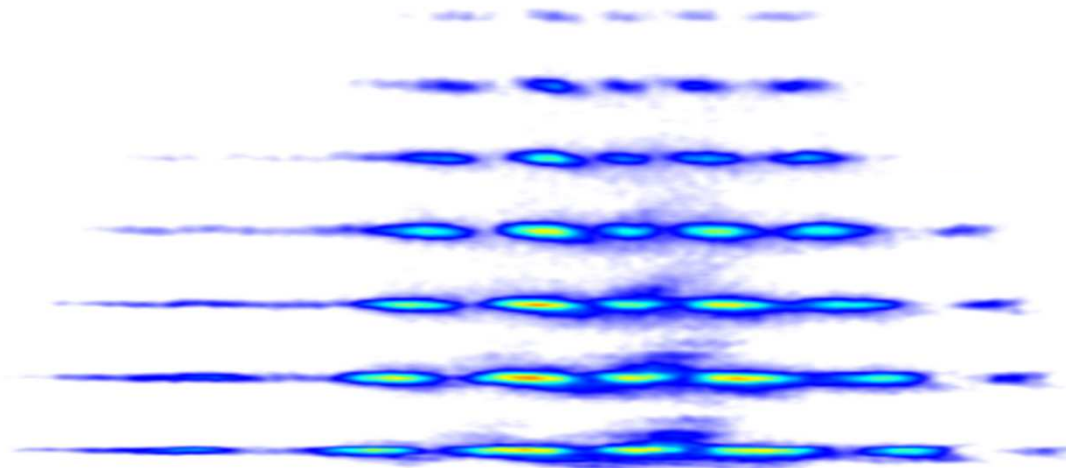


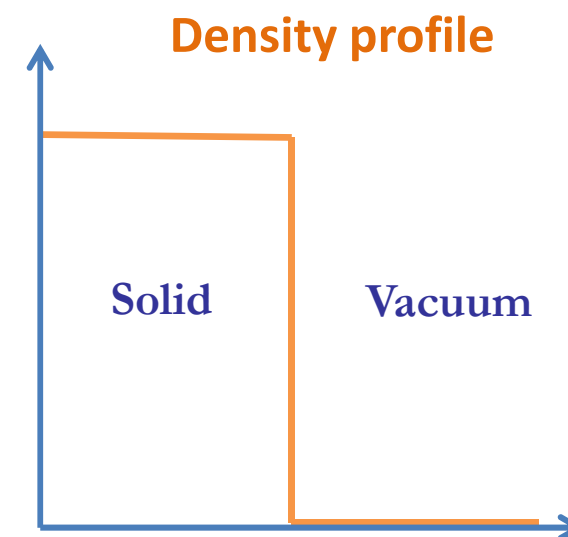
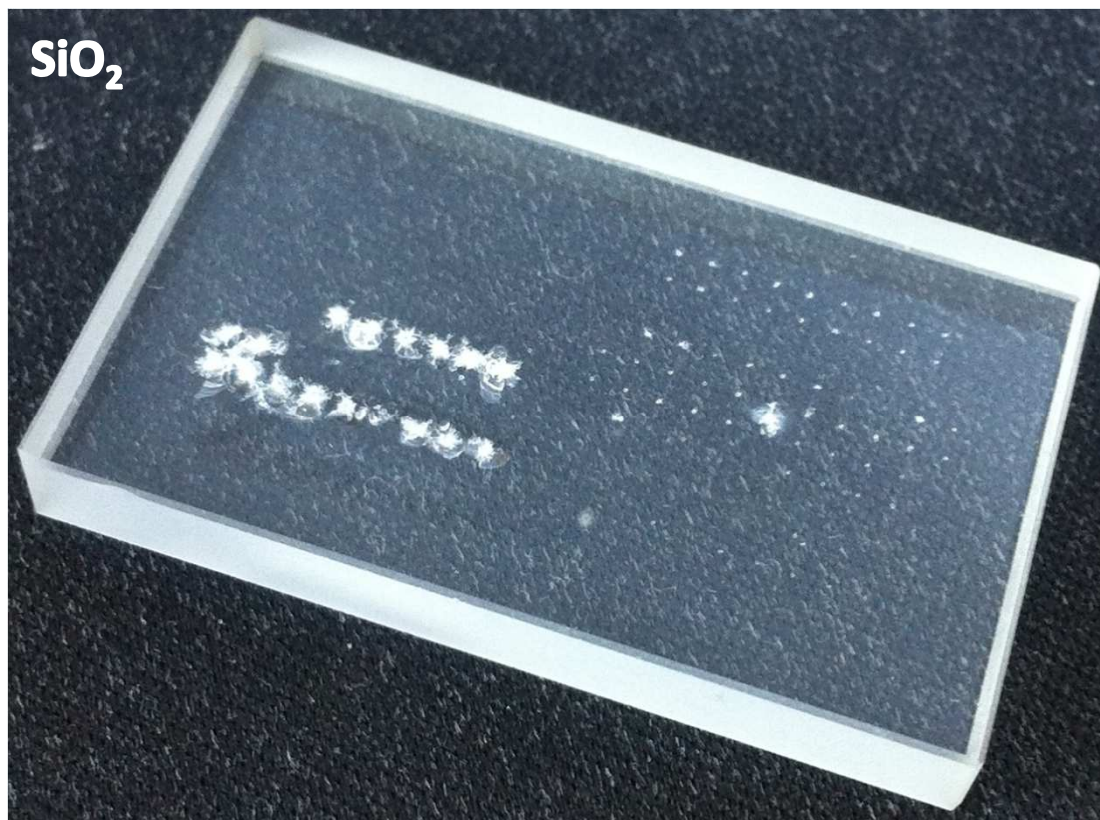
Optically-controlled structuring of plasma on solid targets probed by high harmonic generation



CEA Saclay IRAMIS / LIDyL
Adrien Leblanc
S.Monchocé, S.Kahaly, F.Quéré

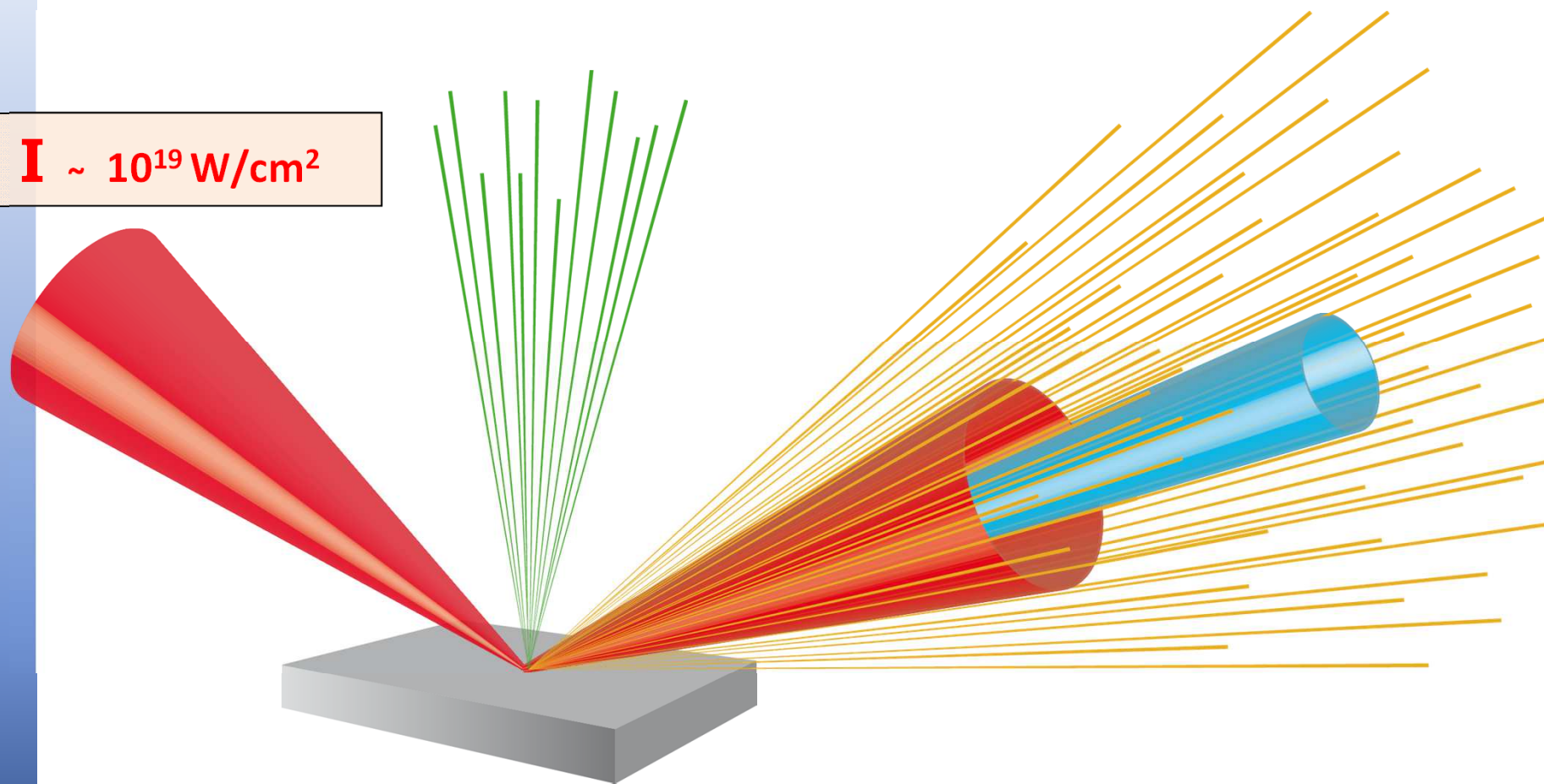


Flat solid target



Laser Plasma Interaction on solid target @ Ultra High Intensity

$$I \sim 10^{19} \text{ W/cm}^2$$



Pre-structured targets

Is it possible to make a tuneable structured target ?

