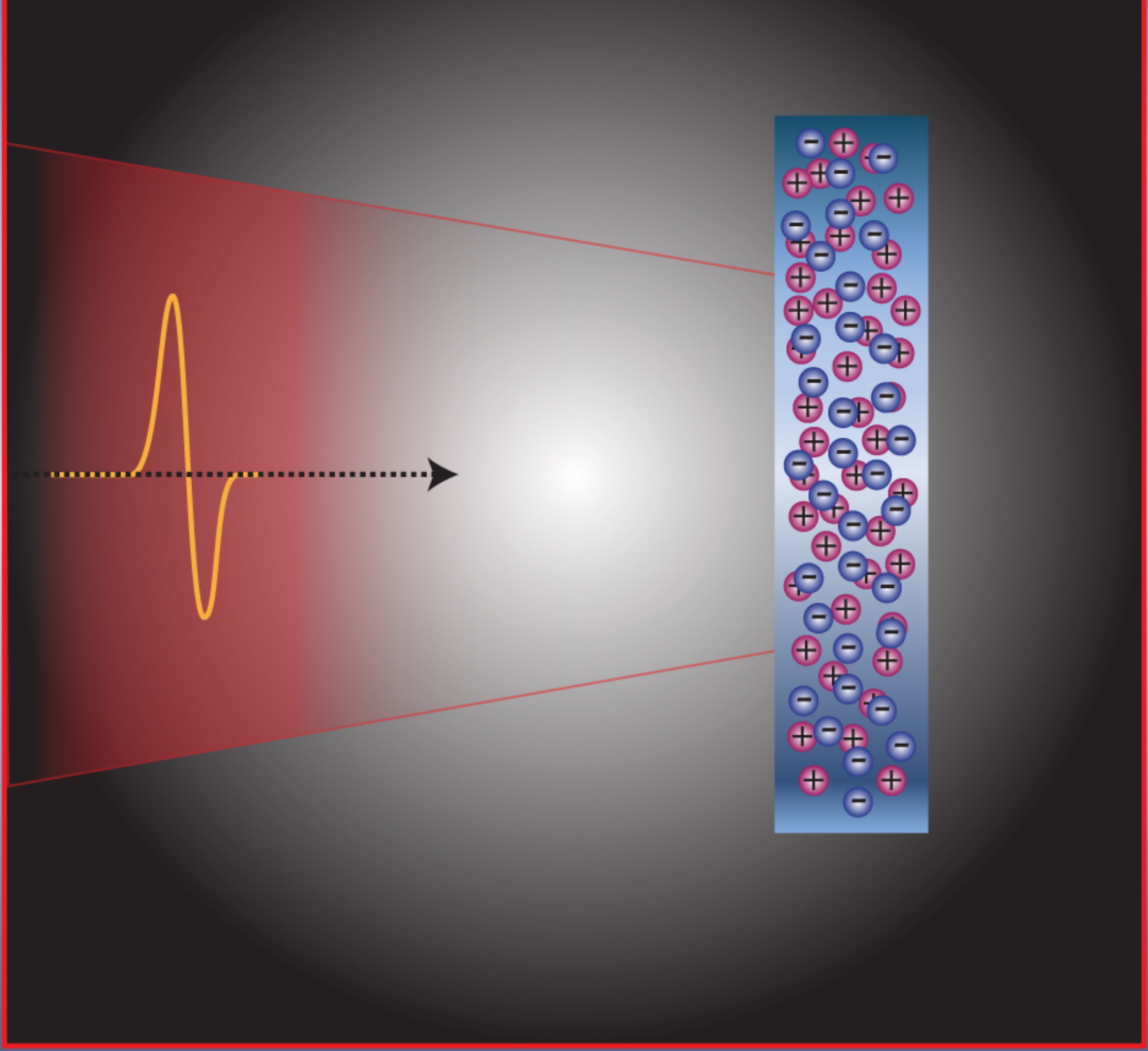
Relativistic Compression

Scalable Isolated Attosecond Pulses

N. M. Naumova, J. A. Nees, I. V. Sokolov, B. Hou, and G. A. Mourou,

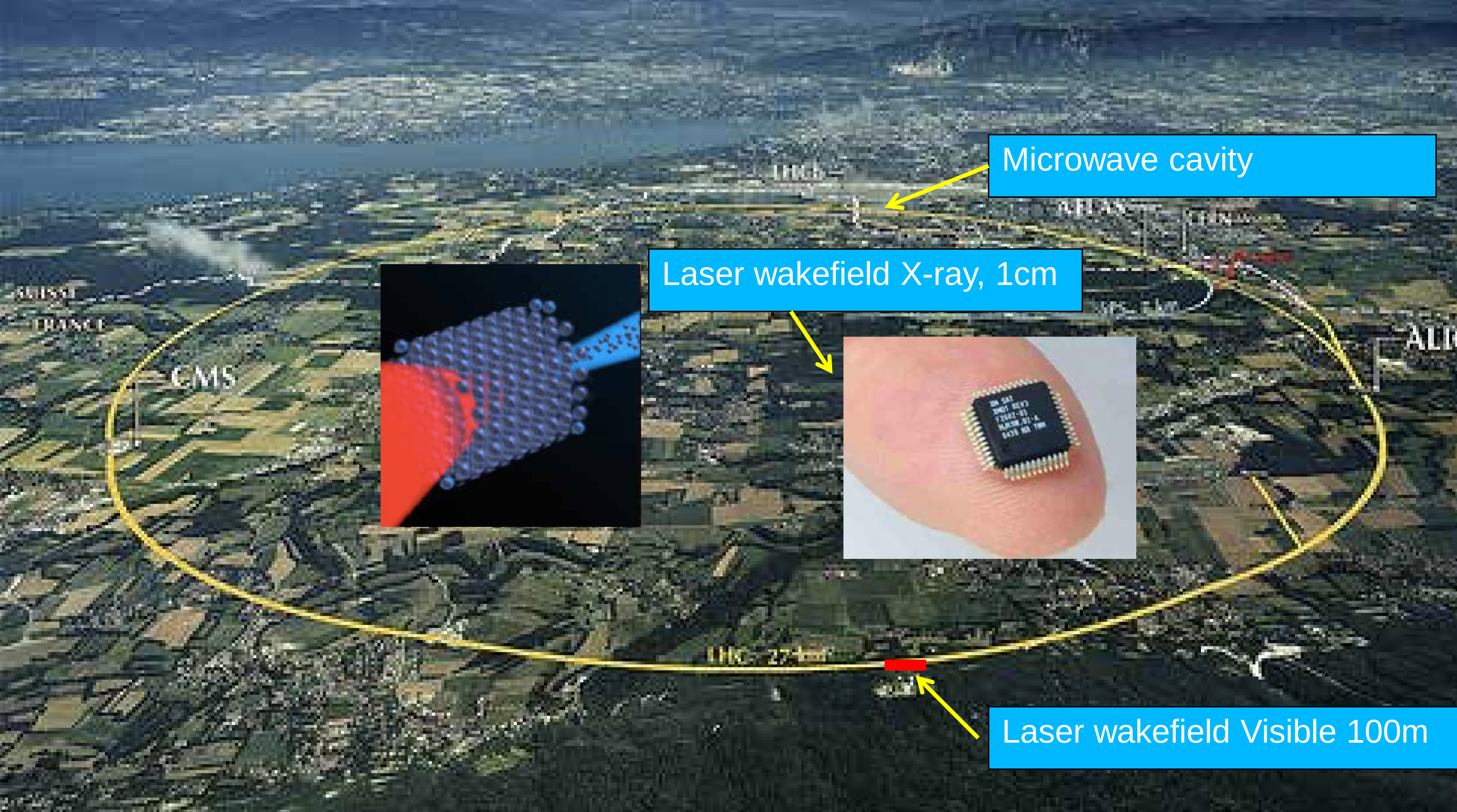
Relativistic generation
of Isolated attosecond Pulses in a l^3 Focal Volume, Phys. Rev. Lett.
