Scientific summary by

Prof. J.T. Mendonsa and Prof. P. Mulser
Instituto Superior Tecnico, Lisbon, Portugal
TQE, Univ. Darmstadt, Darmstadt, Germany

Fundamental plasmas: Advances in plasma sources, plasma diagnostics, astrophysical, cosmic and space plasmas, condensed and extreme state matter, high energy density matter, laboratory astrophysical, planetary, supernova, turbulent plasmas, etc.

Innovative trends in Applications and Technologies: Advances in particle /photon acceleration, Lasers, Nanotechnologies, Novel radiation sources and applications in Biology, Chemistry, Environment, Health, Industries, Safety, etc.

Advances in Nuclear Energy: Development of ultra-laser pulses, Laser-plasma interaction, Magnetically confined plasmas, Inertial fusion plasmas, Nuclear physics under transient state, Recent progress in Fusion studies, Target and reactor physics, Unconventional energy sources, Z pinch, Hybrid reactors etc.

after 45 The Abdus Salam
International Centre for Theoretical Physics
SCIENCE AND DEVELOPMENT FOR A CHANGING WORLD

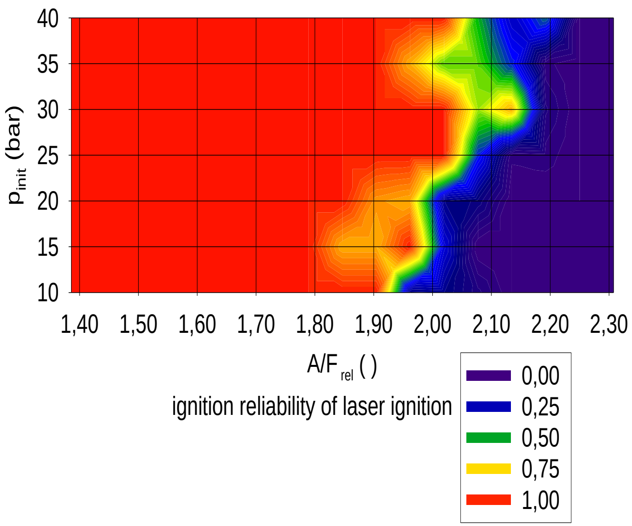
ICTP OVERVIEW

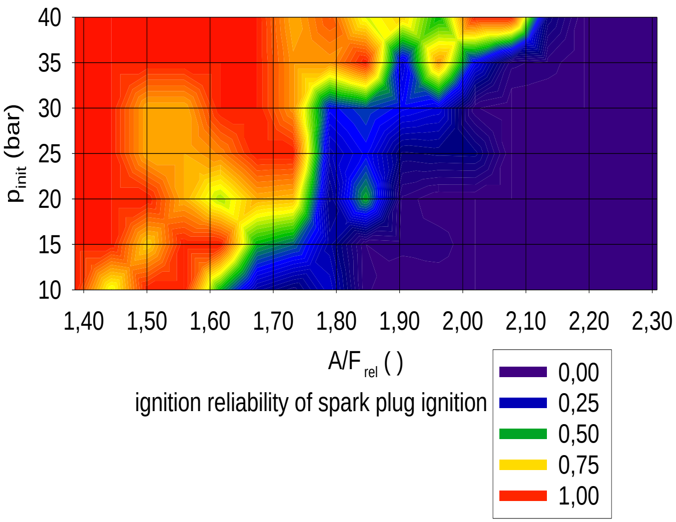
J.J. Niemela for F. Quevedo

ICTP | Strada Costiera 11 | 34151 Trieste - Italy | www.ictp.it

Innovative Technical Plasma Applications: Laser Ignition of Engines by E.Wintner

Direct Comparison , Laser Ignition – Spark Plug Ignition





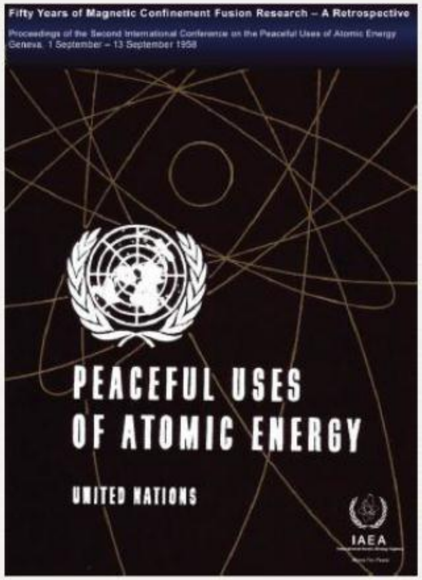
Combustion chamber of constant volume; methane-air, Tgas = 200°C; A/F_{rel} =1.77 on the engine for reliable run, maximum BMEP = 19 bar, typical spark duration = 400 – 500 µs; laser $M^2 < 1.2$; laser pulse energy constant 25 mJ well above the plasma breakdown threshold for all conditions, overall ignition attempts: 1201 for spark plug, 642 for laser

IAEA Activities on Plasma Physics & Nuclear Fusion Research
by R. Kamendje

Fusion History

Light master

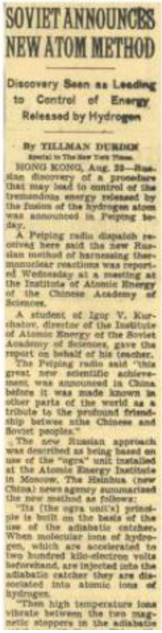
Declassification in 1958: UN Conference in Geneva with Fusion as Main Topic




Opening session of the Second Geneva Conference

The Aachen research group's first plasma experiment with a toroidal geometry in 1958

New York Times



SOVIET ANNOUNCES NEW ATOM METHOD

Discovery Seen as Leading to Control of Energy Released by Hydrogen

By TILLMAN DURDIN
Special to The New York Times.

HONG KONG, Aug. 22—Russian discovery of a procedure that may lead to control of the tremendous energy released by the fusion of the hydrogen atom was announced in Peiping today.

A Peiping radio dispatch received here said the new Russian method of harnessing thermonuclear reactions was reported Wednesday at a meeting at the Institute of Atomic Energy of the Chinese Academy of Sciences.

A student of Igor V. Kurchatov, director of the Institute of Atomic Energy of the Soviet Academy of Sciences, gave the report on behalf of his teacher.

The Peiping radio said "this great new scientific achievement was announced in China before it was made known in other parts of the world as a tribute to the profound friendship between nthe Chinese and Soviet peoples."

The new Russian approach was described as being based on use of the "ogra" unit installed at the Atomic Energy Institute in Moscow. The Hsinhua (new China) news agency summarized the new method as follows:

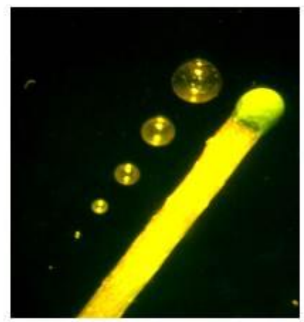
"Its [the ogra unit's] principle is built on the basis of the use of the adiabatic catcher. When molecular ions of hydrogen, which are accelerated to two hundred kilo-electron volts beforehand, are injected into the adiabatic catcher they are dissociated into atomic ions of hydrogen.

"Then high temperature ions vibrate between the two magnetic stoppers in the adiabatic

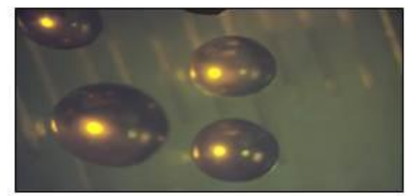
Basics of Laser Fusion by O. Krokhin

Thermonuclear Target Laboratory was founded at FIAN in 1974. *For more than 30 years the laboratory has been providing t he scientific centers in Russia, England, Italy, Germany, France, Czechia, USA, India and China with the targets and production equipment.*

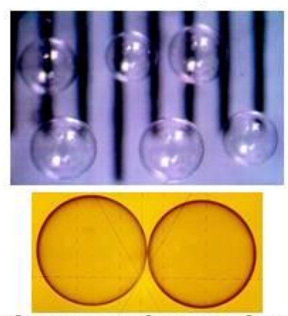
Gravity-type furnace for production of microspheres



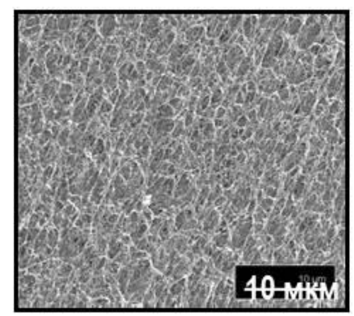
Glass microspheres



Au-coated polymer microspheres

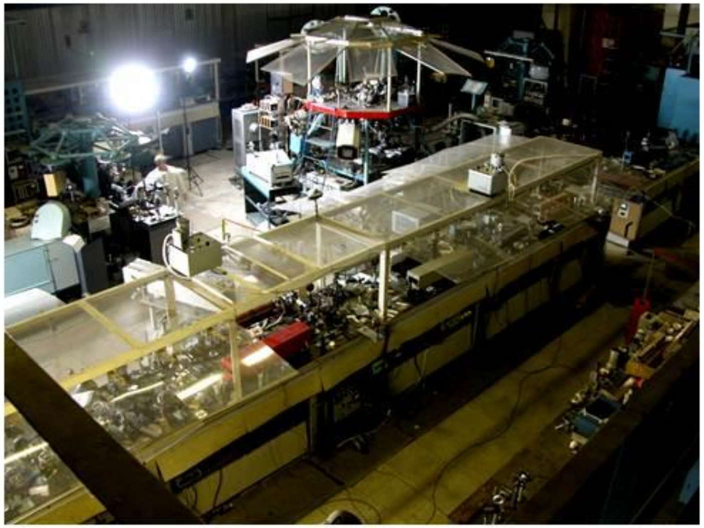


Polymer microspheres



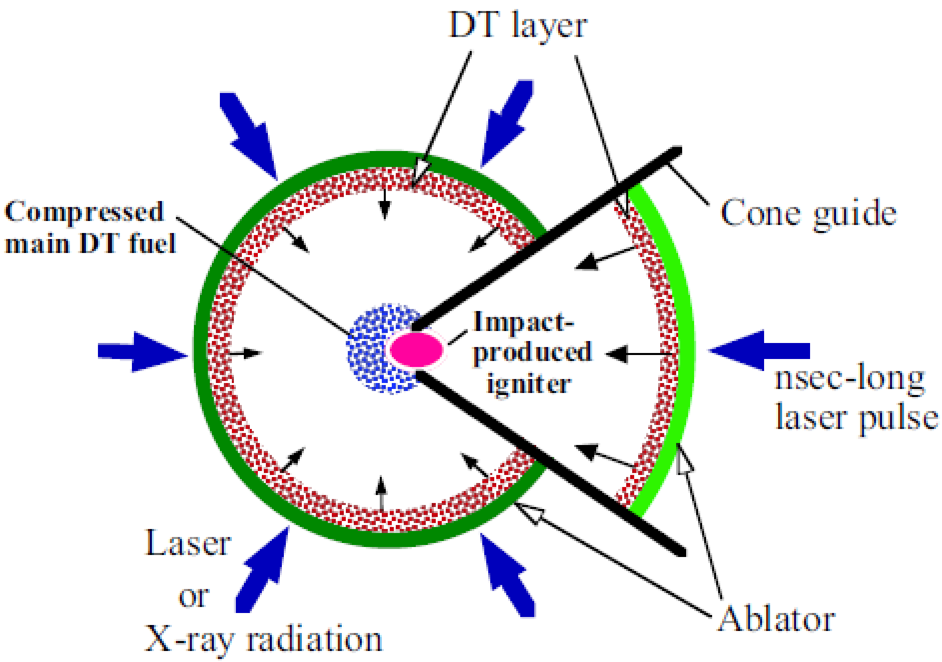
Polymer foam
Density: 0.001 g/cm³

Interaction of laser radiation with controllable coherence with matter and ICF by A. Starodub



- **The experiments have been performed with a Nd-glass laser facility KANAL-2 with controllable coherence of radiation with the following parameters**
  - laser pulse duration 2.5 ns
  - pulse energy up to 300 J
  - output aperture 60 mm
  - degree of spatial coherence ~ 0.05 – 0.015
  - degree of temporal coherence ~ $5x10^{-4}$ – $5x10^{-3}$
  - degree of radiation polarization ~ 0.5
  - pulse radiation contrast > 10^6

Laser Fusion Research in ILE, Osaka by M. Murakami et al.



