

# Quasistatic and PIC simulations of electron self-trapping by the wake of low power laser pulse

Petr Tuev, Alexander Sosedkin, Konstantin Lotov



Budker Institute of Nuclear Physics SB RAS, Novosibirsk, Russia



Novosibirsk State University, Novosibirsk, Russia





## Outline:

QSA and trapping

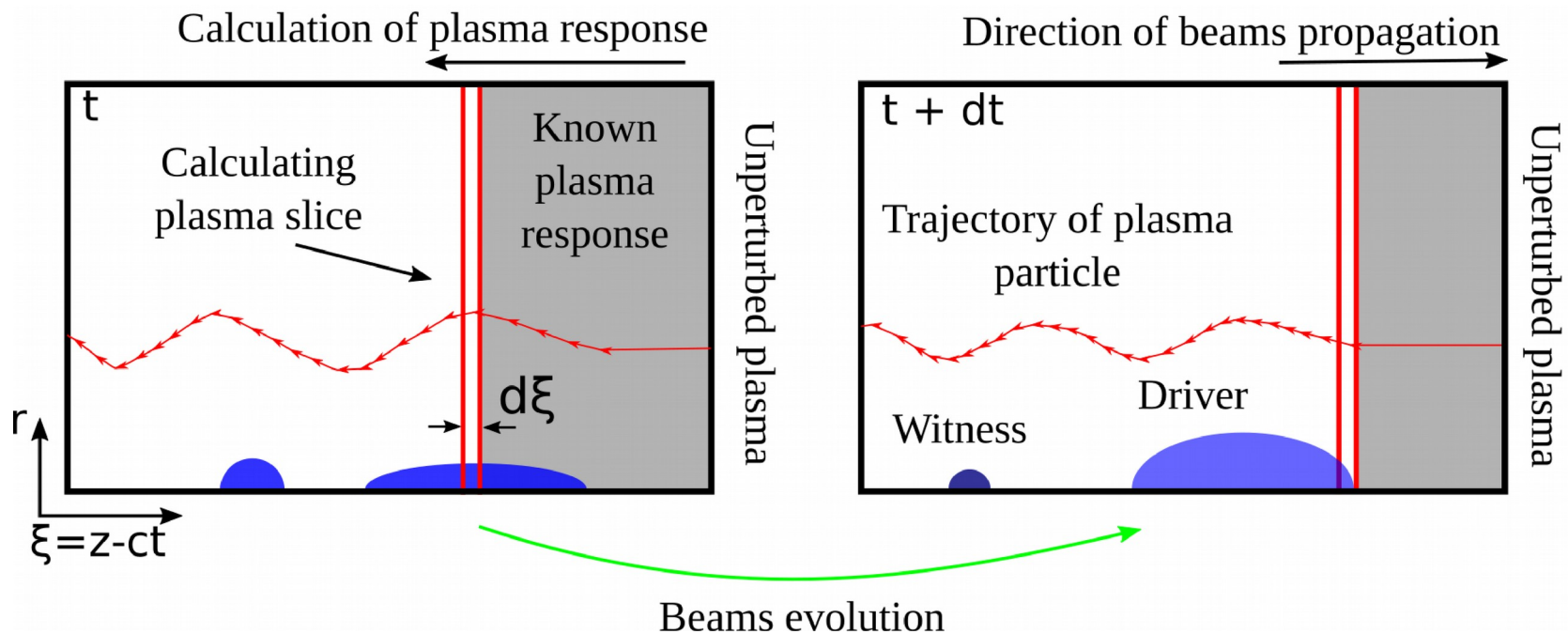
Parameters

Fast scans with QSA

Full simulation with usual PIC code

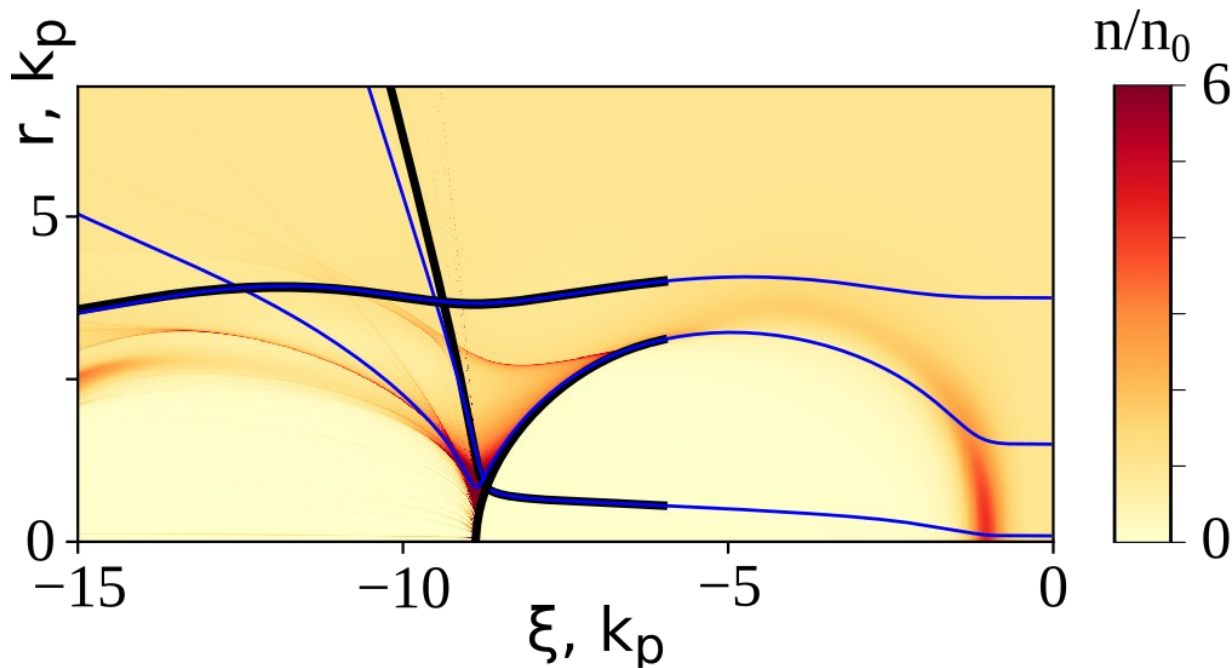
Summary

# QSA and trapping



No layers interaction  $\rightarrow$  no self-trapping

# QSA and trapping



Driver parameters:

$$a_0 = 3.5$$

$$\tau_0 = 1/\omega_p$$

