Long plasma source based on a capacitive discharge for proton driven PWFA

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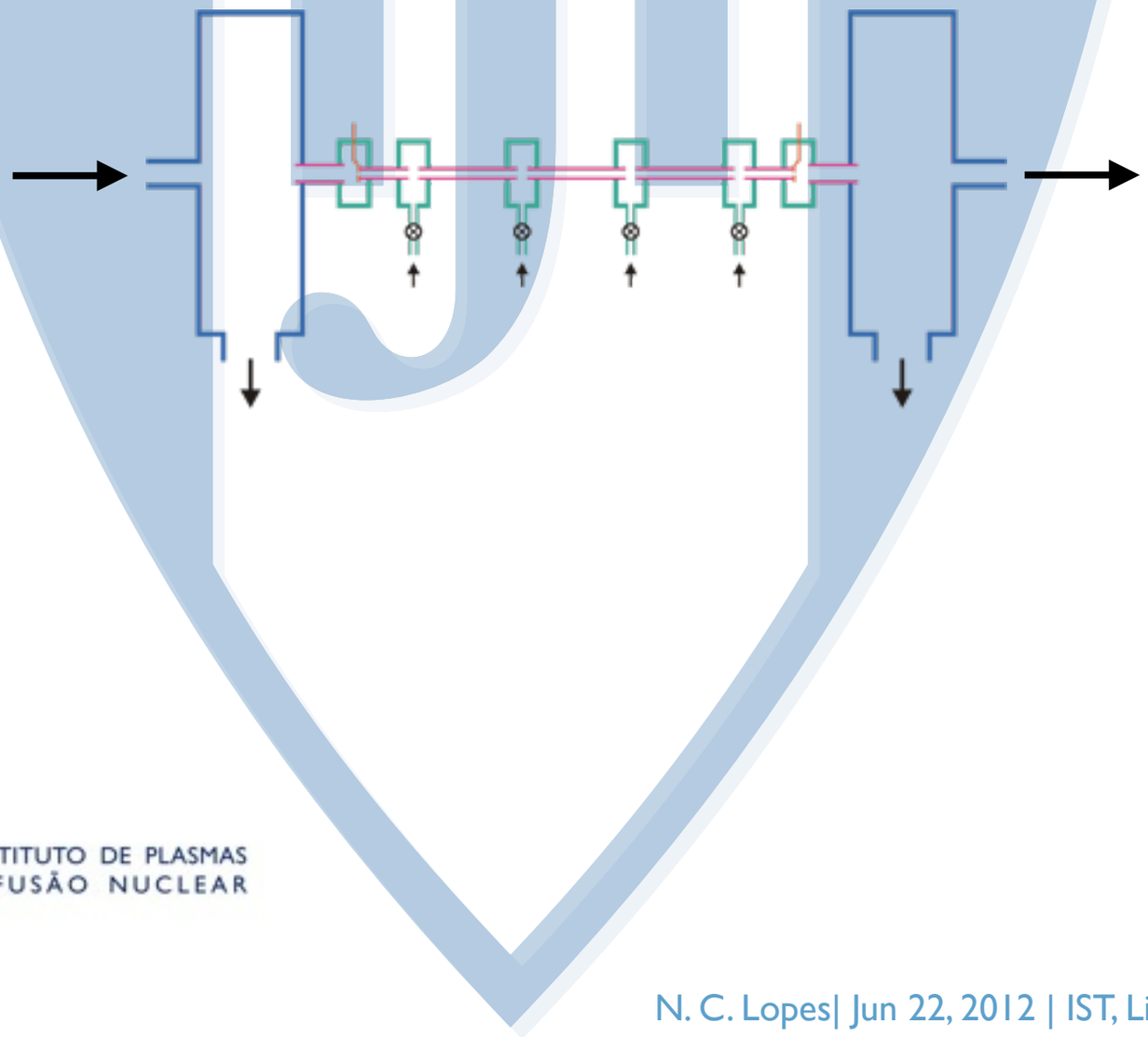
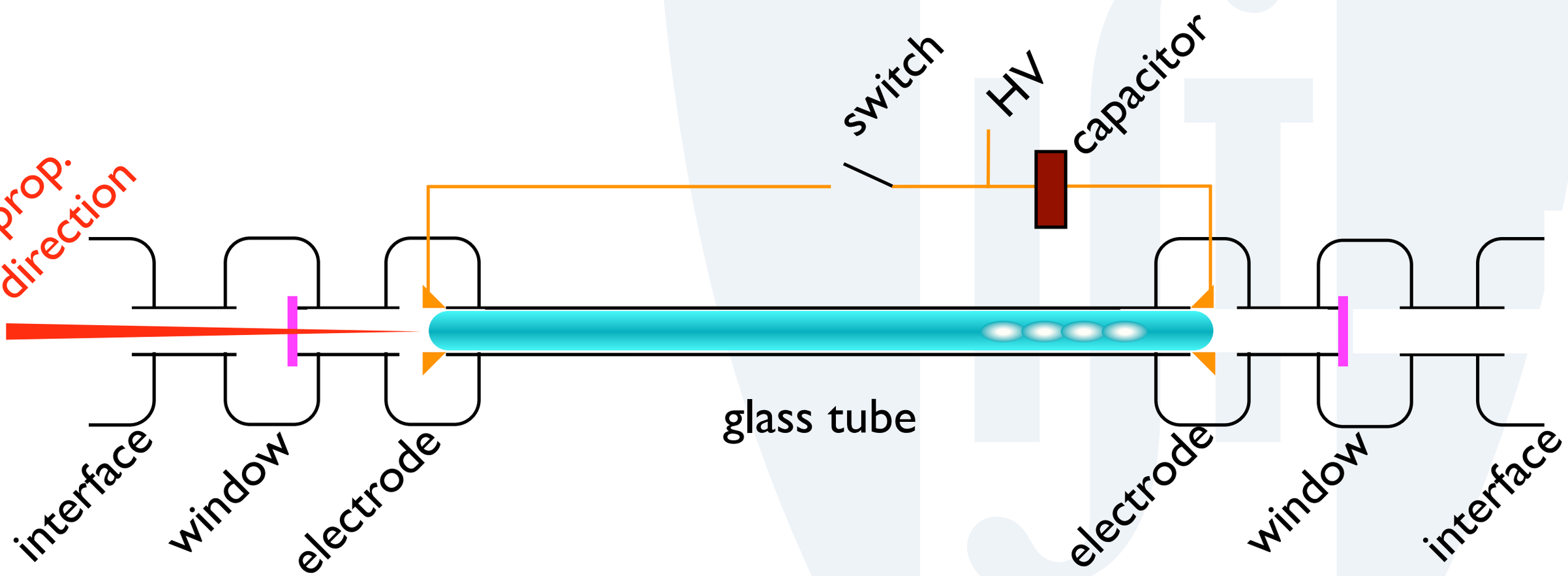
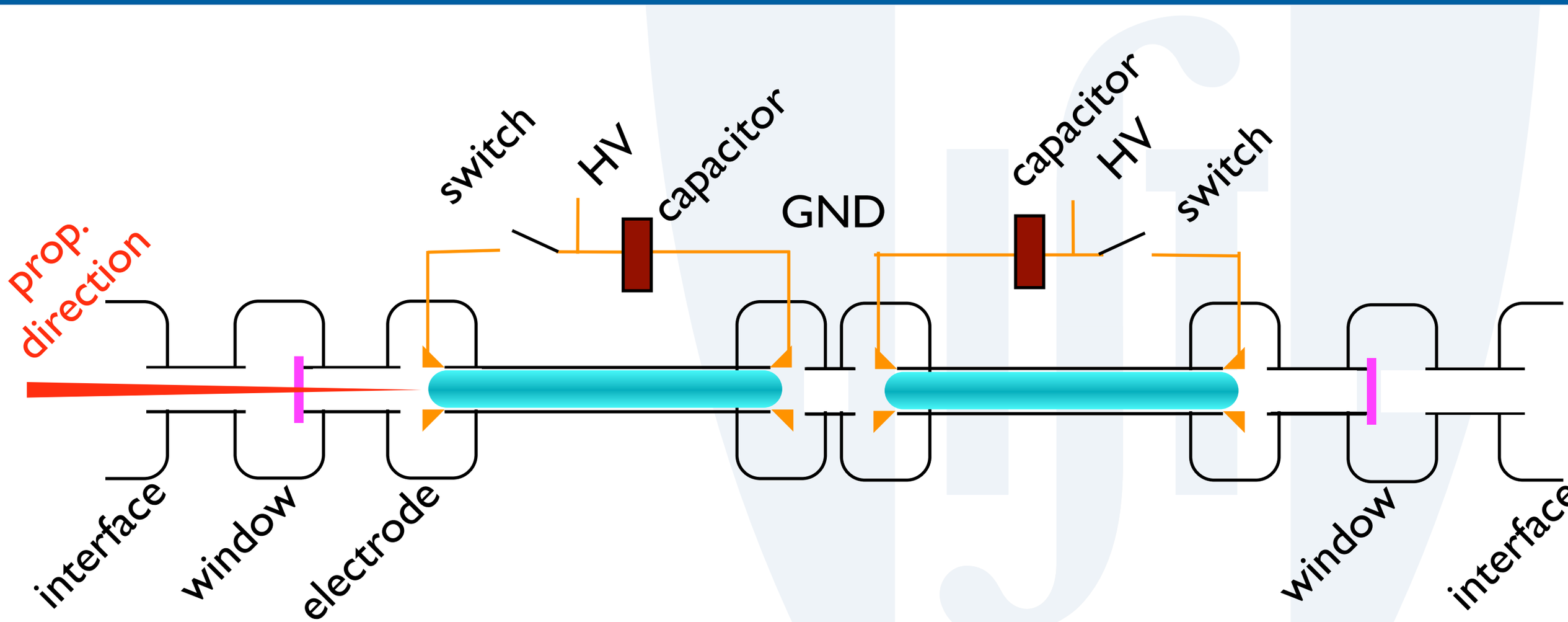