Effects of Long Rarefied Plasma inside Cone on Fast Electron Generation for FIREX-I Targets by H. Sakagami et al.

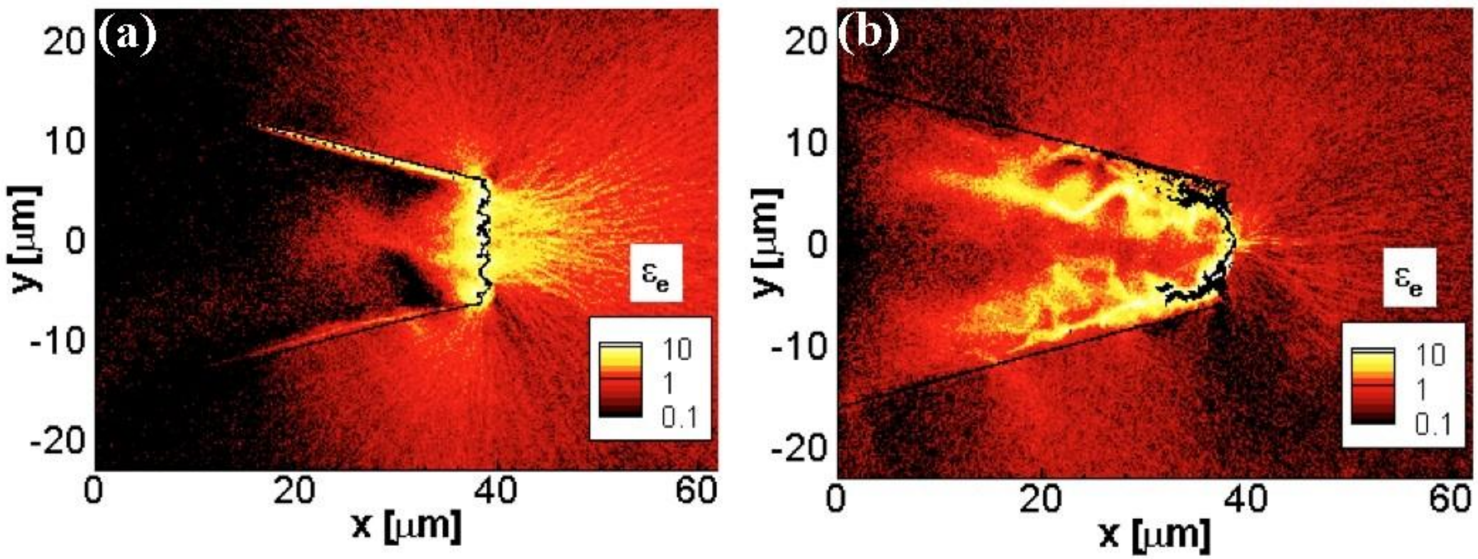
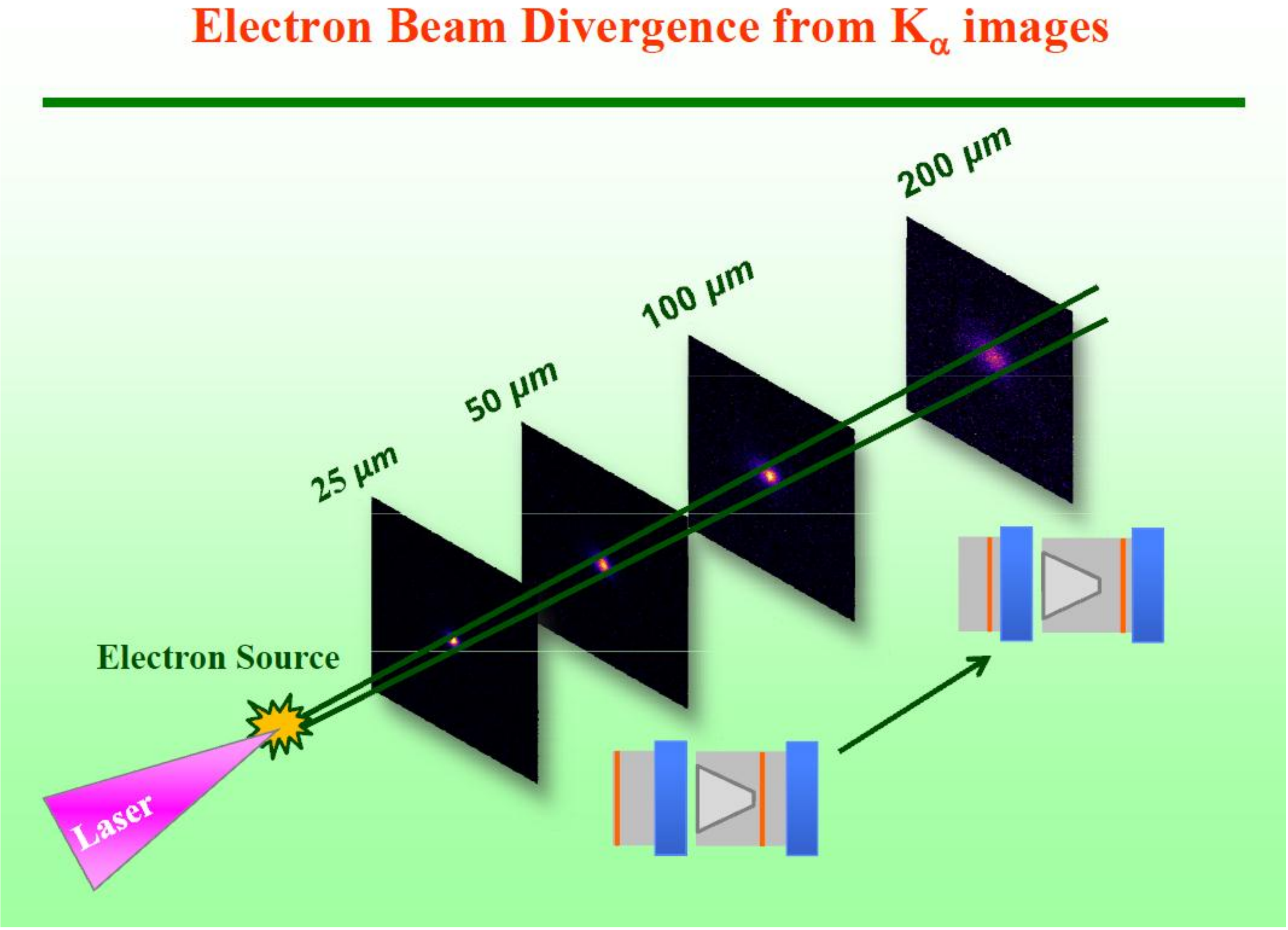


Figure 2:Fast electron energy densities at 1 ps for (a) without and (b) with preformed plasmas

MeV electron generation and transport using second harmonic laser pulses for fast ignition by R. Fedosejev et al.