92, 063902-1 (2004).

Relativistic Compression



Georgia tech

Outlook for
Laser-Particle acceleration TeV



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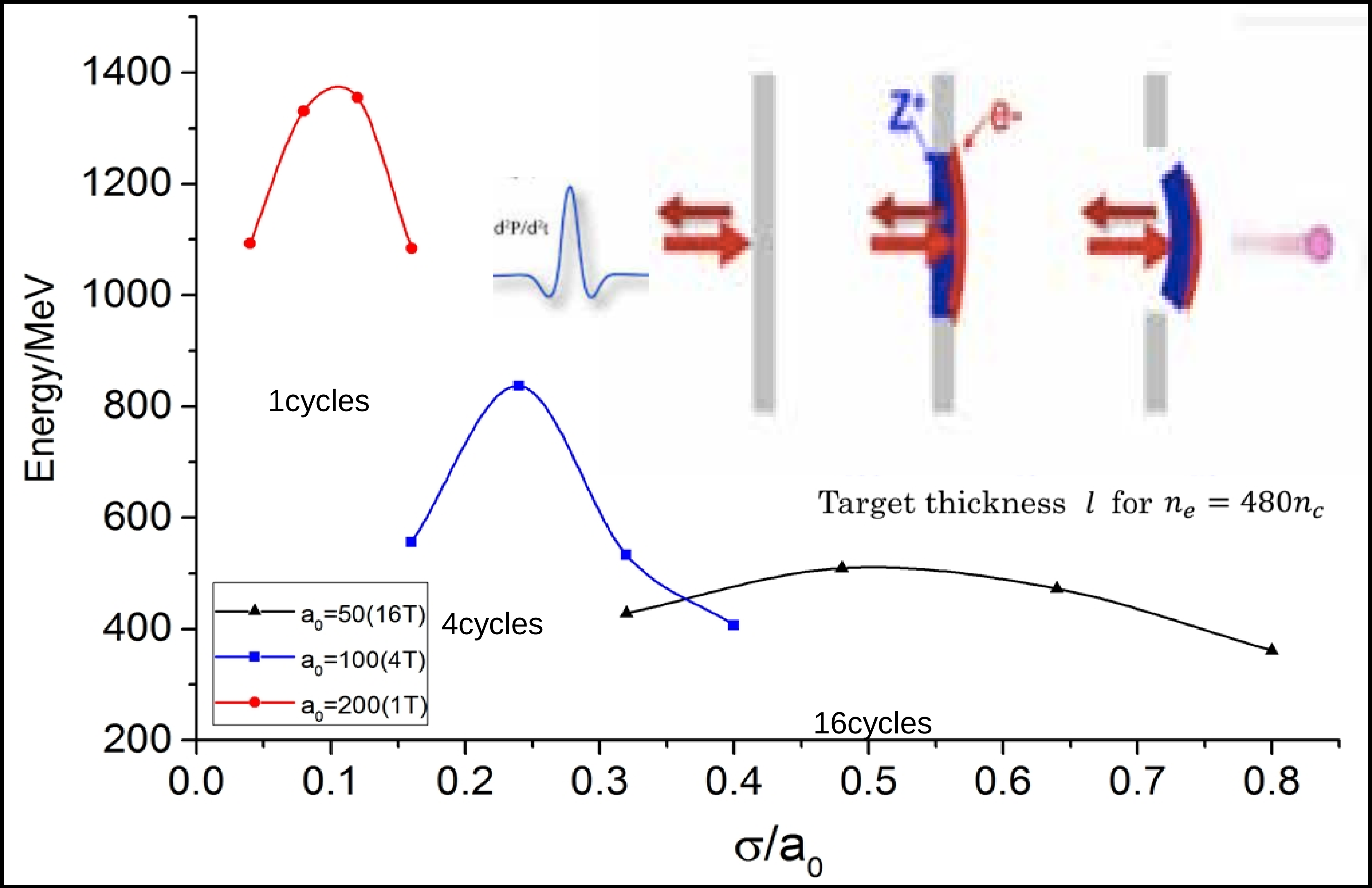
Applications of Single Pulse Cycle to Relativistic Proton Generation vs a_0