0 10 15 20 25 30 35 40 45 50
Incidence angle (degrees)

PRL 111, 185001 (2013)

Structuring a plasma from a flat solid target

Plasma scale length



It is very important to control the
plasma scale length :
key parameter of the interaction

n_e

$L \ll \lambda$

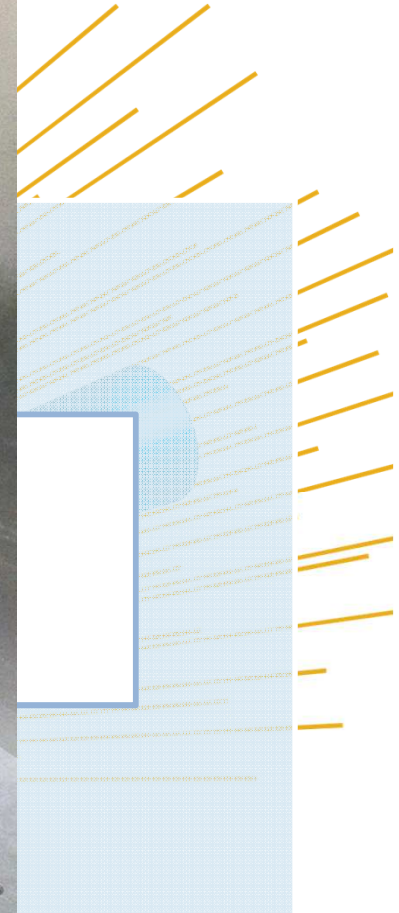
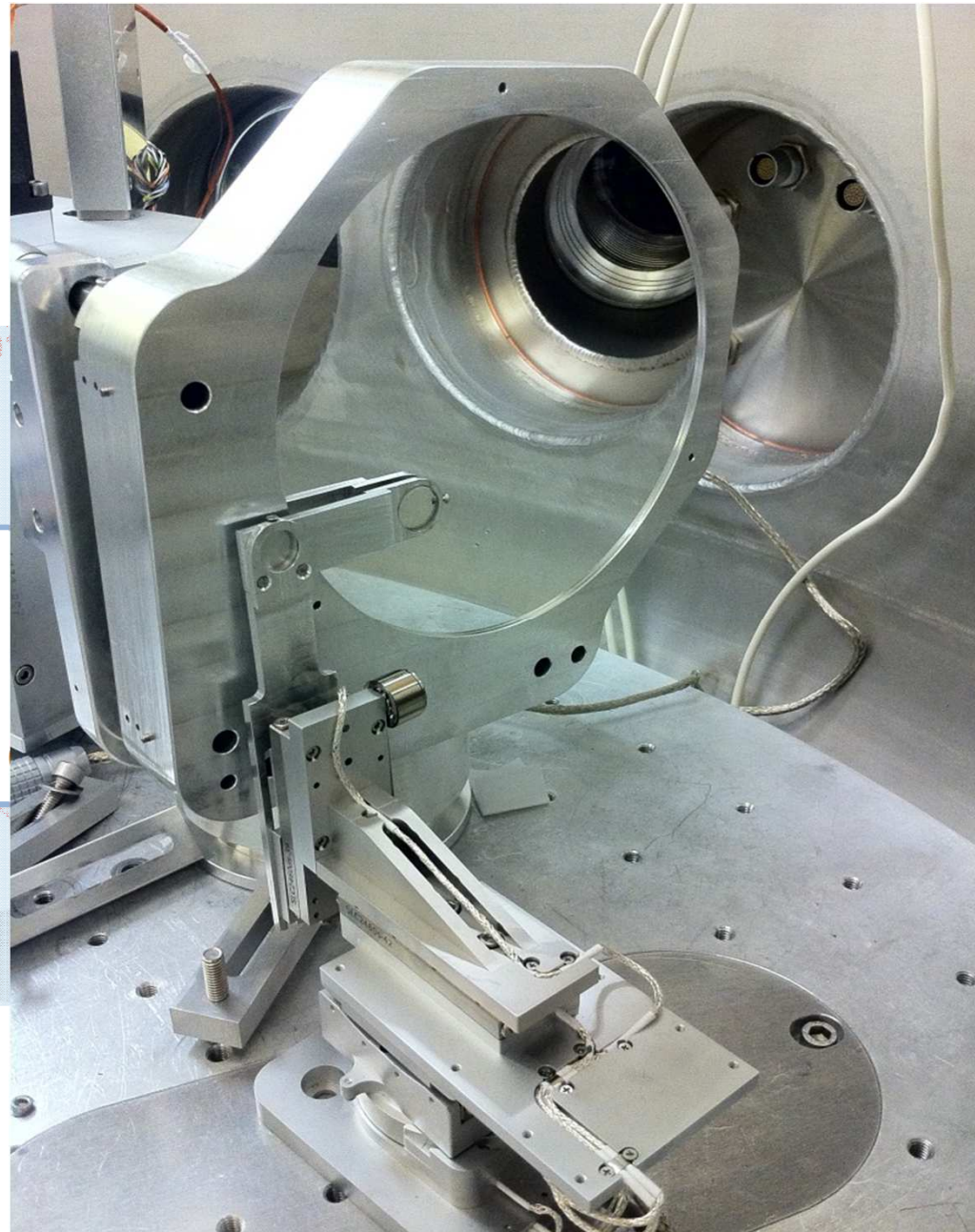
X

There is always a gradient of
plasma on the target surface

Controlling

Main pulse : 10^{15}W/cm^2

Pre-pulse :
 10^{15}W/cm^2

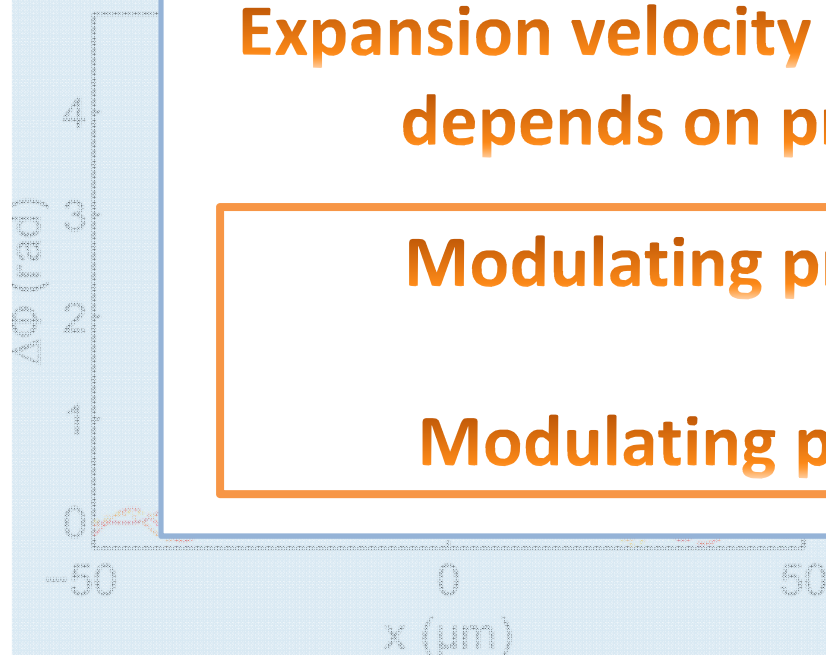


Measuring the plasma scale length

Expansion of plasma into
vacuum for different delays
at a given pre-pulse fluence

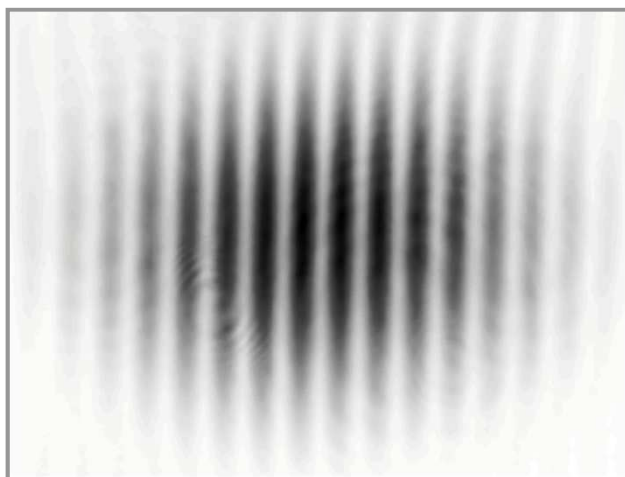
**Expansion velocity of plasma into vacuum
depends on pre-pulse's fluence**

**Modulating pre-pulse's fluence
=
Modulating plasma expansion**

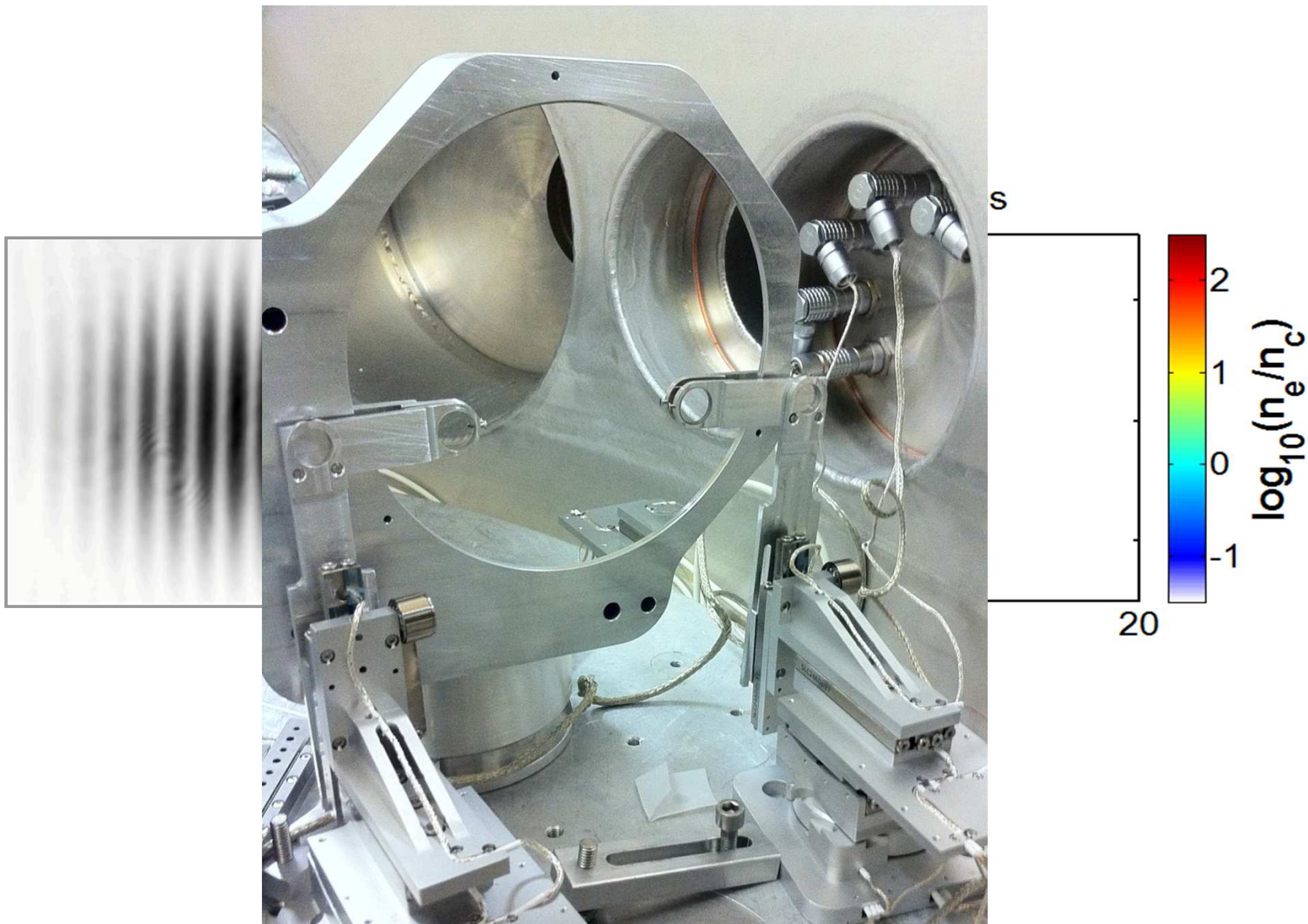


PRL 112, 145008 (2014)

