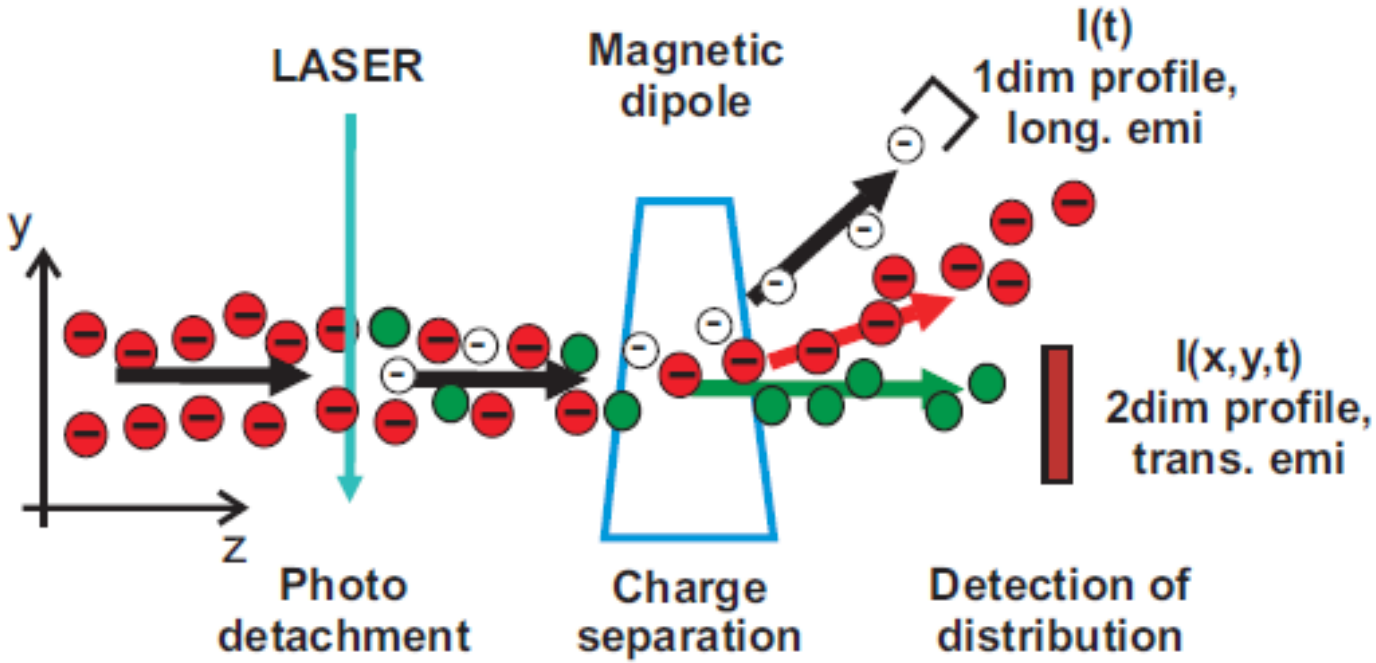
Update on Photo-Detachment (PD) diagnostics for FETS