M.L. Zhou, X.Q. Yan, G. Mourou, J.A. Wheeler, J.H. Bin, J. Schreiber and T. Tajima, Phys.Plasmas **23**. O431129, 2016) Proton acceleration by single cycle laser pulses offers a novel mono energetic and stable operating regime single cycle.

Extreme Light Grand Challenges: Scientific and Societal Applications

Scientific Applications

Laser Astrophysics and Cosmology

Polarization of Vacuum, Materialization of Light

Beyond the Standard Model

Higgs Factory

Dark Matter

Societal Applications

Transmutation of Nuclear Waste

Under Critical Reactor

Nuclear Pharmacology

Proton Therapy

Orbital Debris Elimination by Deorbitation

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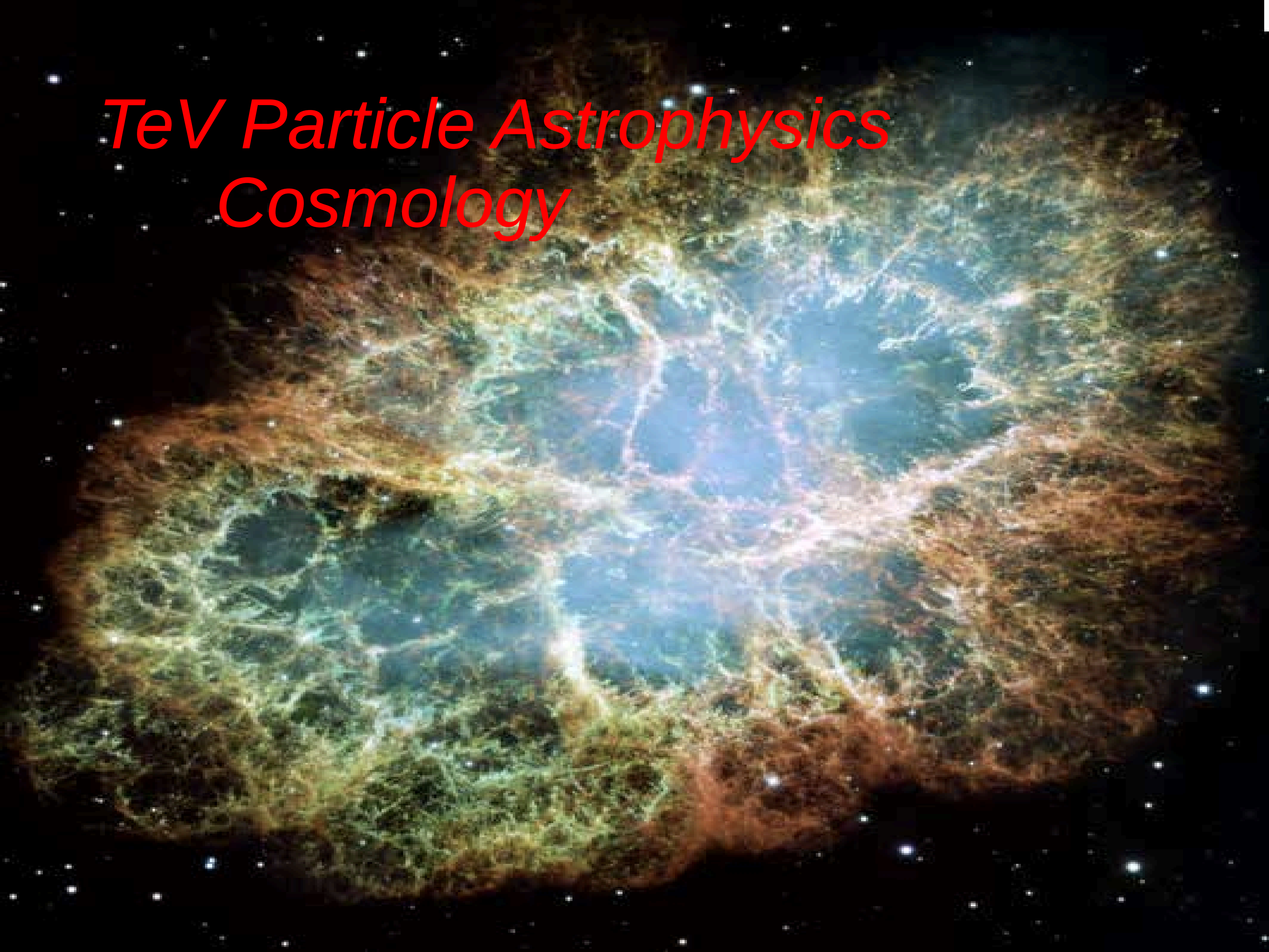

