EUROPEAN
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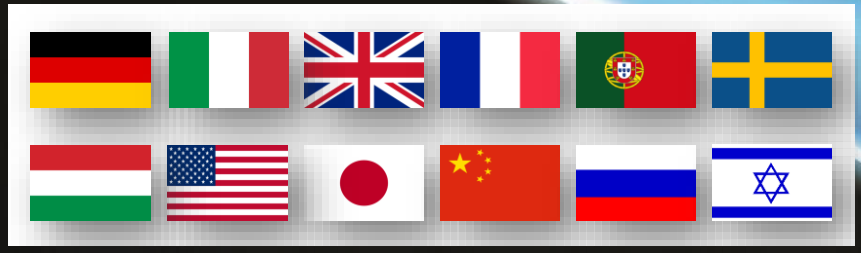
EXCELLENCE IN
APPLICATIONS

EuPRAXIA

Imperfections, Redundancies, Diagnostics, Control&Feedback

Discussion convener:

Arnd Specka, LLR Ecole Polytechnqiue – CNRS/IN2P3

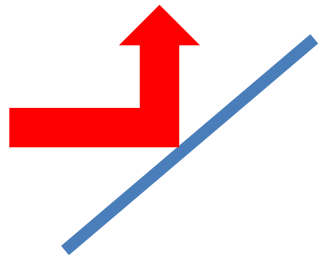


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 653782.

Introduction

- Original title of the session:
  Diagnostics & correction devices (dipoles, mirrors,...), realistic imperfections and required redundancies
- Imperfections : **assess!**
- Redundancies : **anticipate!**
- Diagnostics : **measure!**
- Control&Feedback : **mitigate!**
- **AIM: list of diagnostic/control elements with their**
  - **functionalities**
  - **footprint & geometry constraints**
  - **measurement/action ranges**
  - **measurement/action precision**

