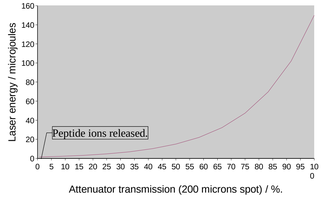
# Zoom Optics for Optimised MALDI Sensitivity

Mark D Mills, Stephen P Thompson, Victor C Parr : Scientific Analysis Instruments, Manchester, England

## Introduction

- One of the factors limiting the speed of analysis in peptide mass fingerprinting by MALDI is the available laser power.
- Commercial nitrogen lasers deliver ~ 150 microjoules of energy at 337 nm wavelength.
- Peptide ions can be released in significant quantities with fluences as low as 50 J/m$^2$ (1).

Laser energy v. attenuator transmission.



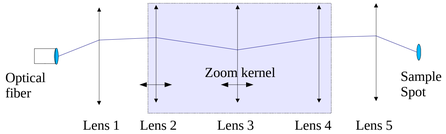

- If the laser spot is 200 microns in diameter then 99% of the available laser energy will be absorbed in the neutral density filter attenuator.
- To use all the laser energy in each shot the laser spot could be as large as 2 mm diameter.

## Methods

### 1a) The Laser Optical System

- The laser optical system uses an optical fibre to introduce multiple reflections and give a homogeneous laser intensity over the laser spot.
- The nitrogen laser (Spectra Physics 337i) is focused into a 200 micron fibre.
- The fibre has the following properties as a source of light at 337 nm.

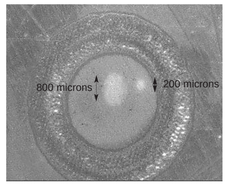
| | |
|---|---|
| Diameter of emitting disc | 200 microns |
| F-number | 0.2 |
| Total emission angle | 23 degrees. |




- Short focal length lenses are desirable in order to reduce the diameter of the lenses.
- The large F-number of the fibre makes it difficult to introduce the laser beam at an angle of less than 30 degrees from the sample normal.
- The zoom kernal gives a variable magnification of between 1 to 4. This produces a variable laser spot diameter of 200 microns to 800 microns.

### 1b) Images of the Laser Spot Shape

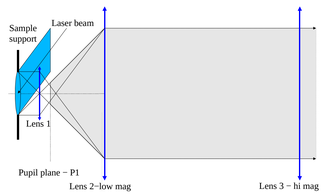
- The zoom optics coupled to the optical fibre gives a continously variable homogenous laser spot on the sample in the range 200 microns to 800 microns.




### 2a) The Ion Optical System

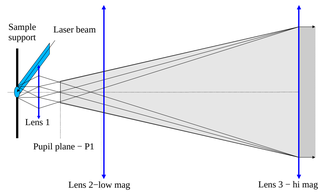
- In the high magnification mode, lens 1 magnifies the field image of the sample into the plane of lens 3. The linear magnification is "x 12".
- In the low magnification mode, lens 1 magnifies the field image of the sample into the plane of lens 2. The linear magnification is "x 3".

**Diagram of Zoom Optics− Low magnification mode**




- In both cases there exists a real pupil image to the right of lens 1 through which all rays pass. Lens 2 and/or lens 3 focus the rays from the pupil onto the detector. When lens 2 is active, lens 3 is inactive and vice versa.

**Diagram of Zoom Optics− Small field of view mode**




- The laser beam is focused down to a beam diameter which matches the field of view of the optics.

### 2b) Effect on Sensitivity

- In the low magnification mode the sensitivity is proportional to the collection area, i.e. proportional to the (field of view)$^2$, but...

  it becomes more difficult to collect ions which are emitted over a large emission angle.

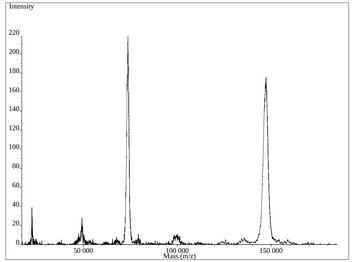
- For cool matrices such as DHB, a higher laser power density is required so operation over a large area is not feasible unless the laser has a high power output.

### 2c) Effect on Resolution

- In the low magnification mode the ions which are emitted with trajectories close to the ion optical axis are collected preferentially. Ions in this category are likely to deliver the highest resolution because they suffer least from temporal distortions.

## Preliminary Results

- Preliminary data was ran using a sample of IgG (Mass 147.3kDa) varying the laser spot from 200 to 800 microns.




- The above data shows 100fMol on sample with S/N < 50:1
- The use of the optical fibre and zoom optics gave an order of magnitude improvement in useful sensitivity compared to conventional optics.
- The large area spot size removes the need for excessive ‘hunting’ for analyte crystals thus producing a faster and easier analysis.

## References

1. G. Westmacott et alios, Int. J. Mass spectrom.221(2002)