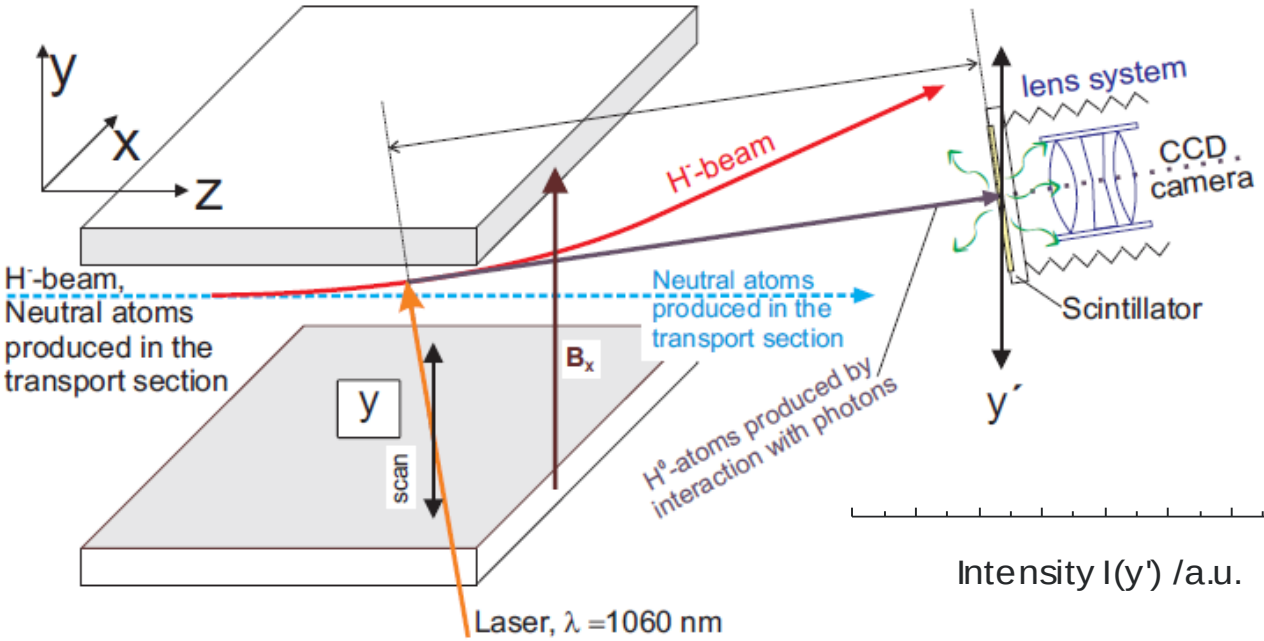
Christoph Gabor (ASTeC south)
Rutherford Appleton Laboratory, STFC

A reminder of PD and an emittance instrument
Consequences of such an instrument
Who is working on what?
Tentative list of things to do/ commissioning

The idea of PD beam diagnostics ..... a reminder.

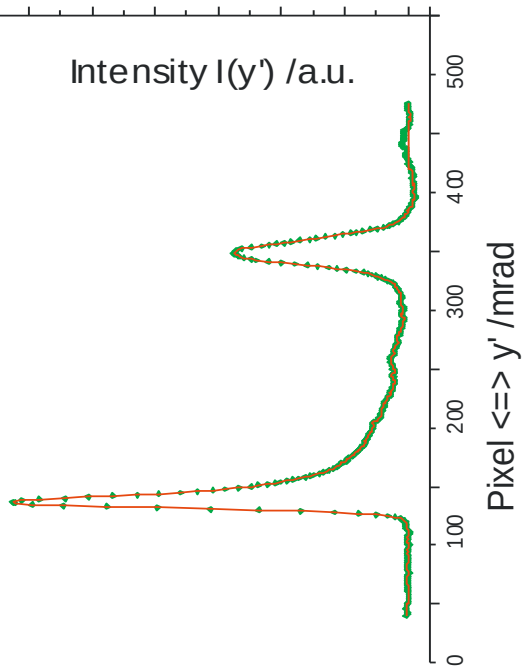


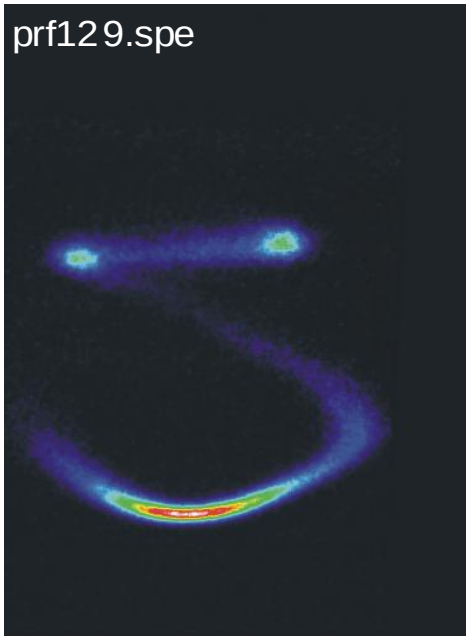
Photo—Detachment Emittance Instrument (PD—EMI)



