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Plasma Technology

The



of plasma-based accelerators

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THE SPEAKERS



✧ Dr. Brigitte Cros, U. Paris Saclay, CNRS, France

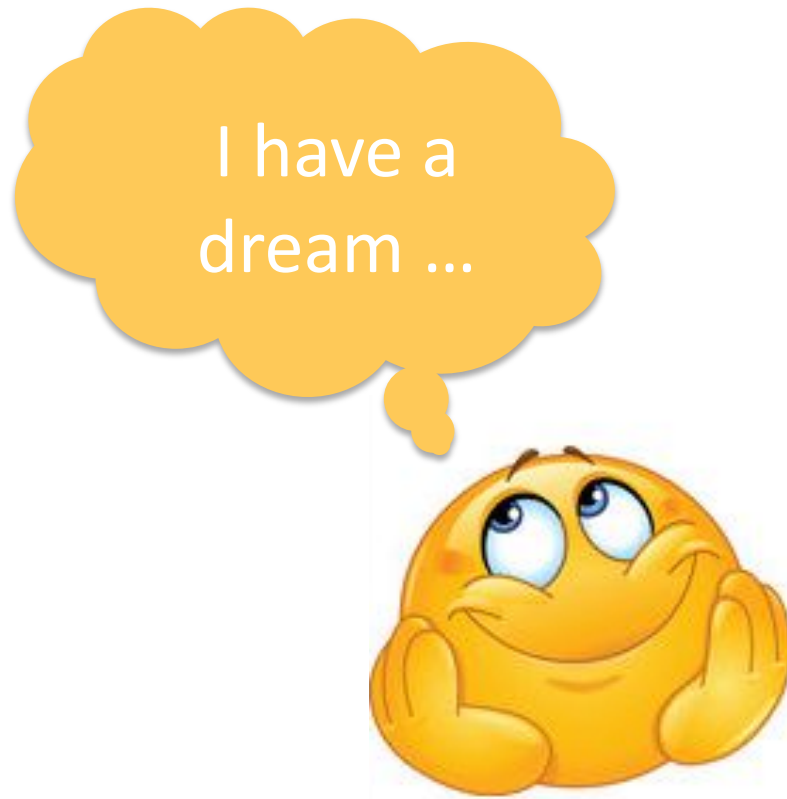
✧ Overview of plasma technology for accelerators



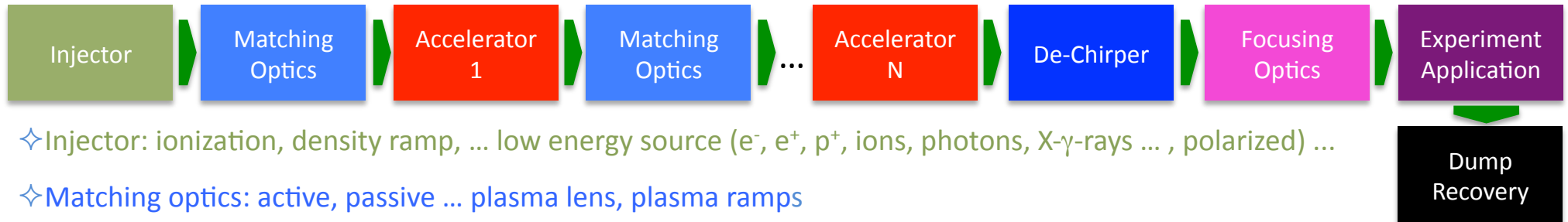
✧ Prof. Howard Milchberg, U. Maryland, USA

✧ HOFI and Capillary discharge waveguides

ALL-PLASMA-BASED ACCELERATOR



ALL-PLASMA-BASED ACCELERATOR



✧ Injector: ionization, density ramp, ... low energy source (e^- , e^+ , p^+ , ions, photons, X- γ -rays ... , polarized) ...

✧ Matching optics: active, passive ... plasma lens, plasma ramps

✧ Accelerator: with (LWFA) or without (PWFA) guiding, hollow channel (e^+ ?)

✧ De-chirper: one, many ...

✧ Focusing optics: active, passive ... plasma lens, collider beam delivery system (BDS)

✧ Beam dump, energy recovery (each stage?), activation minimization

✧ Experiment: plasma-based undulator, ...

✧ Plasma mirrors for LWFA

✧ Wide range of parameters:

✧ Source: gas jet, capillary, gas cell, laser ionized structures (HOFI), discharge, alkali metal vapor, helicon, solids, ...

✧ Size: microns to km

✧ Density: ..., 10^{14} - 10^{19} cm^{-3} , ...