Modulation of the pre-pulse's fluence



Modulation of the pre-pulse's fluence

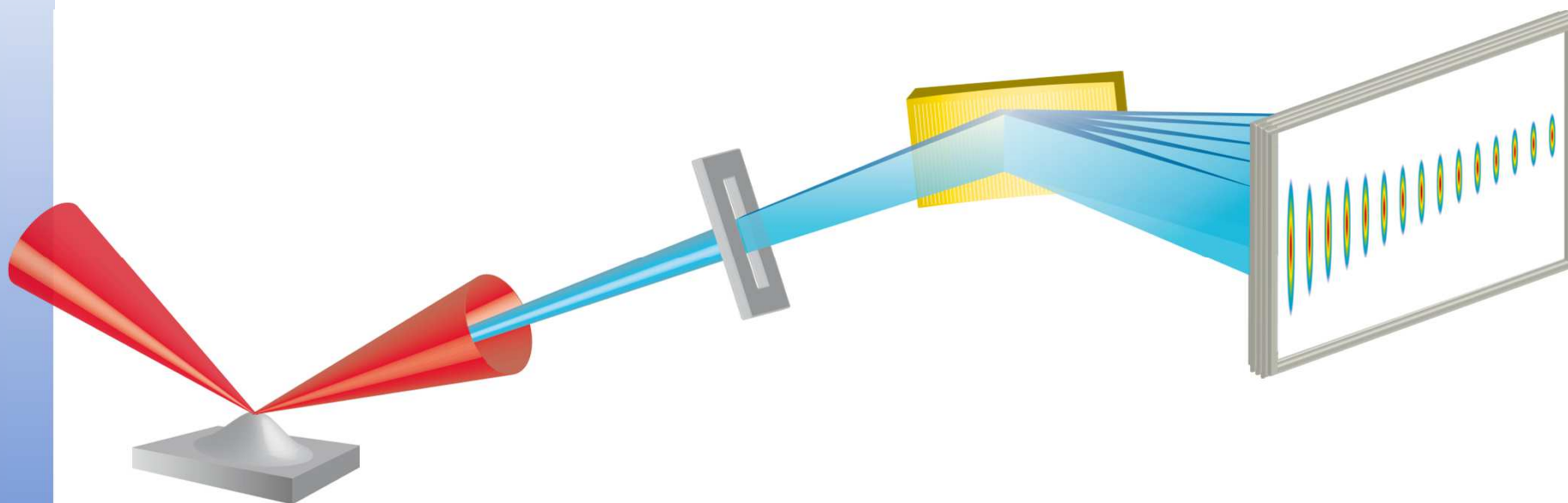


Modulation of the pre-pulse's fluence

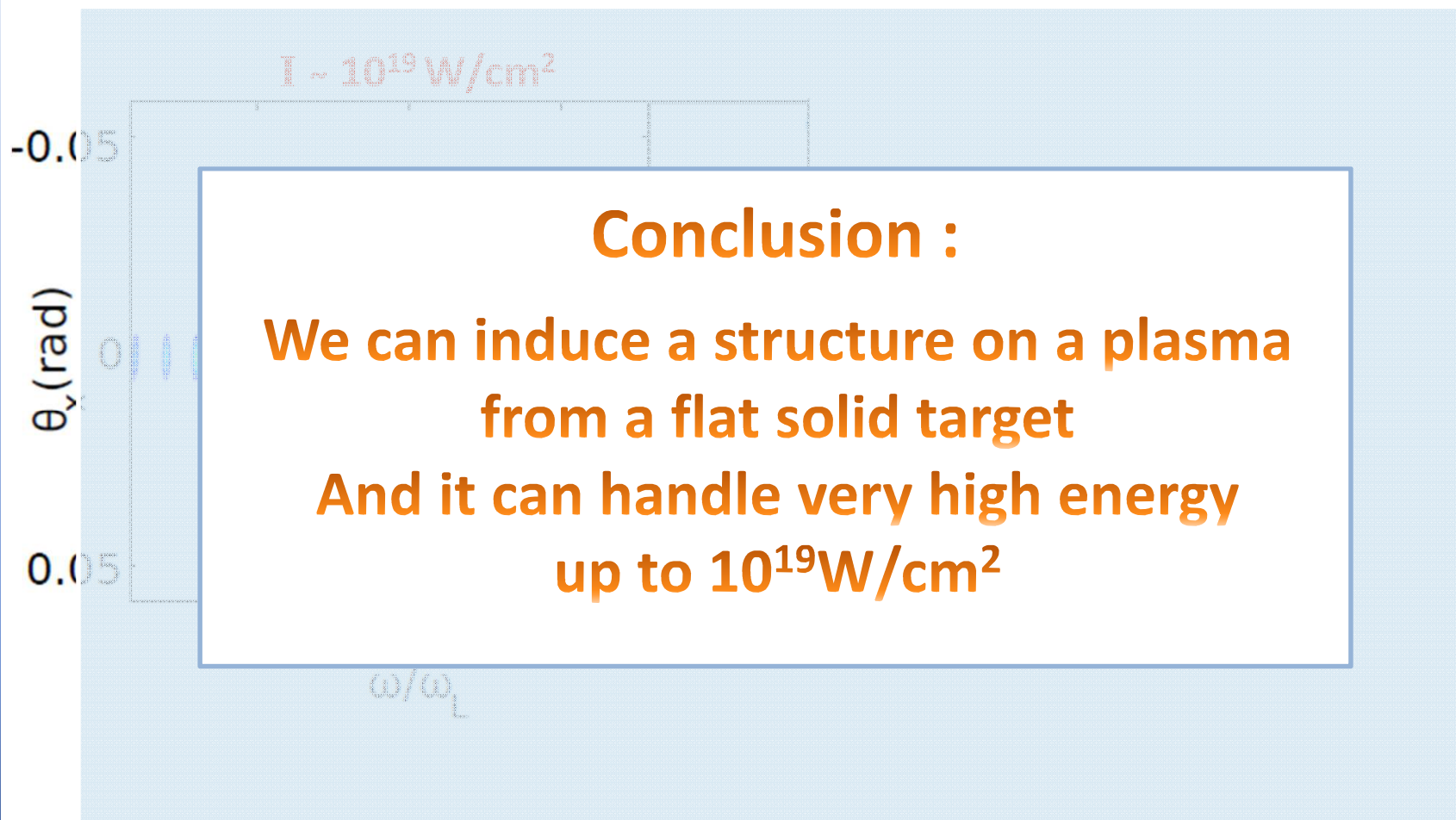
Is such a structure able to handle very high energy up to 10^{19}W/cm^2 ?

**High harmonic generation as a
probe of the plasma structure**

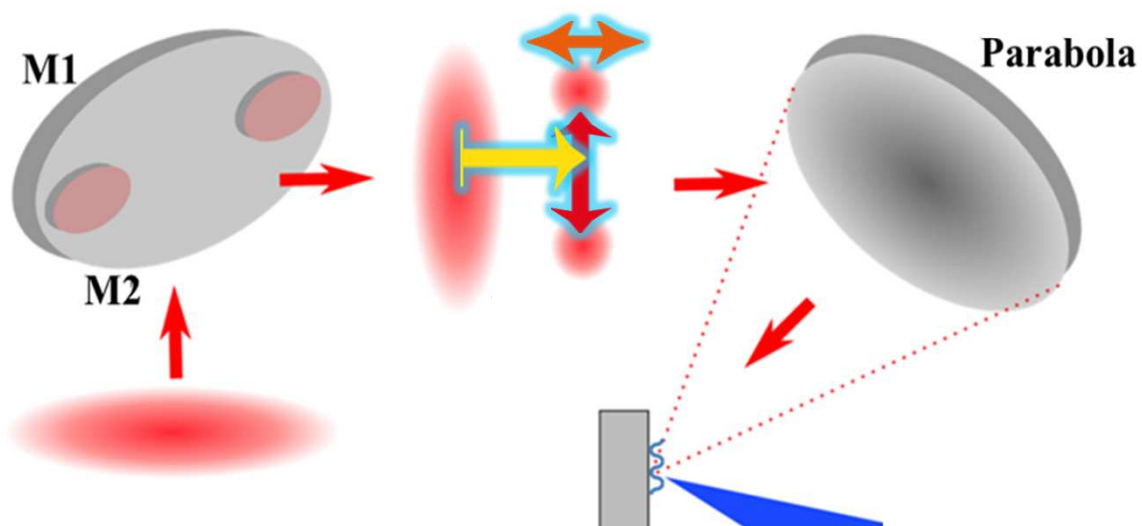
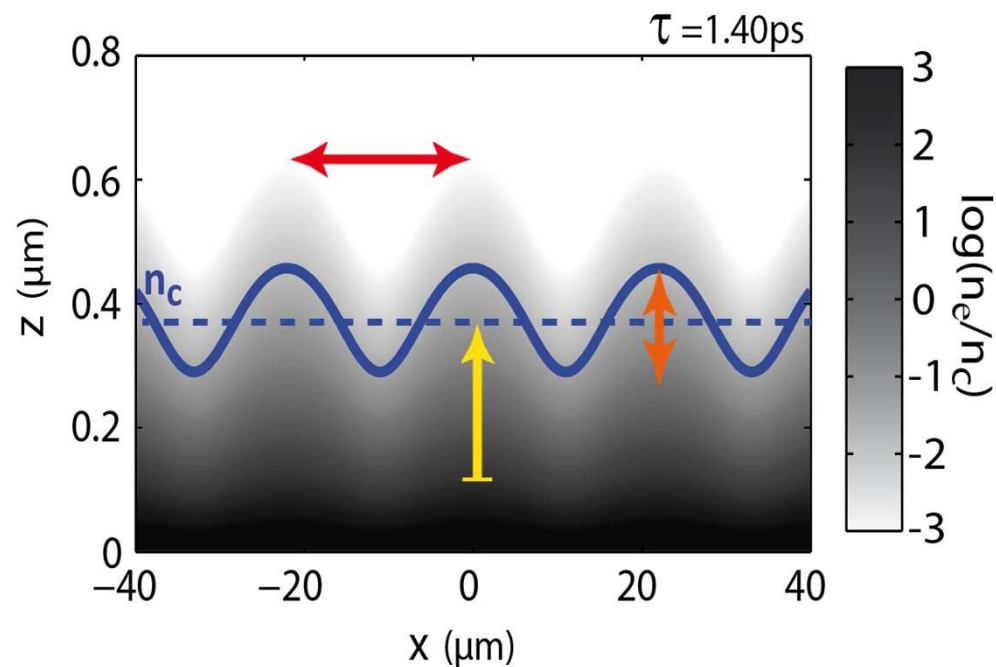
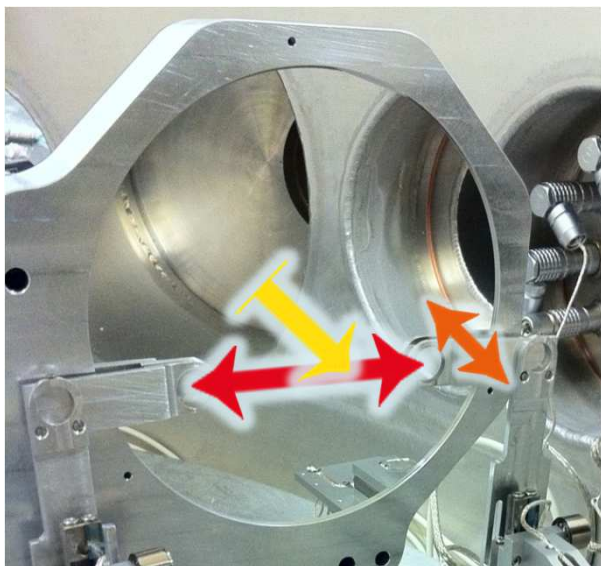
High harmonic diagnostic