$$\int dx\ I(x,y) \longmapsto I(y)$$

$$\Delta y \quad \Longrightarrow \quad y' \approx \frac{\Delta y \quad [mm]}{z \quad [m]}$$





y=+4,7mm

christoph.gabor@stfc.ac.uk

Consequences of such an emittance instrument

Compared to 1D laser wire.....

.....PD-EMI needs fine tuning to a given beam dynamics. It is not simple to use the same dipole for very different beam parameters.

It is the general idea of PD-EMI one transfer to given beam parameters and other requirements. It will be simpler if no experimental beam line.

In such a way, a 1D profile scanner is more

** flexible,
** easier to adapt to a beam line and
** cheaper because of less hardware resources.
** reasonable good time resolution (BSM?).

A PD-EMI as proposed is solely for transverse emittance measurements with a time resolution in the range micro-seconds, it is not unreasonable to aim for 4D-distribution.

For longitudinal emittance measurements a different class of laser is mandatory; the space required is similar to a PD-BPM.

Who is involved in PD diagnostics?

Who	Where	What
Alessio	RHUL	laser & optics
Gary	RHUL	electronics, labview, DAQ, stages
Christoph	RAL	general layout & design, magnet, measurements, SHE, etc.
Peter	IC	3D CAD design & mechanical support
Morteza	IC	MEBT simulations,
Pavel +PhD. student	RHUL	1D profile detector BPM
Alan	ISIS	supervision; makes sure that we stay down to earth .... ☺
Anyone forgotten?		

Tentative list of the different subjects for PD-EMI

One may call that some kind of time schedule but there are many possible reasons to alter order of bullet points, or there is worked simultaneously .

1. MEBT beam parameters are required to finalize particle tracking through the dipole
   extend existing MEBT with appropriate QUADS to transport beam into diagnostics and beam dump.
1. Magnet should be possible purchased in FY2013.
2. Vessel could be started to manufacture before the end of 2013.
3. Laser & optics & controls: [RHUL, 2013+early 2014]
   a) mock-up of the vessel to test installation of stage, mirrors, vacuum windows etc.
   b) first tests with alignment laser, later with full laser power
   c) can we improve laser pulse energy? → repair of the laser
   d) laser safety, assuming of the installation within the radiation shielding
5. Commissioning of RFQ & MEBT with beam
   support frame for magnet, optics and camera to install at the beam line
6. Software and controls for DAQ [basic functionality by end of 2013]
   further development as needed or with the progress of the project

Procedure to commission the PD-EMI

It is not realistic to assume that all the different pieces of equipment work from the beginning on let alone using the e-scanner as a black box with just one button.

There are too many things we can actually test only empirically with beam.

This may look far too conservative but I've seen pigs fly when I worked on the proof of principle in Frankfurt.