Recent studies on hohlraum energetics and hohlraum design

Ke Lan

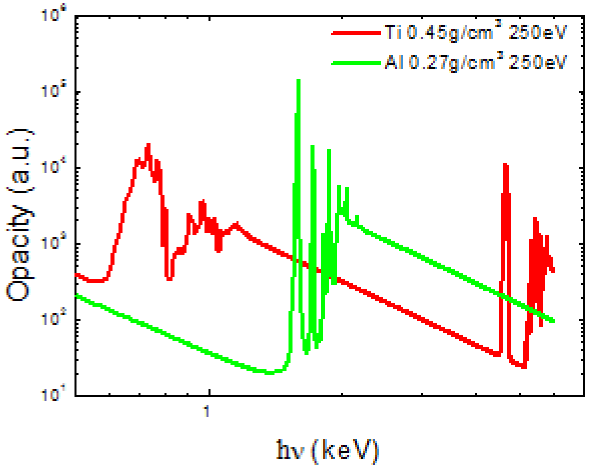


FIG. 4. (Color online) Opacity vs frequency for Al and

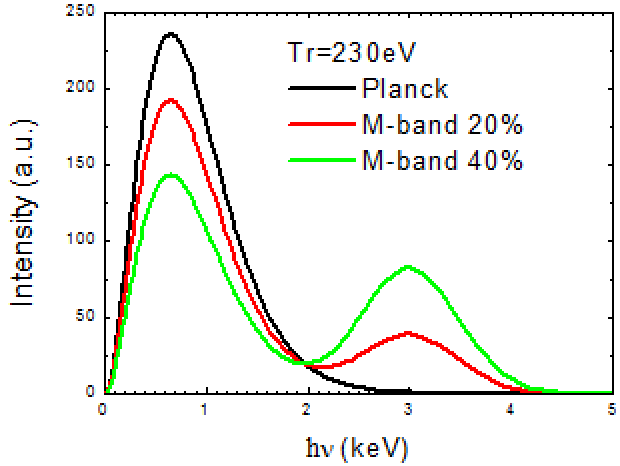
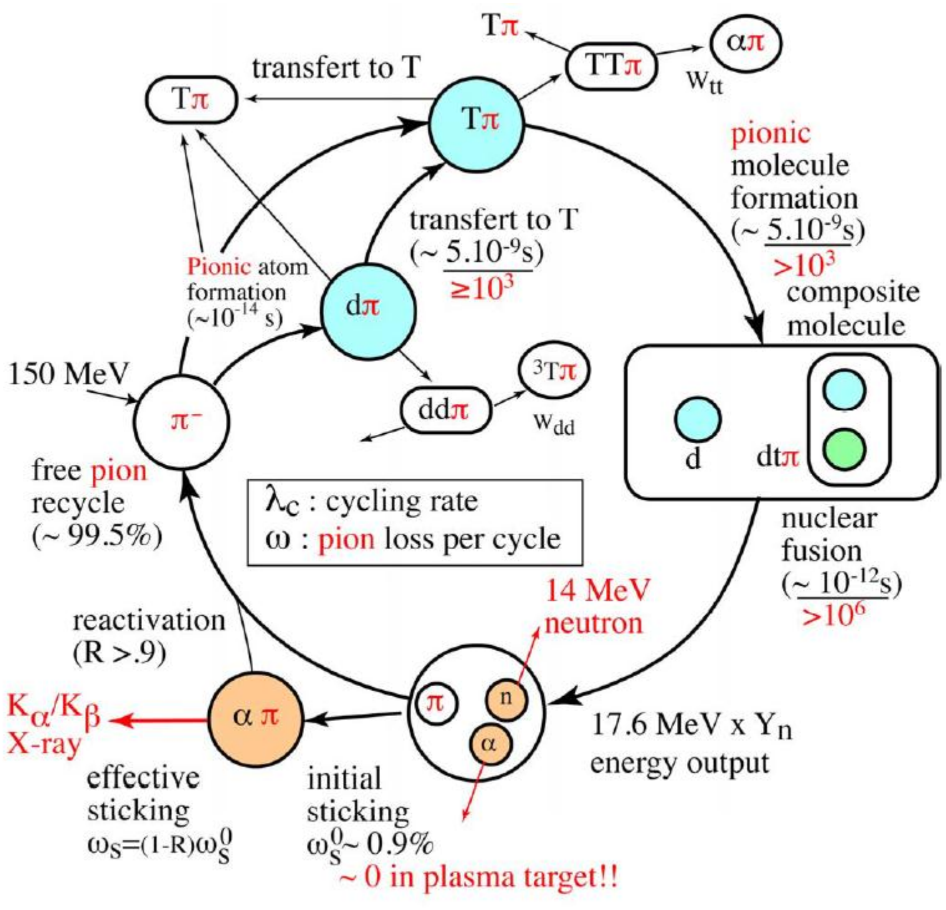


FIG. 5. (Color online) Spectral distributions of radiation source for simulation.

FAST IGNITION AT VERY HIGH ENERGY
C. Deutsch



Possible diagram of the pion catalyzed fusion cycle
in FIS conditions

Pellet Injector for Inertial Fusion

J. P. PERIN

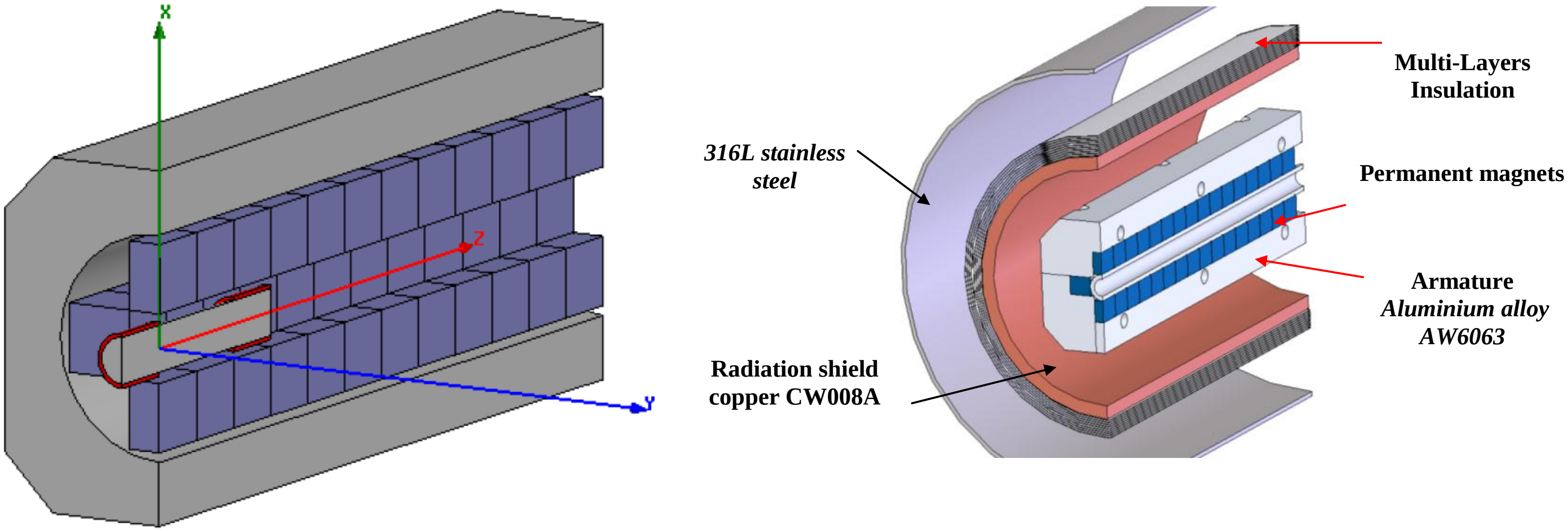


Figure 9 – Cut of a section of a guiding section with mechanical structure and thermal insulation

COHERENT BEAM COMBINATION

TECHNIQUE USING SBS-PCM FOR HIGH REPETITION RATE LASERS

Hong Jin Kong

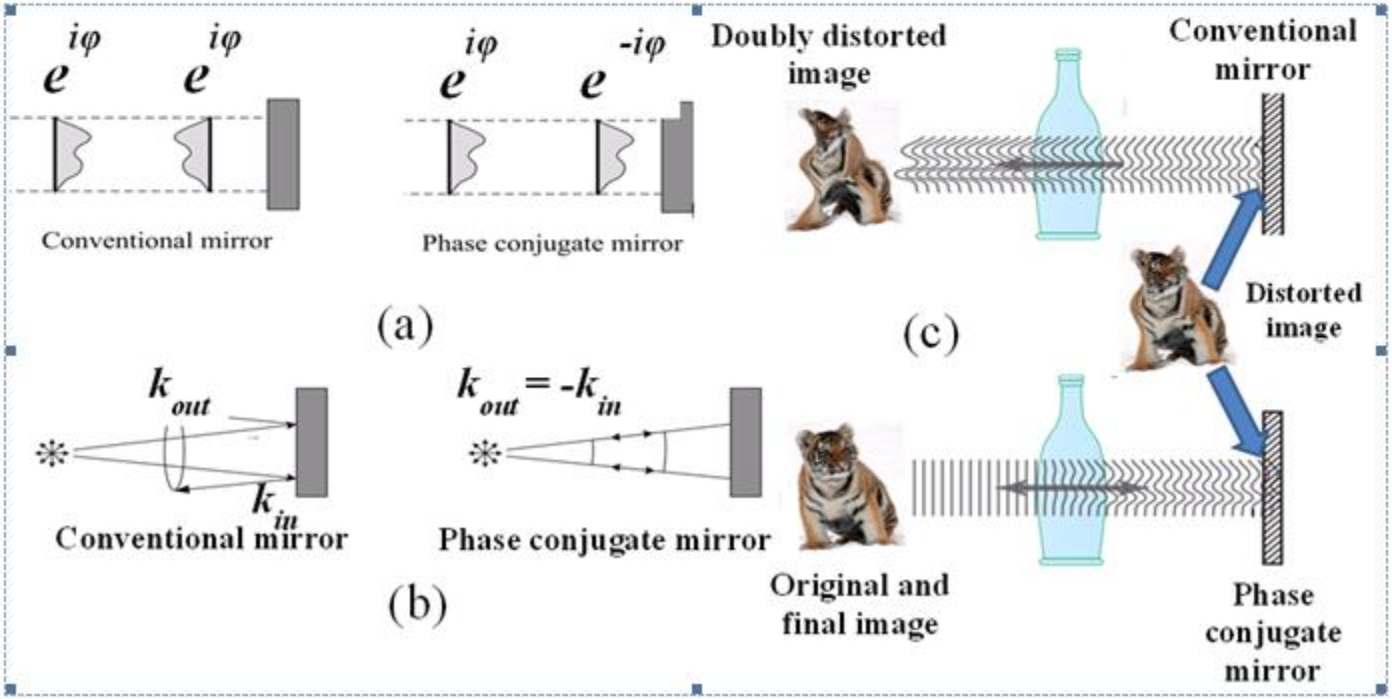
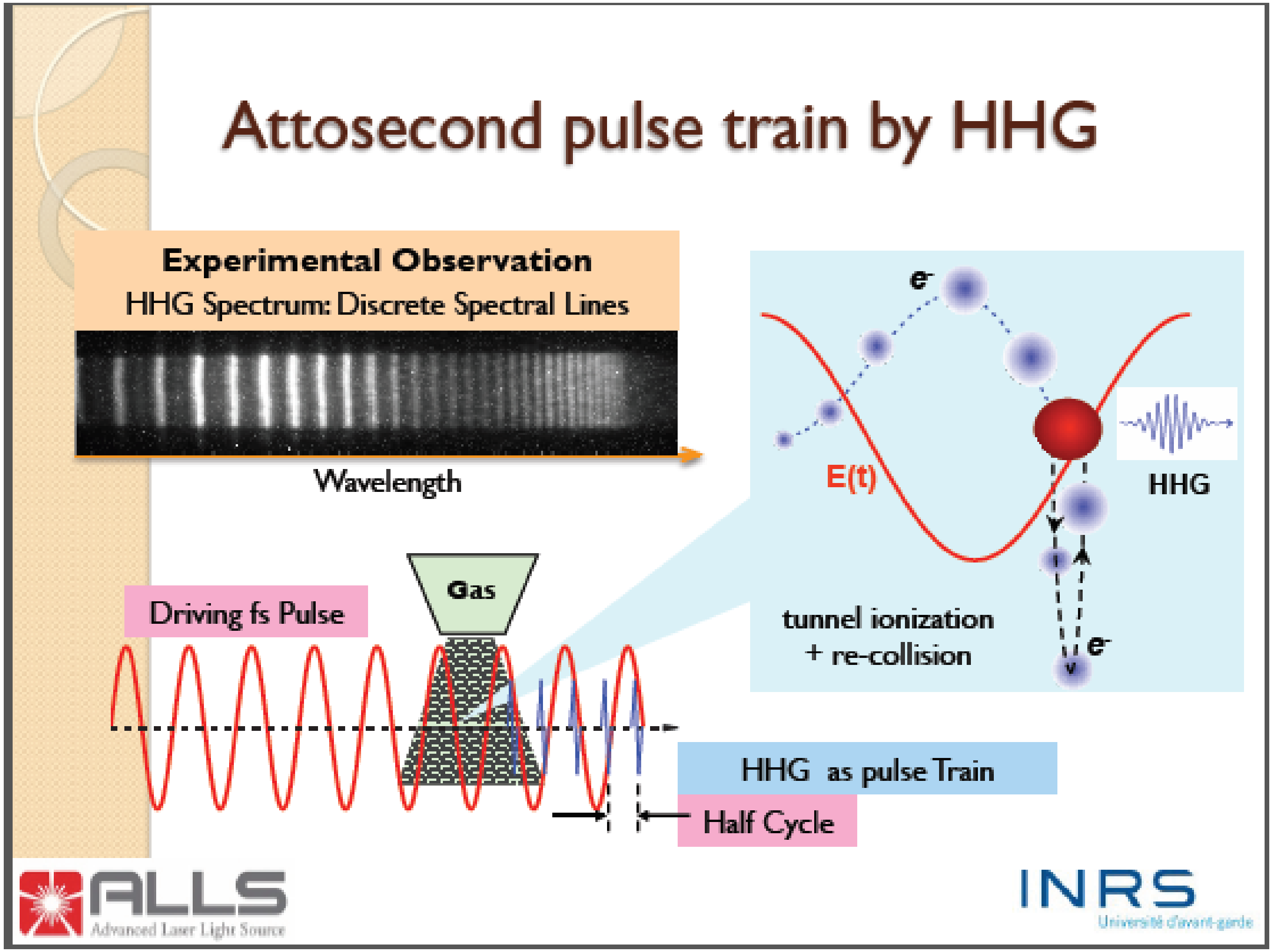


Figure 1. comparison of the conventional mirror and the phase conjugation mirror(PCM). (a) a phase property of the wave. (b) for the point source. (c) for the wave-front.

