Analysis of interferometry data

Tommaso Vinci Theory and Simulation of Photon-Matter Interaction. July, 3rd 2018

Coupling optical and X-ray

- nanosecond optical lasers are the only way to explore Mbar regime and T ~ 1eV
- X-ray gives insight of this matter (diffraction, spectrum)

ESRF

ID24

SACLA

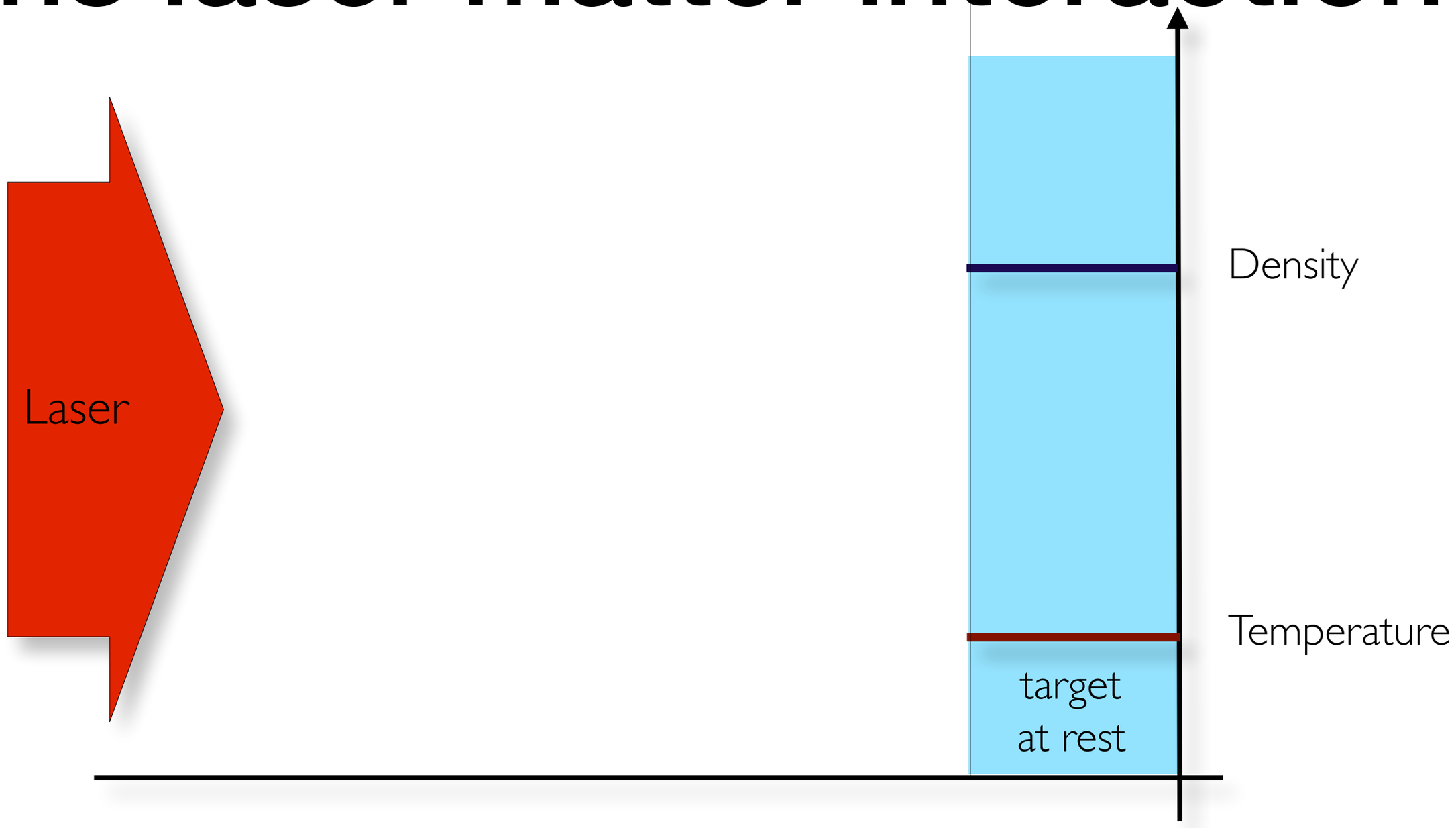
SLAC NATIONAL ACCELERATOR LABORATORY

MEC

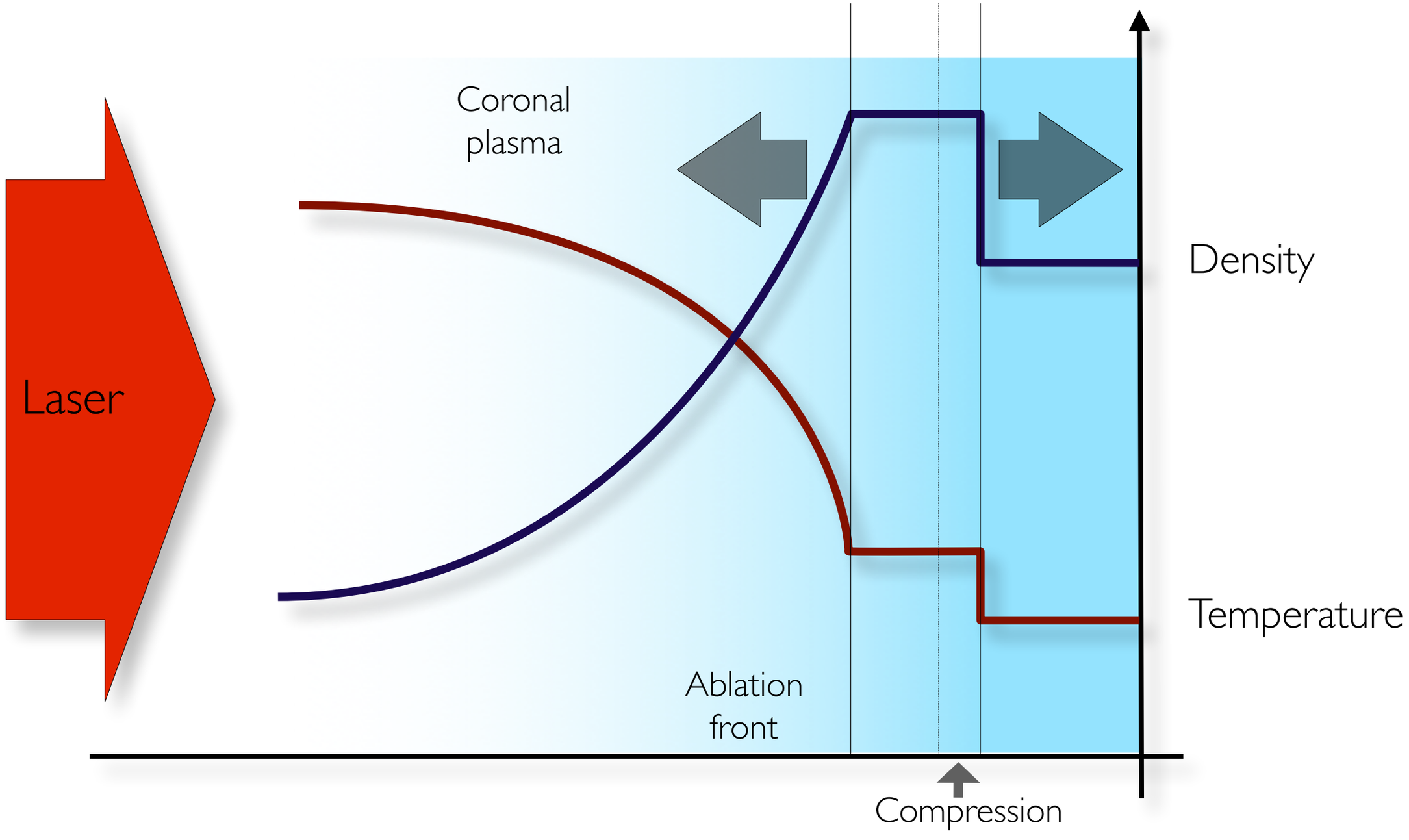
European XFEL

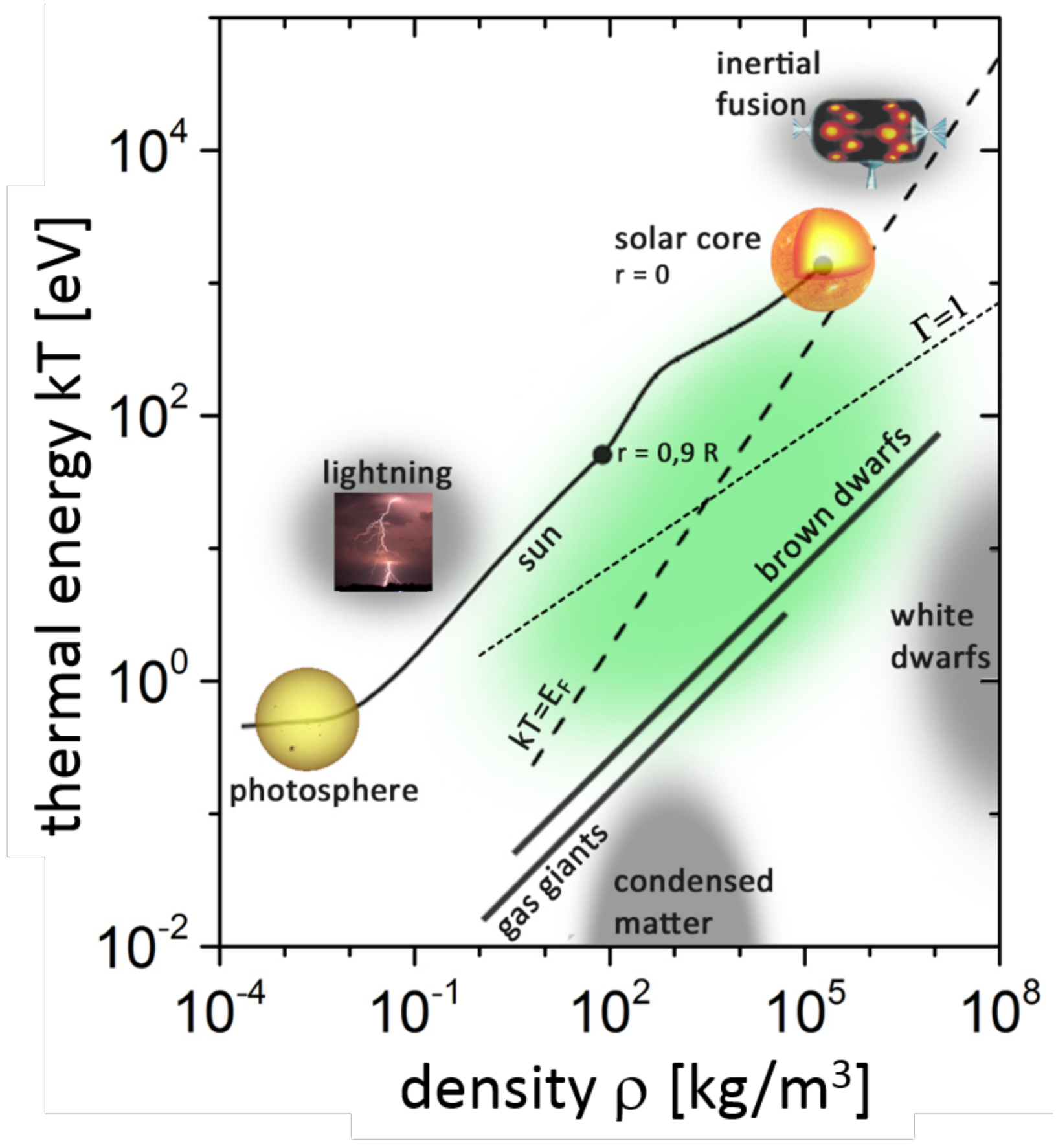
HED

ns laser matter interaction

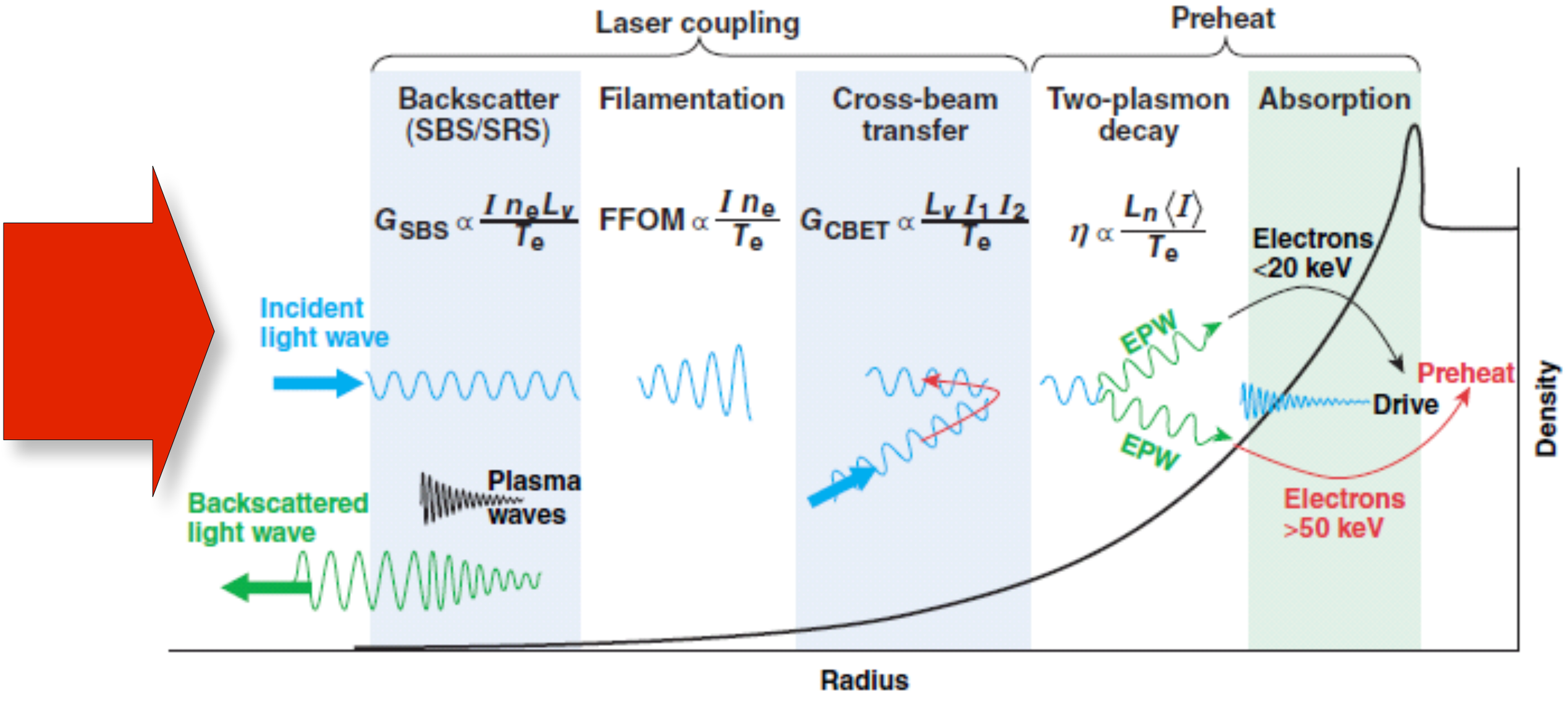