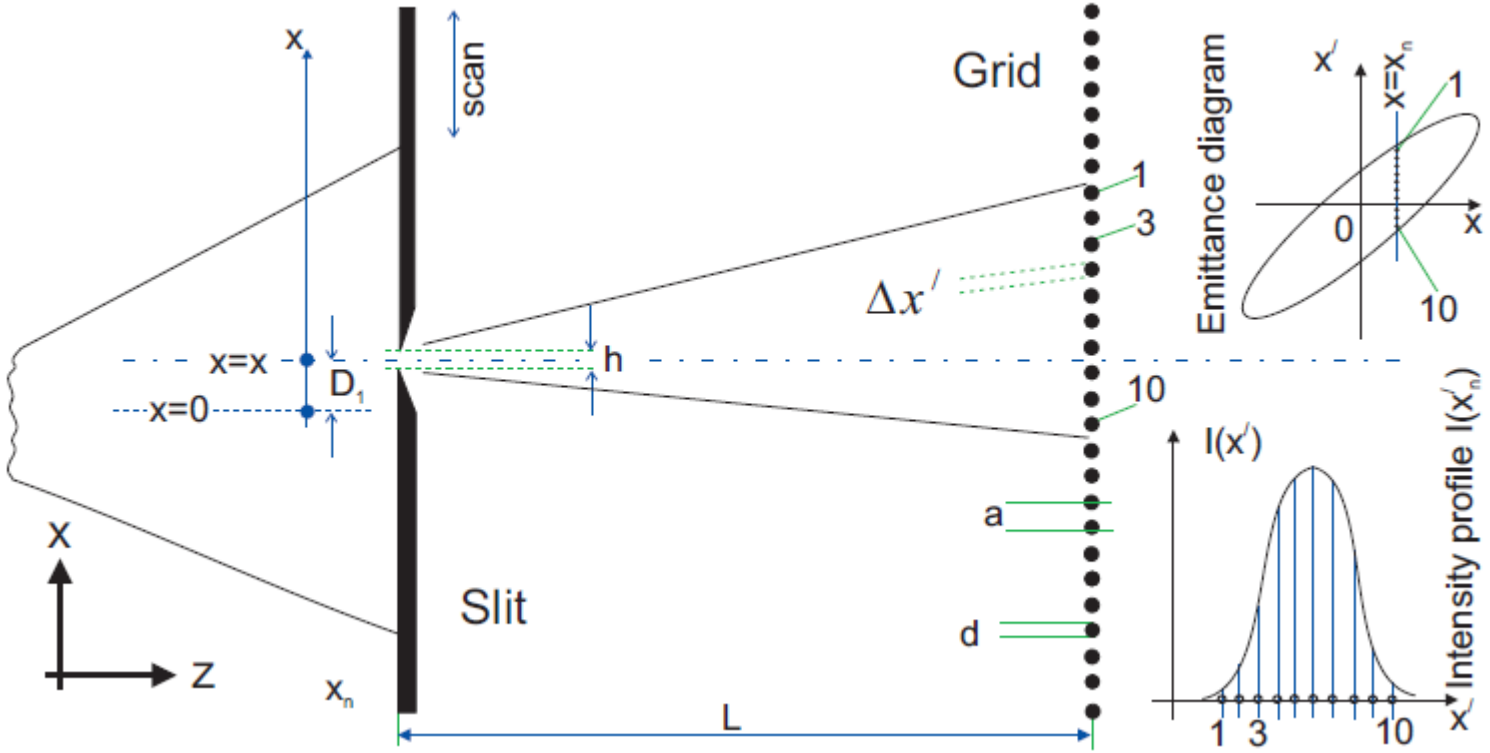
PHASE 1:

1. Do mechanics and controls work remotely in the tunnel with beam and magnet field? Does the procedure for installation and alignment works?
2. Everything is stationary, at the best the laser is collimated → find PD—neutrals
3. Move the laser at certain positions, vary beam optics → does the scintillator do what expected?
4. Do full scans, does the DAQ work sufficiently, post processing?
5. Emittance reconstruction (kind of 4D) by varying the focal length of the H- beam.

