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Plasma-based Acceleration at Imperial College

Zulfikar Najmudin

S. Mangles, A. E. Dangor, S. Kneip, M. Bloom
(+ ion acceleration team + theory)

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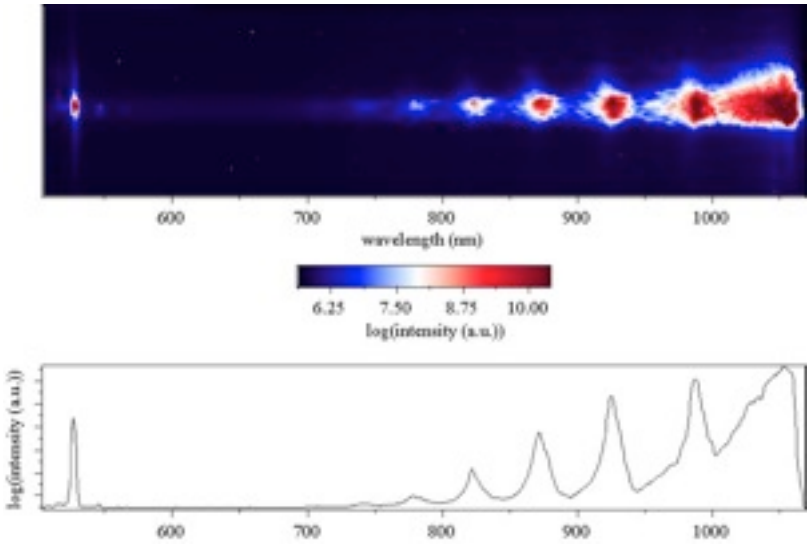
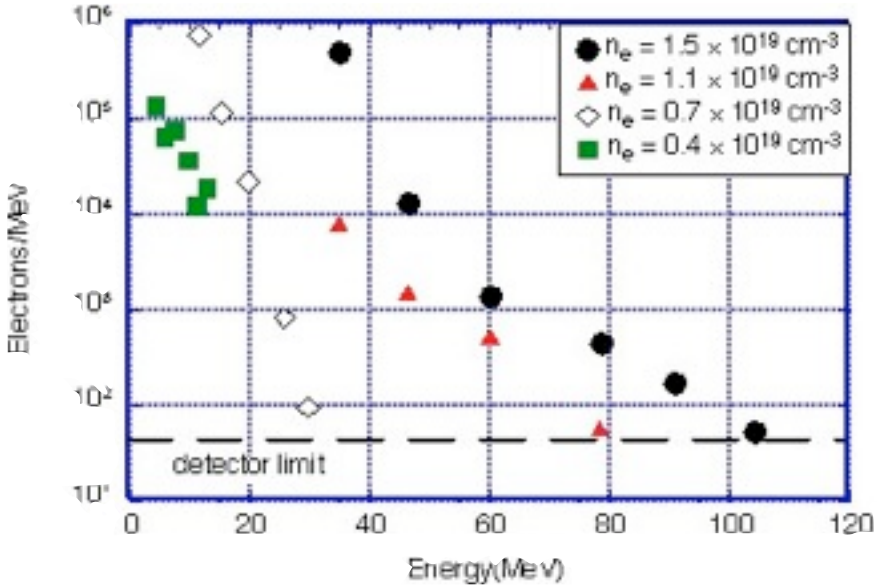
Laser Wakefield acceleration : self-modulated experiments

First demonstration of self-modulation of intense laser beams with VulcanCPA laser