$$r_0 = 2.6/k_p$$

$$k_0 = 30k_p$$

Blue lines — plasma electrons with QSA

Black lines — test electron tracking without QSA

Thresholds for changing model\*:

1. Energy ( $\gamma > 1.2$ )

2. Axis-crossing

\*WAKE-code team: PHYSICS OF PLASMAS 17, 063106 (2010)



# Outline:

QSA and trapping

## **Parameters**

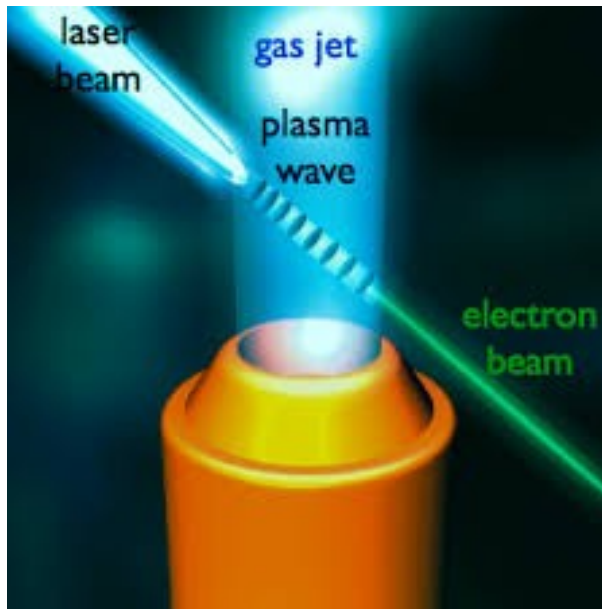
Fast scans with QSA

Full simulation with usual PIC code

Summary

# Parameters

## ILP SB Laser System



Energy (mJ)	300
Duration (fs)	20
Waist (mkm)	10
Power (TW)	14
Intensity (W/cm <sup>2</sup> )	$4.5 \cdot 10^{18}$
wavelength (nm)	810
$a_0$	1.45