High harmonic generation to probe the plasma grating



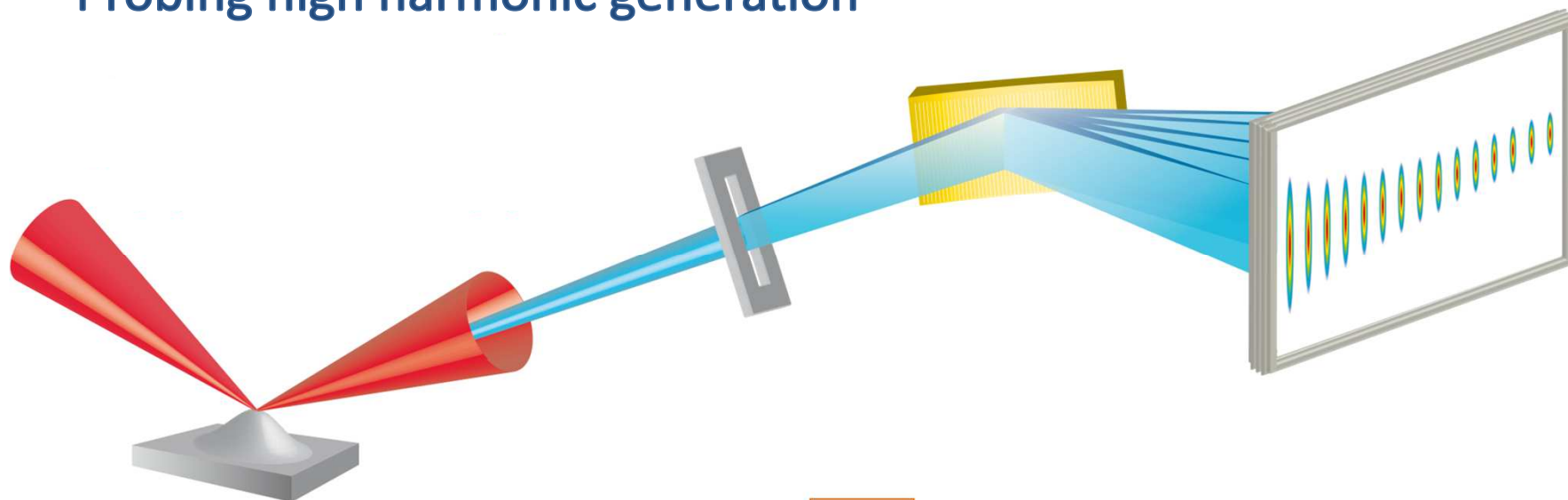
Tunability of the structure



- Grating step
- Grating depth
- Average scale length

**First application of optically
controlled plasma structures :
Probe the high harmonic source**

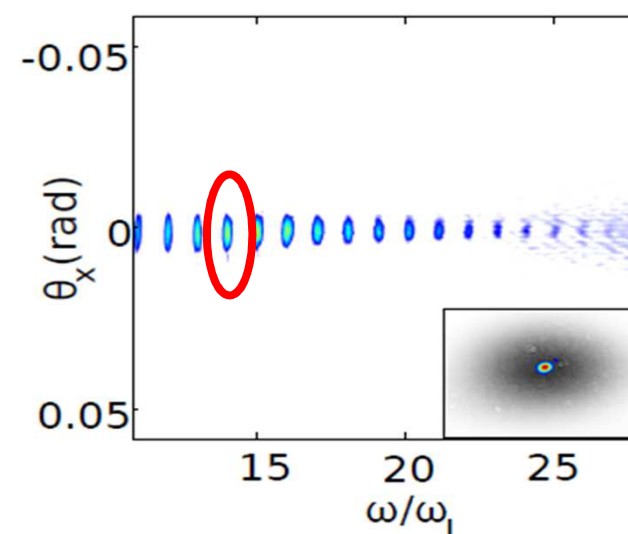
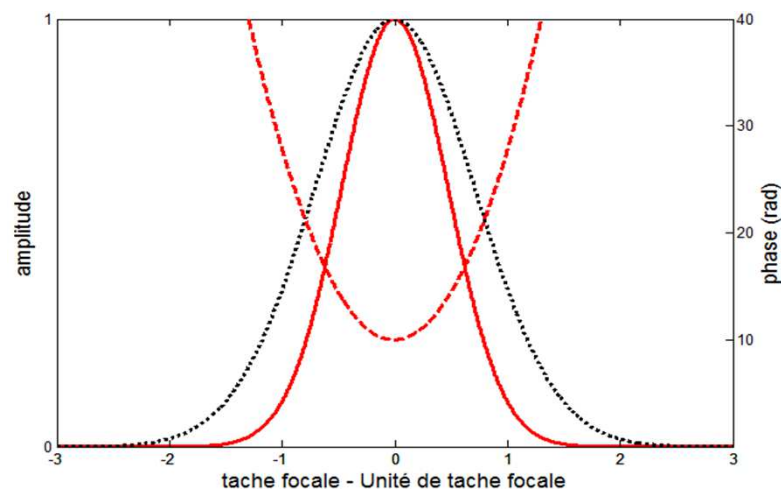
Probing high harmonic generation



Harmonic source (target plane)

FT

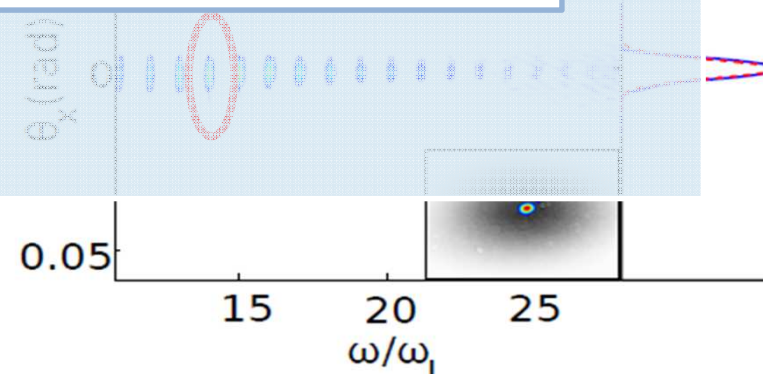
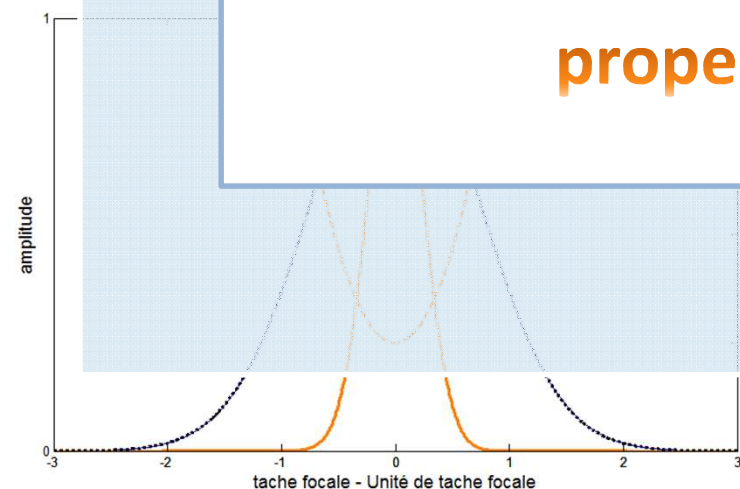
Far from target



Toward an understanding of high harmonic generation

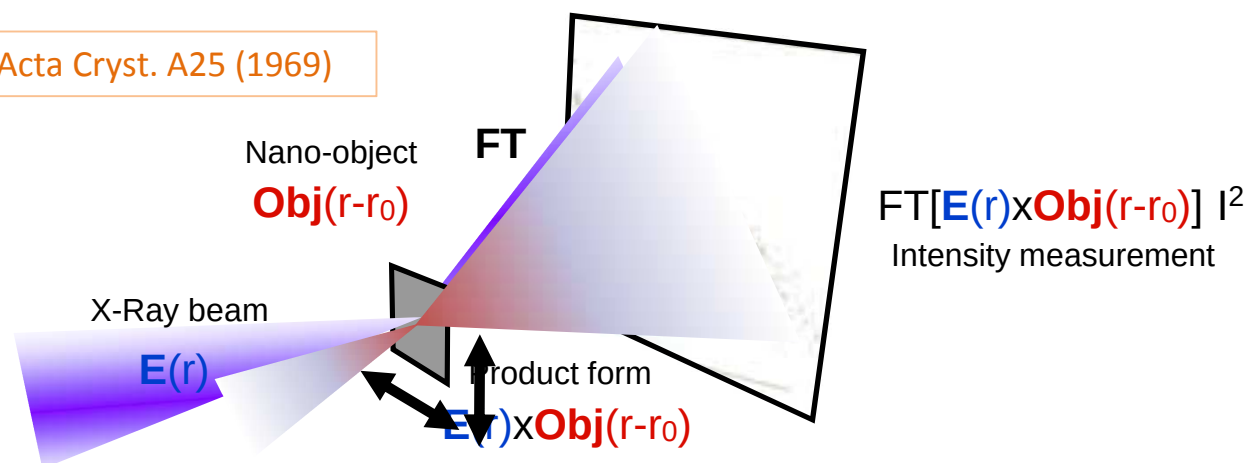
Harmonic field spatial properties far from target are understood.

How to deduce the harmonic source properties on target ?