Shock generation



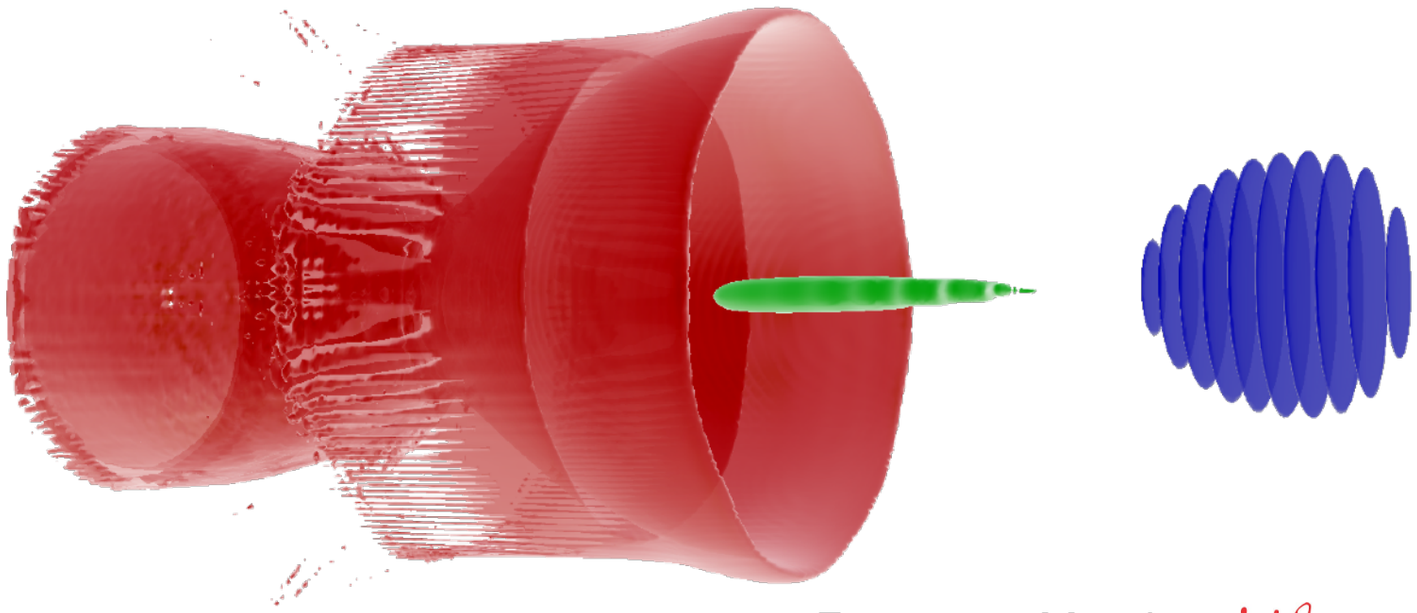

inertial
fusion
solar core
r = 0
Γ=1
r = 0,9 R
lightning
sun
brown dwarfs
white
dwarfs
kT=E_F
photosphere
gas giants
condensed
matter
10^4
10^2
10^0
10^-2
10^-4
10^-1
10^2
10^5
10^8
thermal energy kT [eV]
density ρ [kg/m^3]

Laser matter interaction



PIC

Smilei



Francesco Massimo

PIC code

Open-source: smileipic.github.io/Smilei

- code & diagnostics distributed under CeCILL B license
- documentation and code

High-Performance Computing:

- massively parallel (tested up 240k MPI tasks)
- hybrid MPI-OpenMP parallelization