Laser Plasma as a Source of Intense, Single Attosecond Pulses via High-Order Harmonic Generation

T. Ozaki



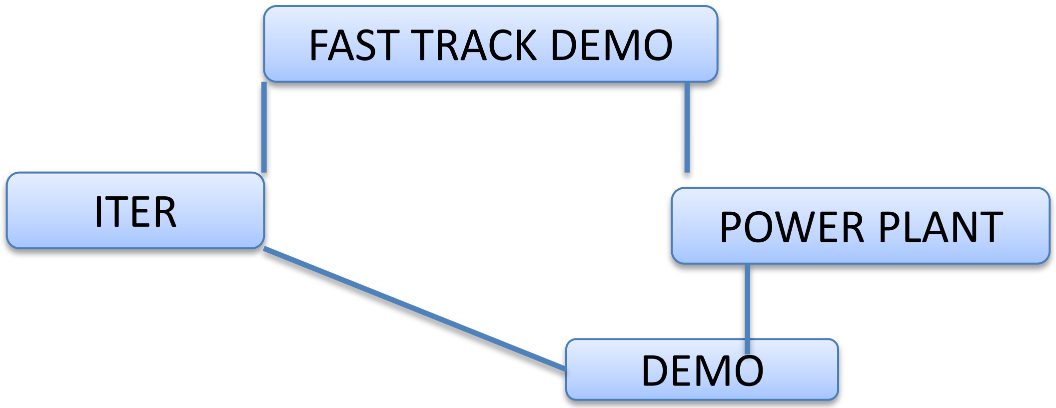
F4E STRATEGY TOWARDS FUSION ENERGY
by C. Varandas

- **Two important questions have been recently raised:**
  - **Which is the adequate facility to test and to qualify materials?**

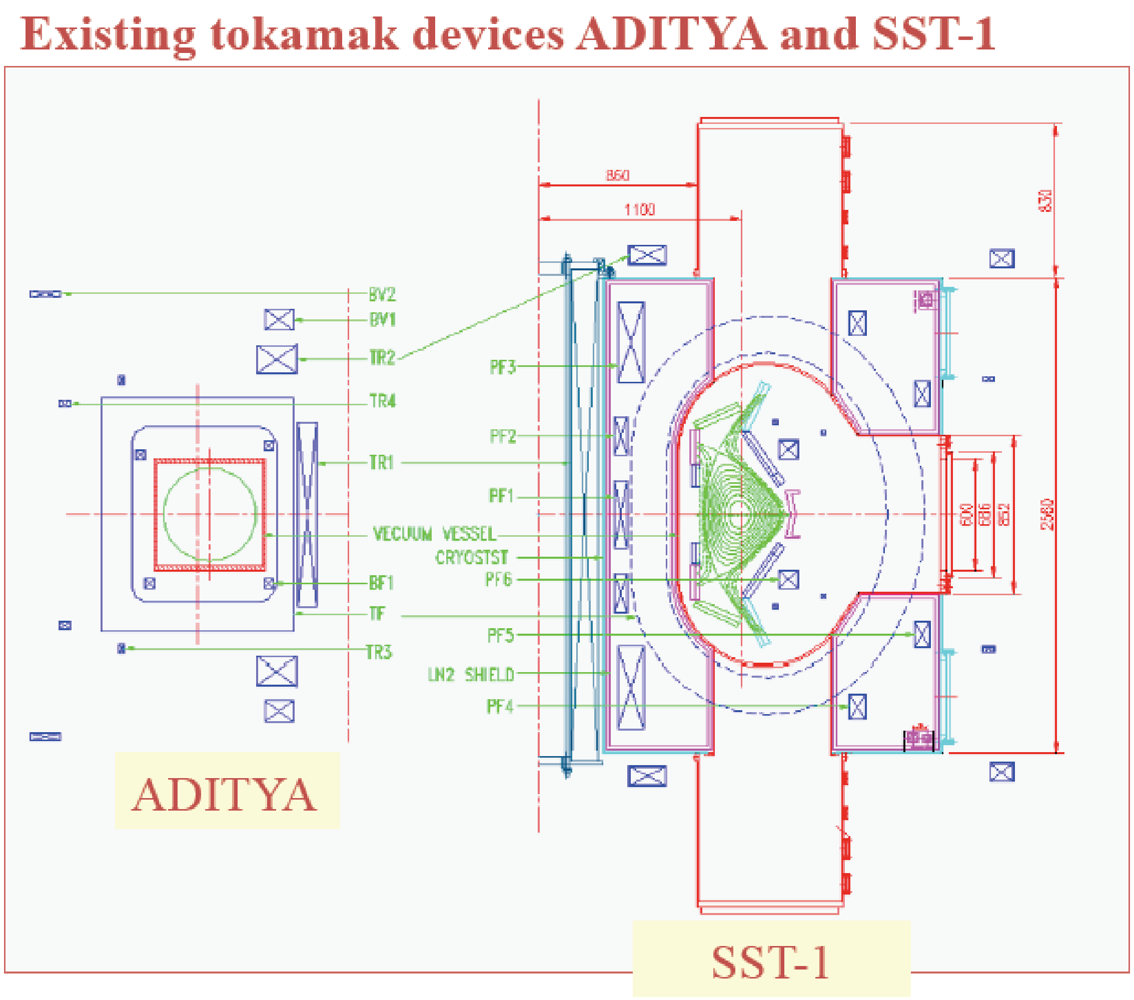
    - IFMIF (European Union) - CTF (USA)

    - Tanden Mirror (Russian Federation)
  - **What can we do to speed up the path towards Fusion Energy?**

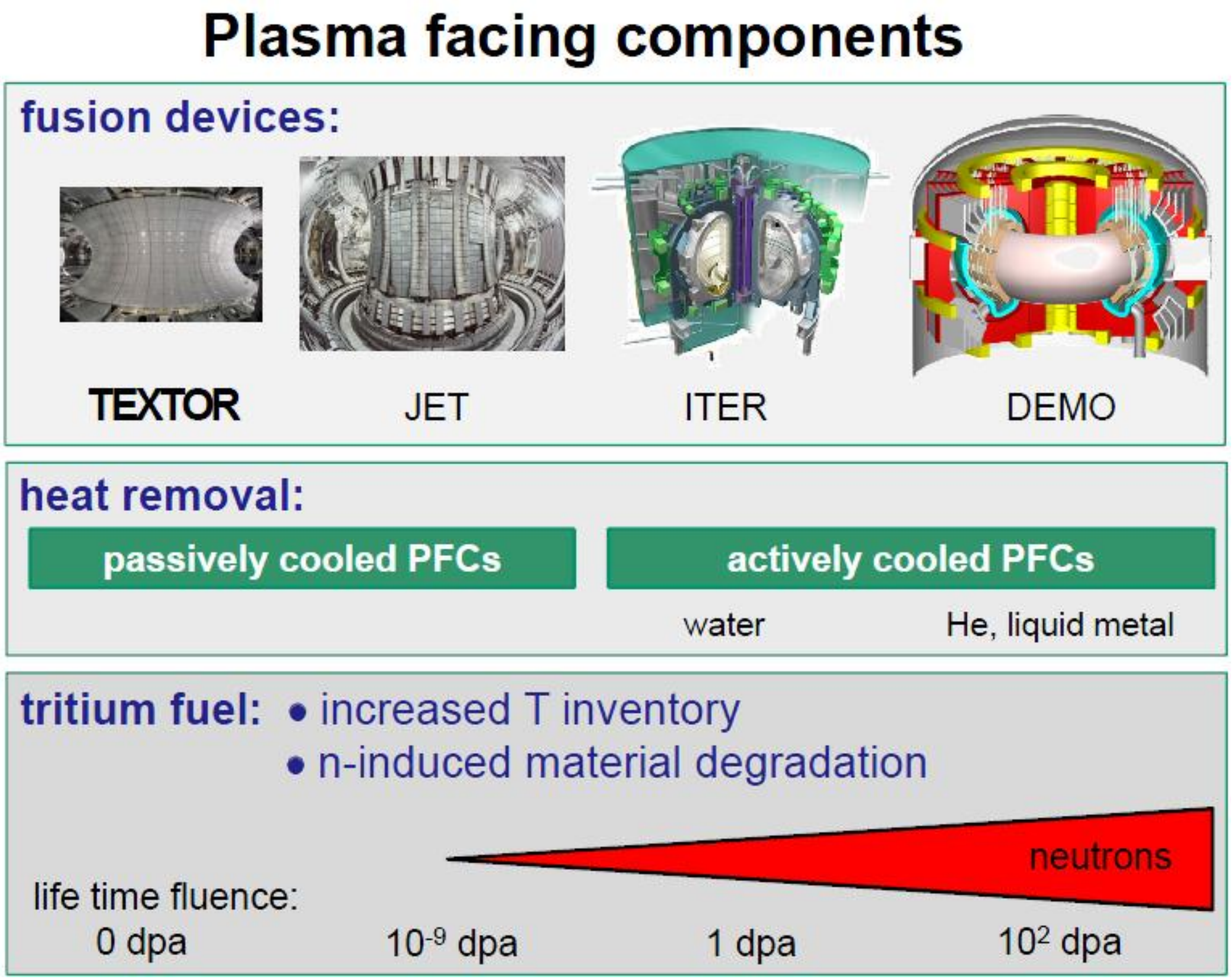
    - To start immediately the design of a small DEMO



Magnetic Fusion Energy Program of India by Abhijit Sen et al.