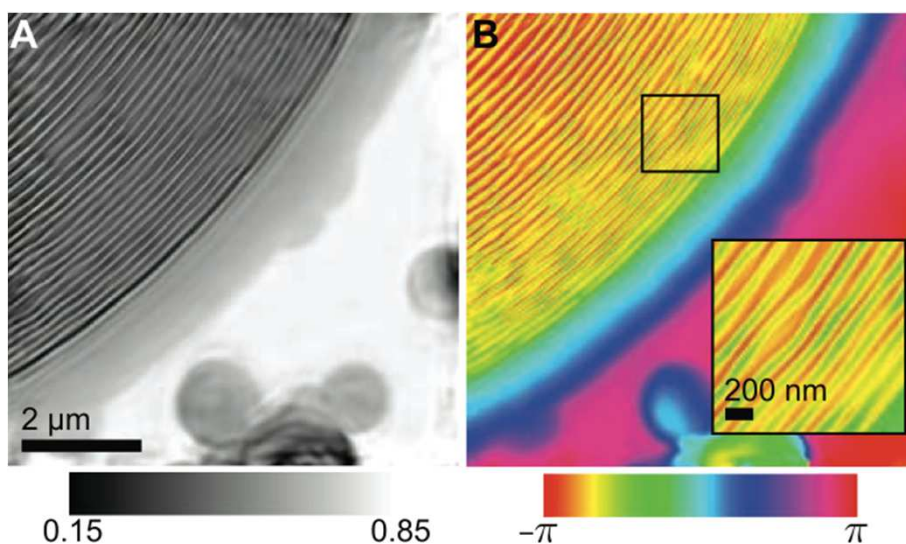
Ptychography

W. Hoppe, Acta Cryst. A25 (1969)

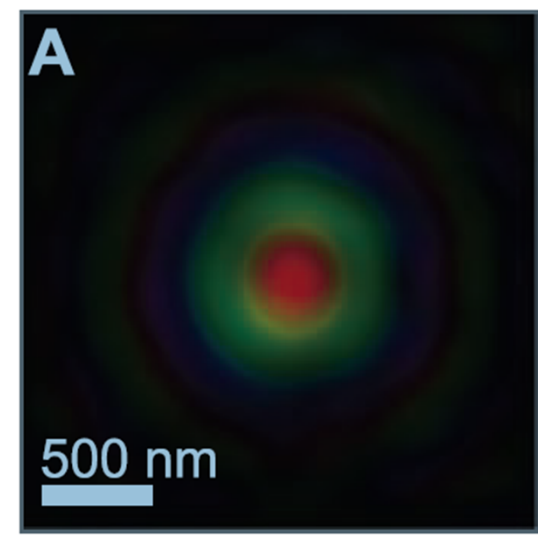


Thibault et al., Science, **321**, 379 (2007)

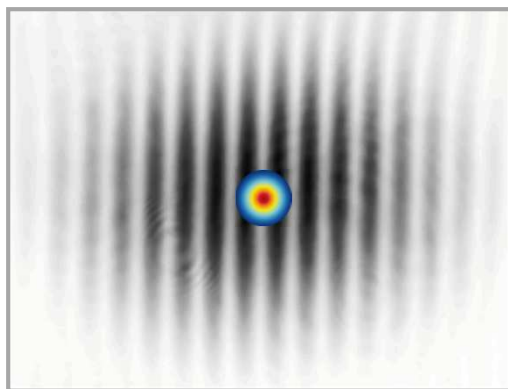
Nano-object: $Obj(r-r_0)$



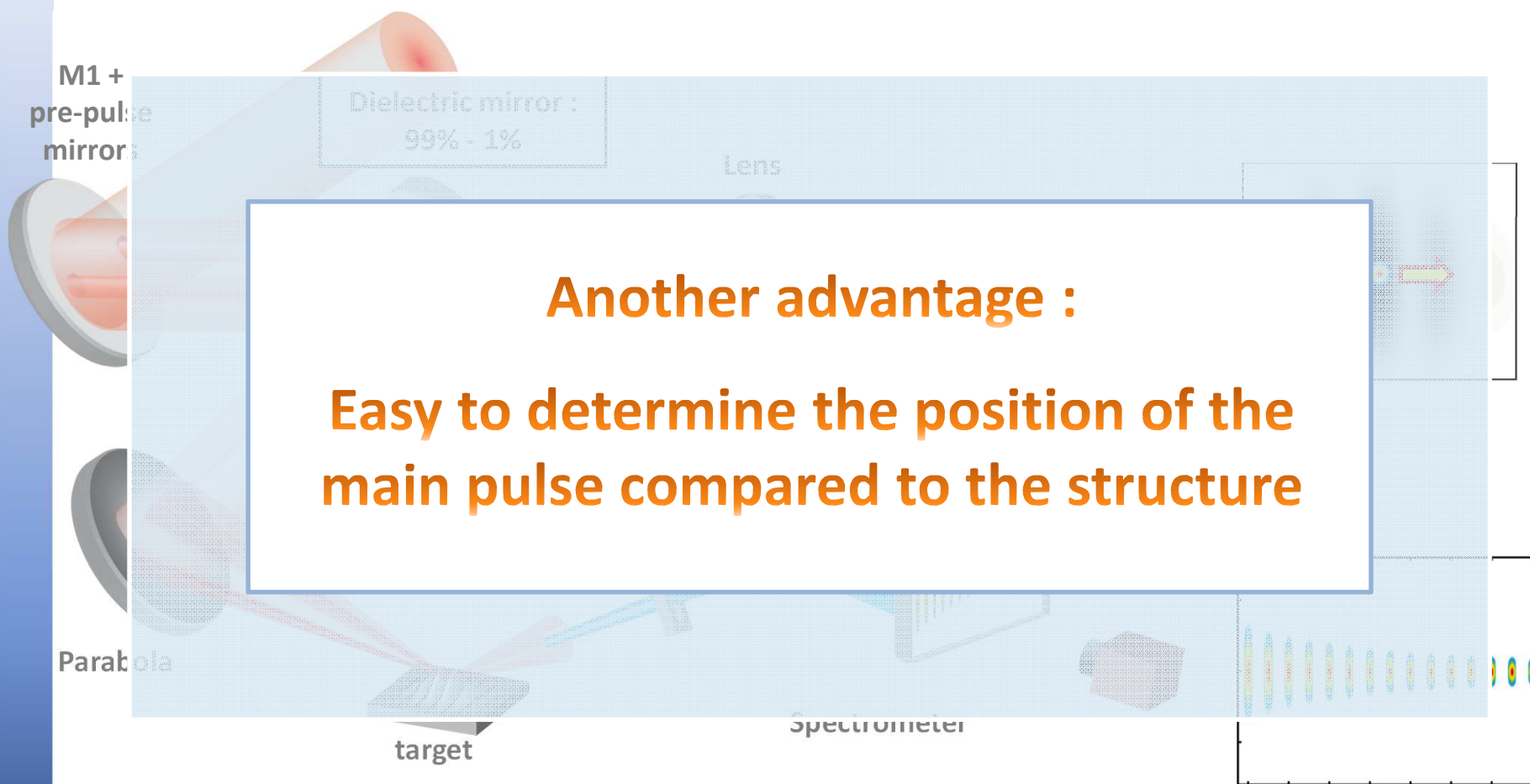
X-Ray beam: $E(r)$



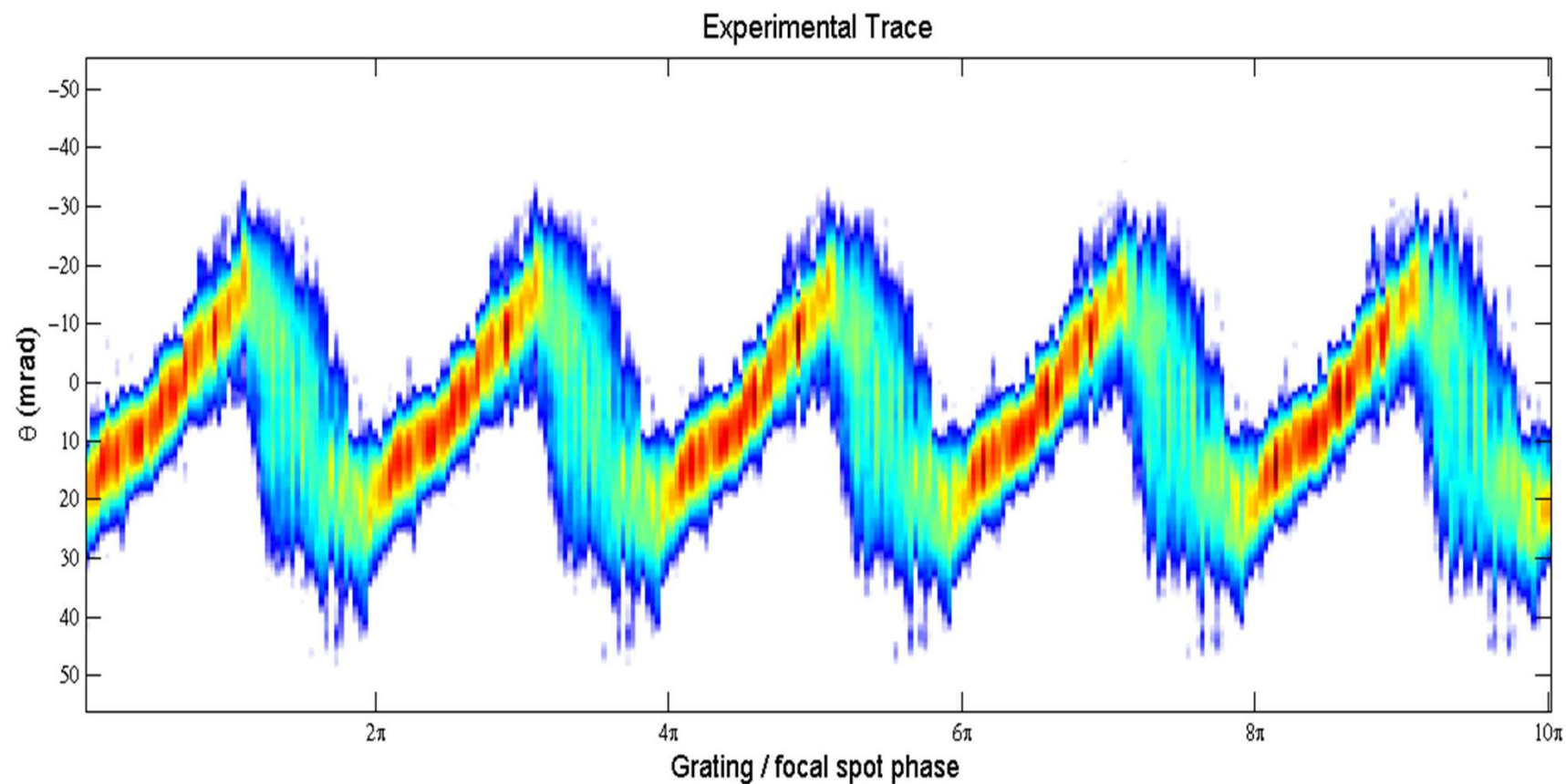
Toward an understanding of high harmonic generation