- Self-trapping
- Short interaction distance (1 mm)
- Potential users



## Outline:

QSA and trapping

Parameters

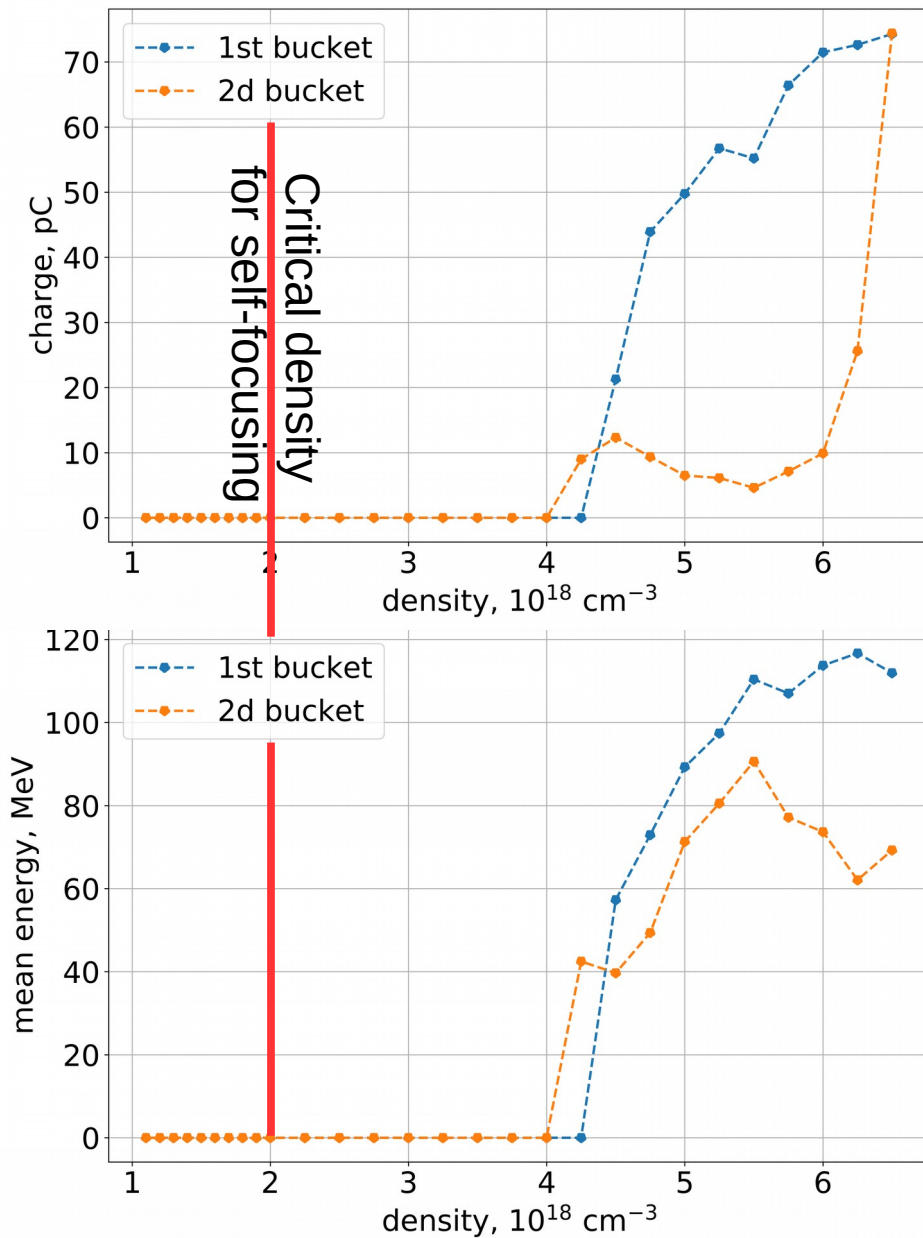