TeV Particle Astrophysics
Cosmology

Black Hole Information Paradox

Simulating Black Hole on the Table

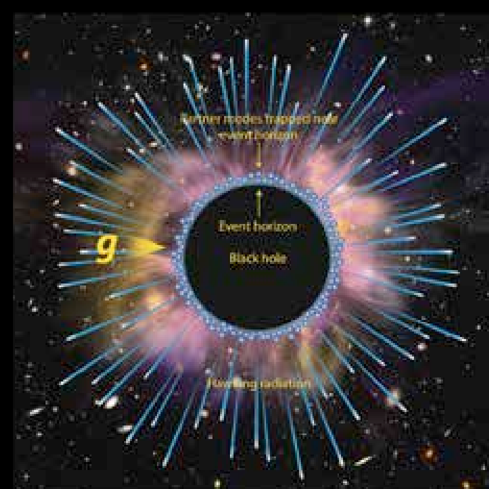
P. Chen and G. Mourou

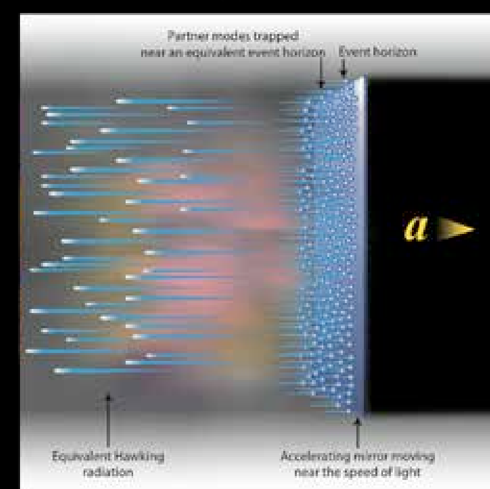
P. Chen and G. Mourou Physical, Phys. Rev. Lett. 118, 045001 (2017)
Accelerating Plasma Mirrors to Investigate Information Loss Paradox

In quantum mechanics, the probability, or information, must be preserved before and after a physical process like the BH evaporation process.

SIMULATING A BLACK HOLE ON A TABLE

P. Chen





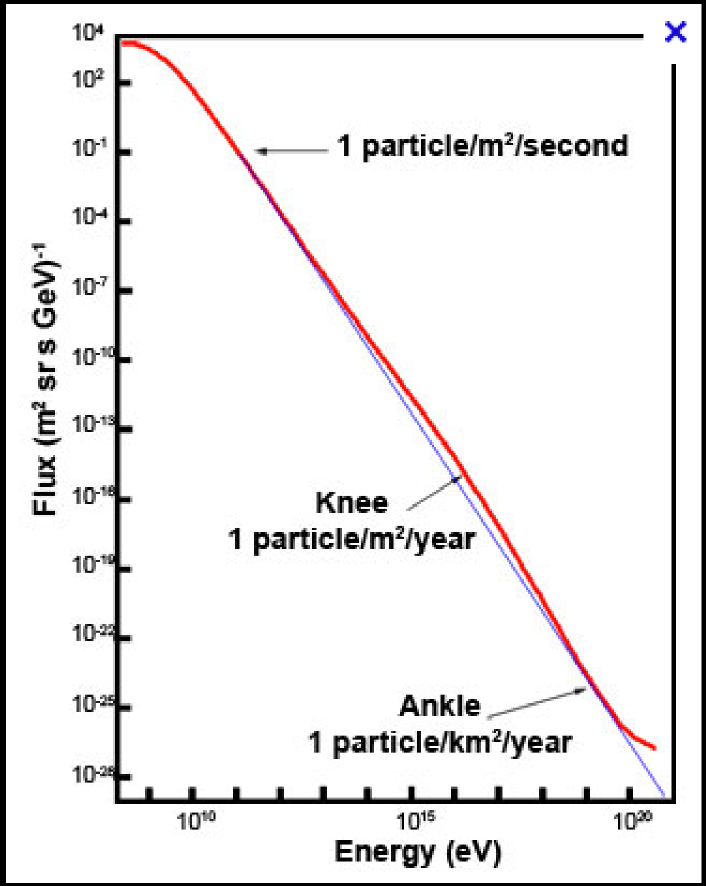
According to the equivalence principle
Accelerating mirror mimics evaporating Black hole.

Wake Field Mechanism Generation of the Highest Energy Cosmic Rays

T. Ebisuzaki and T. Tajima, *Asrophysical ZeV acceleration in the relativistic jet from an accreting supermassive blackhole,* Astropart. Phys. **56**, 9 (2014).

T. Ebisuzaki

T. Taima@



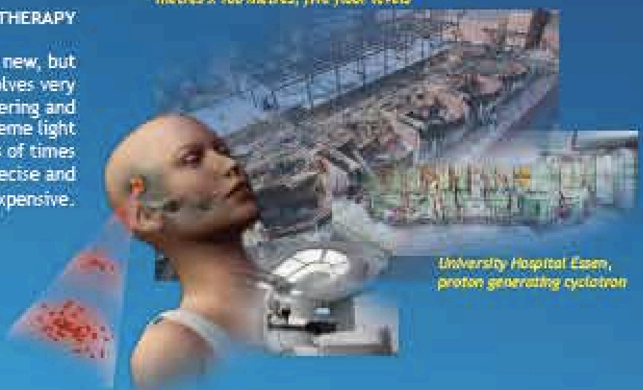
LWFA: Societal Applications

Extreme Light Societal Applications

The most recent development in extreme light laser technologies, such as UV generation, x-ray generation and proton acceleration, open the way to the incredible potential of high-tech applications development; a "blue sky" of innovation in a completely new market, especially in medical fields. These are some examples :

1 PROTON THERAPY

Proton therapy is not new, but present technology involves very large scale engineering and construction. Extreme light technology will be tens of times more compact, more precise and less expensive.