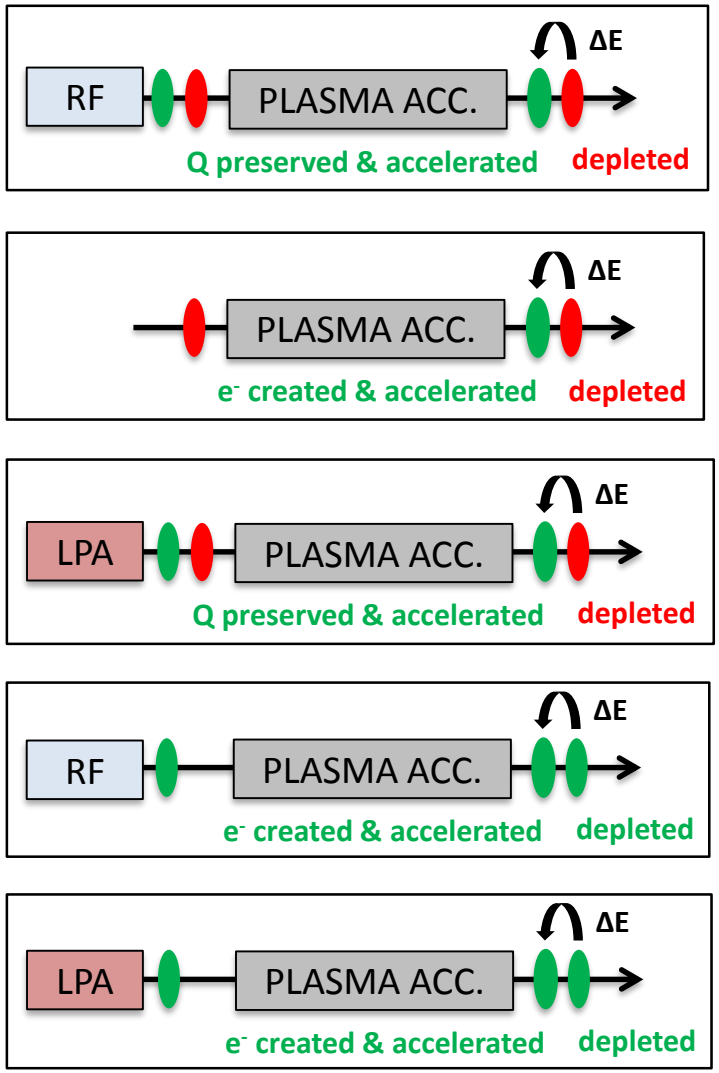
example:flat laser mirror



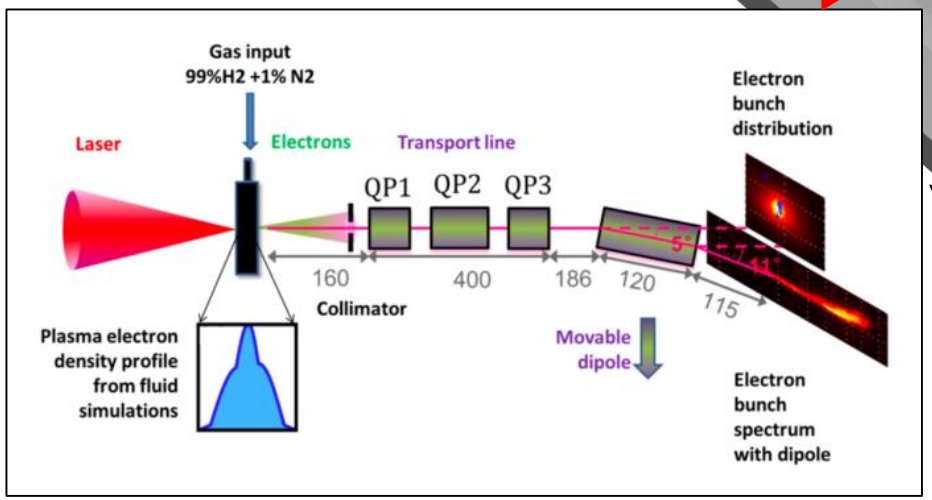
Choice of configuration

- one-does-it all v/s
- one-by-one option
- RW: user area perspective

- **identify clearly which monitoring and control functionalities are common to all, which are proper to a single configuration**



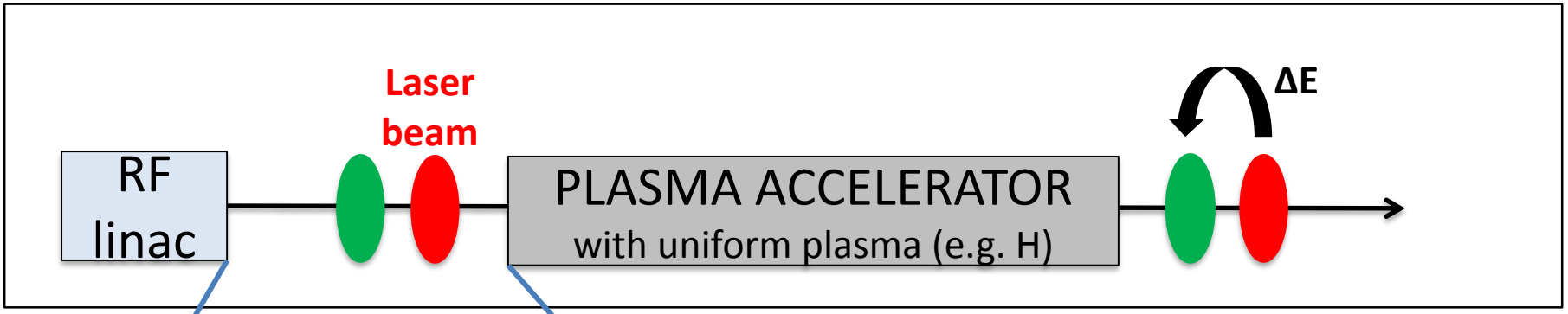
Layout proposal



See poster: B. Cros et al., 'Electron injector for multi-stage laser-driven plasma accelerators', IPAC'17, **WEPVA001**

3D design by Dariusz Kocoń (ELI-Beams)