a plasma source module...



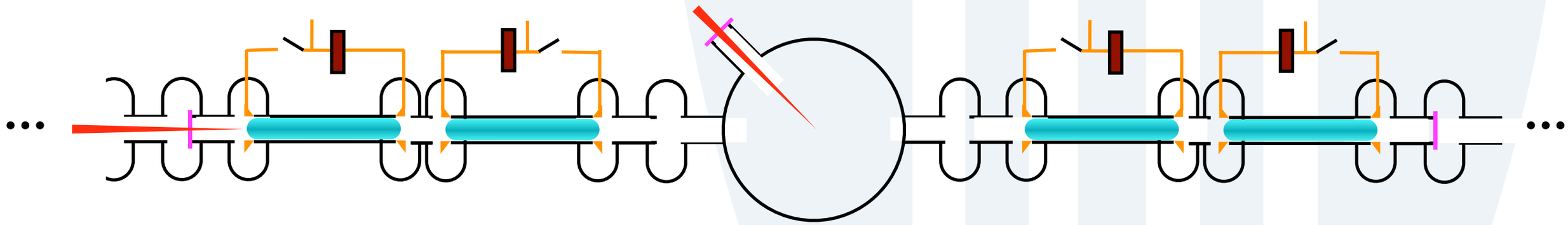
- tube diameter: 5 - 10 mm
  (requires 0.5 - 1.0 kA / cm^2)
- plasma length: 5 m seem possible
  (requires VHV for reduced jitter)

how to stage modules...



- operate in low rep. rate
- can share same switch or can have two independent plasmas
- can we have two segments of plasma???

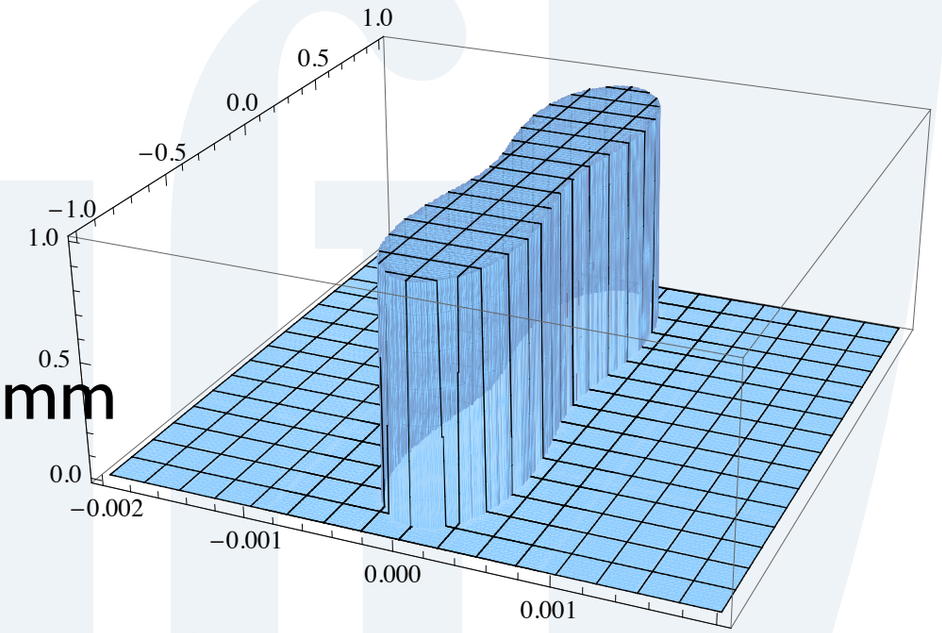
how to stage modules...

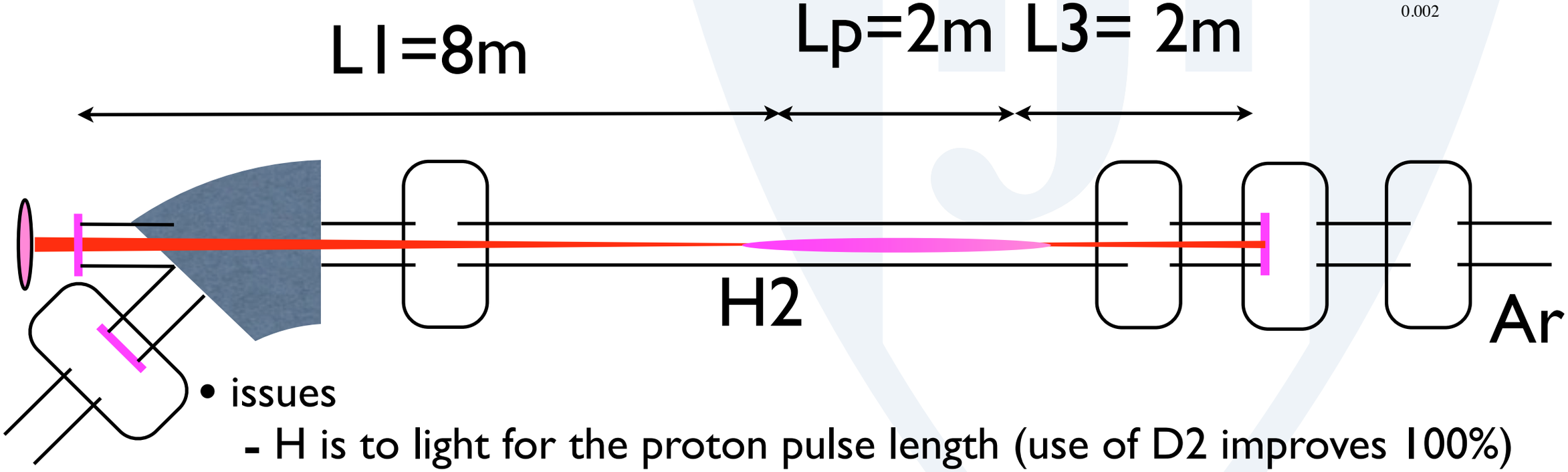


- all plasmas at same pressure (connected)
- plasma modules are independent form rest of experiment systems
- design should minimize the length with no plasma
- can we have four segments of plasma???

self-modulation seeding using a gas...