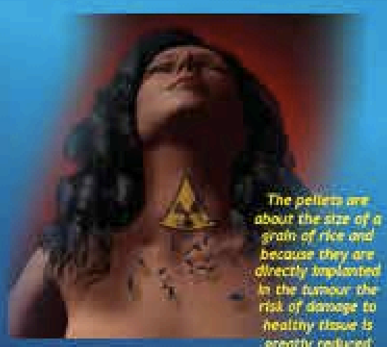


2 NUCLEAR DIAGNOSTICS

Medical scanners, such as positron emission tomography (PET), depend upon a radioactive isotope being injected into a patient. Although this presents no great risk, the isotope can only be produced in a nuclear reactor. It takes time to get it to a clinic, so the radioactive content has to be much higher to compensate.

Extreme laser proton acceleration means that isotopes could be produced in the clinic instead of a distant nuclear reactor.

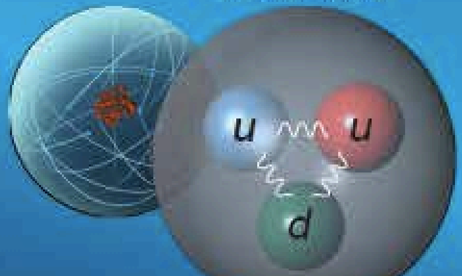
3 NUCLEAR THERAPY



Radionuclides are also used to treat patients directly, often by implanting tiny radioactive pellets directly into a tumour. Again, the only available radioactive source at present is a nuclear reactor, and so the potential application of extreme laser proton acceleration is an attractive proposition.

THE MAGICAL PROTON

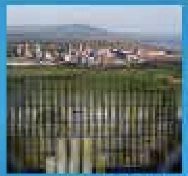
A proton is a sub particle within an atom. It has a negative charge and is made up of six smaller pieces: 2 up quarks, 1 down quark and 3 gluons, which stick the quarks together.



4 NUCLEAR WASTE DISPOSAL

Extreme laser proton acceleration may also provide a means to transmutate dangerous nuclear waste into something relatively harmless and much shorter lived.

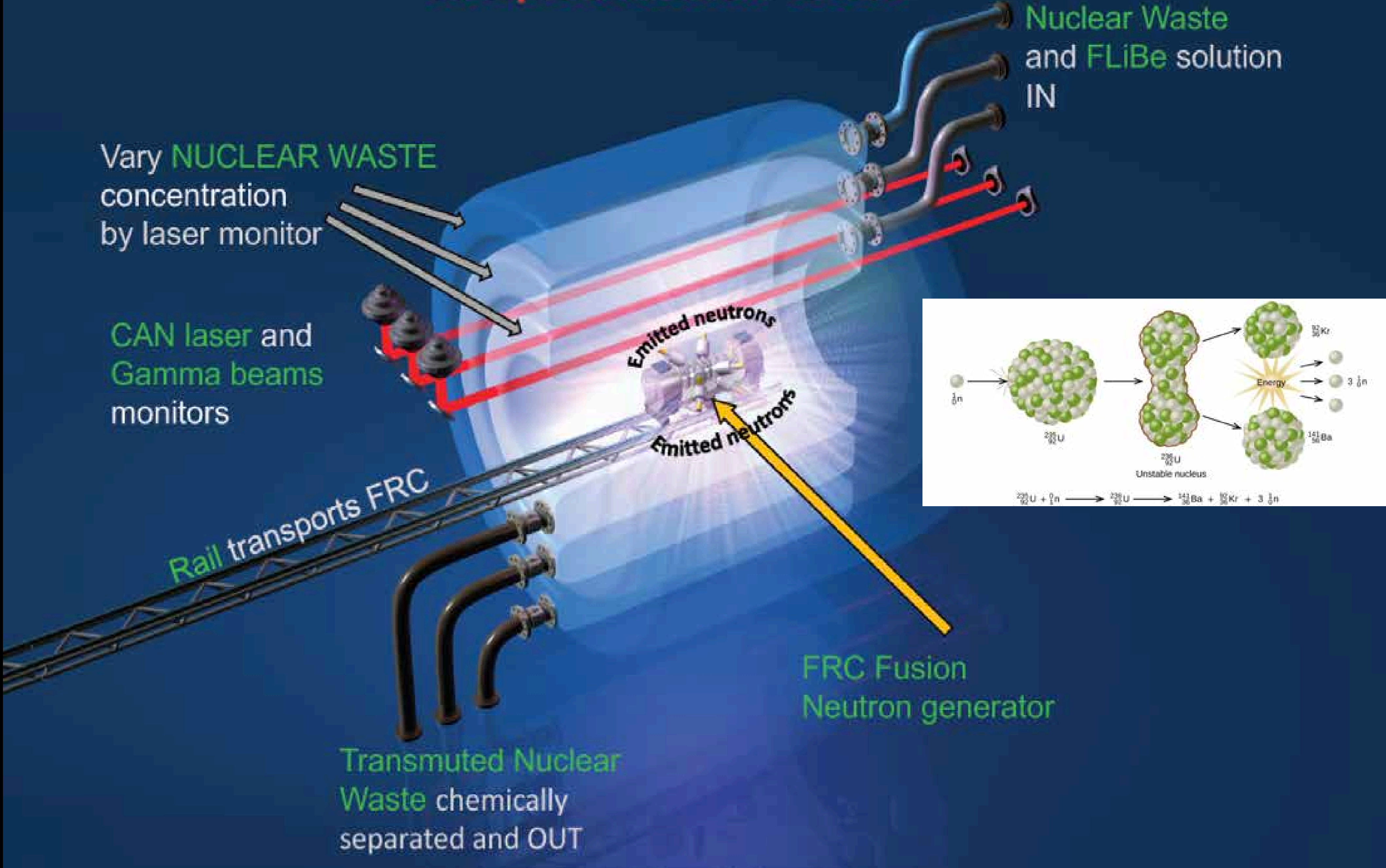
The staggering cost of collecting and disposing of toxic nuclear waste makes this application very exciting.