Acceleration to 100 MeV scale



A. Modena et al., Nature 1995

IC / RAL / UCLA / LULI

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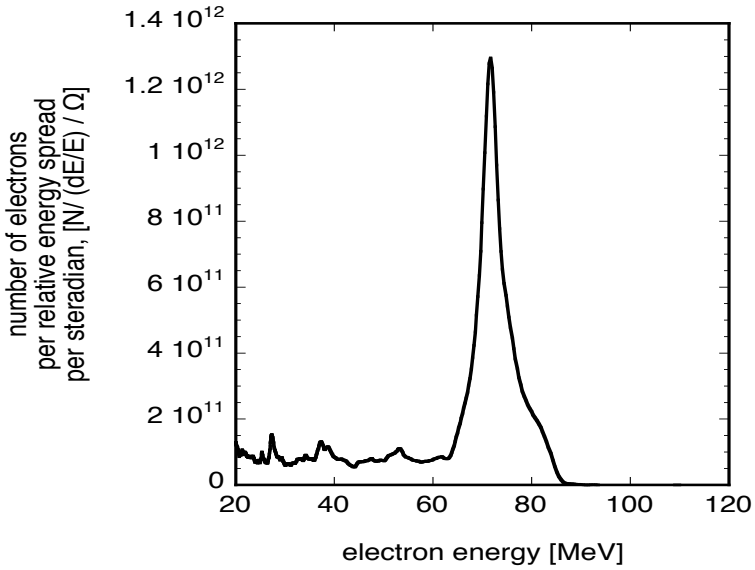
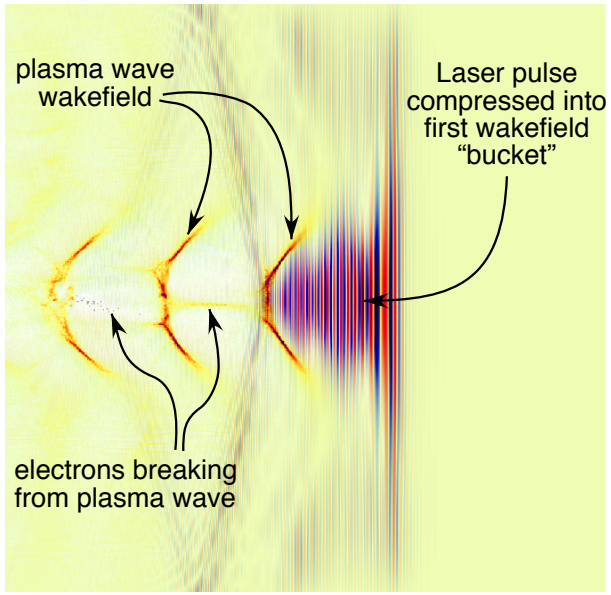
Laser Wakefield acceleration : monoenergetic beams

First demonstration of energy control in self-injected beams



Simulations showing "controlled injection"