- H2 ionization - laser parameters
  - 0.1 J, 50 fs, 800 nm
  - beam: 2 cm diameter, Focal distance 10 m
  - tenuous plasma: length 2 meter, diameter 0.5 mm

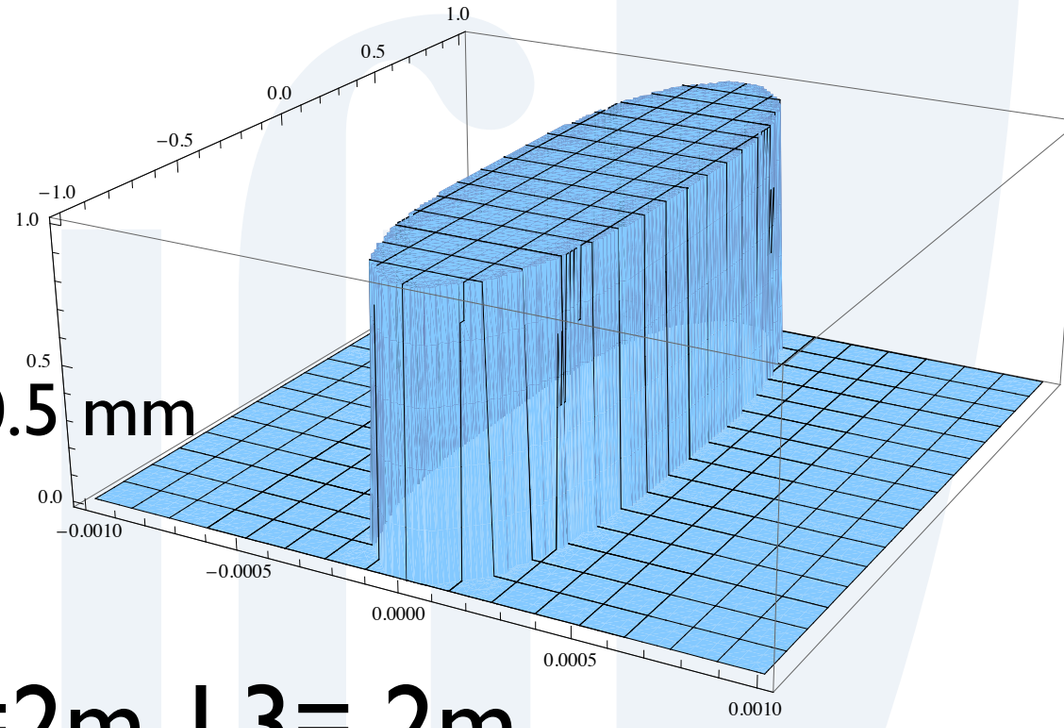




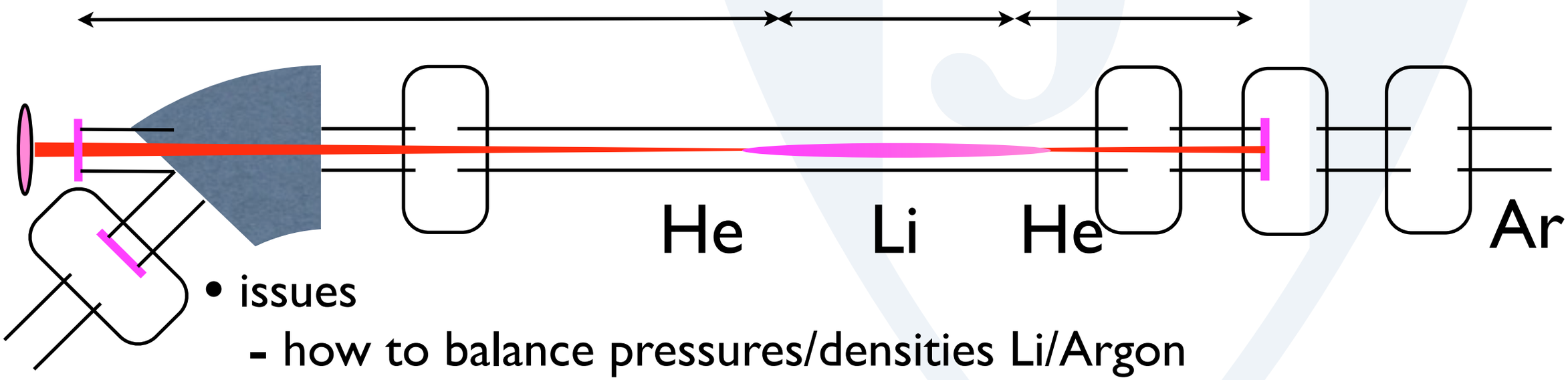
- issues
  - H is to light for the proton pulse length (use of D2 improves 100%)
  - how to balance pressures/densities Argon/H2
  - w1 close to damage threshold, w2 above damage threshold

self-modulation seeding using lithium...