- dynamic load balancing
- HDF5/OpenPMD I/O

Collaborative & Multipurpose

- Co-development between HPC specialist & physicists
- Github & continuous integration
- from laser-plasma interaction to astrophysics

A teaching & research platform

- teaching at the Master level & international training workshop
- 6 PhD thesis
- 2 post-doctoral fellowship
- 11 scientific papers

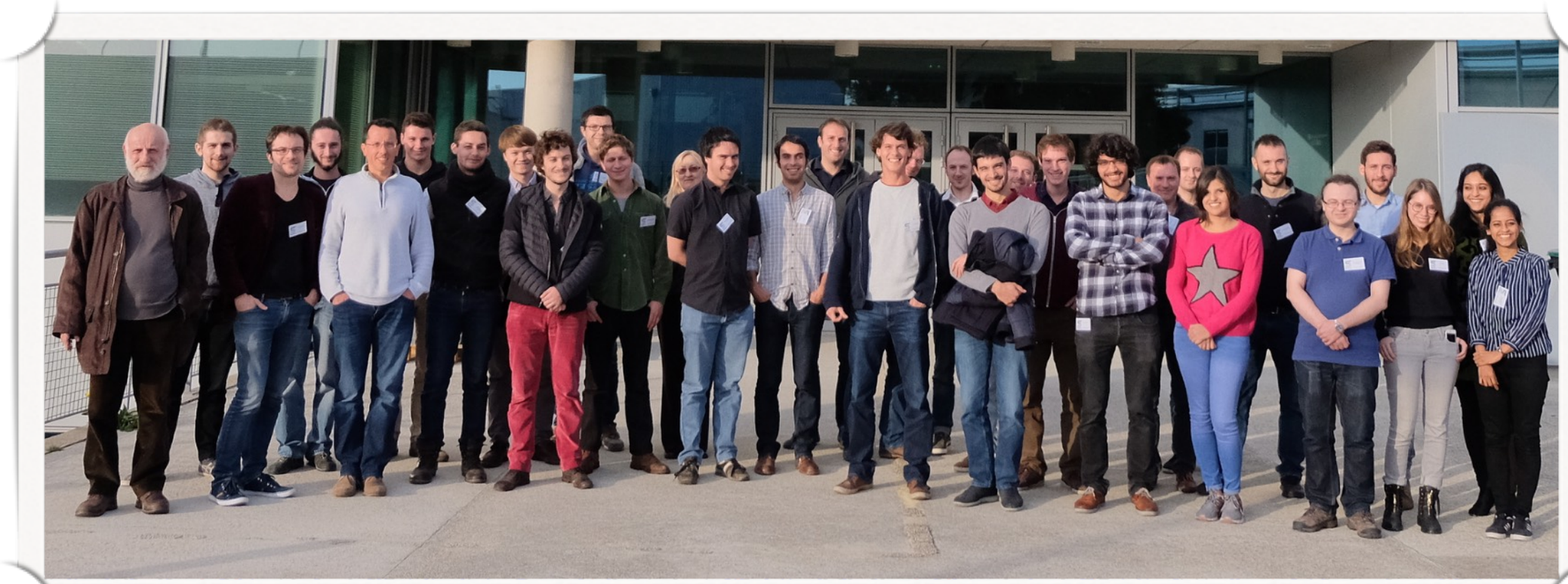
Advanced physics modules

- QED processes under extreme light (Apollon & ELI)
- Field ionization
- Binary collisions & impact ionization