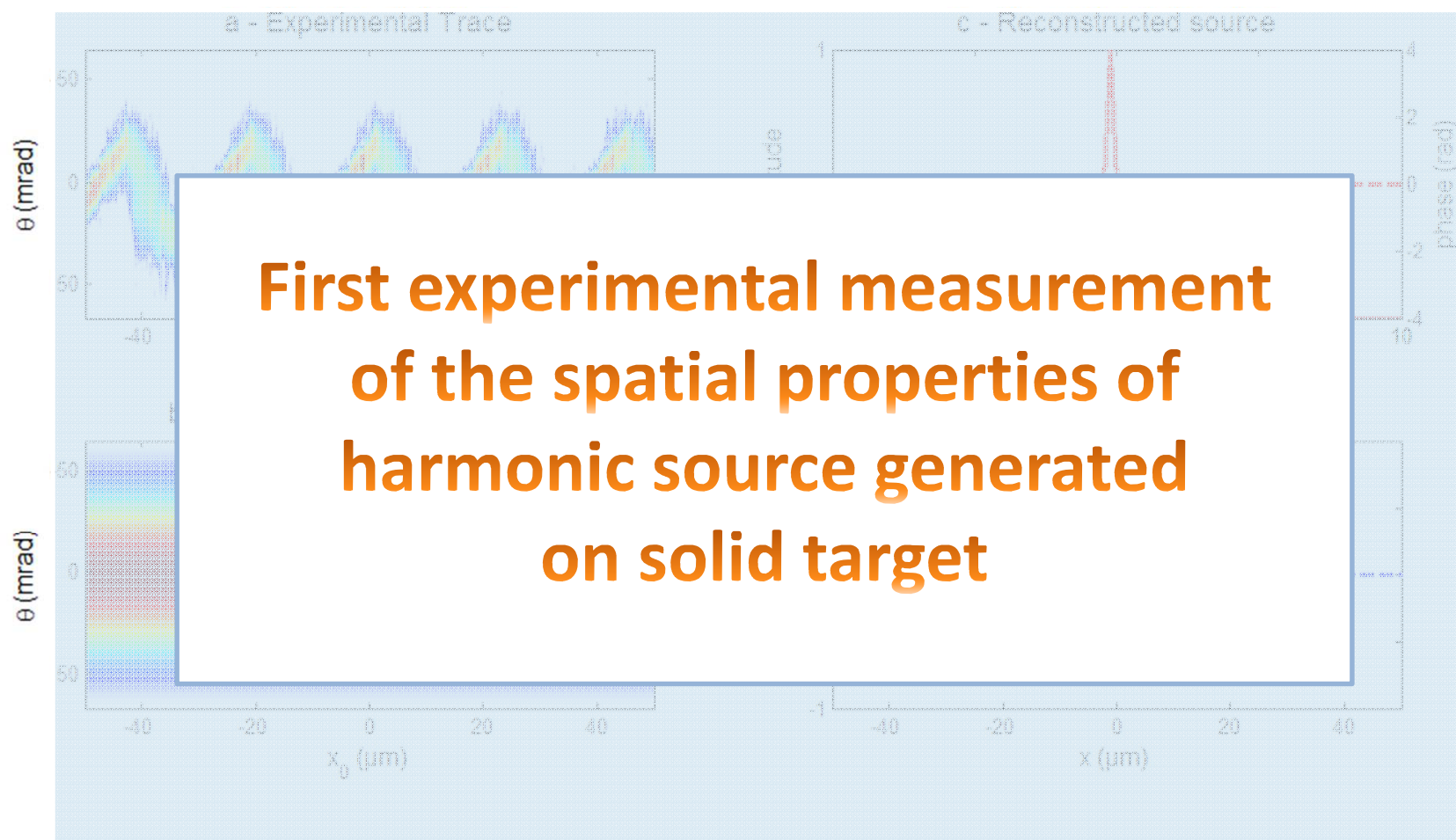
Toward an understanding of high harmonic generation



Ptychography



Ptychography





Optical

-

-

-

-

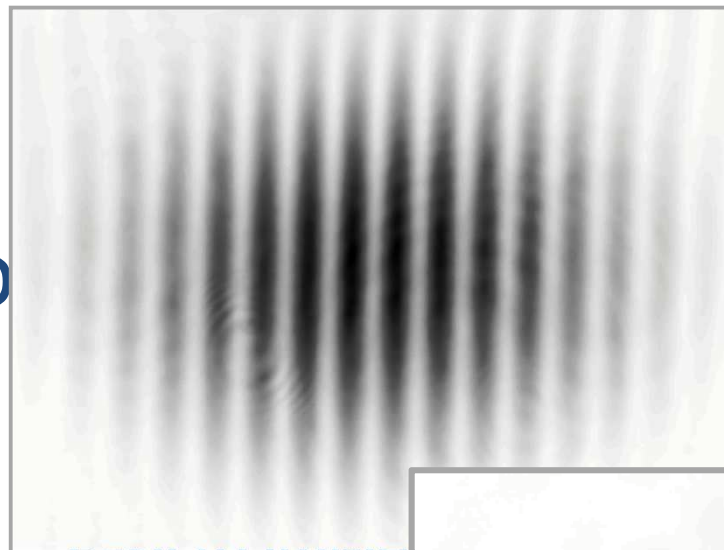


Use

-

-

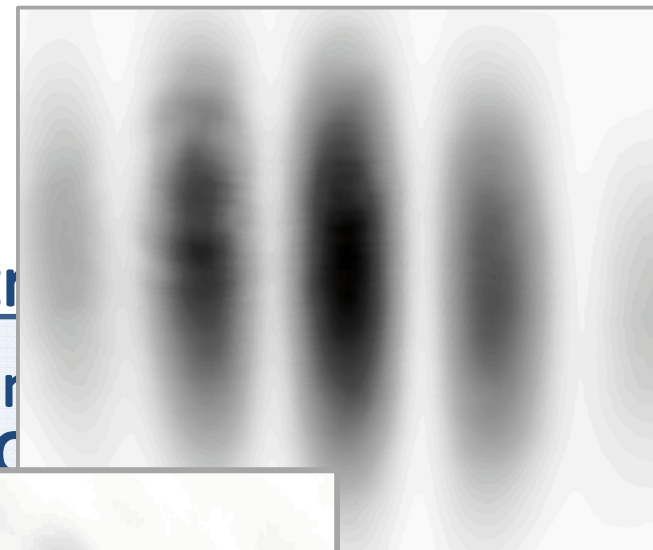
-



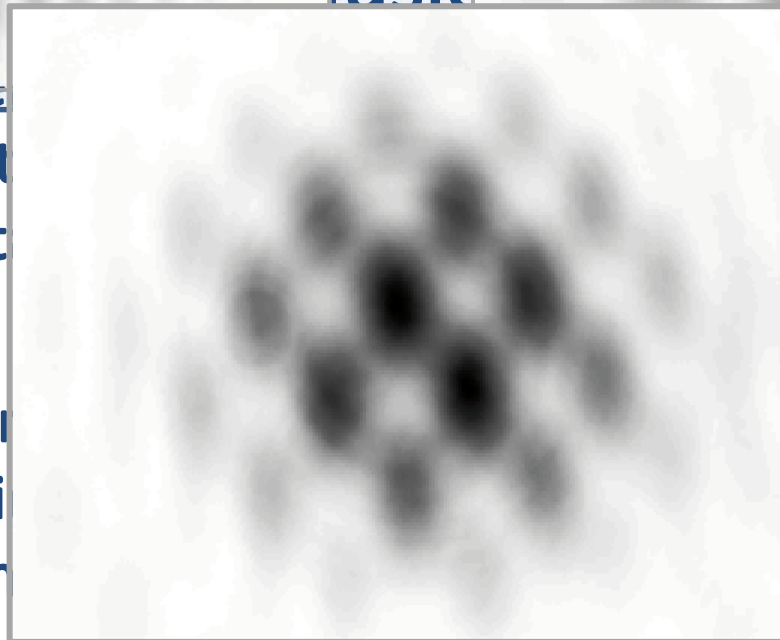
na str

it can

usic

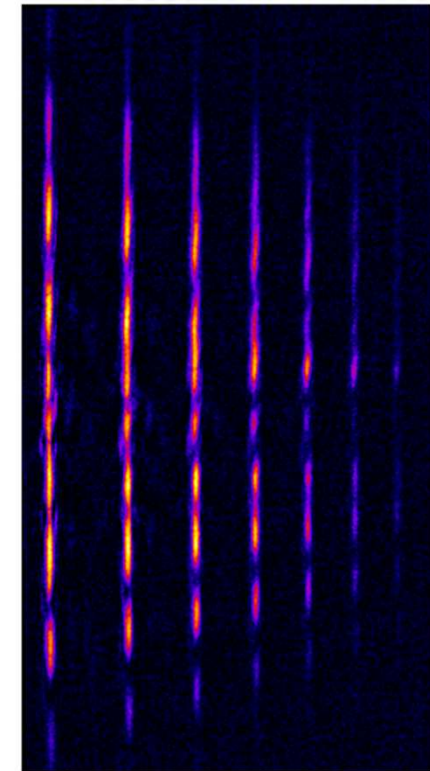
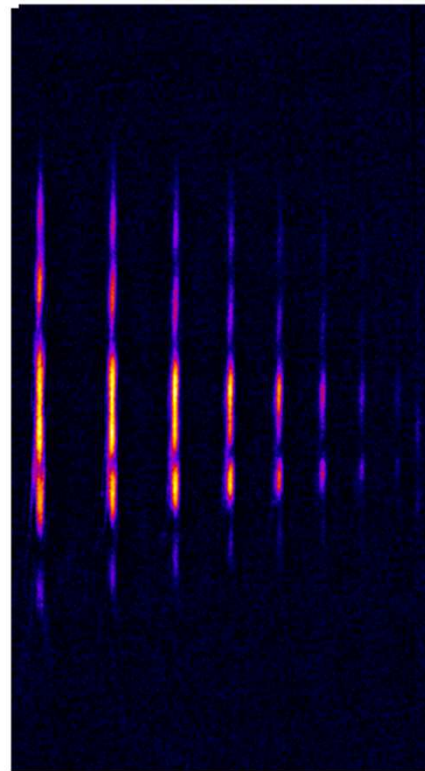
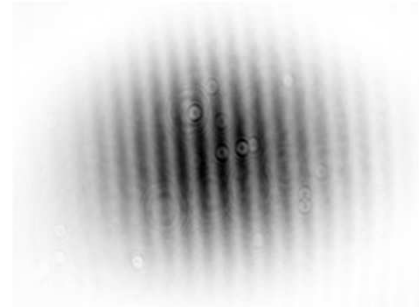
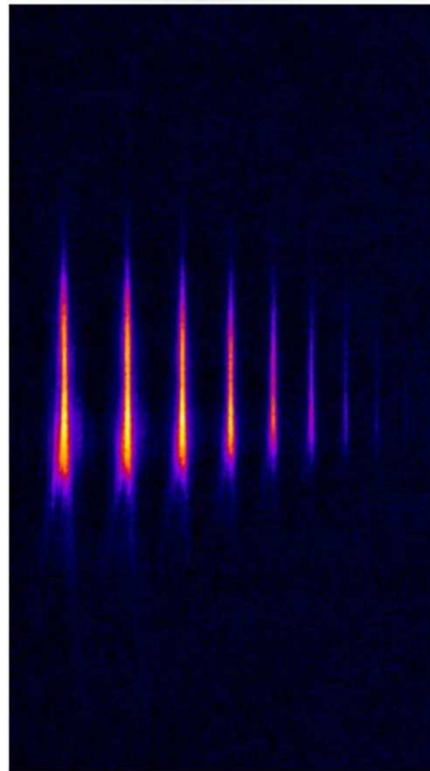
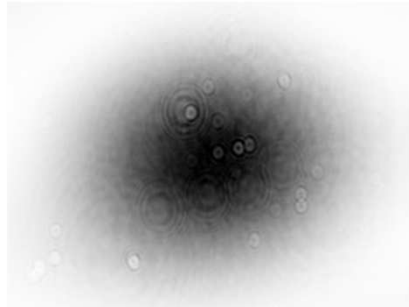