**Fast scans with QSA**

Full simulation with usual PIC code

Summary



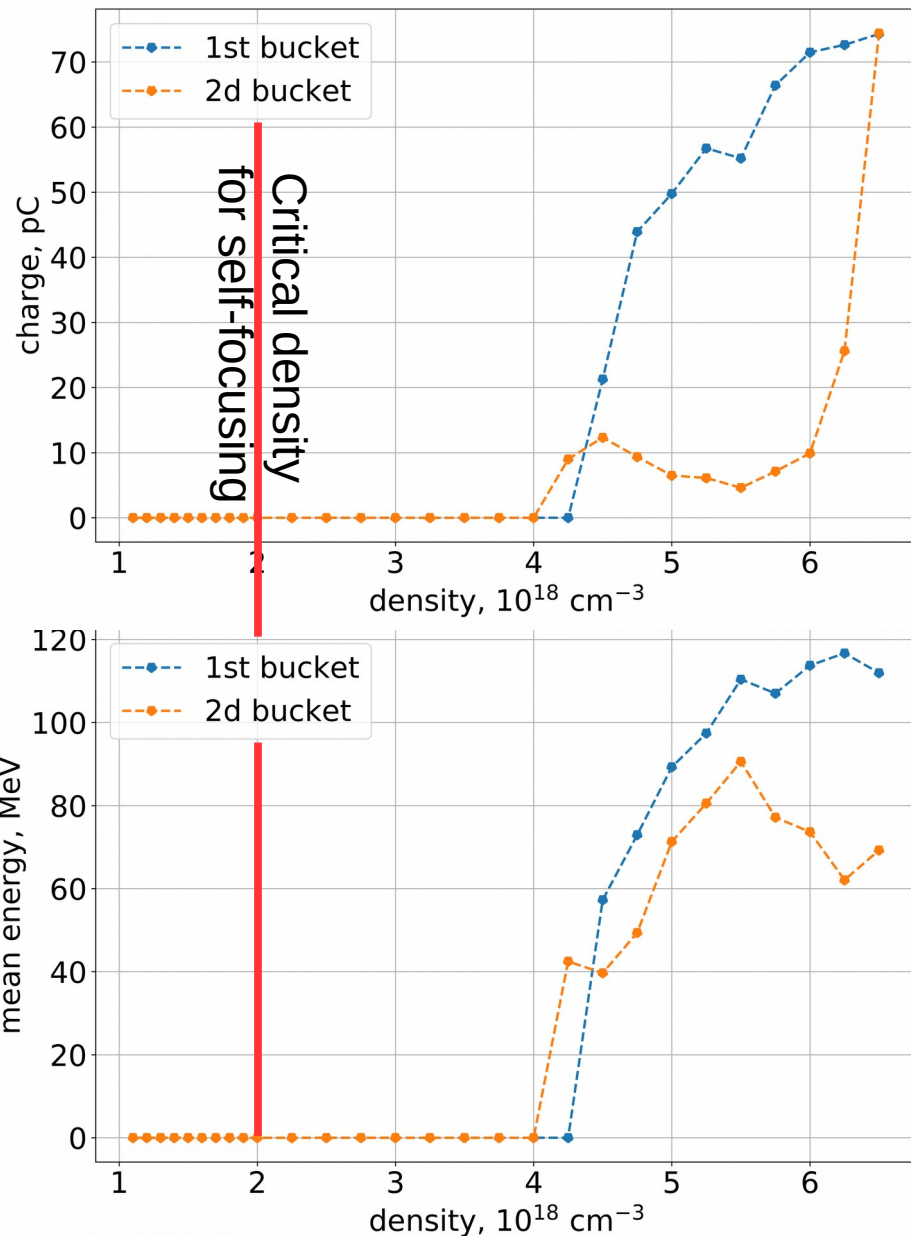
# Fast scans with QSA



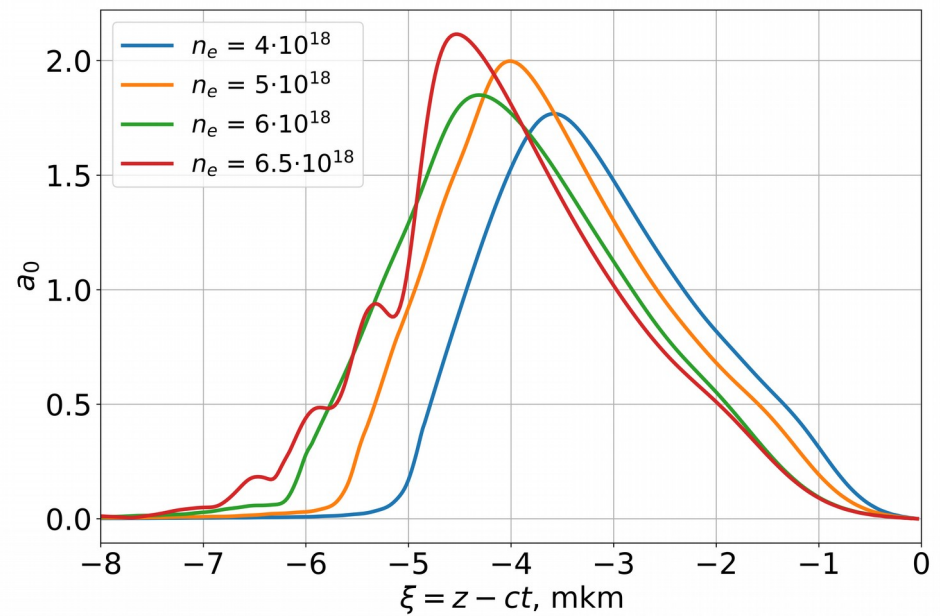