- Lithium ionization - laser parameters
  - 2.5 mJ, 50 fs, 800 nm
  - beam: 1 cm diameter, Focal distance 10 m
  - tenuous plasma: length 2 meter, diameter 0.5 mm

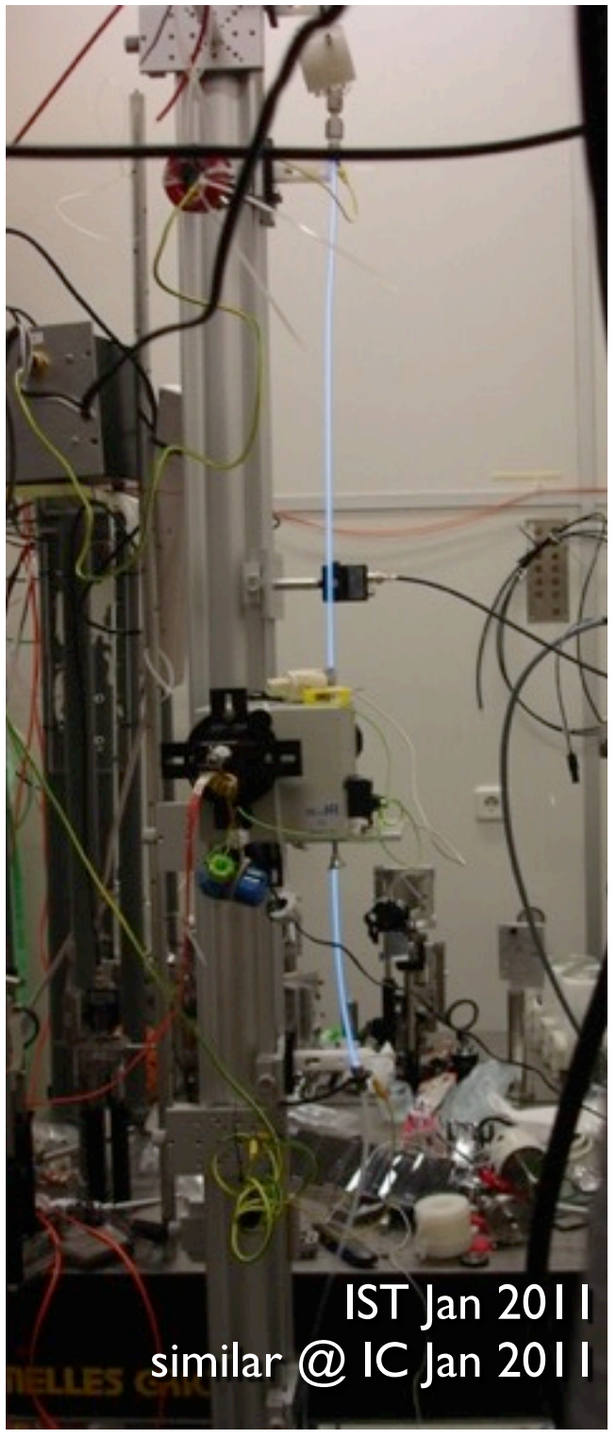


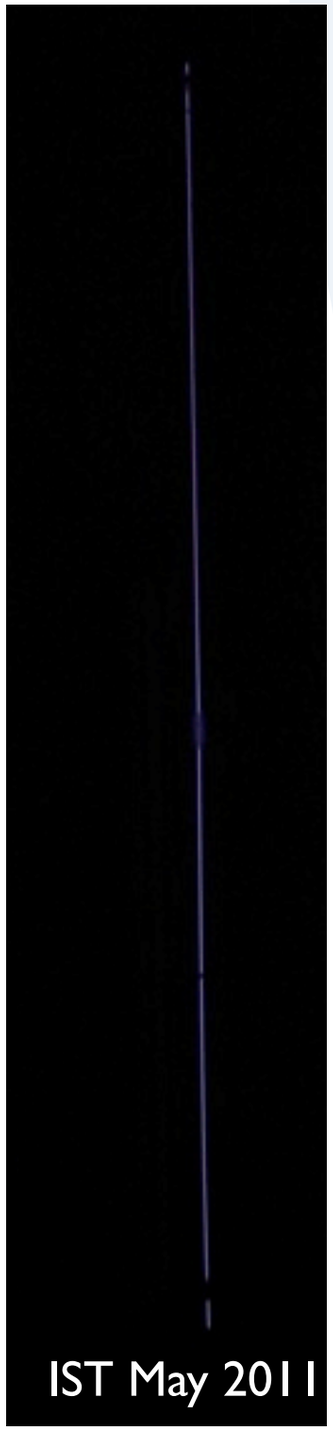
L1=8m Lp=2m L3= 2m

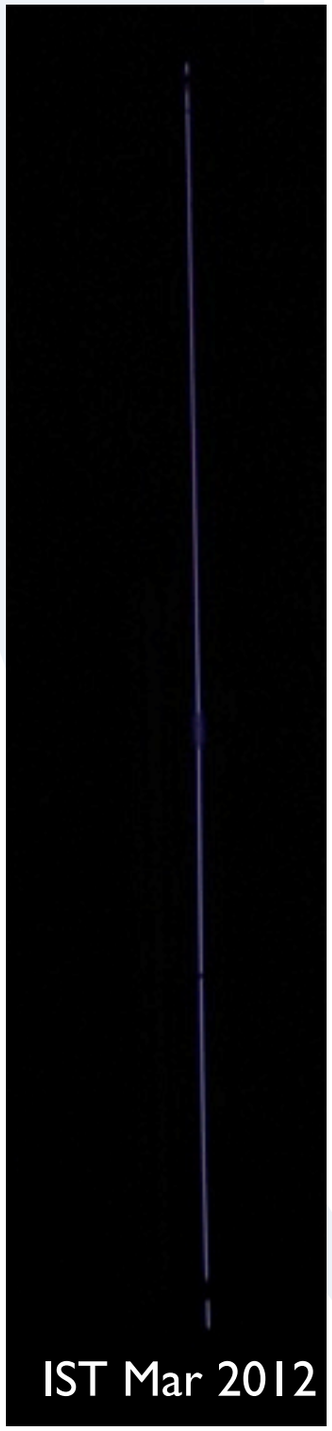


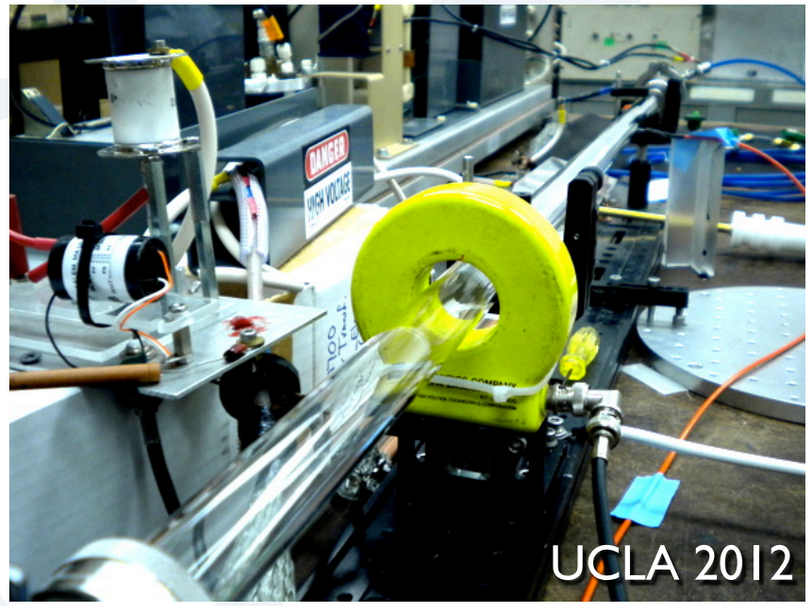
- issues
  - how to balance pressures/densities Li/Argon

simple demonstrations done so far ...

