

# *Laser Plasma Accelerators: Achievements and plans*



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<http://www.lpgp.u-psud.fr/operations/interaction/anad.htm>

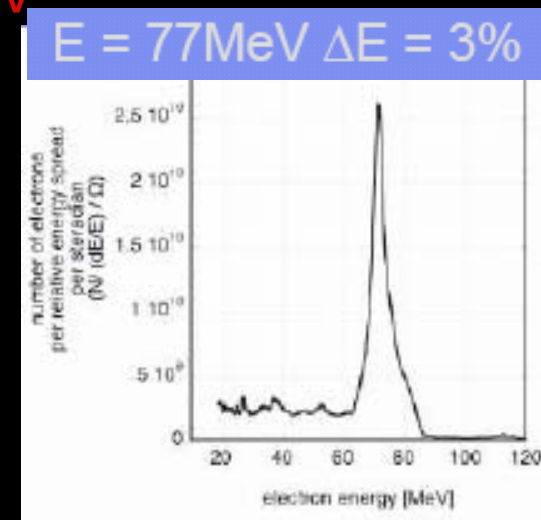
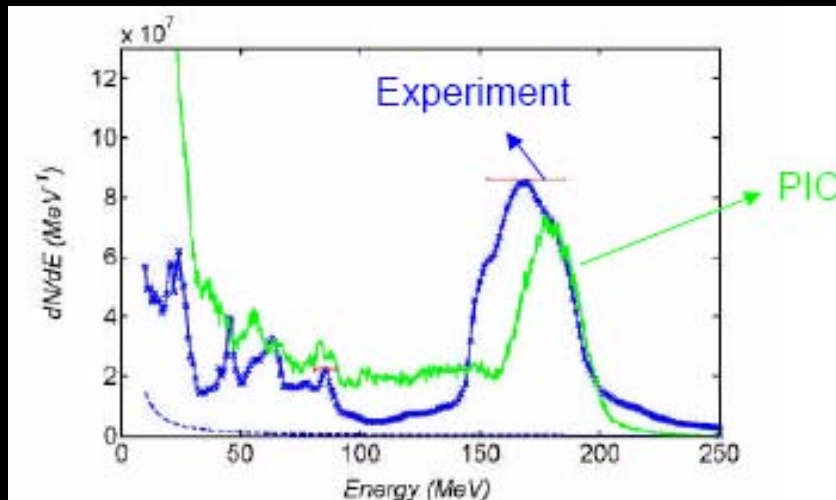
# Outline

- ❖ **Scientific advances**
- ❖ **Coordination efforts:**
  - ❖ **Paris workshop**  
<http://polywww.in2p3.fr/actualites/congres/heeaup2005/>
  - ❖ **European projet**
- ❖ **Future projects**

# Generation of quasi-monoenergetic electron beams

- ❖ Intense laser **10TW 30fs** plasma interaction generate e- beams **70~170MeV**

LOA  
Group



IC  
Group

- ❖ Pioneered by 3 groups (Nature 04) and now achieved by several groups around the world...but stability has to be improved