S. Mangles et al., Nature 2004

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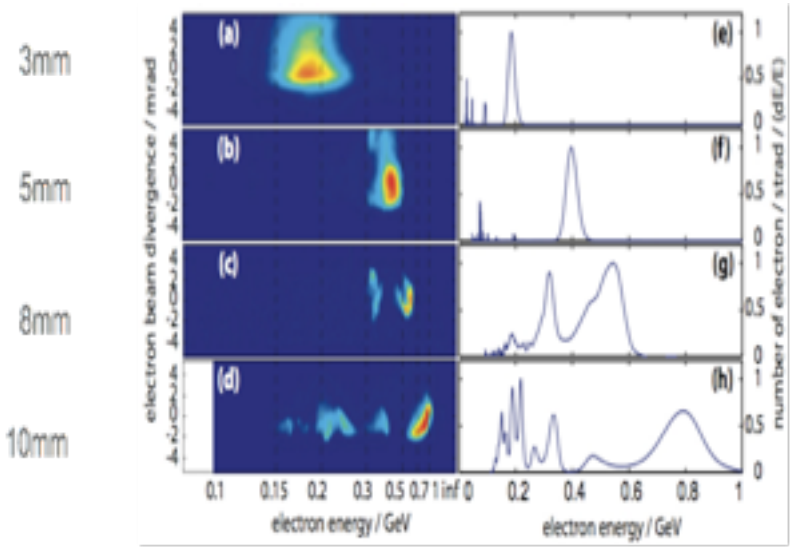
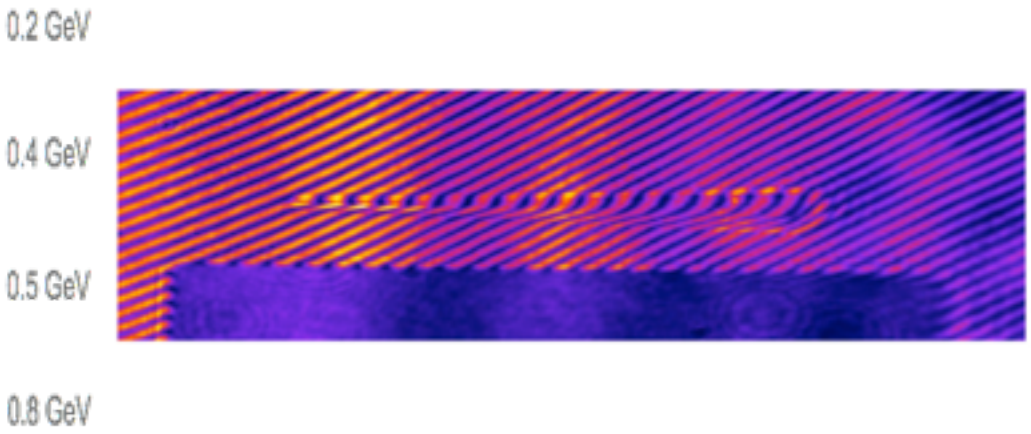
Laser Wakefield acceleration : near GeV acceleration

Acceleration seen to GeV level

in ~ 1cm self-guided channel





S. Kneip et al., Physical Review Letters 2009

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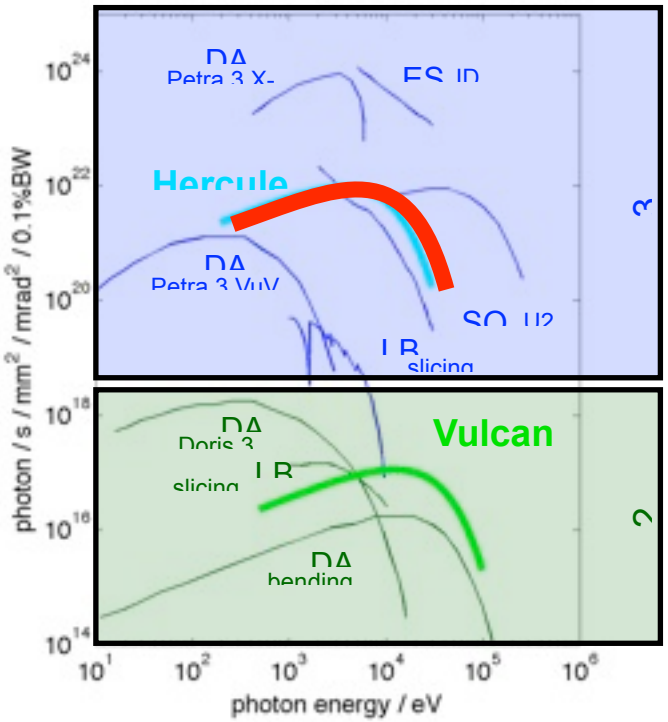
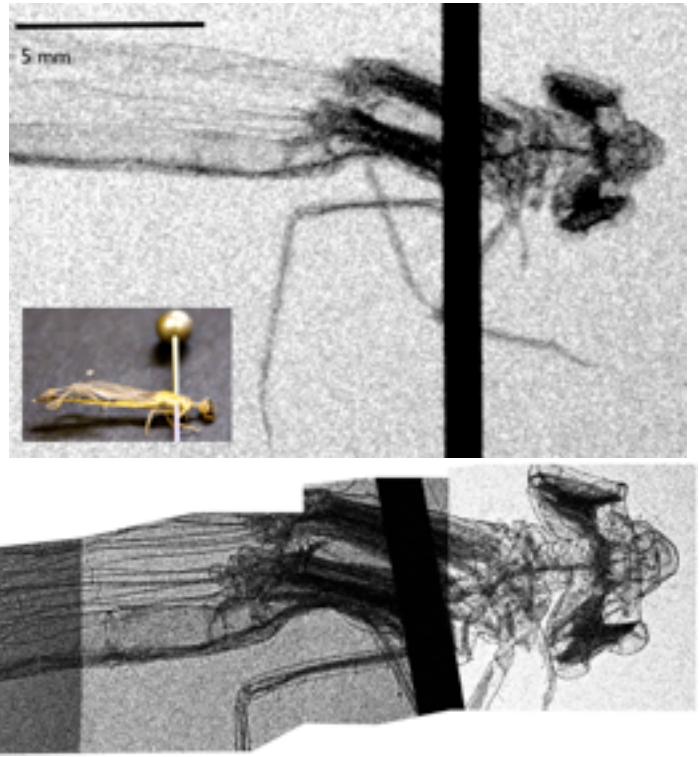
Laser Wakefield acceleration : betatron radiation