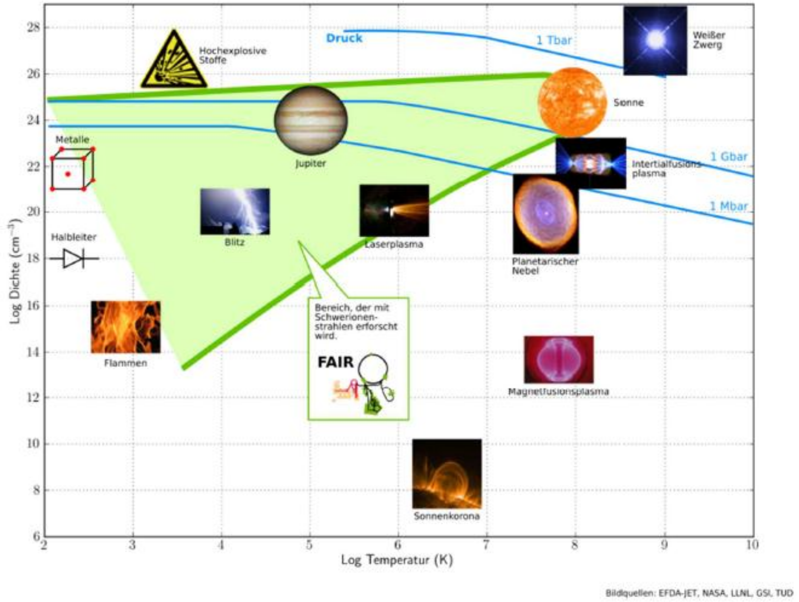


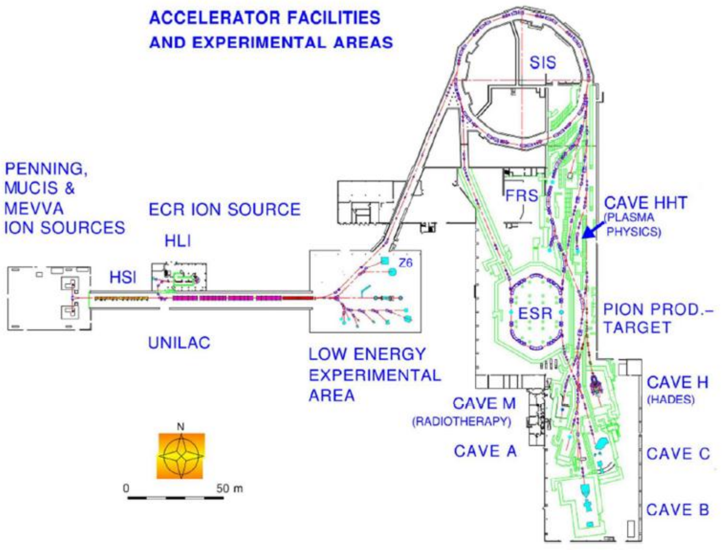
Material challenges for plasma facing components in future fusion reactors C. Thomser et al.



High Energy Density Physics with heavy ion beams
by D.H.H. Hoffmann et al.

Plasma: Matter at the Extreme



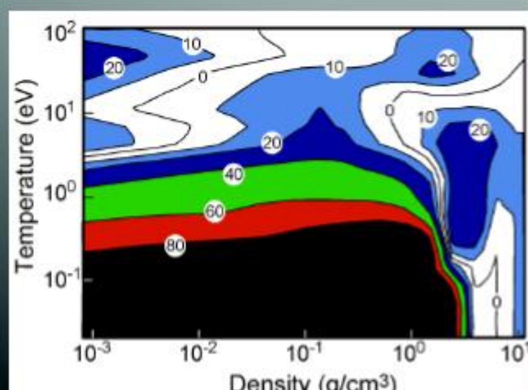


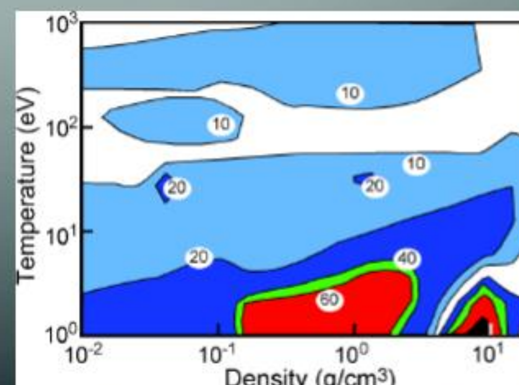
The MEC endstation at LCLS
New opportunities for high energy density science

Bob Nagler

Overview

A comparison between the Equation of State predictions between different codes. The codes calculate the pressure in Warm Dense Matter for a given Density and Temperatur. Plotted are the differences in percent between the prediction of the different simulation codes for iron and copper.





Differences larger than 80% in the Equation of State are common in the Warm Dense matter region are common.

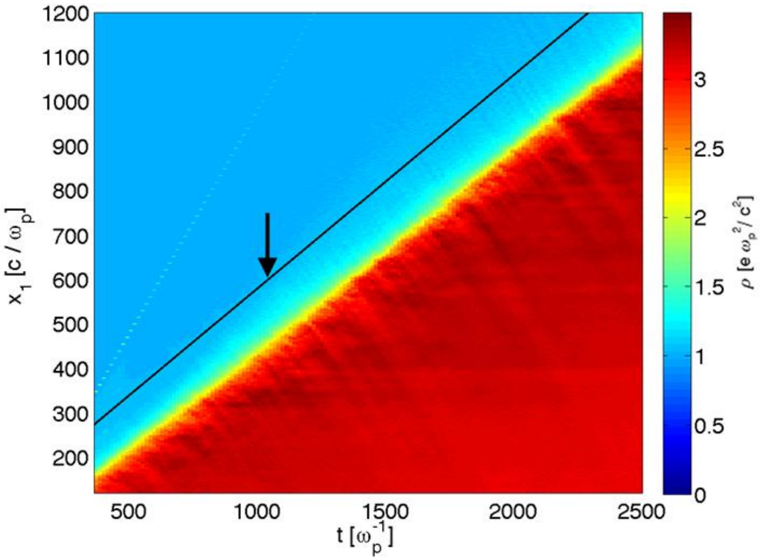
Where data exist, along the principal Hugoniot which can be reached by shock experiments, the different codes agree, showing the importance of experimental validation of Equation of State tables.

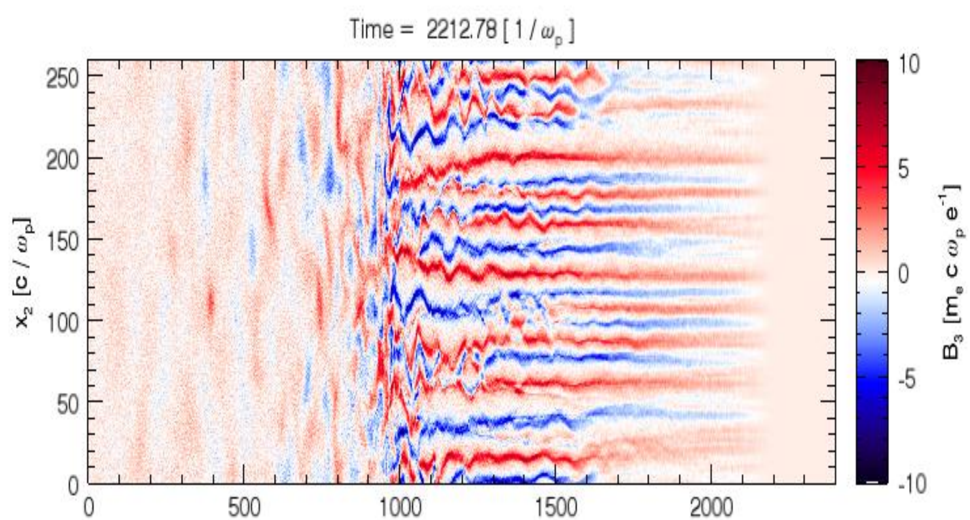
Kinetic Effects in Relativistic Shocks

A. Stockem

Fig.4: Plotting the density on x and t allows to determine the shock speed. The theoretical prediction is given by black line indicated by the arrow.

Figure 7: Self-consistently generated out of plane magnetic field.





Experiments and Simulations of Radiative shocks
B. Fryxell

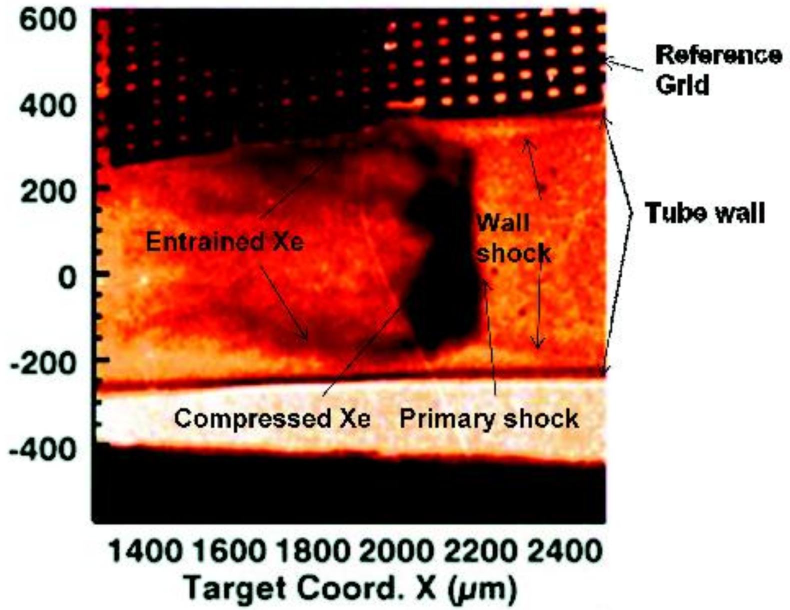


Figure 2. Radiograph from a typical CRASH experiment obtained at 14 ns showing the main features observed in the flow (adapted from [5]).

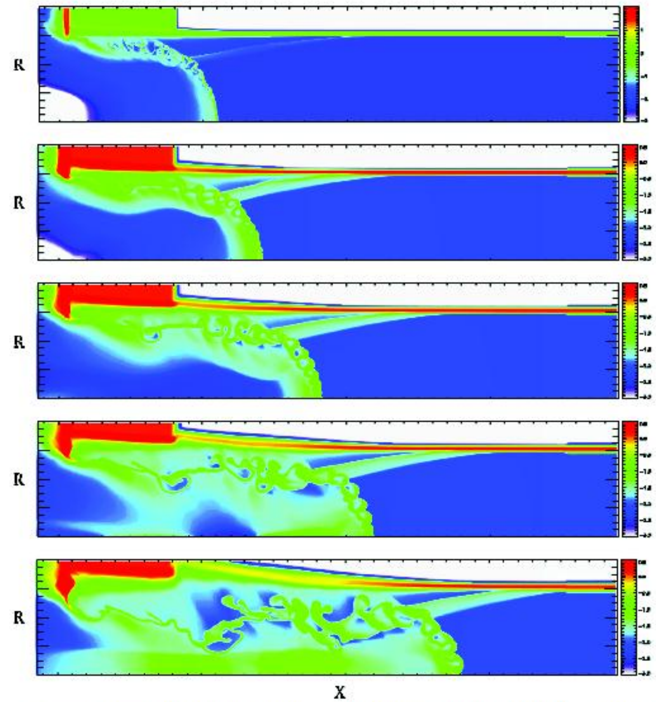


Figure 7. Time sequence of the density structure obtained from a simulation with a tube diameter of 1200 μm. For this case, instability appears at the primary shock.