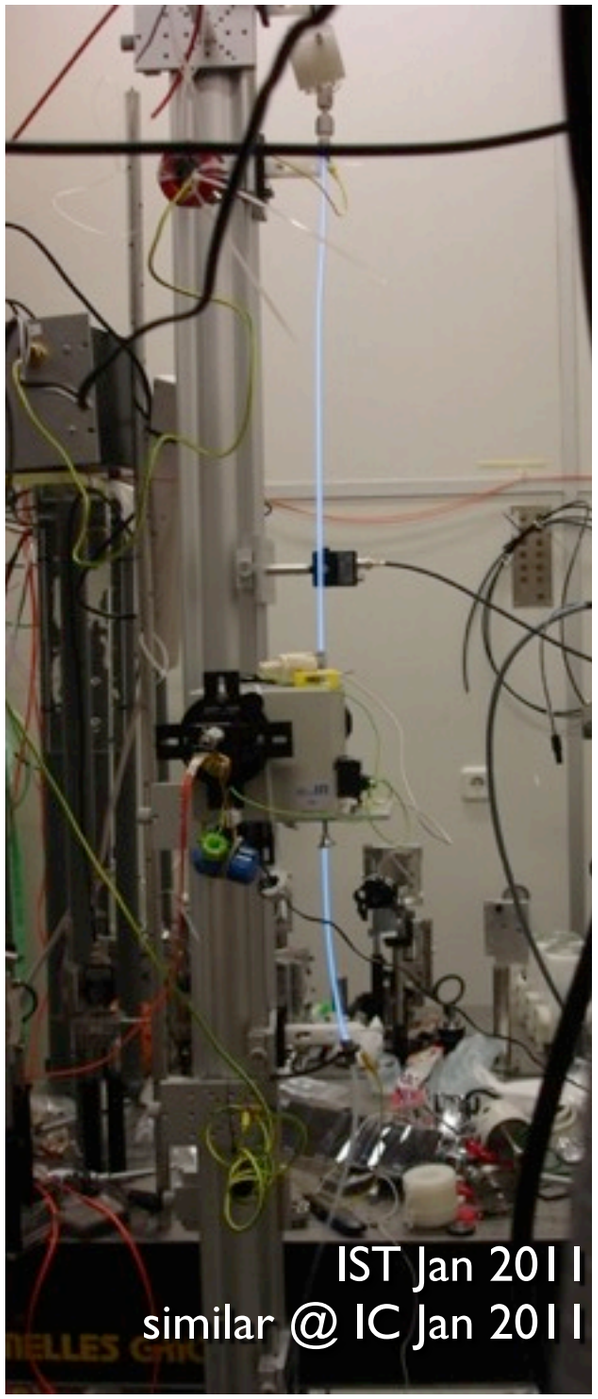




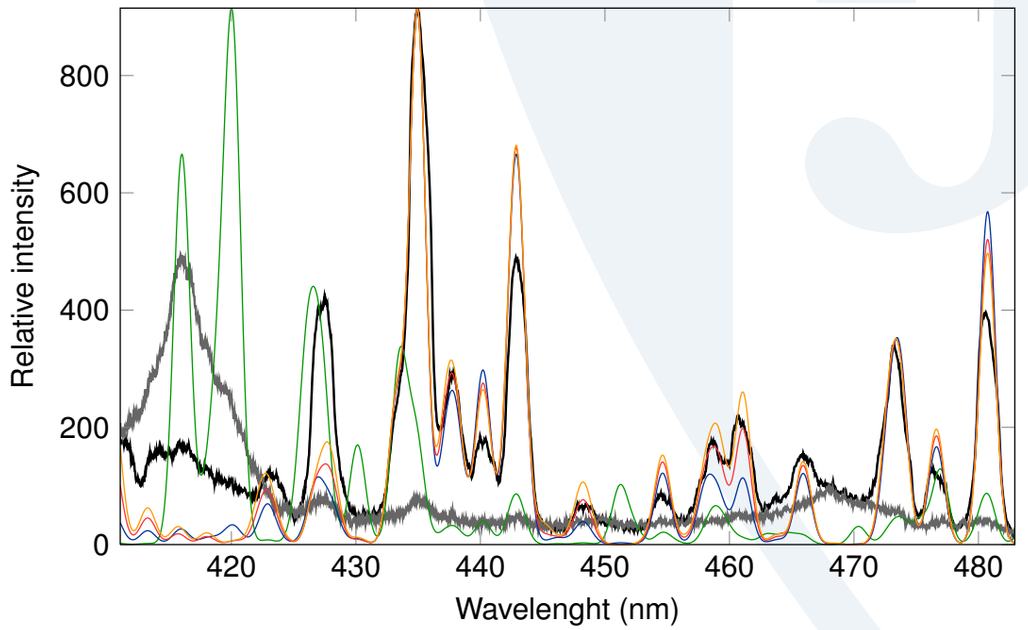


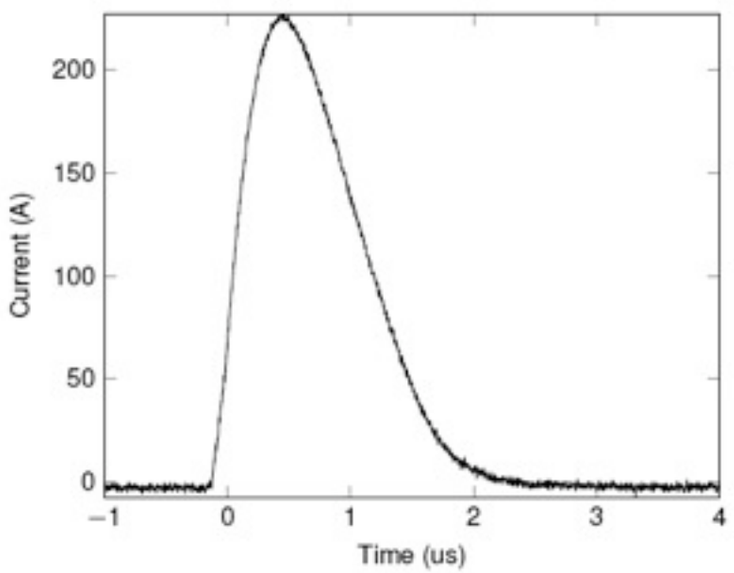


what did we learn...

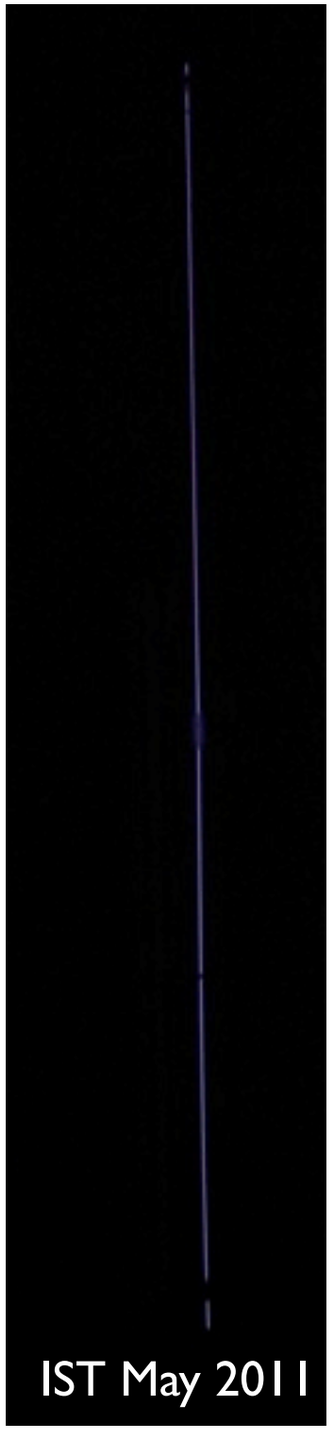


- 1.5 m plastic tube, 5mm ID, < 20 kV, self-trigger
  - cap. discharge in 1.5 microseconds
  - temperature > 0.9 eV $\Rightarrow$ ArII > 90%
  - A=20 mm^2, Ipeak=220 A, J=11 A/mm^2





what did we learn...