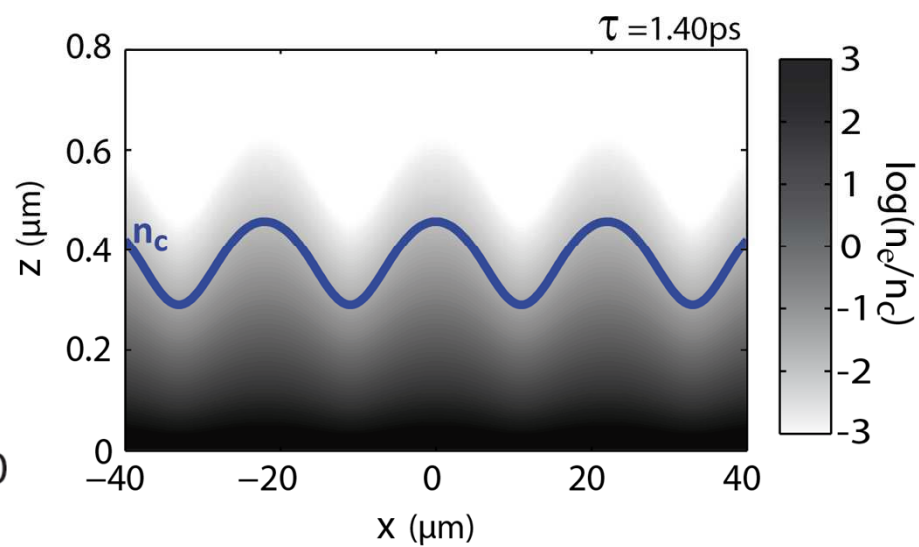
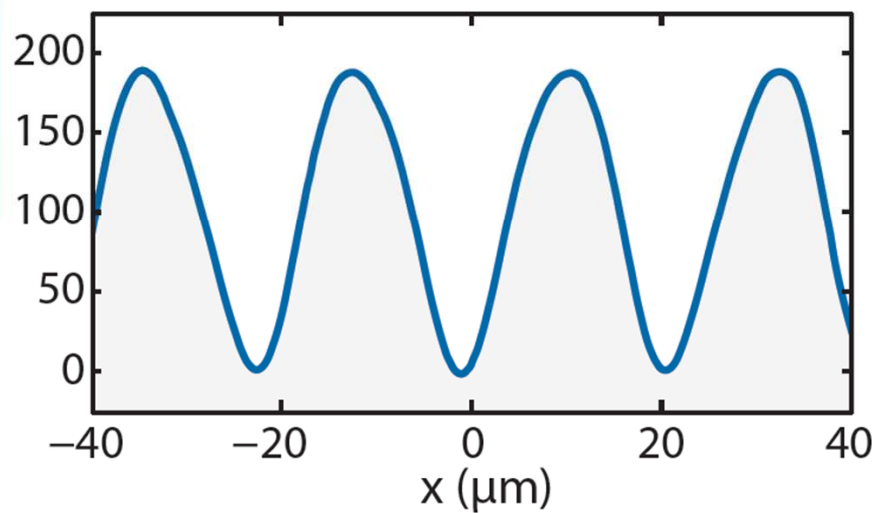
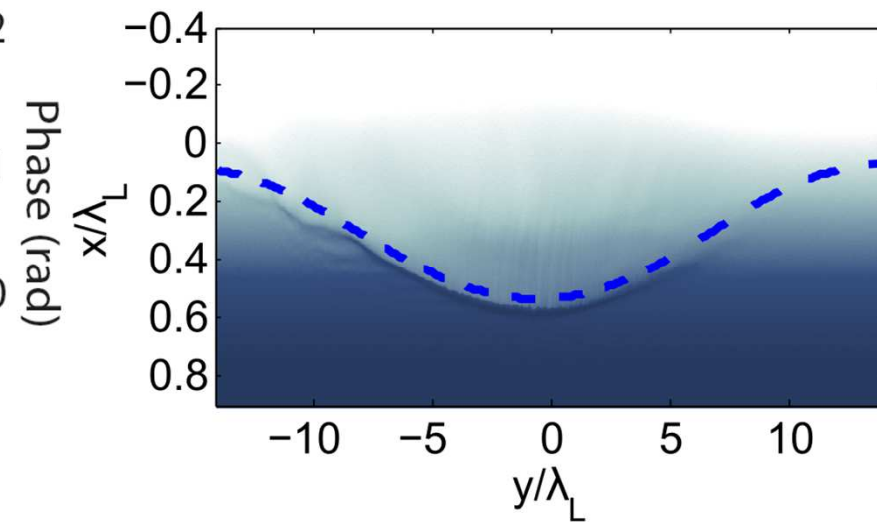
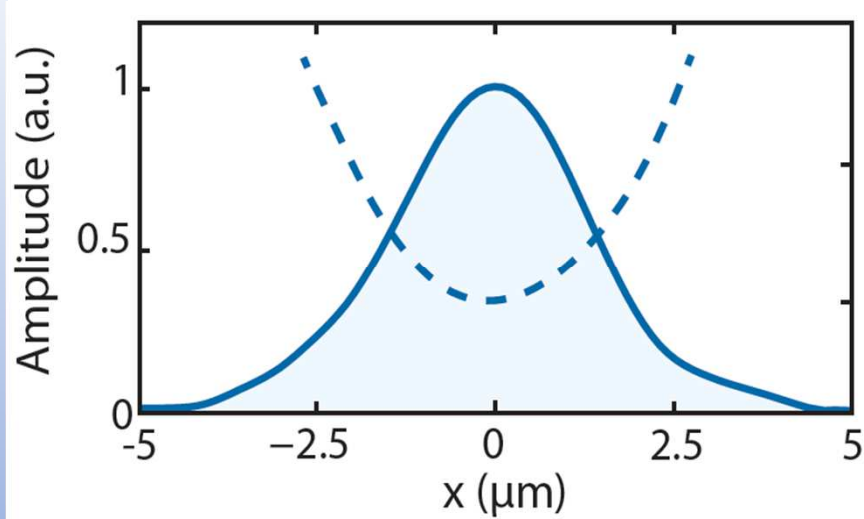
et



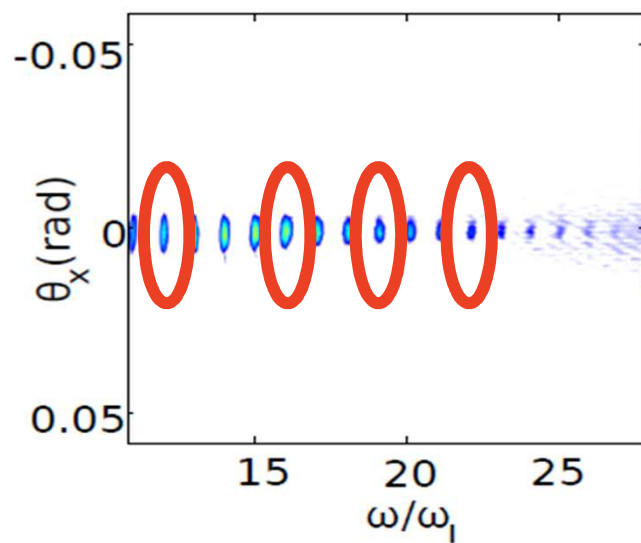
properties of

Bonus 1

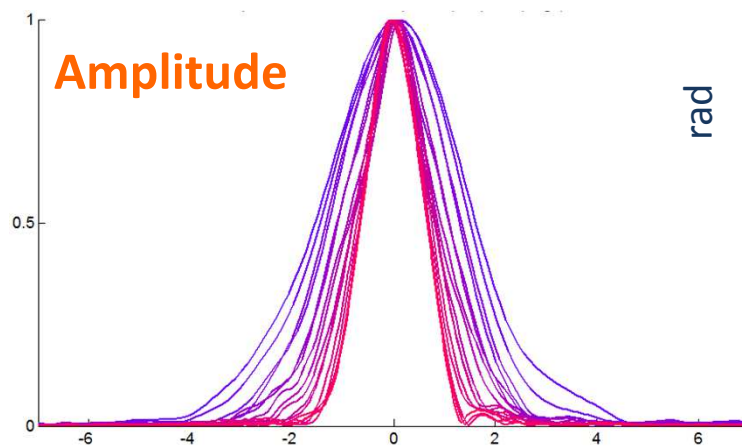




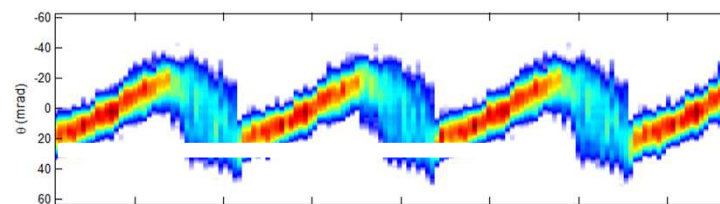
Bonus 3



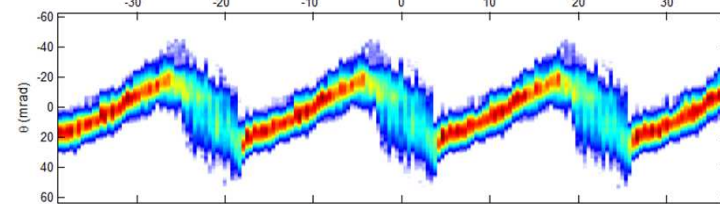
From blue to red : 11th to 26th



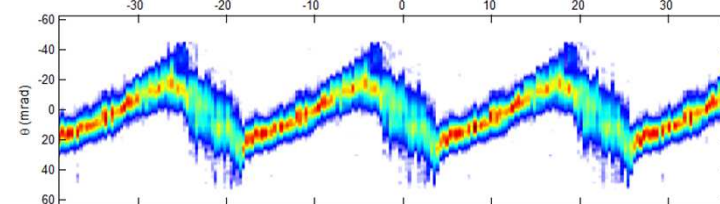
12



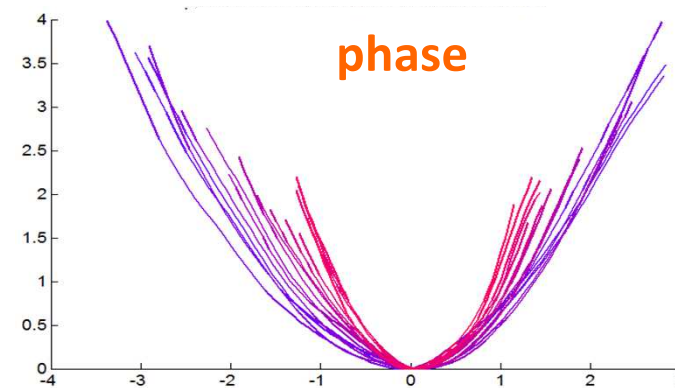
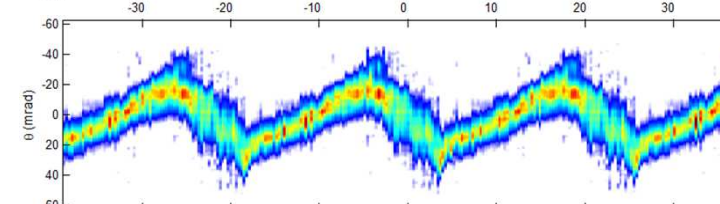
16