Hypersonic Shocks: The Role of Radiation
C. Stehlé

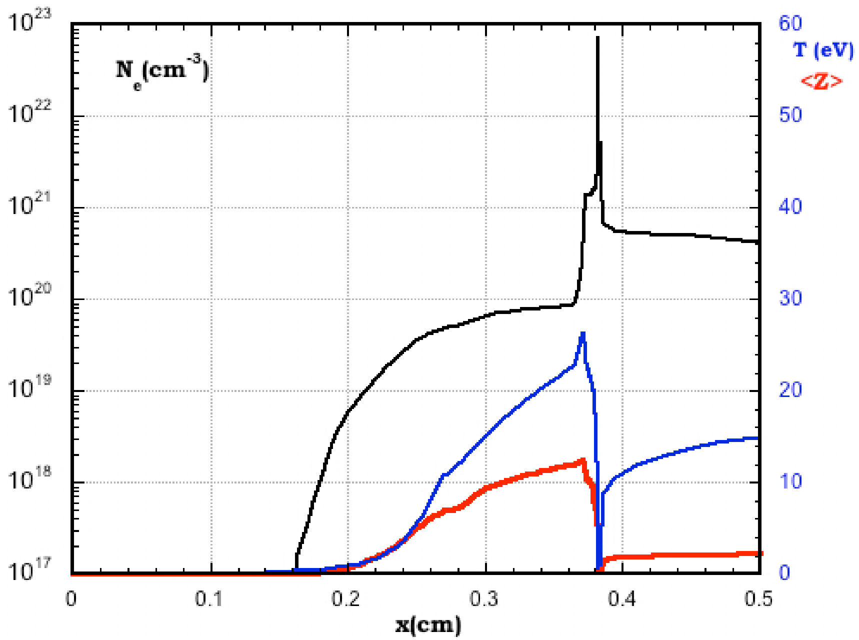


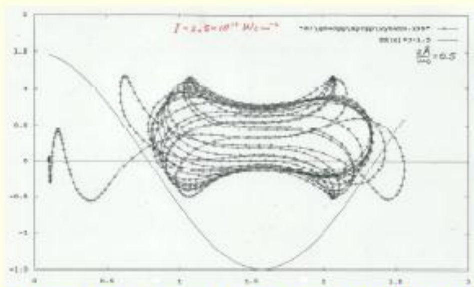
Figure 5: Snapshot of the plasma at 20 ns from 1D simulations [16]. The initial position of the piston is at x = 0.5 cm and the laser is coming from the right. The position of the shock front in xenon is located at 0.37 cm. The electron density peaks at 1.4 1021 cm−3 , the electron temperature at 26 eV and the mean ion stage at 13. The Xe- Au interface is at 0.386 cm and the CH-Au interface is located at 0.382 cm.

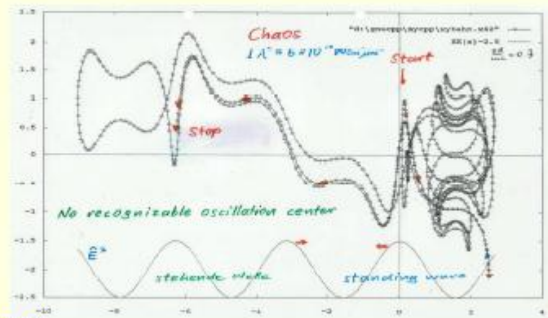
The electron in super-strong laser fields

P.Mulser

C. Chaos & resonant orbits

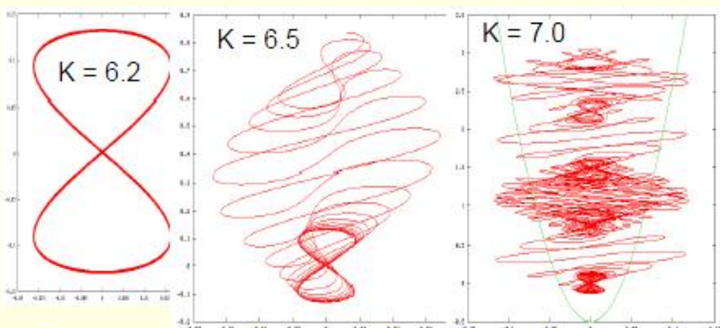
- **Ponderomotively induced chaos** : One regular field, two different time scales

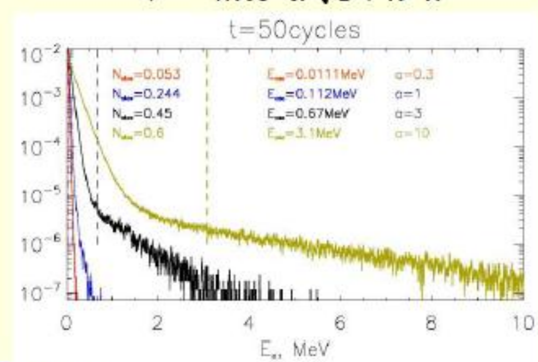




- ***Chaos in crossed regular fields*** : Static E – field

$$V = m_e c^2 \hat{a} \sqrt{1 + \kappa^2 x^2}$$





- ***Fast resonant* electrons** : Do not undergo regular motion

PARTICLE BEAM INDUCED LIGHT EMISSION
by A. Ulrich

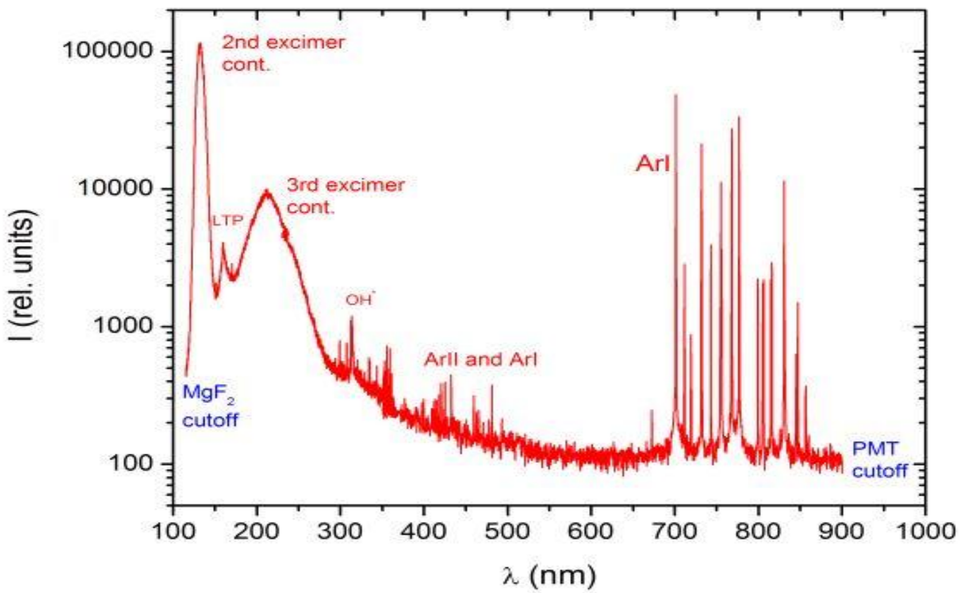


Fig. 1: Overview spectrum of light emitted from argon gas at a pressure of 600 mbar over a wide spectral range from ~100 to ~1000 nm. The gas was excited by a dc 120 MeV ^{32}S beam.

Recent experimental studies of ion acceleration driven by intense laser radiation
Kar et al

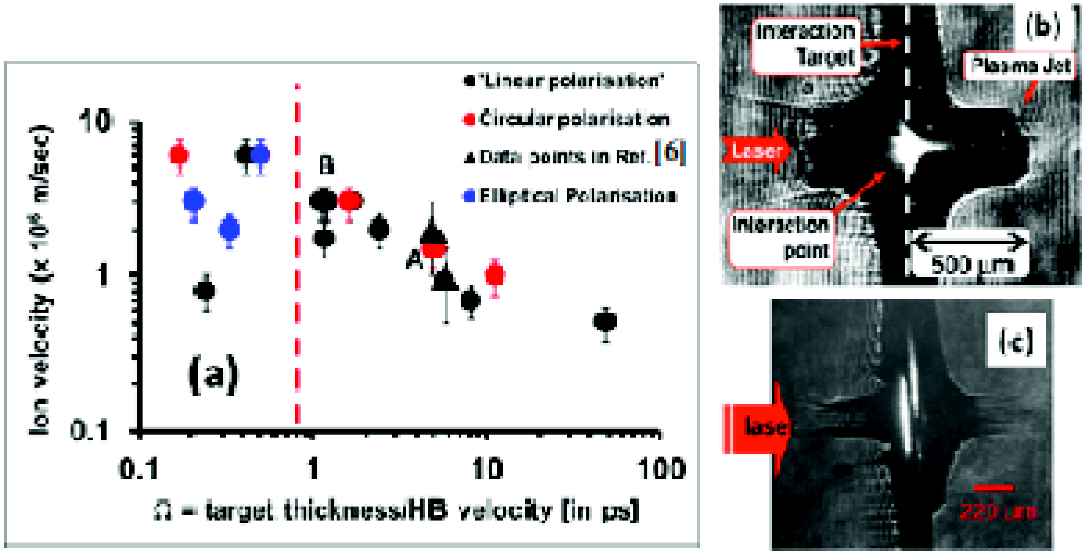
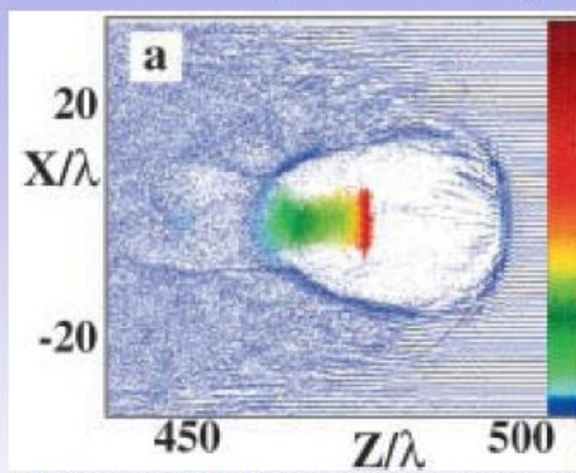


Fig 2. (a) Graph showing estimated ion velocity for different value of Ω, a parameter that depends on the laser and target parameters (as explained in the text). The red dotted line indicates the pulse duration of laser used in our experiment. **(b)** and **(c)** shows the interferograms correspond, respectively, to the data points 'A' and 'B' in (a).