Smilei

https://smileipic.github.io/Smilei

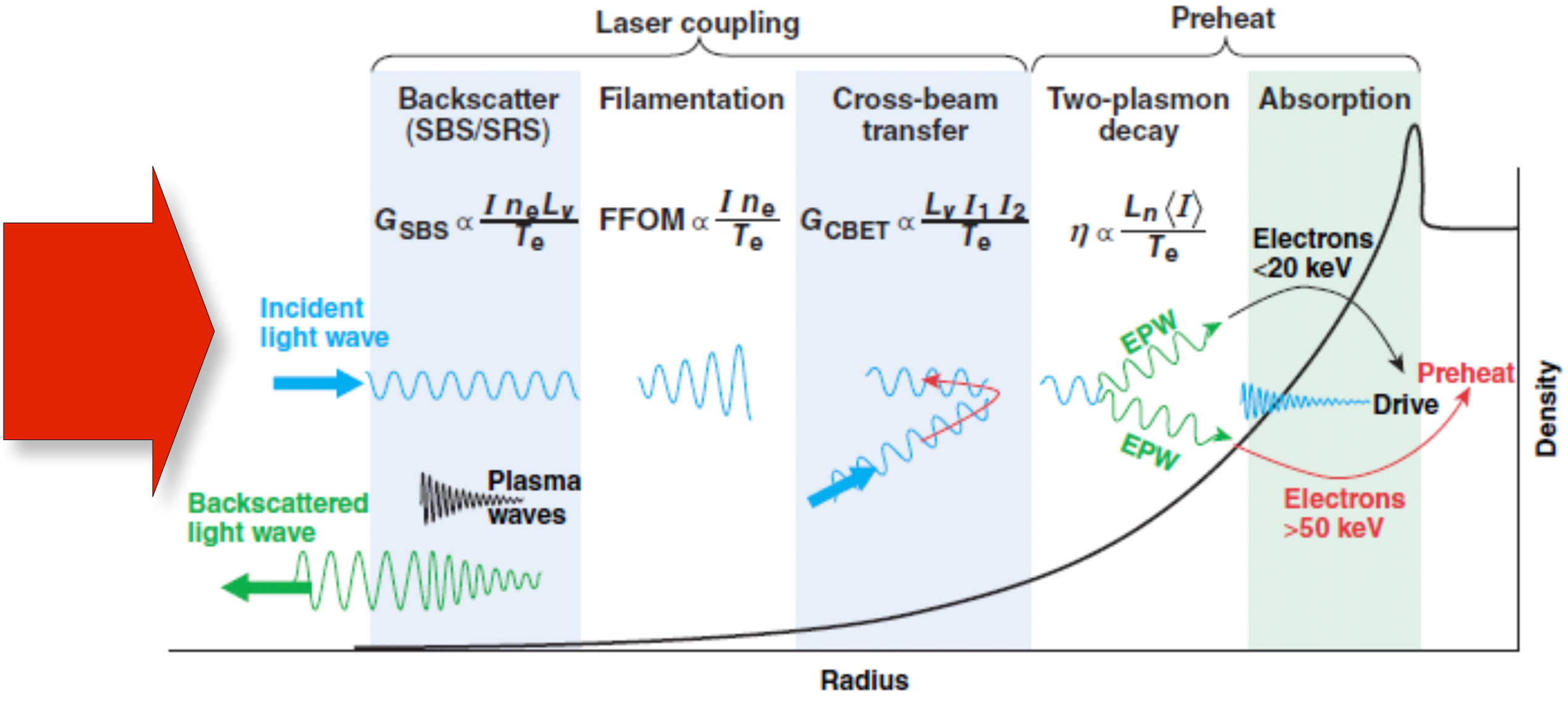
SMILEI PIC first training workshop, Nov. 6-7 2017