DANGEROUS AND EXPENSIVE!

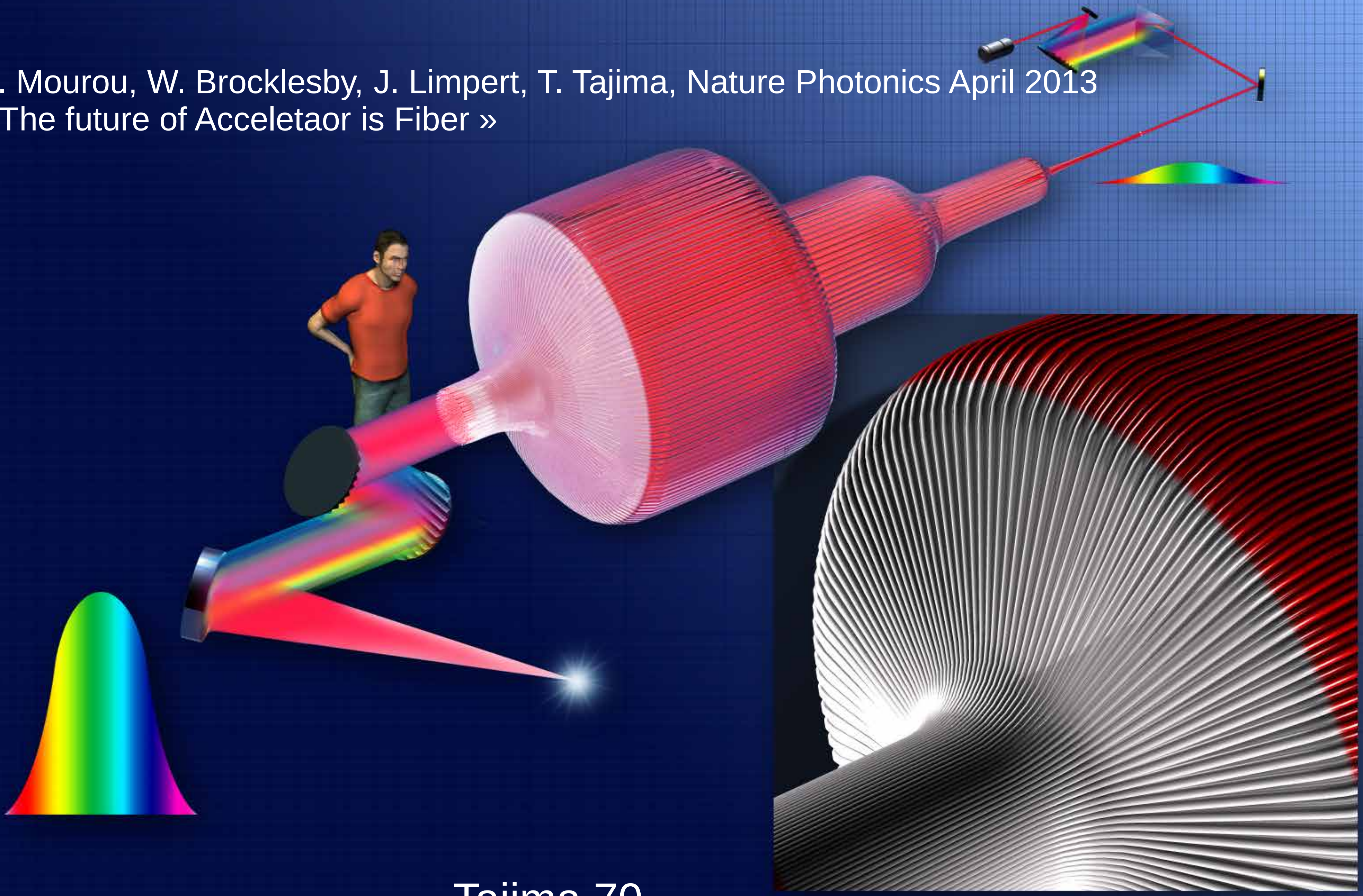
In February, 2013, the UK government estimated that the total lifetime cost of removing all radioactive nuclear waste from the Sellafield nuclear waste facility and burying it in Cumbria would cost over €90 billion!