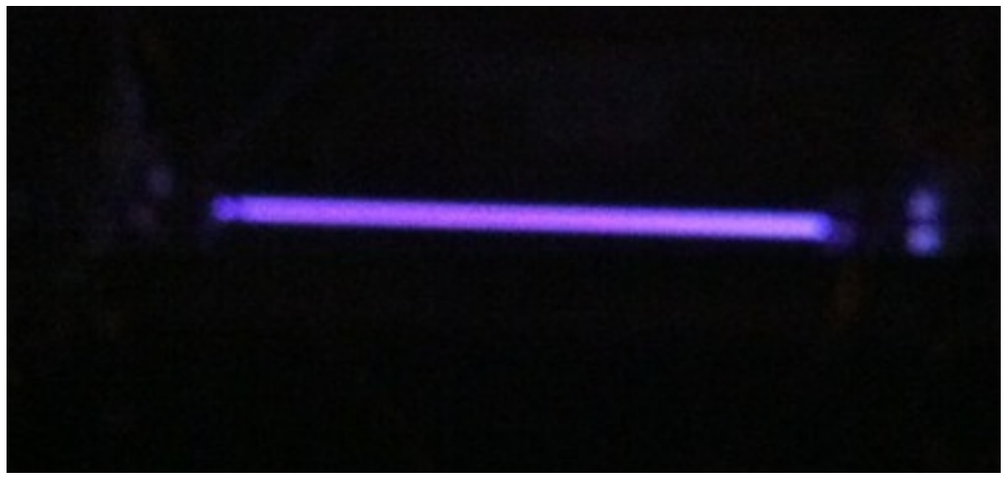


- 3 m glass tube, 5mm ID, < 25 kV, self-trigger
  - same qualitative behavior, but higher discharge voltage
  - temperature > 0.9 eV $\Rightarrow$ ArII > 90%

- 3 m glass tube, 5mm ID, < 25 kV, laser triggered switch
  - temperature > 0.9 eV $\Rightarrow$ ArII > 90%
  - A=20 mm^2, Ipeak=520 A, J=26 A/mm^2
  - Jitter~ 1 μs (problem) - need to increase the pulse voltage (how much?)

- near future
  - thyratron switch10 kV - 60 kV, Jitter studies, density studies
  - rebuilt the setup - learn how to eliminate leaks at low density
  - design interface particle and laser beams
  - how to measure/control plasma density (0.1%!!!)

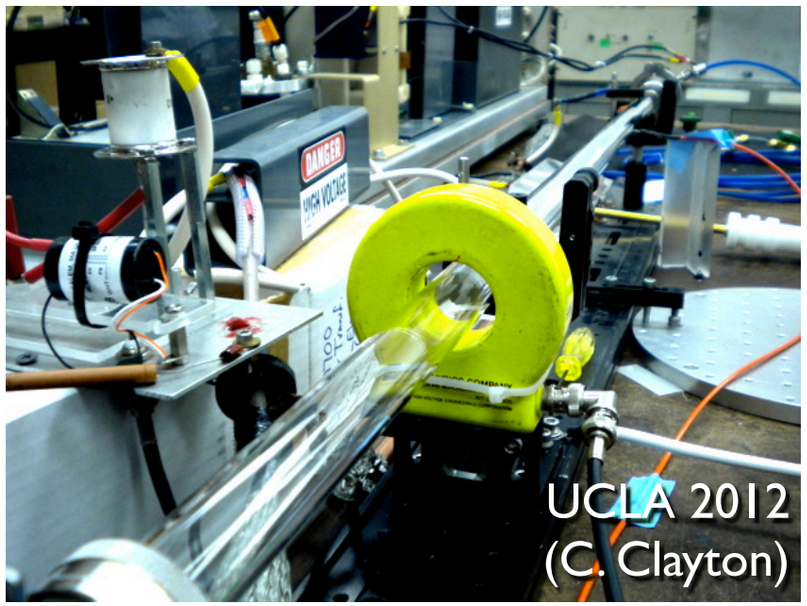
what did we learn...



- 0.5 m glass tube, 5mm ID, < 10 kV, self-trigger
  - n_0(H2) 10^{15} cm^{-3} - 10^{16} cm^{-3}
  - temperature > 0.9 eV $\Rightarrow$ ArII > 90%

- near future
  - 10 kV switch for jitter studies
  - development of diagnostics for density

what did we learn...



- 1.5 m glass tube; 0.5”, 1”, 1.5” ID, ~ 20 kV, self-trigger
  - plasma density ~ 10^{17} cm^{-3}
  - same qualitative behavior, larger tube diameter/ capacitance
  - temperature > 0.9 eV $\Rightarrow$ ArII > 90%
  (confirmed by Stark Broadening)
  - larger tubes aiming better density uniformity
  - requiring >10’s of μF

next steps...

- MPP setup - 10 kV switch
  - 10 KV, 1 kA switch
  - development of density diagnostic
  - jitter studies
  - automatic operation (???)

- IST setup - thyratron based switch (max 60 kV, 12 kA)
  - maximum length with 60 kV and <100 ns jitter
  - increase tube diameter from 5 mm to ~15 mm
  - eliminate leaks - stable operation
  - design of interface

- start working in a project oriente way...