Second will be in January or February 2019

https://smileipic.github.io/tutorials

Laser matter interaction



Radiative hydrodynamic

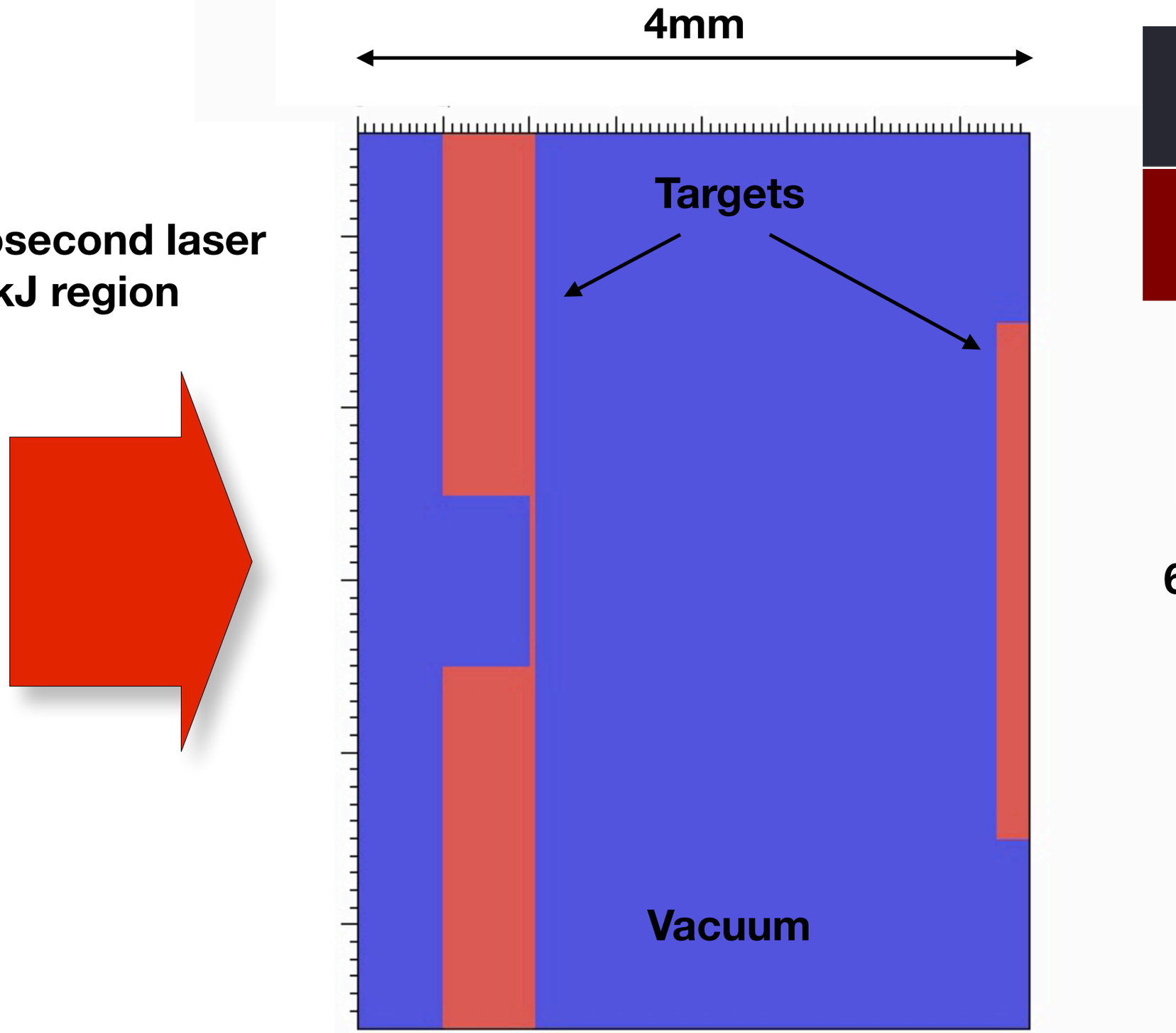
Hydro code

Laser
Radiation
Vacuum
Multi material
Phase transformation
Spallation
Equation of state
Conductivity
MHD
Adaptive Mesh Refinement
1D, 2D & 3D