Compact, Safe, Mobile, Liquid TRANSMUTATOR of Spent Nuclear Waste

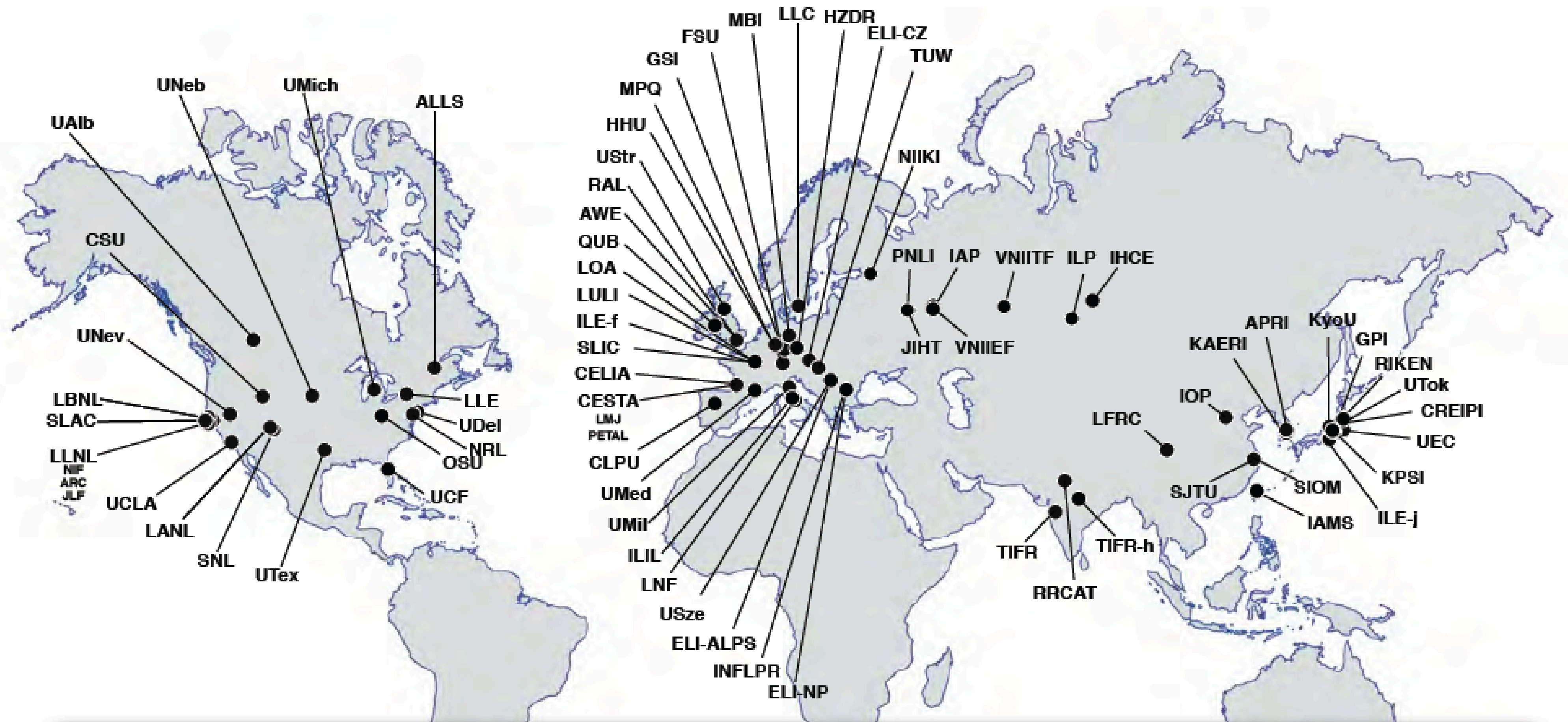


Compact High Peak and High Average Power with Good Efficiency, XCAN

G. Mourou, W. Brocklesby, J. Limpert, T. Tajima, Nature Photonics April 2013
« The future of Acceletaor is Fiber »



To Conclude T. Tajima Socio Economic Impact on the World Map

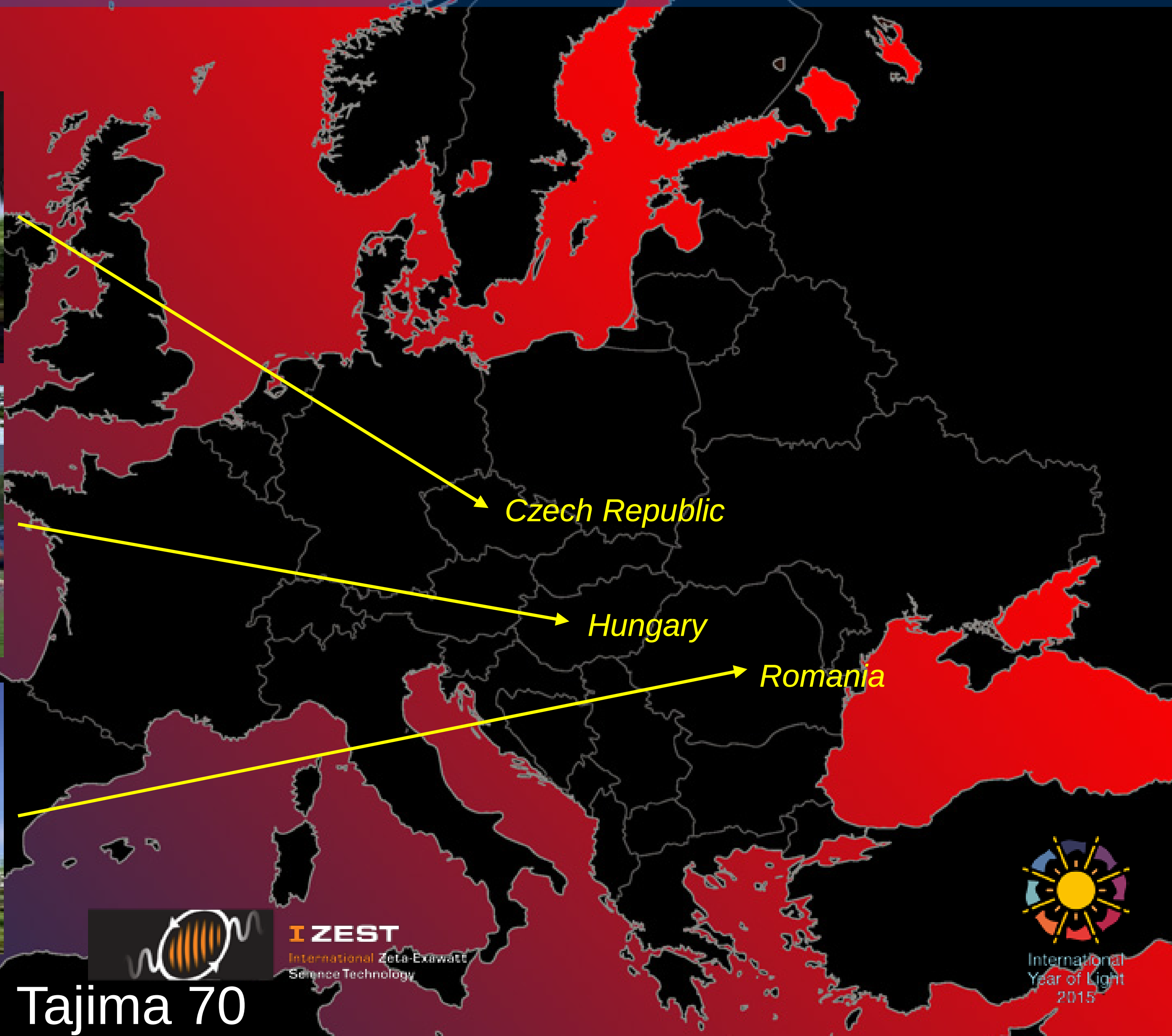