# Modeling of LPA

## ❖ Analytical efforts

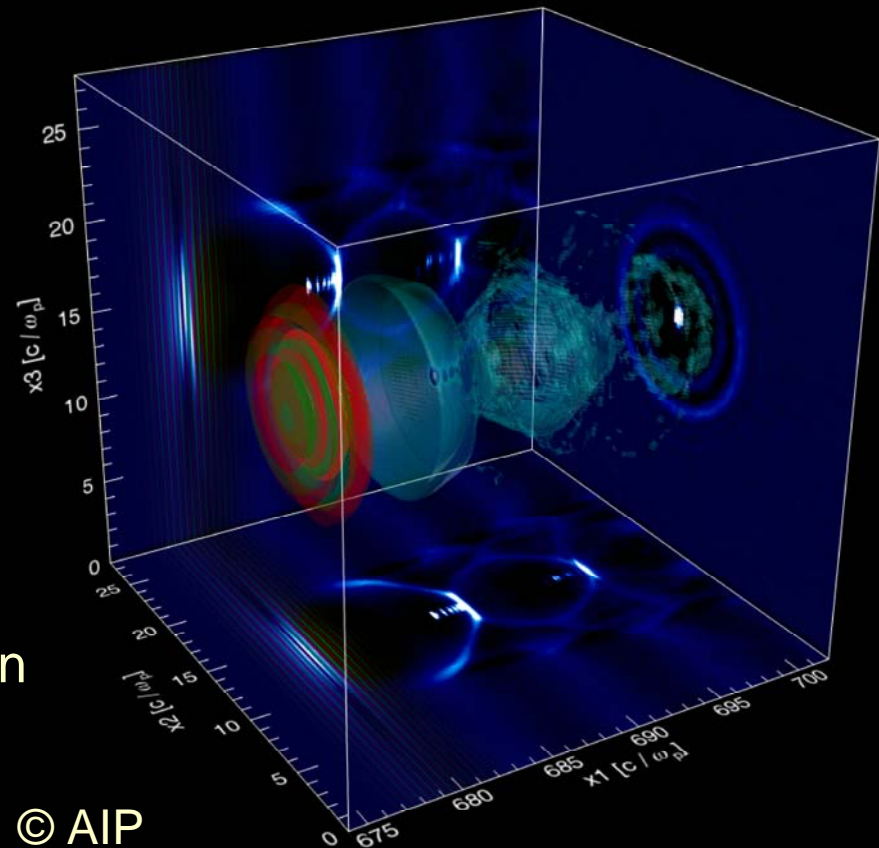
### ❖ Scalability of the bubble: similarity theory

A. Pukhov  
Group

## ❖ 2D-3D simulations

IST  
Group

See L. Silva talk  
in the ANAD session this afternoon



## *LPA in guided regime*



Recent achievements, S.Hooker (U. Oxford) & W.Leemans (LBNL) groups

See S. Hooker talk  
in the ANAD session this afternoon

# *A successful proposal*





## ***EuroLEAP project : starting***

### ***European Laser Electron controlled Acceleration in Plasmas to GeV energy range***

- ❖ **NEST-Adventure R&D project, elaborated in the frame of ELAN, and supported by ESGARD**
- ❖ **2006-2009, 2 MEuros, 11 labs**
- ❖ **Kick-off meeting (May 16th 06)**
- ❖ **Contract to be signed soon**



## ***EuroLEAP Objectives***

- ❖ **To build a laser-plasma accelerator**
- ❖ **To accelerate electrons to the GeV energy range in a plasma wave.**
- ❖ **To test the issues related to the control of the properties of the electron beam**
- ❖ **Expected result: accelerated e-beam with**
  - ❖ **energy in the GeV range,**
  - ❖ **energy spread of the order of 1%,**
  - ❖ **pulse duration of the order of 100 fs,**
  - ❖ **charge in the range 10 pC to 100 pC.**





## ***EuroLEAP R&D activities***

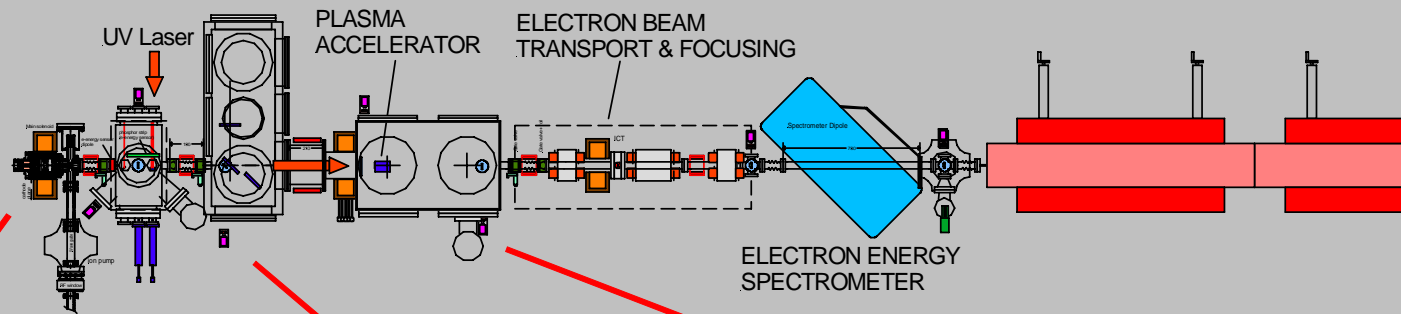
- ❖ **WP1: Laser Injector Development**
- ❖ **WP2: RF Photo-Injector Development**
- ❖ **WP3: Production of a plasma wave over a long distance**
- ❖ **WP4: Injection & Controlled Acceleration**
- ❖ **WP5: Diagnostics**

# Planned integrated experiment at U. Strathclyde

See D. Jaroszynski talk in the ANAD session this afternoon

- Curved cathode design has been adopted.
- Bunch duration significantly reduced.
- Around 100 fs at plasma channel entrance.