Coexistence and footprint



Laser injection

electron injection

Laser diagnostics

electron diagnostics

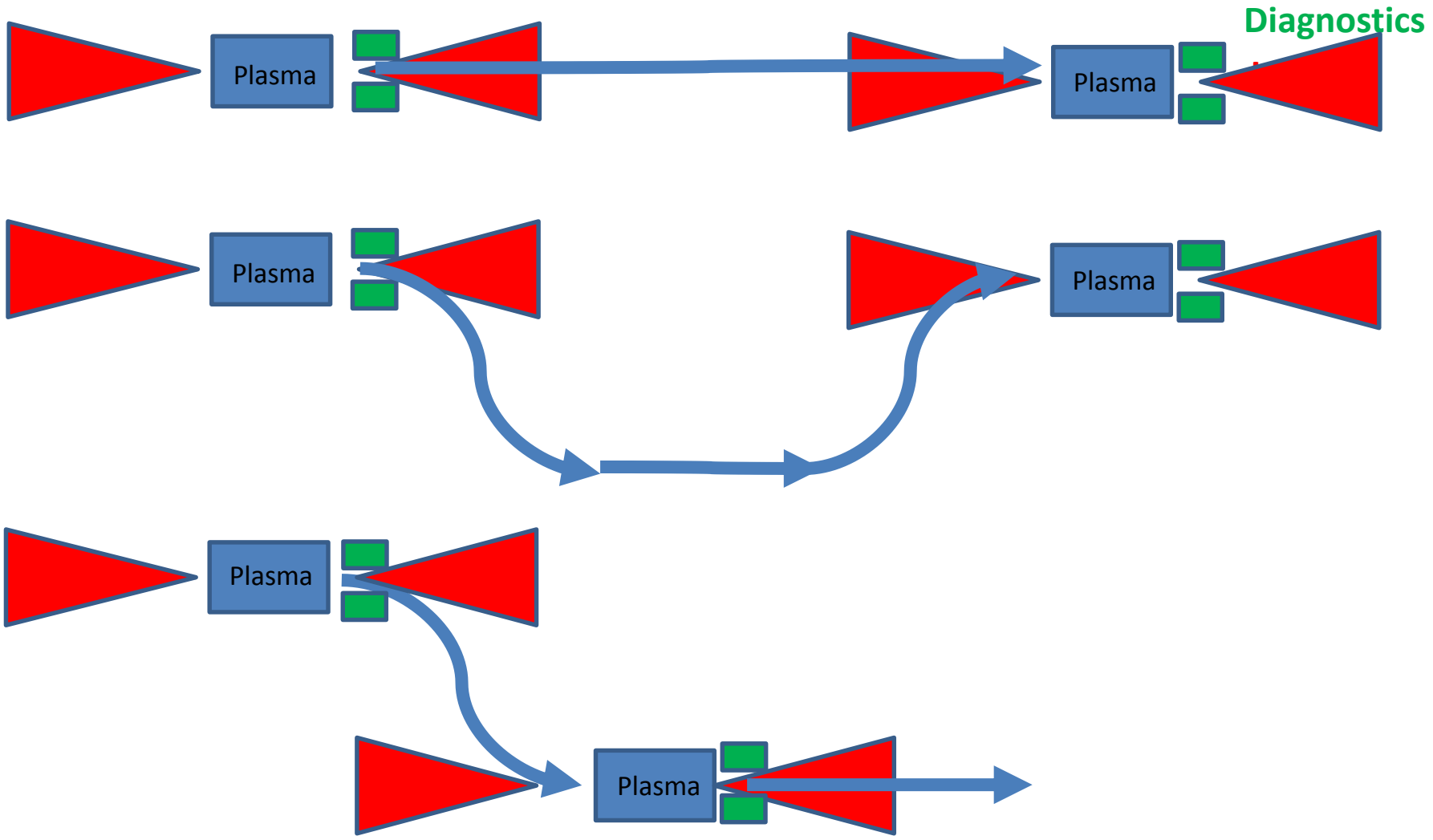
electron injection

electron diagnostics

Laser injection

Laser diagnostics

Particular case: LPA injector



a-priori assessment of imperfections

- determine working point(s) of plasma accelerator(s)
- determine robustness/sensitivity of these WPs to:
  - how are parameters of outgoing electron beam affected
  - driver parameters (laser or particle)
  - plasma parameters
  - simulations (full PIC, simplified?) -> WP2
    published results -> WP3
- **=> sensitivity response matrix also for LPFA PWFA**
- define “phase space acceptance” of WP (injection efficiency)
- define desired measurement ranges for outgoing electron beam diagnostics

required diagnostics

- incoming electron beam (all schemes)
- incoming laser beam (laser driver)
- outgoing electron beam (all schemes)
- [outgoing laser beam (laser driver)]
- plasma diagnostics (n_e,…)
- ….

laser diagnostics

- ahead of / at / downstream of interaction point
- pulse energy
- pulse duration, spectrum
- phase front (“near field”) -> determines spot quality
- focal spot size, shape, transverse energy distribution

laser control elements

- steering mirrors: position, angle of laser
- deformable mirrors: phase front correction
  -> excellent spot quality is vital to LWFA
- optical delay lines (synchronization)
- passive stability v/s active feedback
- …

e^- diagnostics: beam parameters

- 6D phase space, up to 2nd order moments
- zero order moment: charge
- 1st order moments (averages):
  positions, angles, energy, arrival time (synch)
- 2nd order moments: (spreads and correlation)
  spot size, divergence, emittance, E-dispersion, duration, spot shape, chirp
- more refined (but potentially essential):
  - slice energy spread
  - long. bunch shape

e^- diagnostics: incoming beam

- LPA injector: (depends on energy)
  - conventional macroscopic transport diag's v/s miniaturized devices (plasma lenses)
  - is the injected phase space well enough defined?
  - single-shot non destructiveness v/s reproducibility
  - …
- RF-injector/beam-driven:
  - standard diagnostics to be integrated in transport line
  - extra space for sophisticated diagnostics ? (e.g. bunch duration
  - single-shot/non-destructiveness may not be mandatory
  - …

e^- diagnostics and control : outgoing beam

- 1-5 GeV: more space required
- single-shot emittance measurement at 5GeV? undulator radiation ?
- measurement of bunch duration/beam current?
- beam steering? (assumes reproducibility)
- …