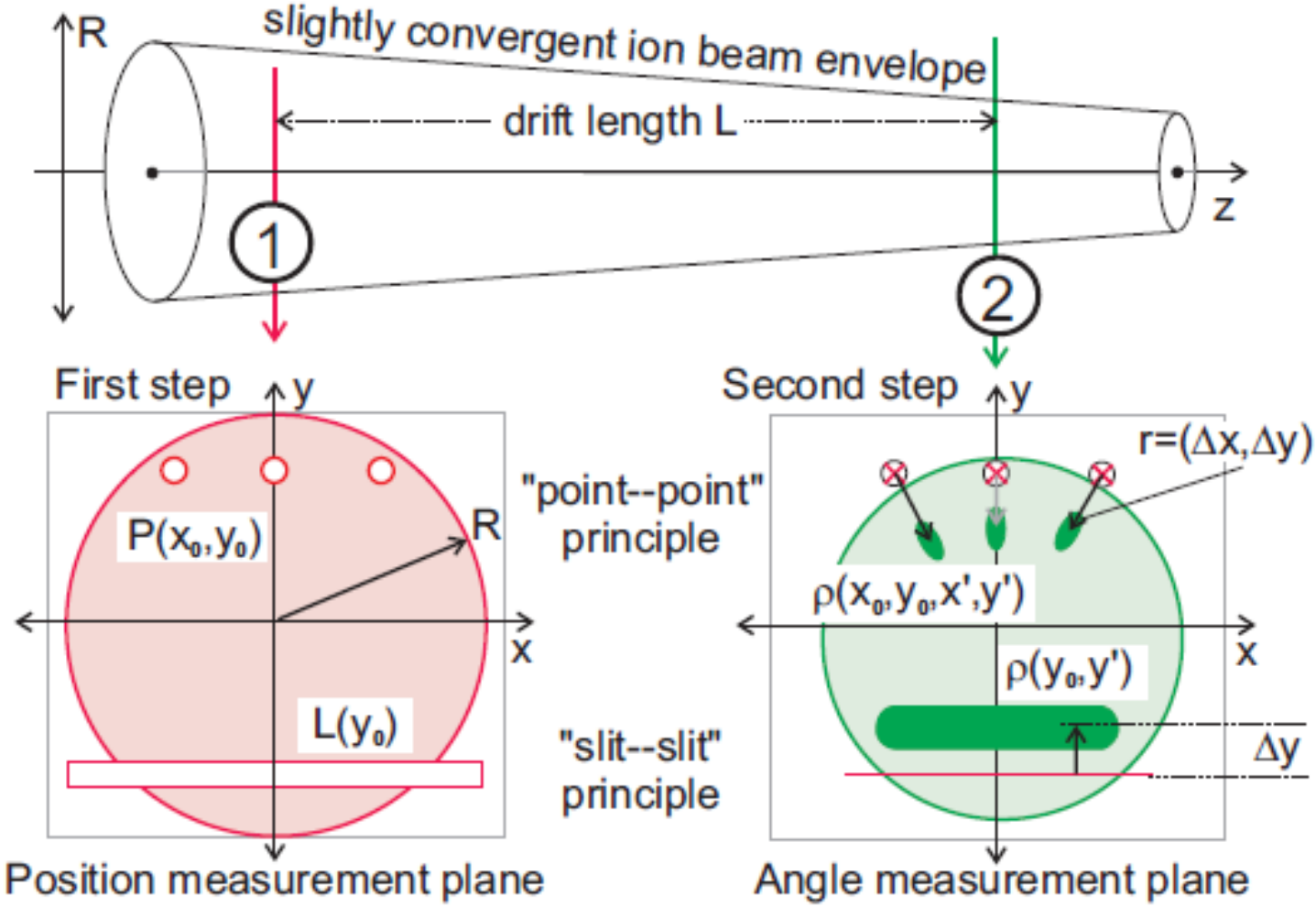
PHASE 2 (2015 and later):

1. Installation of a second stage.
2. Better control of the behaviour of the for laser and monitoring beam parameters.
3. Optics to move the laser focus along the radial direction.
4. Movable particle detector, only if really necessary.
5. How do skew QUADS influence the reconstruction of the 4D distribution.
6. New laser from RHUL with increased pulse energy and better time resolution.

Example of technical realization for a slit-slit emitance instrument



Differences between a point-point and slit-slit emittance measurement technique



MEBT—Design (Morteza)