- Model (diffusion M1 raytrace)
- Opacity data

- Thomas fermi
- SESAME
- BLF
- ab-initio

FLASH 3D hydro code



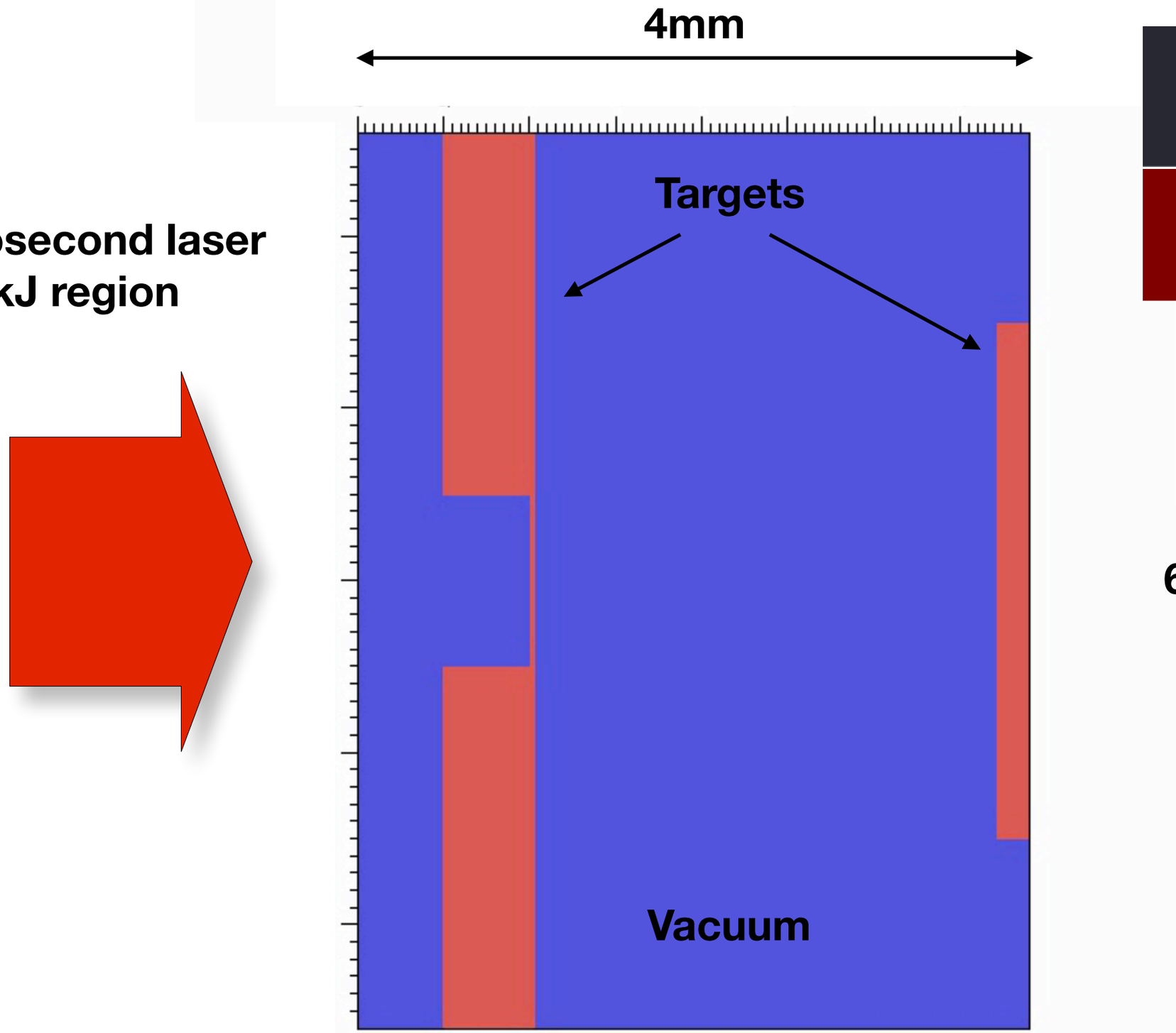
nanosecond laser
kJ region

60 ns total

Flash Center
for computational science

THE UNIVERSITY OF CHICAGO

FLASH 3D hydro code



nanosecond laser
kJ region

60 ns total

Flash Center
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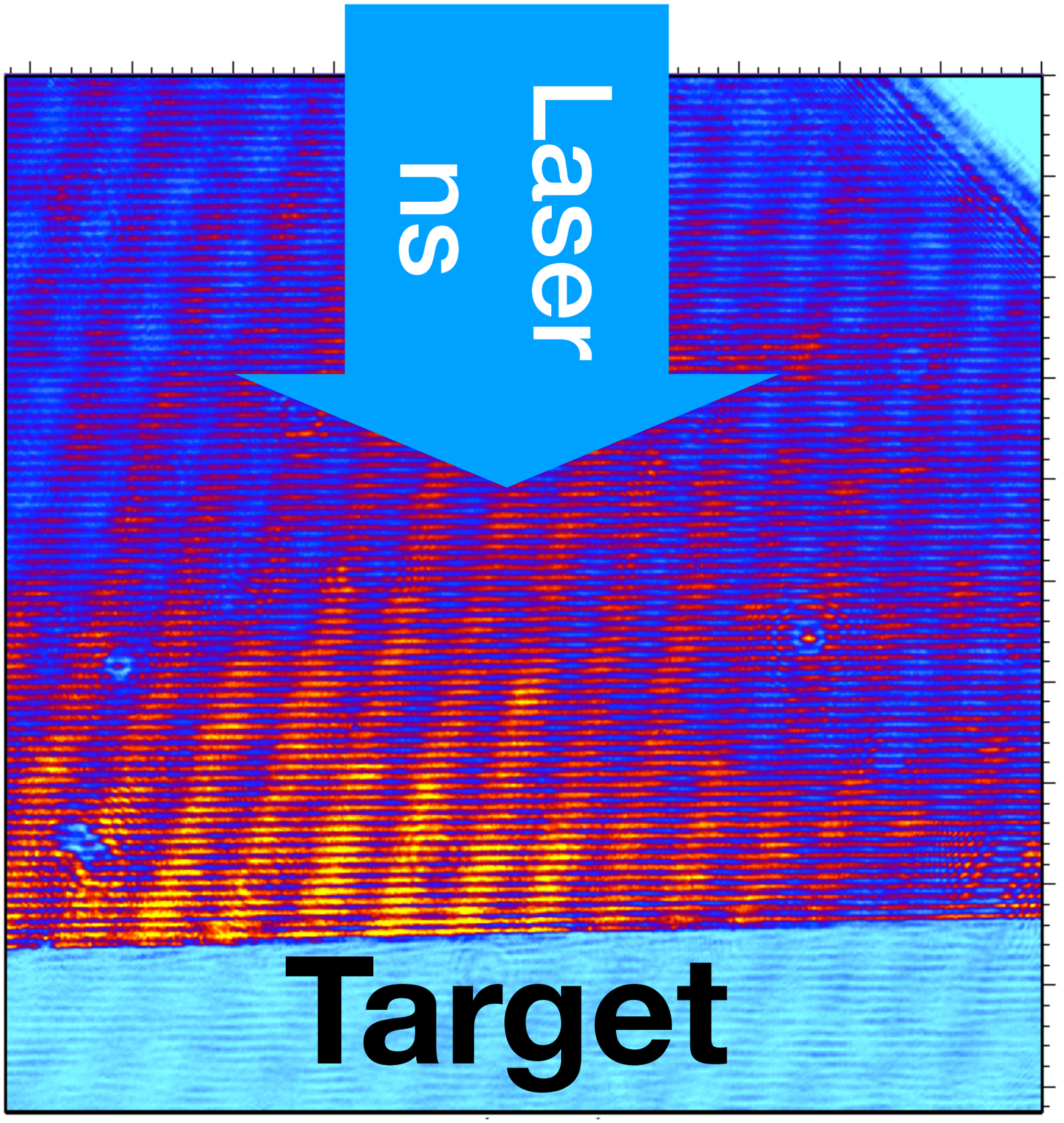
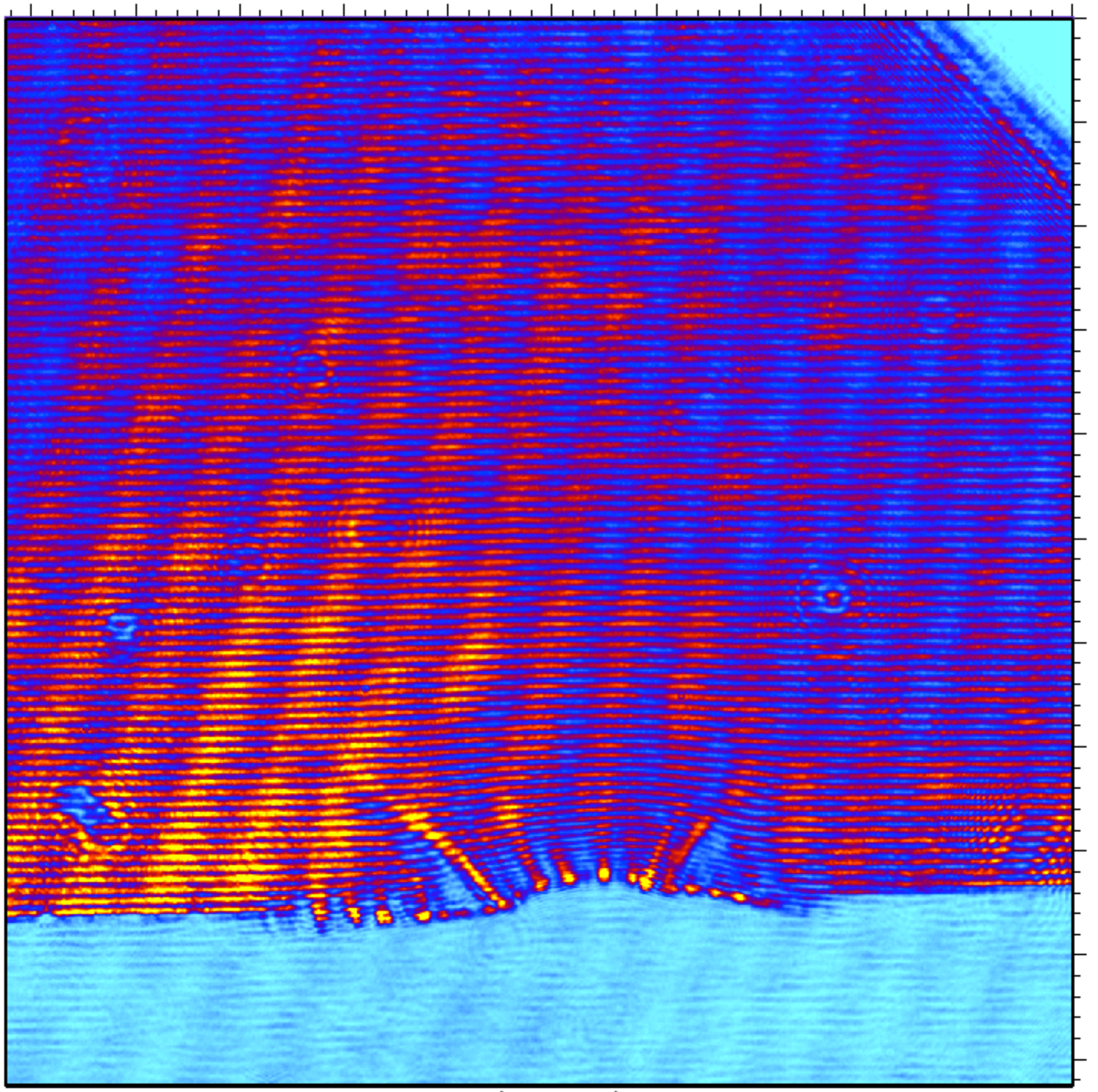
Interferograms