Bright x-ray source comparable to 3rd generation light source



other light sources from A. Rousse *et al*, EPJD, 2008

small source size ideal for phase contrast imaging



S. Kneip et al., Nature Physics 2010

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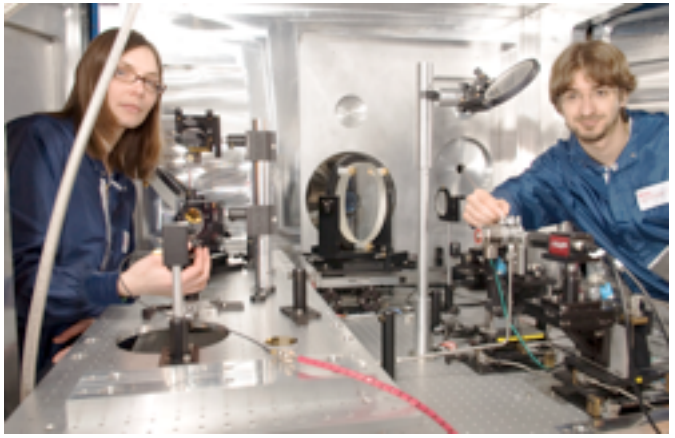
Lasers at Rutherford Laboratory

Vulcan laser: 500J at 500 fs (1 PW) (self-modulation expts)

Astra laser: 500mJ at 40 fs (12 TW) (monoenergetic pulses)



Astra Gemini: 10 J at 40 fs (240 TW) (GeV gain, bright x-rays)

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Laser developments

Vulcan 10 PW upgrade:
OPCPA: 300 J in 30 fs
approved awaiting funding

Acceleration to 10 GeV scale predicted

Laser developments at Imperial College

Laser	Energy (now)	Pulse Length (now)	Rep-rate	Energy planned	Pulse Length planned
Cerberus	10 J	500 fs	minutes	300 J	150 fs
Femtosecond	~ mJ	10 fs	kHz	30 mJ	10 fs

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Experimental Collaborations

Proton driven wakefield collaboration – (see talk of Alan Caldwell)

John Adams Institute - diagnostic development, experimental collaborations etc.

Cockroft Institute – joint experiments, use of facilities etc.

Other experimental collaborations – Lund, Michigan …

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Plans

High energy :

Gemini experiments with improved laser characteristics over longer lengths (RAL).

10 PW experiments should approach 10 GeV. (RAL)

“Controlled” experiments:

kHz short-pulse laser development for low energy high-rep rate source. (IC)

Higher energy long pulse development for higher charge higher energy beams. (IC)