# Fast scans with QSA



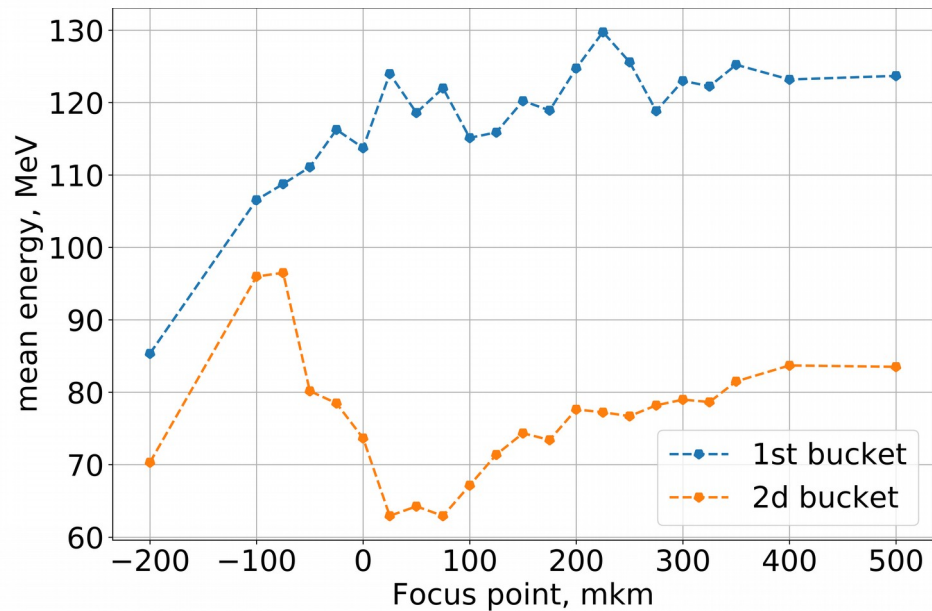
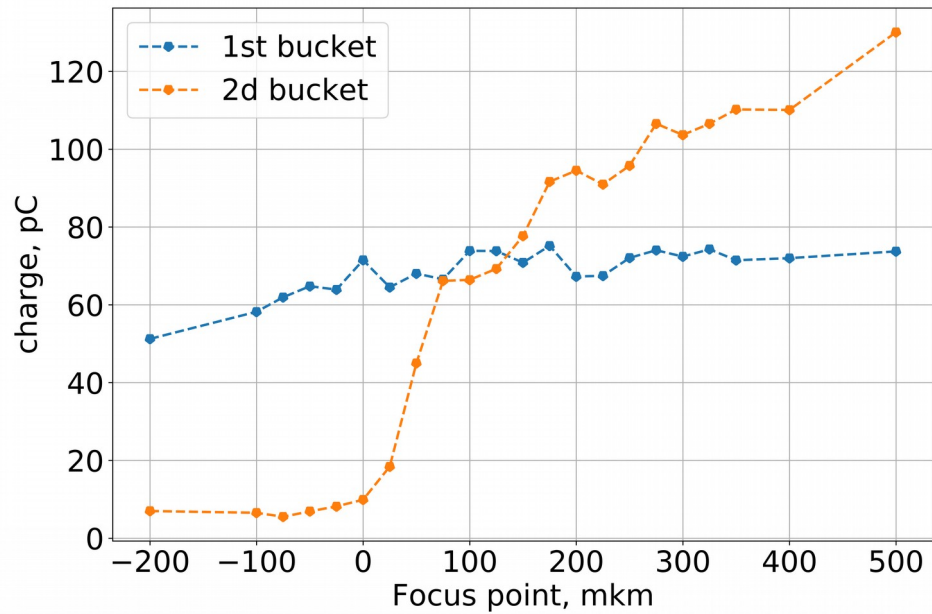
## Laser pulse envelope after 1 mm interaction