Before shot

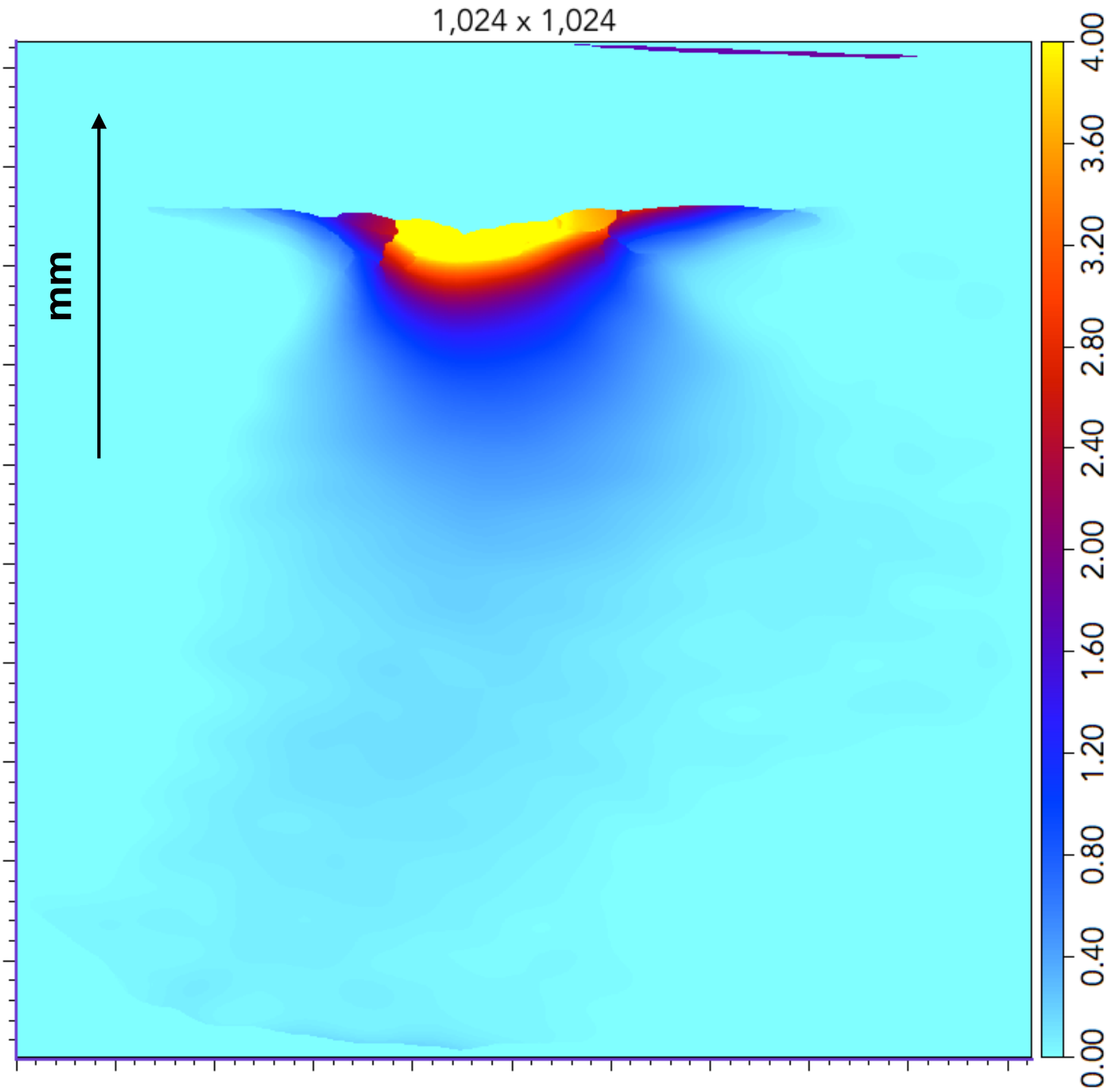


mm

Shot



mm



FringeShift

Neutrino…
… another image processing tool

Collaboration
A. Flacco

Neutrino…
… another image processing tool

NATURE | NEWS

Neutrinos not faster than light

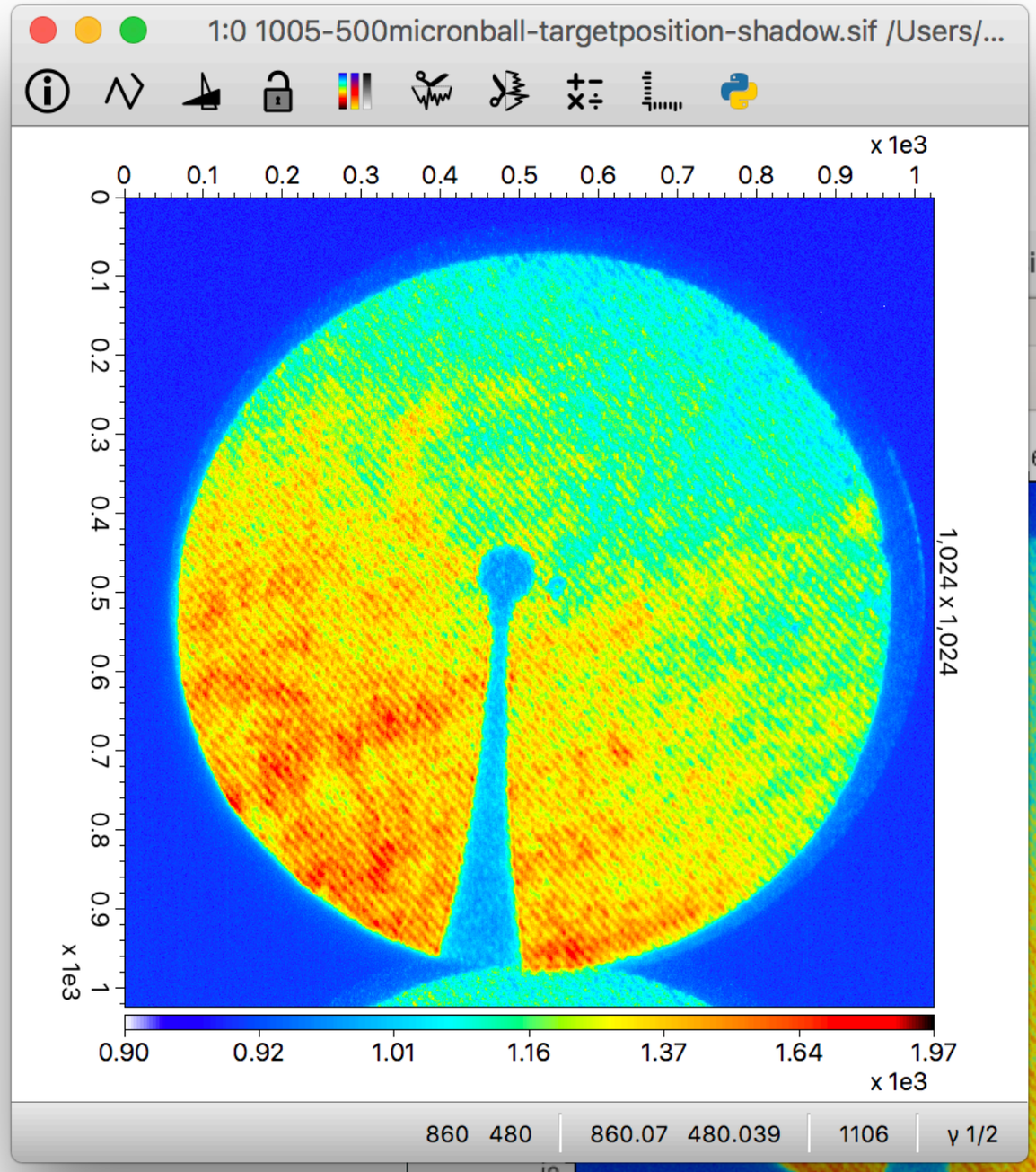
ICARUS experiment contradicts controversial claim.