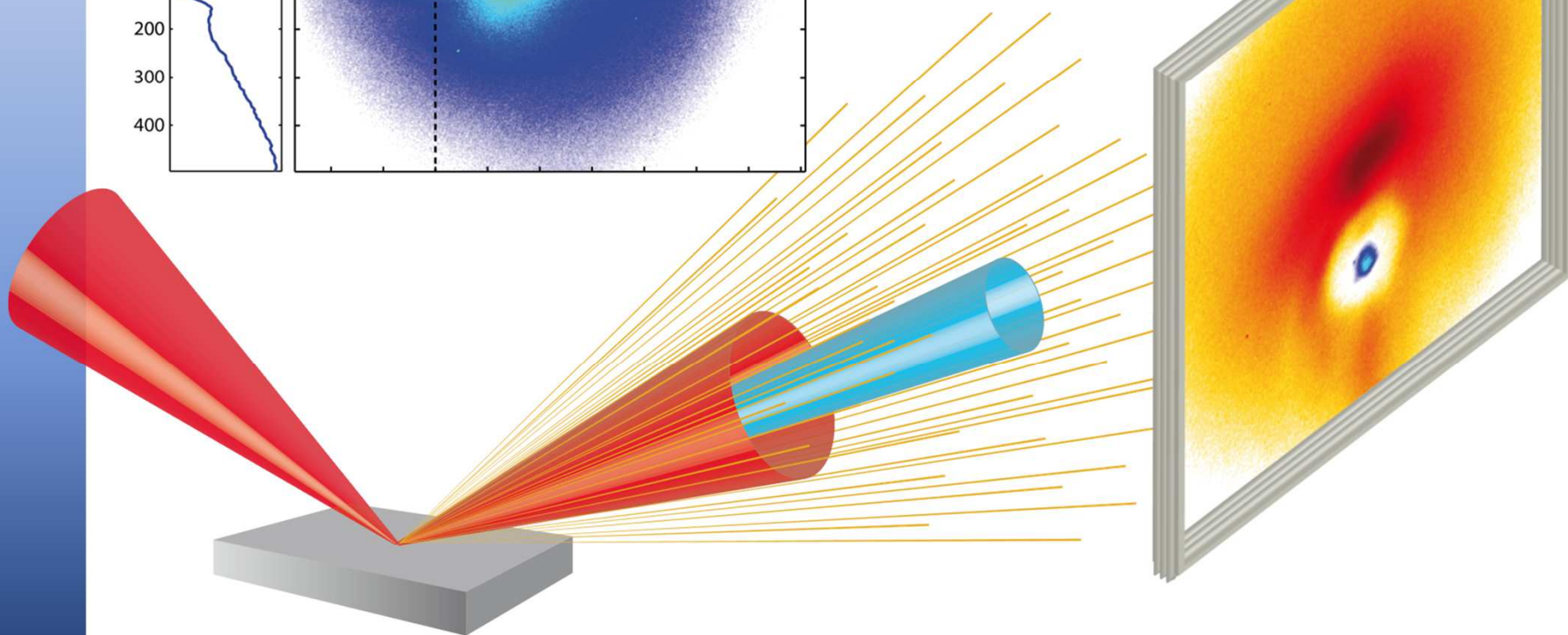
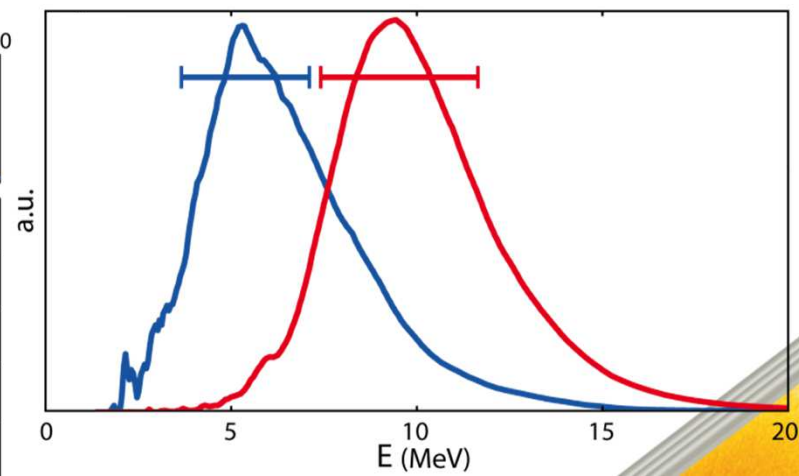
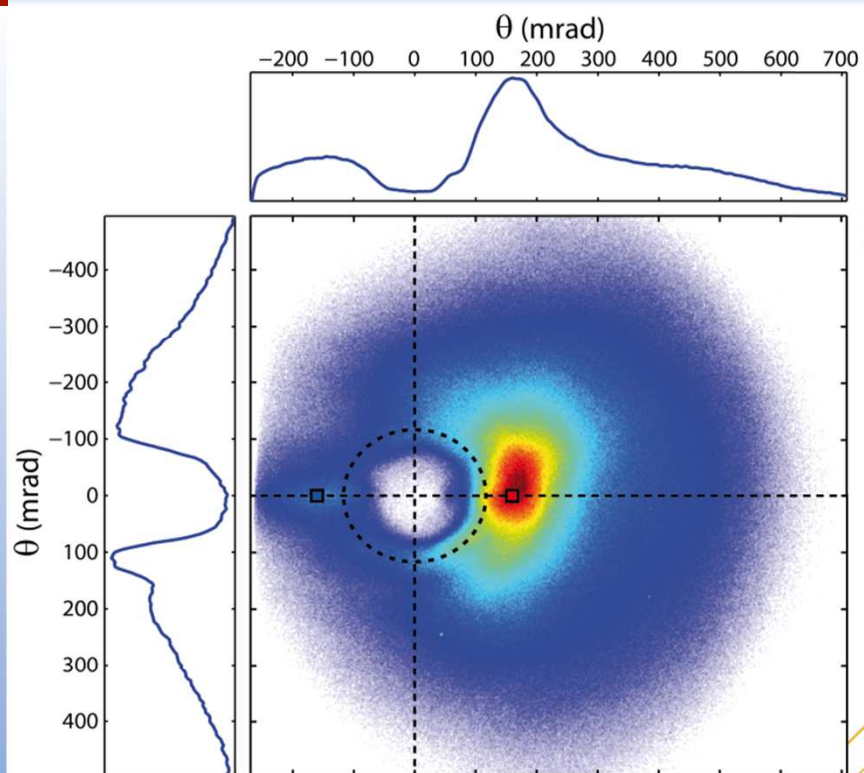
19

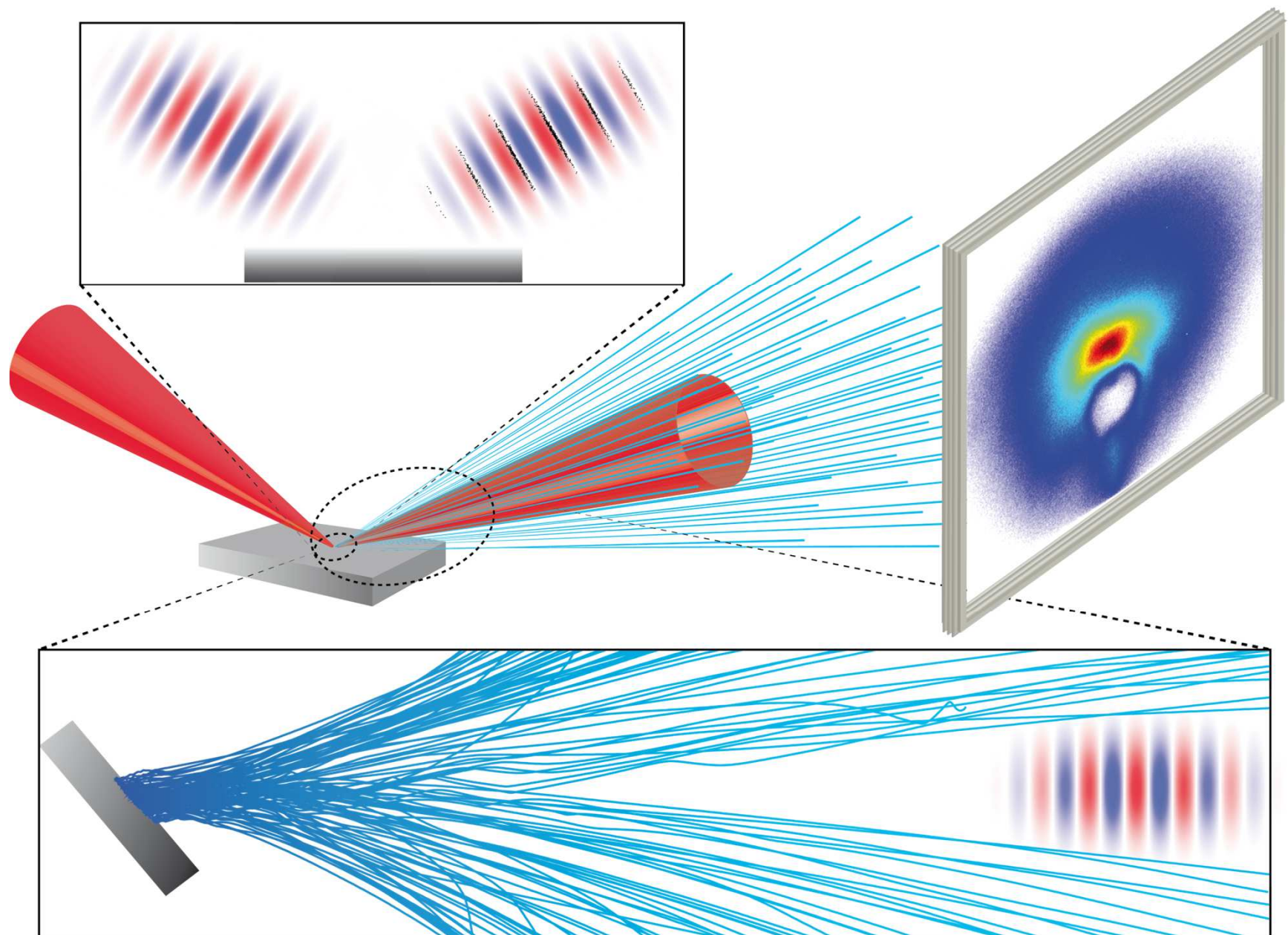


22



Bonus 4





Bonus 6