Plasma density above  $6 \cdot 10^{18} \text{ cm}^{-3}$   
to dense for such laser pulse

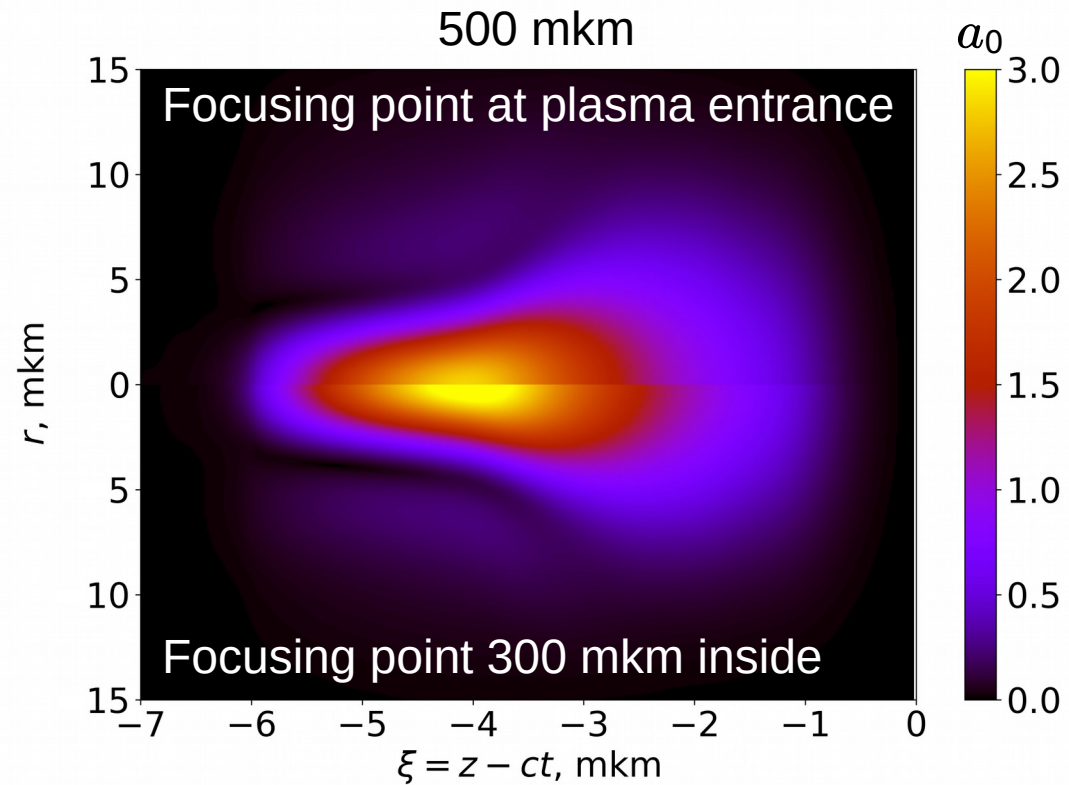
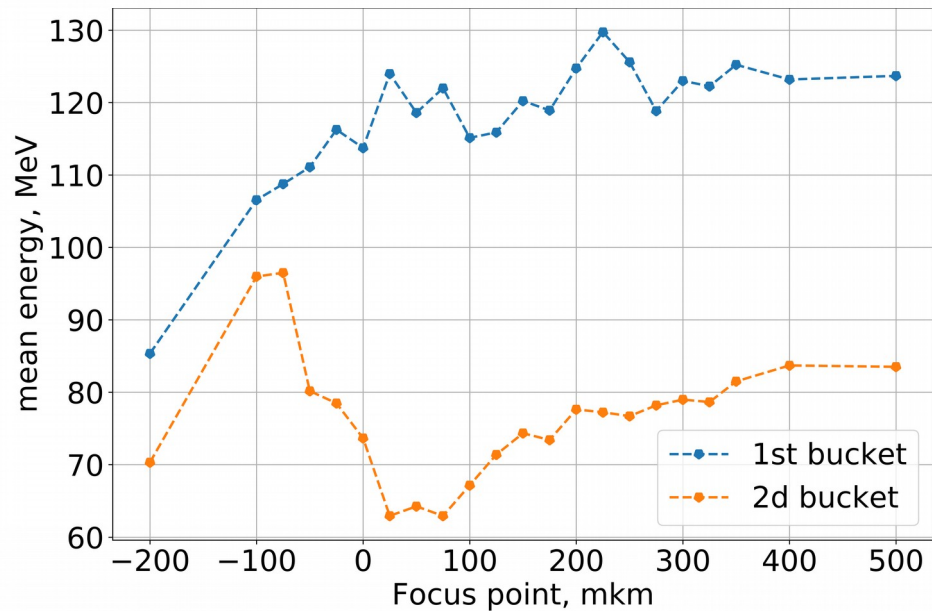
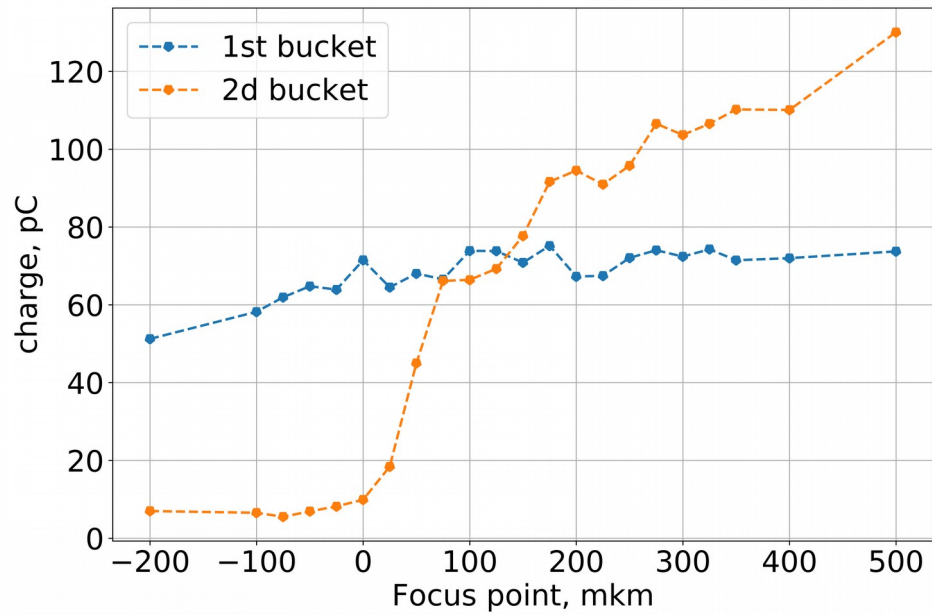