## Beam Line Layout (under construction)



Photoinjector  
(LAL, U. Paris-Sud)



RF Field



Laser Pulses

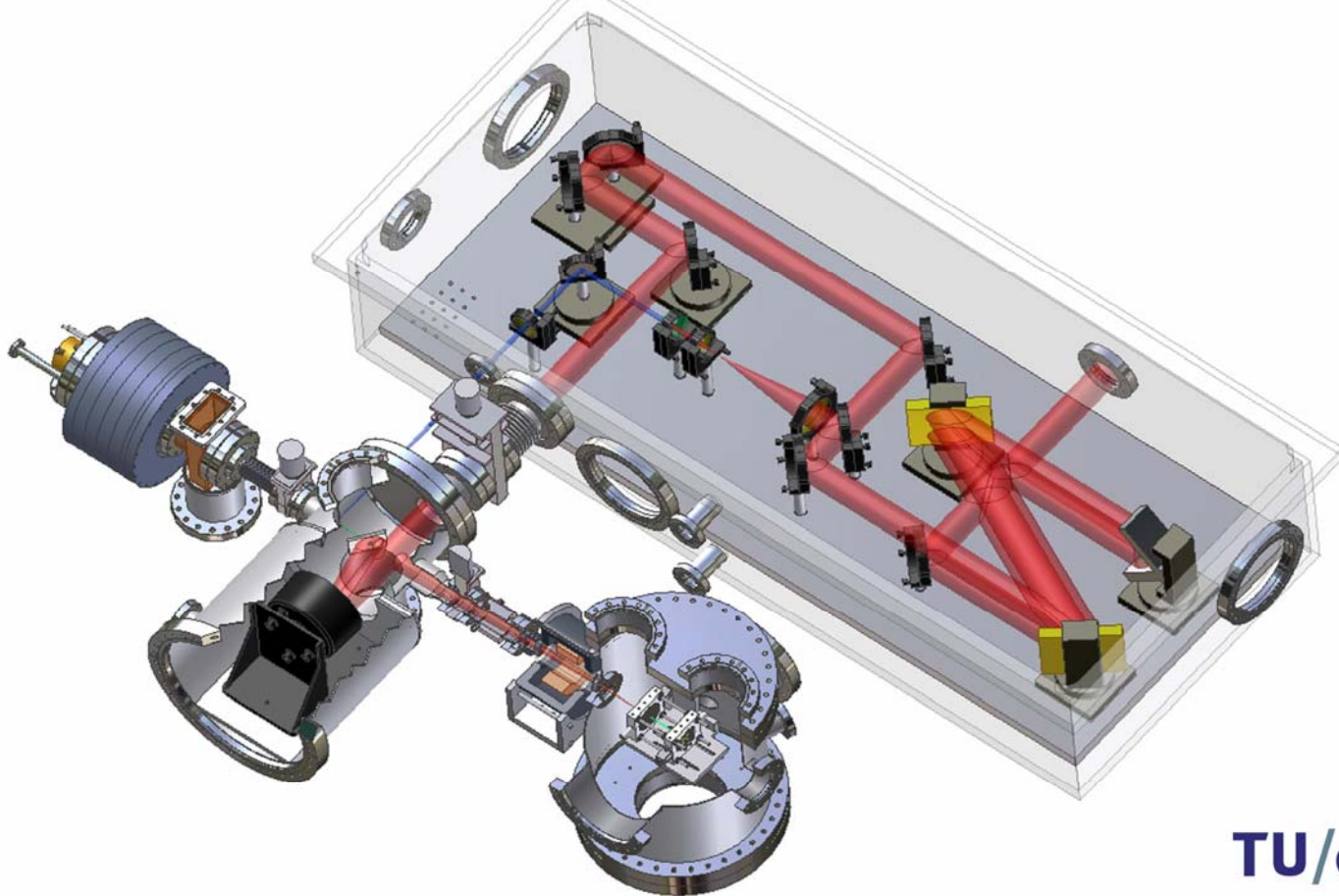


Plasma  
Channel  
(U. Oxford)