More than 100 laboratories, 5 Large scale infrastructures, 2000 researchers,in the next 5 years will be involved in laser subatomic Physics and Application. They represent > 3M investissement.

Extreme Light Infrastructure - ELI

The Largest Civilian Laser Infrastructure
Initiated and Coordinated(PP) by, G. Mourou (EP)
ELI (Delivery Consortium) W. Sandners



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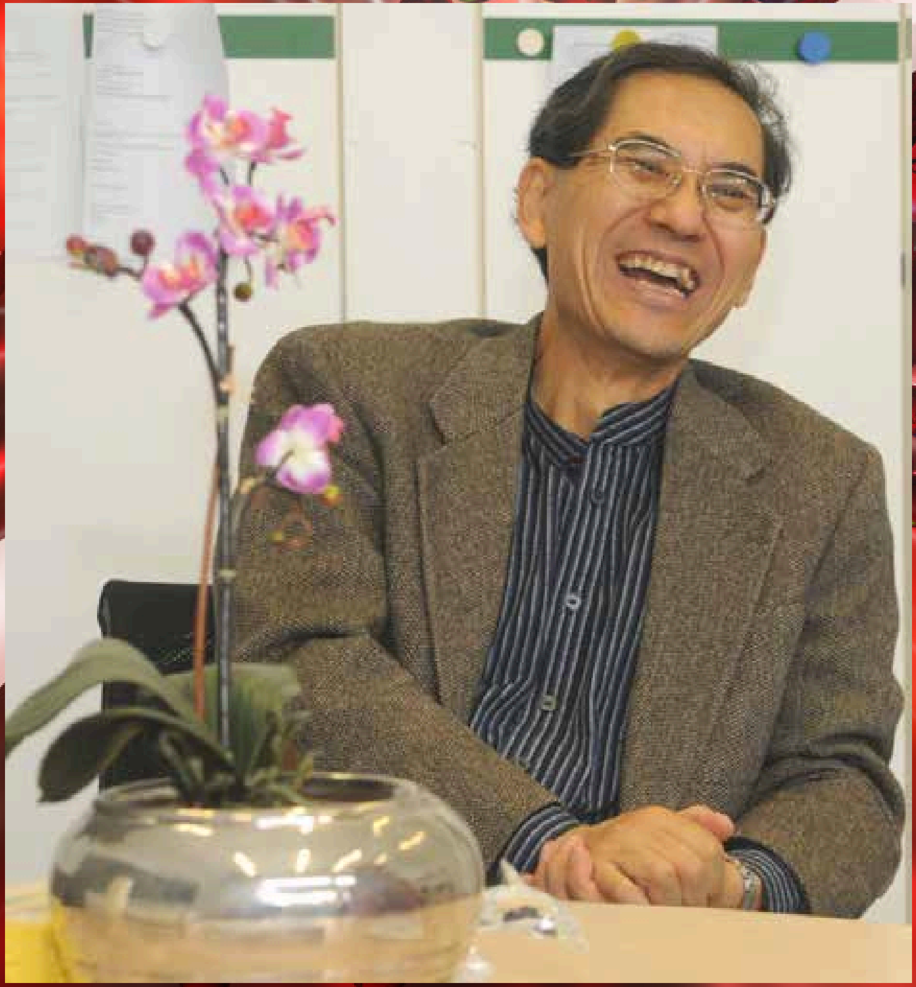
Thank you Toshi !!



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