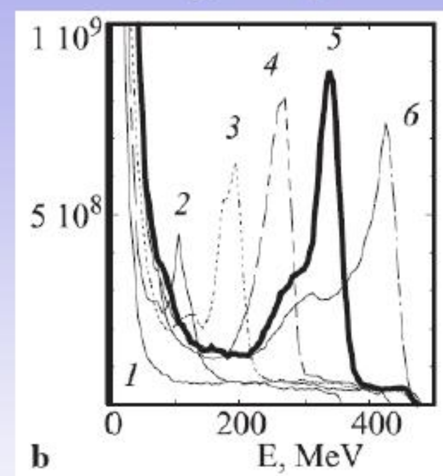
Optical probing of Laser driven electron acceleration by M. Kaluza et al.

IOQ Jena | **Laser-Driven Electron Acceleration** | HELMHOLTZ GEMEINSCHAFT Helmholtz-Institut Jena

- When plasma wave breaks, it forms a "bubble-like" plasma cavity
- Electrons are injected into the bubble and are accelerated to relativistic energies exhibiting quasi-monoenergetic spectra



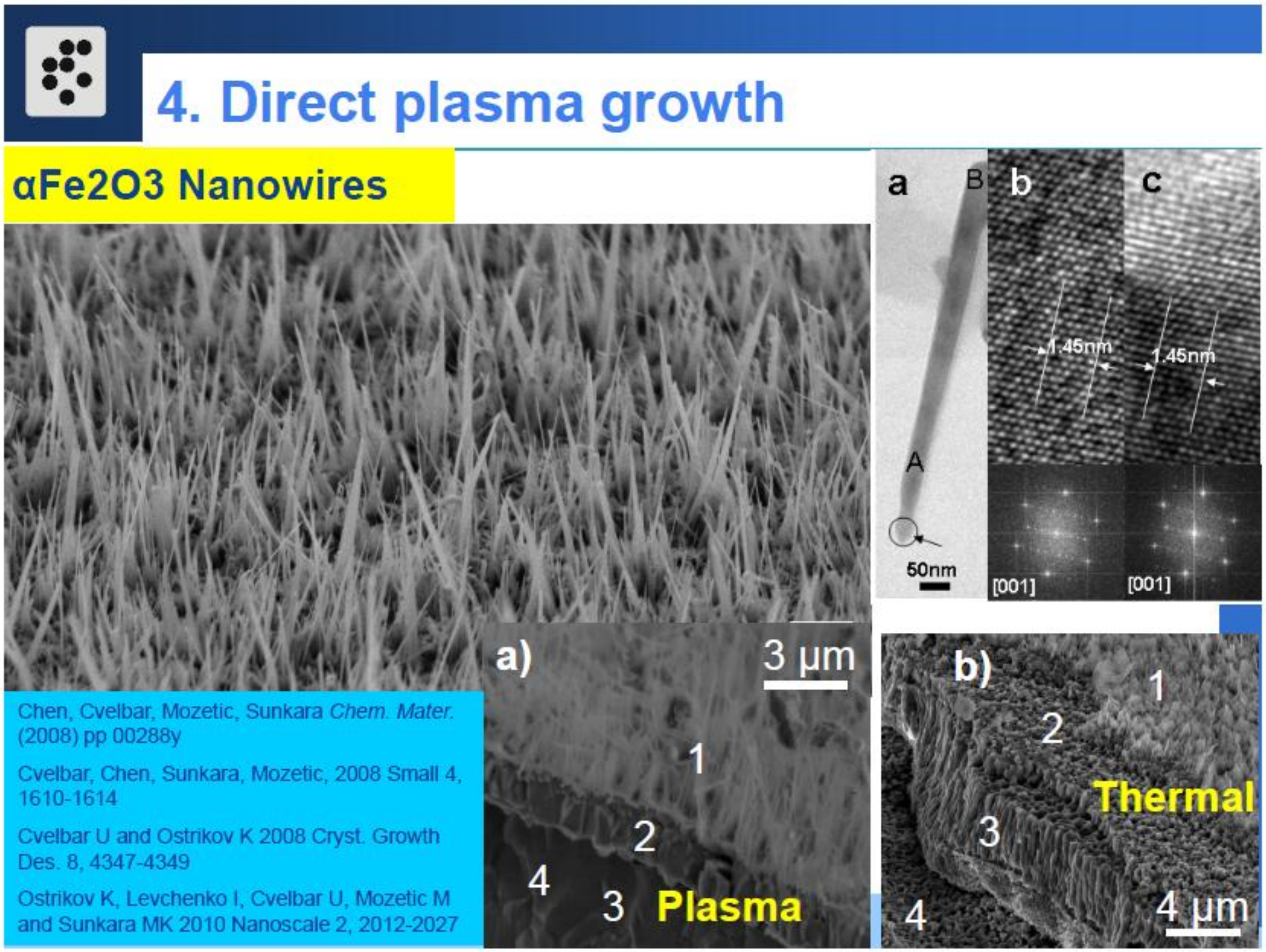
A. Pukhov and J. Meyer-ter-Vehn, APB (2002)



- First experimental verification: S.P.D. Mangles *et al.,* J. Faure *et al.,* C.G.R. Geddes *et al.,* Nature (2004)

Building new catalytic sensors and devices with plasma nano-structuring and large scale synthesis of nanowires

Uros Cvelbar



Nano-structuring of solid surface by EUV Ar $^{8+}$ Laser
Kolacek et al.

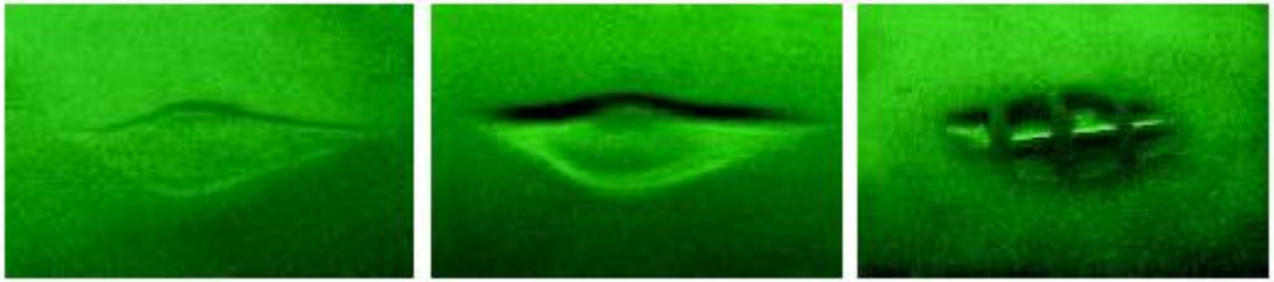


Figure 3. *Left – PMMA ablated by one shot of Ar^{8+} laser. Middle – PMMA ablated by five shots. Right – PMMA ablated through Ni grid (step 100x100 µm, free windows 70x70 µm, traverses 30 µm) by five shots; all these three pictures are in the same scale and with false colours.*

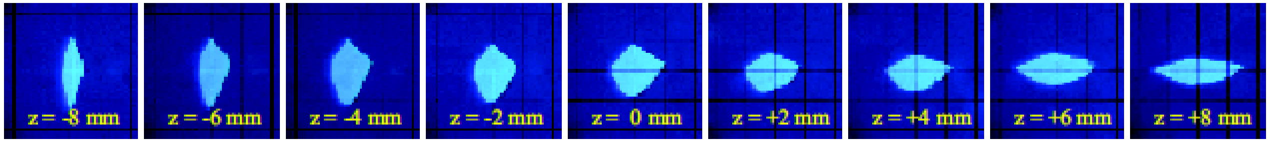


Figure 4. *Z–scan of laser beam footprint on gold-covered PMMA; apparent astigmatism is visible with astigmatic difference ~16 mm; the pictures were taken at blue illumination through microscope the measuring objective of which had grid 125x125 µm/div.*

Silicon carbide film formation by pulsed laser ablation and its characterization study