# *Planned RFP injector test experiment at T.U. Eindhoven*

See S. Brussaard talk in the ANAD session this afternoon



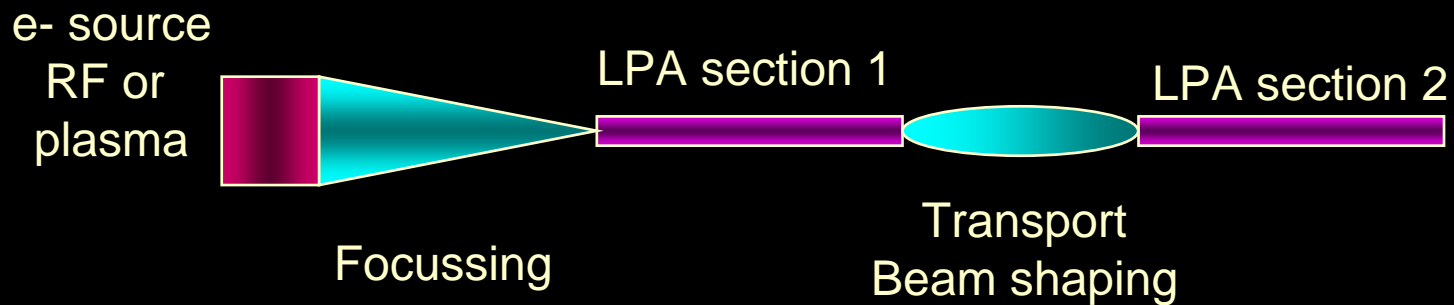
# *Future Plans*



# JRA LAPTECH in FP7-CARE

## LAsEr Plasma TEChnology

- ❖ 4 years, 20 labs, 20 MEuros project
- ❖ 2 sections plasma accelerator to
  - ❖ Study beam transport issues between plasma accelerator sections
  - ❖ Control acceleration to the 10 GeV range



- ❖ Theoretical beam- beam interaction studies for ultra short electron bunches, polarisation studies, generation of positrons, and full scale modeling. **Contributors welcome!**

# *Extreme Light Infrastructure*

- ❖ New Facility for LPA studies: ELI project initiated by G. Mourou. <http://loa.ensta.fr/>
- ❖ Recommended to be on the ESFRI Road Map
- ❖ 3 main scientific fields:
  - ❖ Ultra high Field Science
  - ❖ Attosecond science
  - ❖ High Energy beam facility
- ❖ European project
- ❖ More than 30 labs involved
- ❖ Estimated cost: 197 MEuros over 10 years
  - ❖ 130 MEuros construction (5 years, 3 steps)
  - ❖ 67 MEuros operation (10 years)



# ELI : a three stage project



LOA



# Parameter designs Laser Plasma Accelerators



ELI : > 100 GeV

P(PW) E(J)	$\tau$ (fs)	$n_e(\text{cm}^{-3})$	$W_0$ ( $\mu\text{m}$ )	L(m)	$a_0$	Q(nc)	E(Gev)
0.12/3.6	30	$2e18$	15	0.009	4	1.3	1.12
1.2/120	100	$2e17$	47	0.28	4	4	11.2
<b>12/3.6k</b>	300	$2e16$	150	9	4	13	<b>112</b>
120/120 K	1000	$2e15$	470	280	4	40	1120



# Summary

- ❖ Very significant scientific advances have been achieved in the last few years
- ❖ Fruitful exchanges have lead to the success of a European proposal
- ❖ Let's pursue our joint efforts for the success of new and ambitious projects!

# ***ANAD session programme***

## ***15th May, 06***

- ❖ **15h30** - Status of the work at TUE, Seth Brussaard
- ❖ **15h55** - Pre-formed channels for laser-plasma electron accelerators, Nelson Lopes
- ❖ **16h20** - Demonstration of the generation of GeV electron beams from a plasma accelerator driven in a capillary discharge waveguide, Simon Hooker
- ❖ **16h45 - Break**
- ❖ **17h10** - Scalings for multi-GeV laser-plasma accelerators and recent progresses in numerical modeling, Luis Silva
- ❖ **17h35** - Status of the ALPHA-X project, Dino Jaroszynski
- ❖ **18h00** - Preparation of a database on laser-plasma acceleration, Brigitte Cros
- ❖ **18h30** - End of ANAD session