✧ Shape: cylinder, density depletion (channel), hollow structure, ramps, ...

PLASMA TECHNOLOGY

✧ Wide range of applications:

- ✧ Low energy (MeV, 100's MeV) electron sources
- ✧ X-ray, betatron radiation sources (100's MeV)
- ✧ FEL driver, single(?) plasma (few GeVs)
- ✧ Plasma-based collider, many plasmas or stages (multi TeVs)
- ✧ Components: injector, optic (plasma lens), beam dump, ... (all of the above)

✧ The right plasma for the right application ...

CHALLENGES FOR SCIENCE AND APPLICATIONS

- ✧ Suitable source ... all parameters
- ✧ Shaping: down ramp, guiding channel (laser heating), hollow channel, density step, gradient, ramps, ...
- ✧ Reproducibility
- ✧ Uniformity
- ✧ Repetition rate
 - ✧ Recovery, power, heat dissipation, wear and tear, ...
- ✧ Ion motion
- ✧ Scattering
- ✧ ...

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✧ Overview of plasma technology for accelerators



✧ Prof. Howard Milchberg, U. Maryland, USA

✧ HOFI and Capillary discharge waveguides

Better listen to the experts ...

THE SPEAKERS



- ✧ Dr. Brigitte Cros, U. Paris Saclay, CNRS, France
 - ✧ Plasma Physicist, experimentalist LWFA
 - ✧ Directrice de recherche at CNRS
 - ✧ Member of the expert panel on plasma accelerator
 - ✧ Directrice du GdR APPEL
 - ✧ Spoke person of ALEGRO
 - ✧ Member and past chair of ICFA-ANA panel
 - ✧ WP coordinator in EuPRAXIA
 - ✧ PhD in 1989;-)



- ✧ Prof. Howard Milchberg, U. Maryland, USA
 - ✧ Professor, Dept. of Physics and Dept. of Electrical Engineering, Univ. of Maryland
 - ✧ Postdoc, Bell Labs (1985-87)
 - ✧ Ph.D. Princeton University (1985).
 - ✧ B. Eng. McMaster University
 - ✧ NSERC Fellowship, National Research Council of Canada
 - ✧ NSF Presidential Young Investigator Award
 - ✧ APS John Dawson Award for Excellence in Plasma Physics Research (2005)
 - ✧ Fellow APS, OSA Optical Society of America
 - ✧ UMD Distinguished Scholar-Teacher
 - ✧ Senior Faculty Outstanding Research Award in UMD's Clark School of Engineering
 - ✧ Member of National Academy Committee on Intense Lasers (2017), LaserNetUS scientific advisory board (2018--)
 - ✧ Three of his graduate students have been recipients of APS-DPP's Marshall N. Rosenbluth Outstanding Doctoral Thesis Award (plasma physics).

DISCUSSION TOPICS

- ✧ Many different types of plasmas
- ✧ Many plasma sources

- ✧ Plasma “good enough” for experiments(?)
- ✧ Plasma source, plasma parameters are essential for:
 - ✧ Applications
 - ✧ Reliability, reproducibility, etc.

- ✧ Need for:
 - ✧ Plasma diagnostics
 - ✧ Numerical simulations of plasma source

DISCUSSION TOPICS

- ✧ Wide range of parameters: n_{e0} , L, ... (plasma for ...)
 - ✧ fC, MeV, kHz for ultrafast electron diffraction (UED)
 - ✧ nC, 100MeV for bremsstrahlung source
 - ✧ 100pC, 25kHz, TeV e^-/e^+ for collider, all collider requirements
- ✧ Parameters must be determined for/from applications
- ✧ Especially challenging for “devices” (not experiments)
- ✧ Key parameters:
 - ✧ n_{e0} , longitudinal uniformity? Gap between assumption and reality?
 - ✧ Transverse structure: uniform, guiding, hollow channel? Diagnostics?
 - ✧ Longitudinal tailoring? Gradient, ramps, steps, ...
 - ✧ Reproducibility?
 - ✧ Diagnostics? Control? Jitter: time, density
 - ✧ Need for numerical simulations
 - ✧ Discharge, heating, walls effects, repetition rate, what is needed?
 - ✧ Need input of plasma parameters into codes for wakefields?



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✧ Energy management:

- ✧ Wakefields energy extraction?
- ✧ Heat management?
- ✧ Efficiency? Power per meter (discharge, laser, etc.)?
- ✧ Wall erosion?
- ✧ Favor schemes without walls (HOFI?) for collider applications?

✧ Gas management?

DISCUSSION TOPICS



Thank you!

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