Pratima. K. Mishra

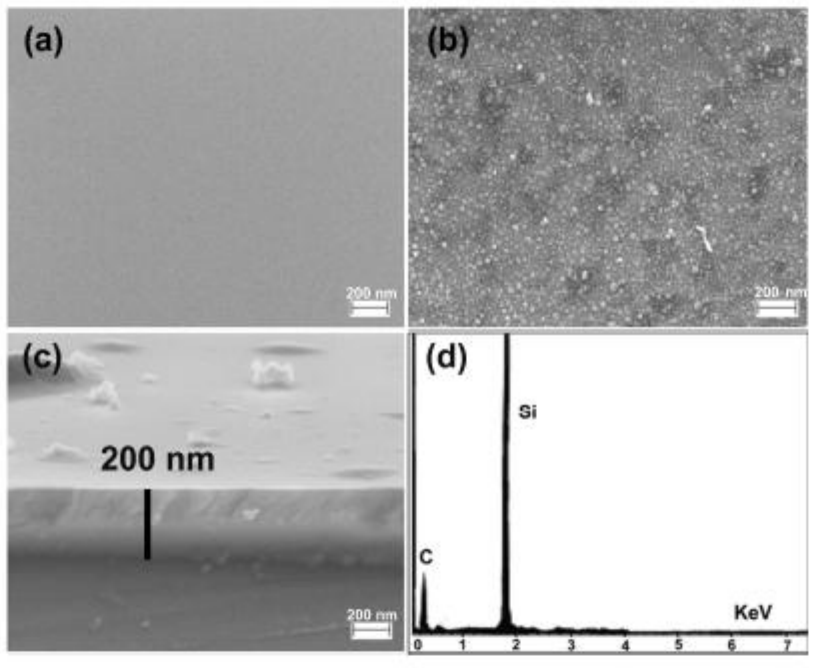


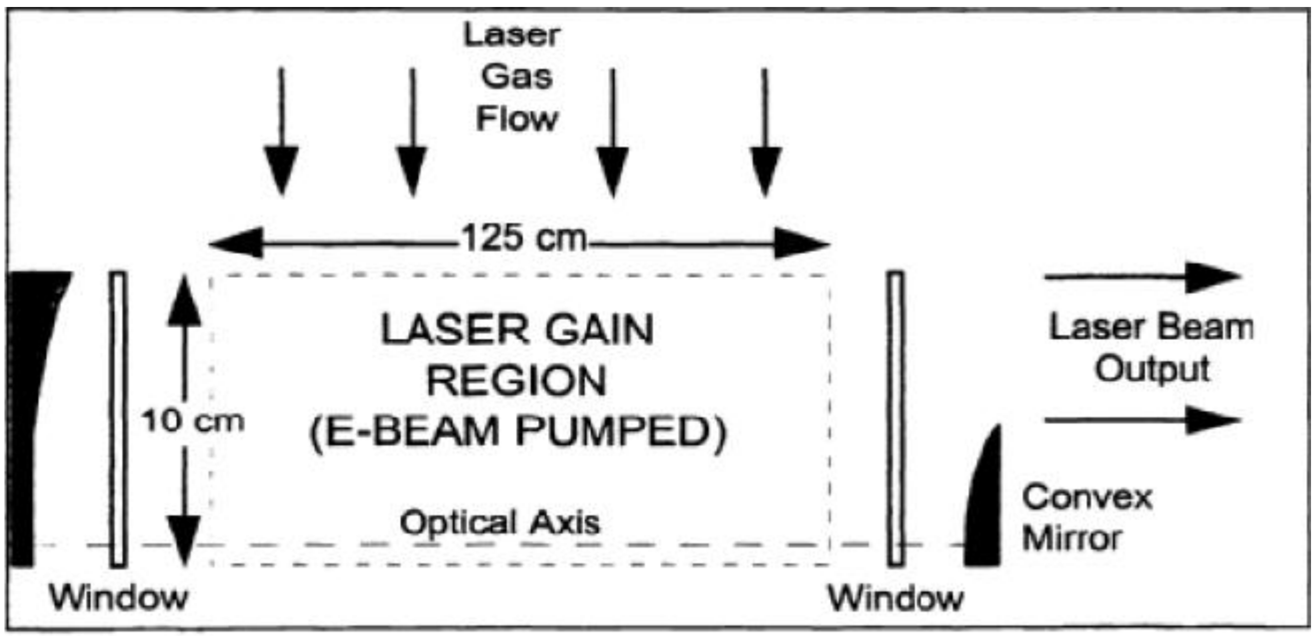
Fig.4 (a) FESEM image of SiC film without annealing deposited on Si substrate

(b) FESEM image of SiC film with annealing at 800^0C

(c) Crosssection image of SiC film showing thickness of about 200 nm

(d) EDAX spectrum of SIC film showing presence of Si and C

Modeling Plasma Processes in Gas Lasers”
R. F. Walter



Long-Distance Transfer of Microwaves in Plasma Waveguides Produced by UV Laser by V. Zvorykin et al.

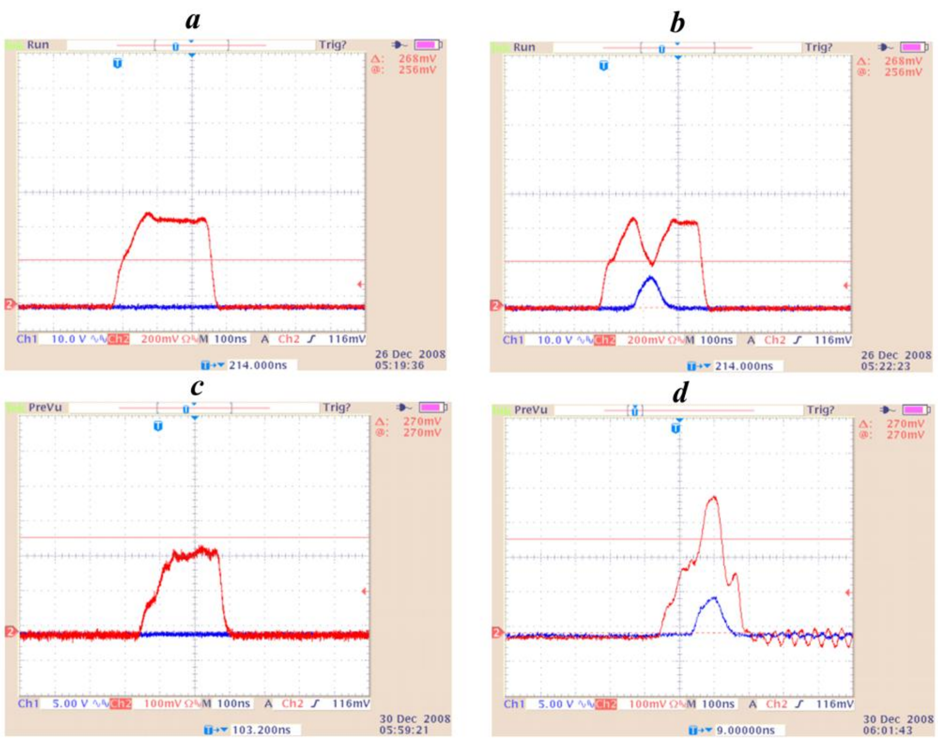
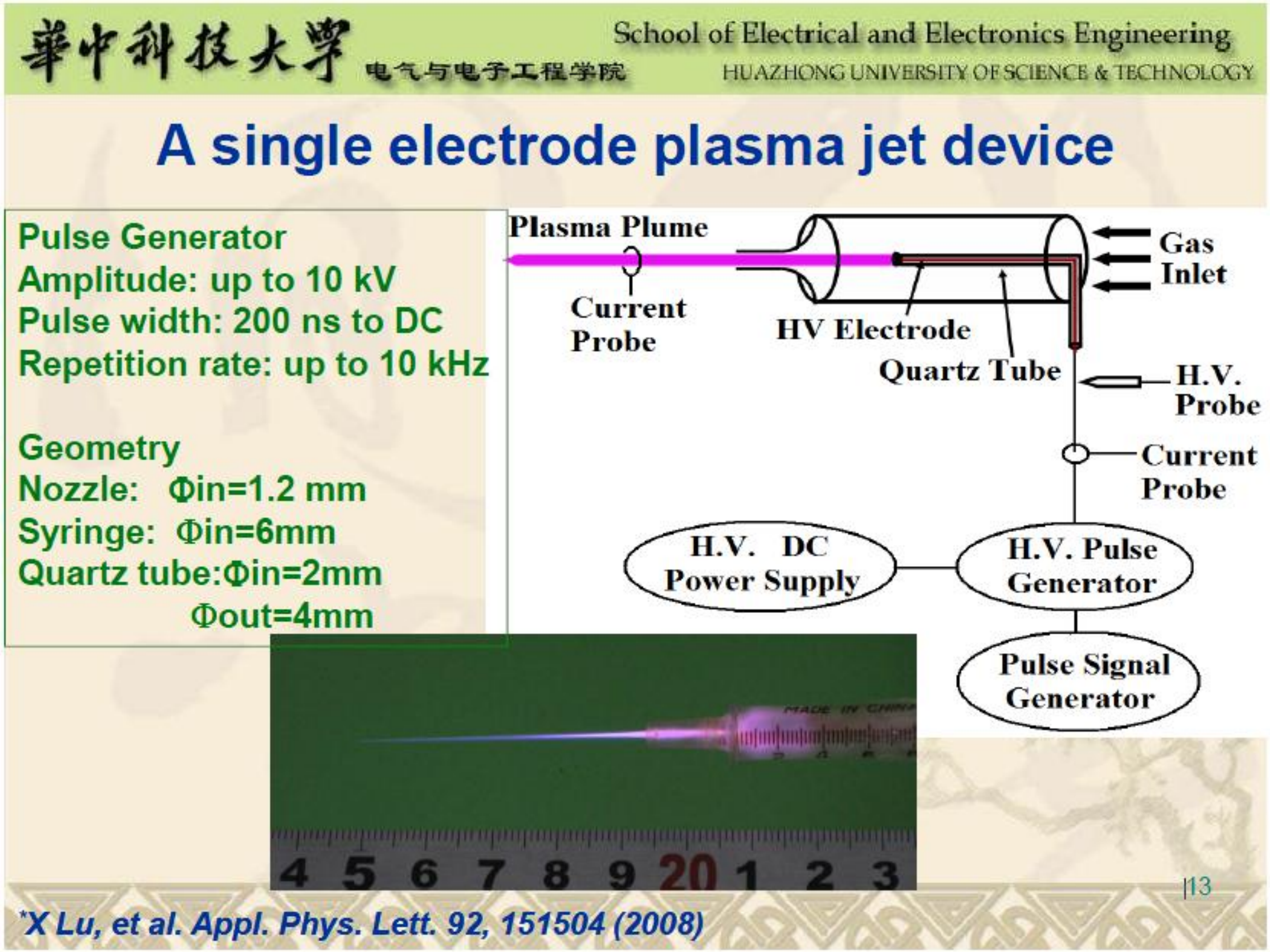


Figure 3: Signals from the microwave receiver (upper beam) and laser pulse (lower beam): upper (a and b) for the setup in Fig. 1a and lower (c and d) for the setup in Fig. 2d. The distance to the receiver L = 12 m.

Advances on non-equilibrium plasma jets
XinPei Lu



Various authors presented very interesting work in their presentations.

Quantum simulations of strongly coupled quark-gluon plasma
V.S. Filinov

First Results of Movable Limiter Biasing Experiments on the IR-T1 Tokamak by Mahmood Ghoranneviss et al.

Generation and spectroscopic investigation of an atmospheric pressure water vapour plasma jet by Viktorija Grigaitiene et al.

Evaluation optical properties carbon nano structures coating on Substrate Surface by Plasma Enhanced CVD by Zahra Khalaj et al.

Multi-radiation modelling of the plasma focus by S Lee et al.

Anisotropic electron distribution functions and the transition between the Weibel and the whistler instabilities by F. Pegoraro et al.

Electron-Hole plasma in solids induced by ultrashort XUV laser pulses by Bärbel Rethfeld et al.

Effect of Weakly Nonthermal Ion Velocity Distribution on Jeans Instability in a Complex Plasma in Presence of Secondary Electrons by S. Sarkar et al.

XUV Spectroscopic Characterization of Warm Dense Aluminum Plasmas generated by the Free-Electron-Laser FLASH by U. Zastrau et al.

Interference effects on the probe absorption in a driven three-level atomic system by a coherent pumping field by V. Stancalie et al.

Effects Of Transverse Electric Field, Couple Stress And Heterogeneity Of A Poorly Electrically Conducting Fluid Saturated Nano Porous Zeolites Acquiring Smart Material Properties by N. Rudraiah et al.

ITB oscillations: towards a limit cycle model by B.F.A.Silva et al.

Two best poster awards

SYNTHESIS OF NANOPARTICLES USING ATMOSPHERIC MICROPLASMA DISCHARGE

Ankit Bisht, G. Roshan Deen, Usman Ilyas, Y. Wang, Alireza Talebitaher, P. Lee, R.S. Rawat
NSSE, National Institute of Education, Nanyang Technological University, 1 Nanyang Walk, Singapore 637616, Singapore

PLASMA IMMERSION ION IMPLANTATION IN RADIO FREQUENCY PLASMA

B. Bora, F. Felipe, H. Bhuyan, E. Wyndham, H. Chuaqui, M. Favre
Department of Physics, Pontificia Universidad Católica de Chile, Chile