# Fast scans with QSA



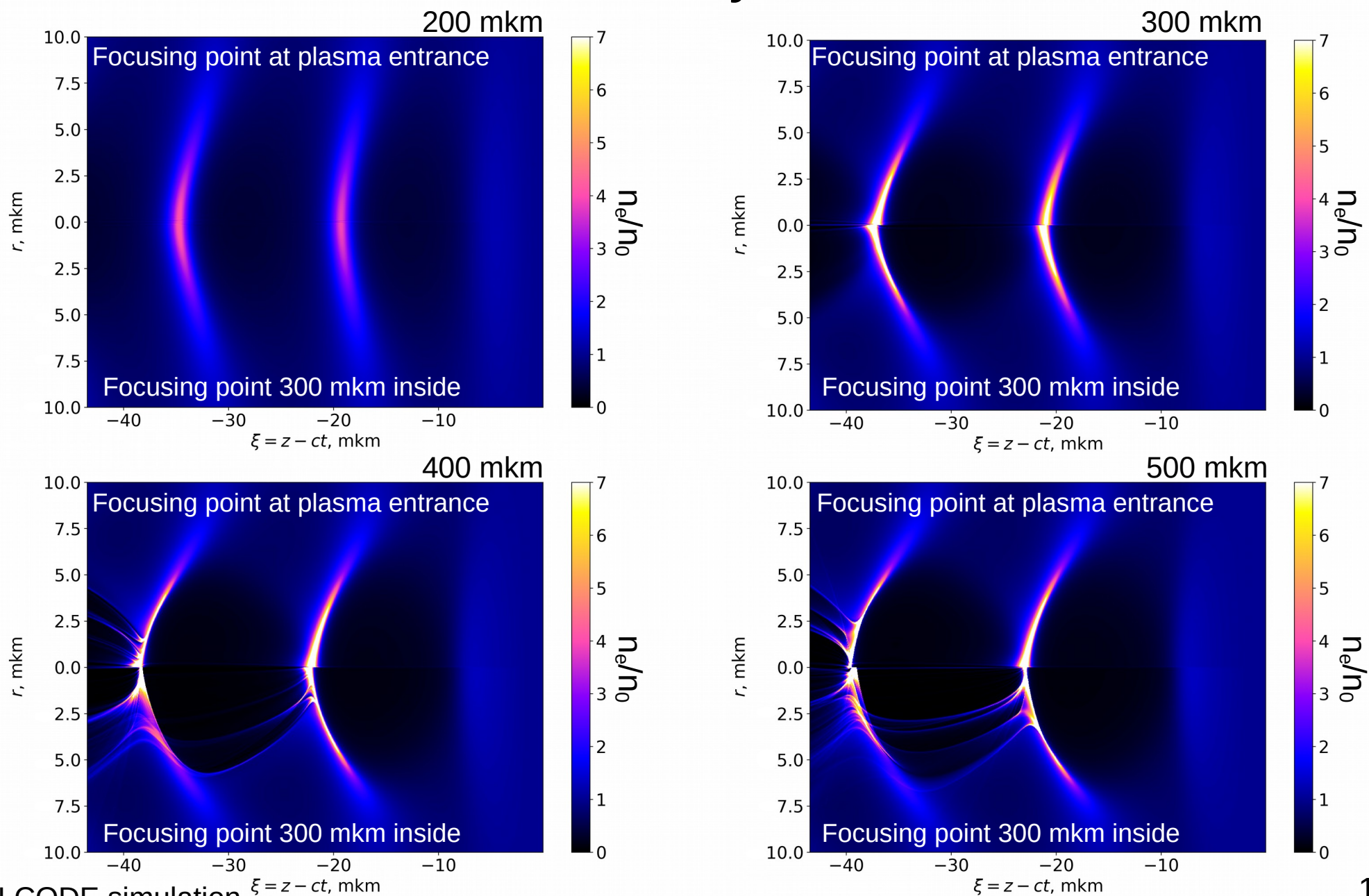


# Fast scans with QSA





# Plasma density distribution







## Outline:

QSA and trapping

Parameters

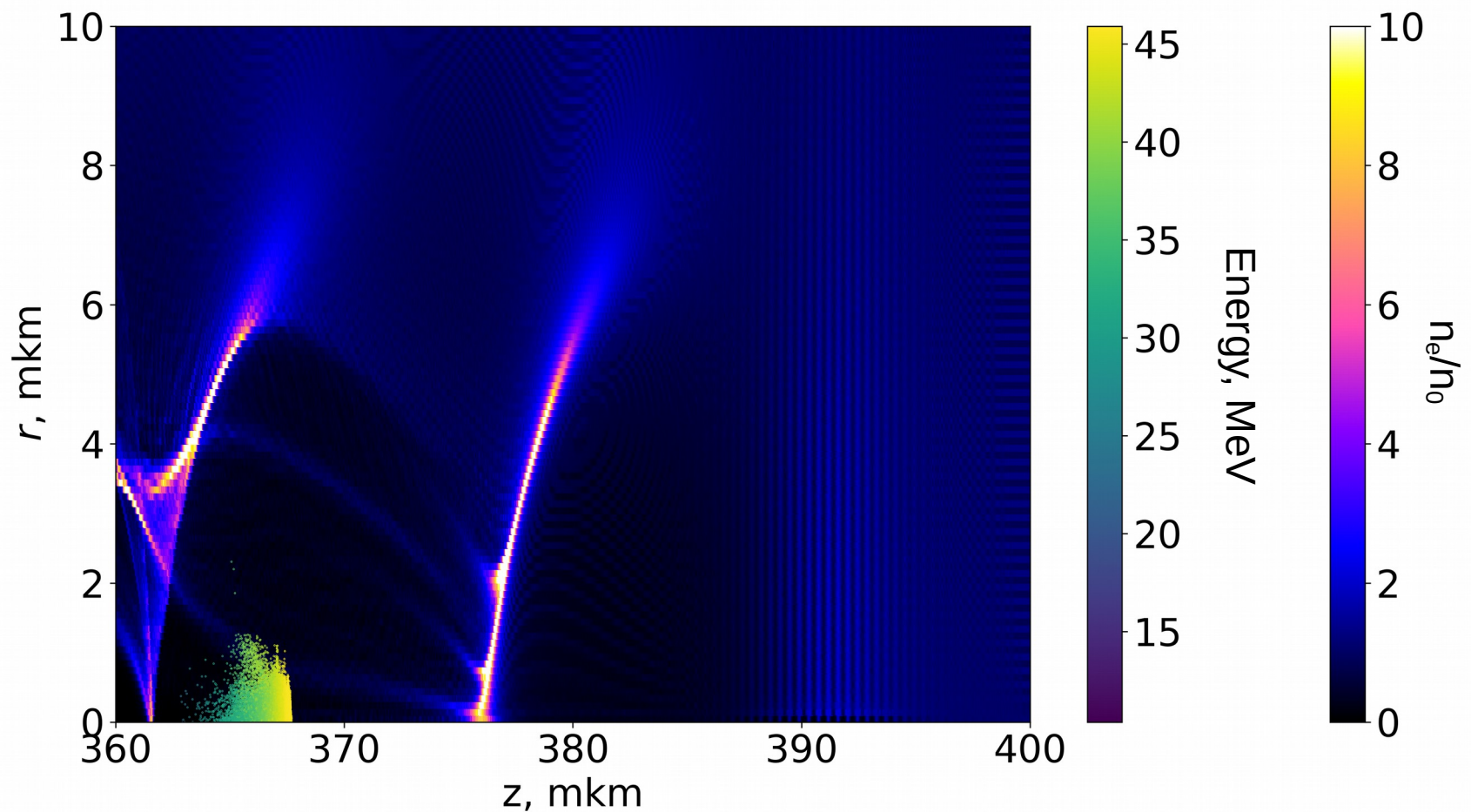
Fast scans with QSA

**Full simulation with usual PIC code**

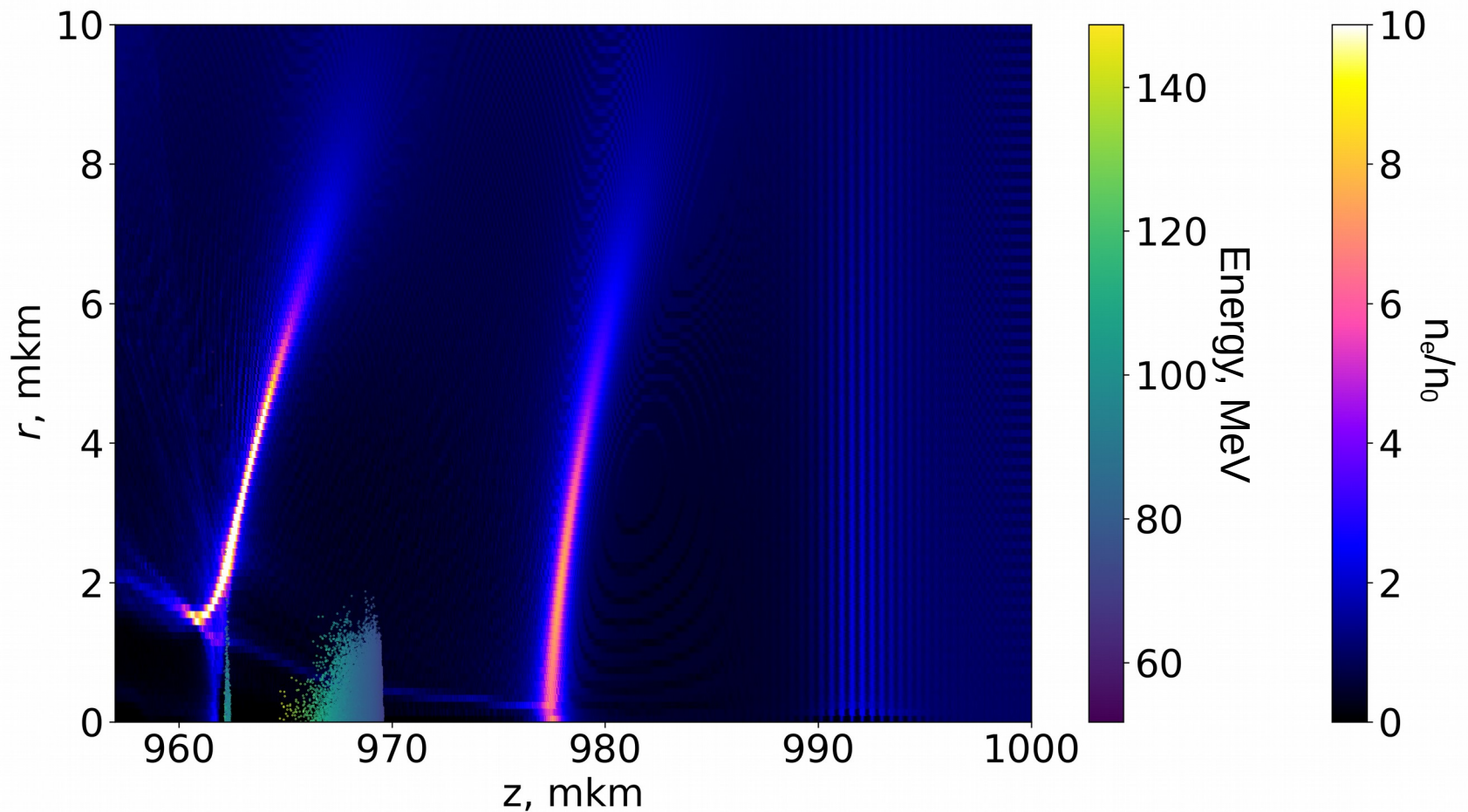
Summary



# Full simulation with usual PIC code



# Full simulation with usual PIC code



E, MeV	RMS, MeV	$\varepsilon_n$ , mm mrad	Q, pC
88	10	1,24	15



## Summary

The self-trapping process can be controlled by changing laser pulse focusing point

The generation of good quality quasimonoenergetic beam is possible with moderate power laser pulses

Simulation code with QSA allow one to do fast ( $\sim 450$  faster than usual PIC) parametric scans, but fullPIC simulation is still crucial

Further QSA extension developments allow us to carry out global study and optimization of parameters for future experiments

Thank you!