Geoff Brumfiel

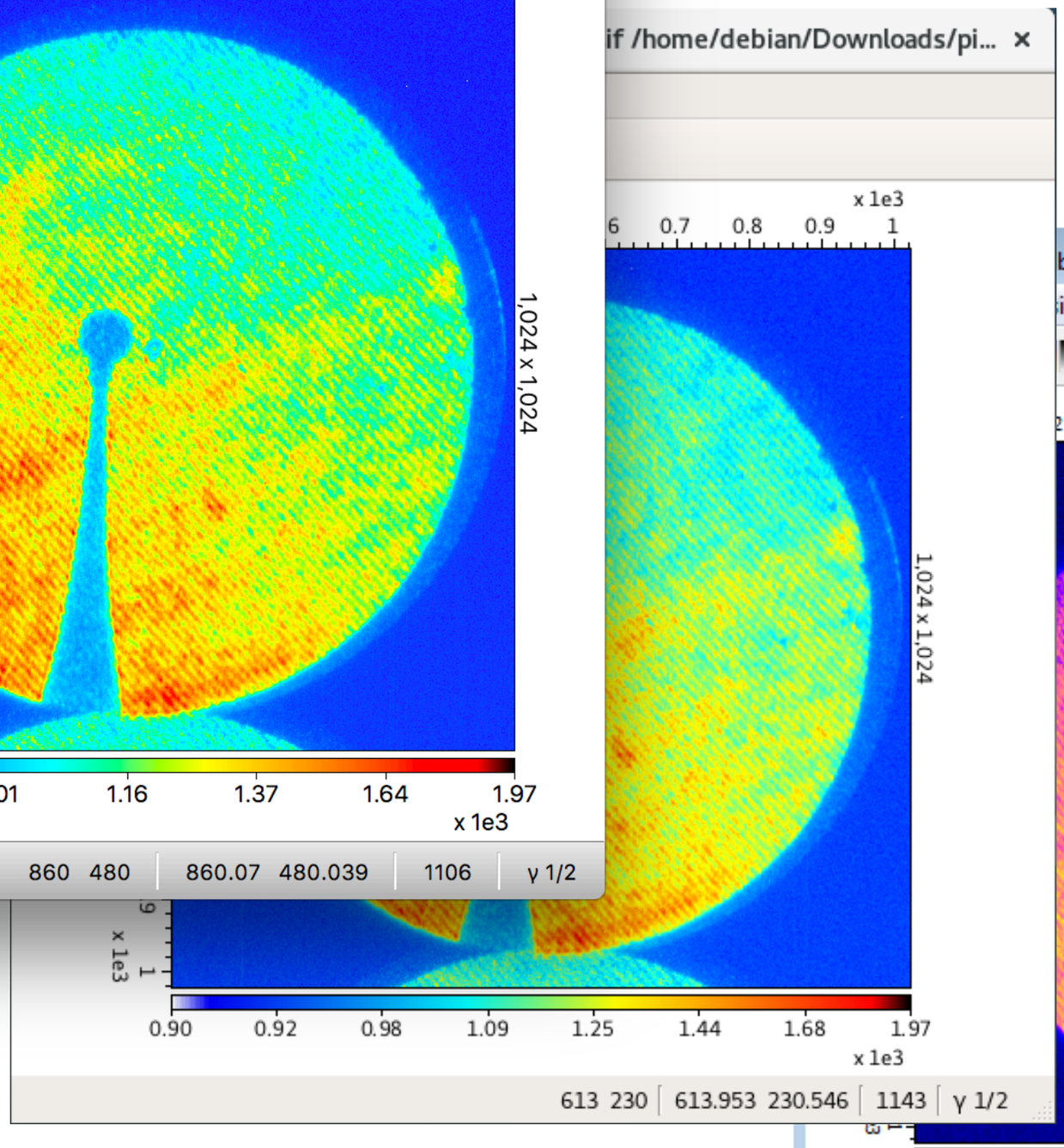
16 March 2012 | Corrected: 19 March 2012

Collaboration
A. Flacco

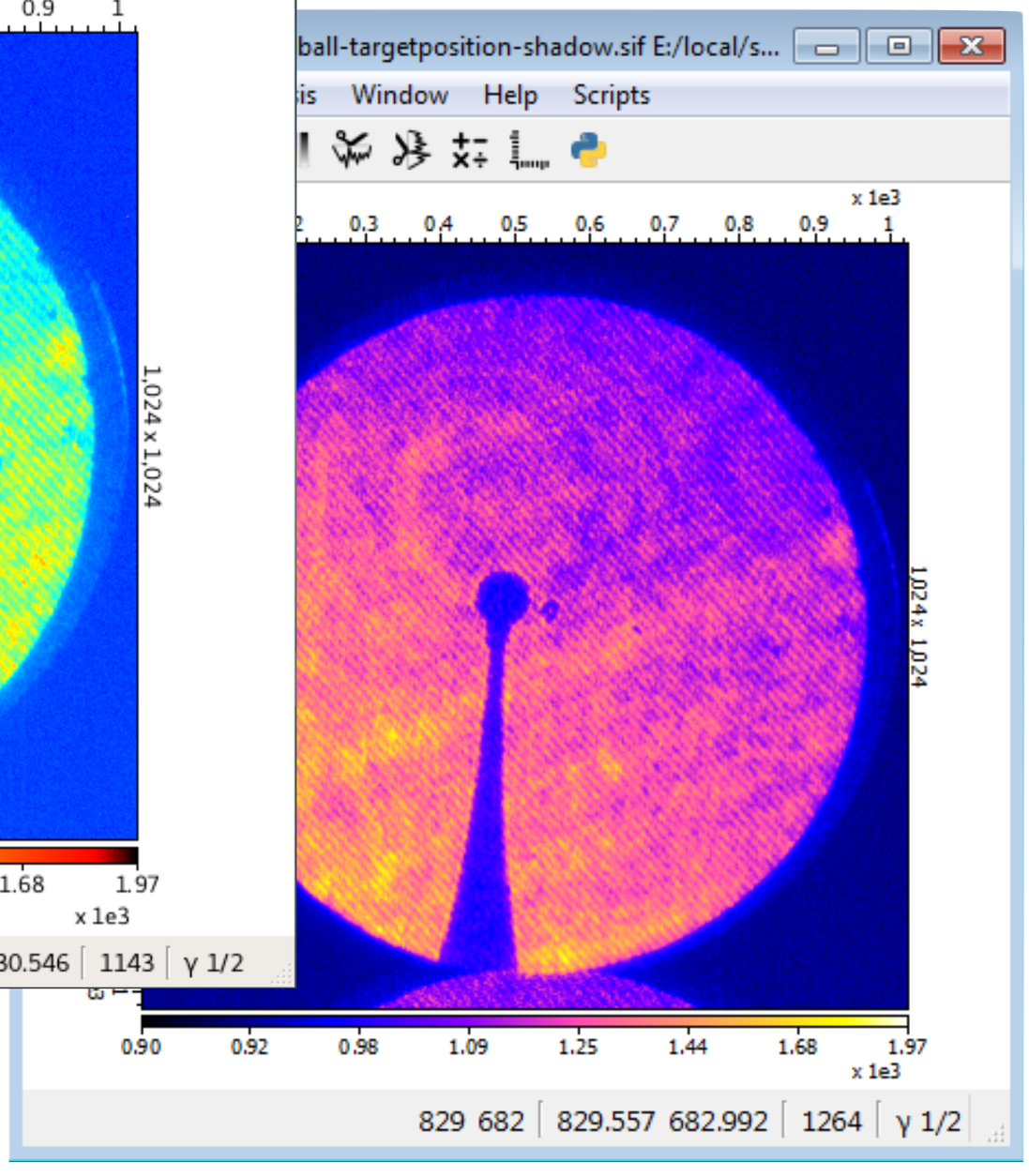
Mac



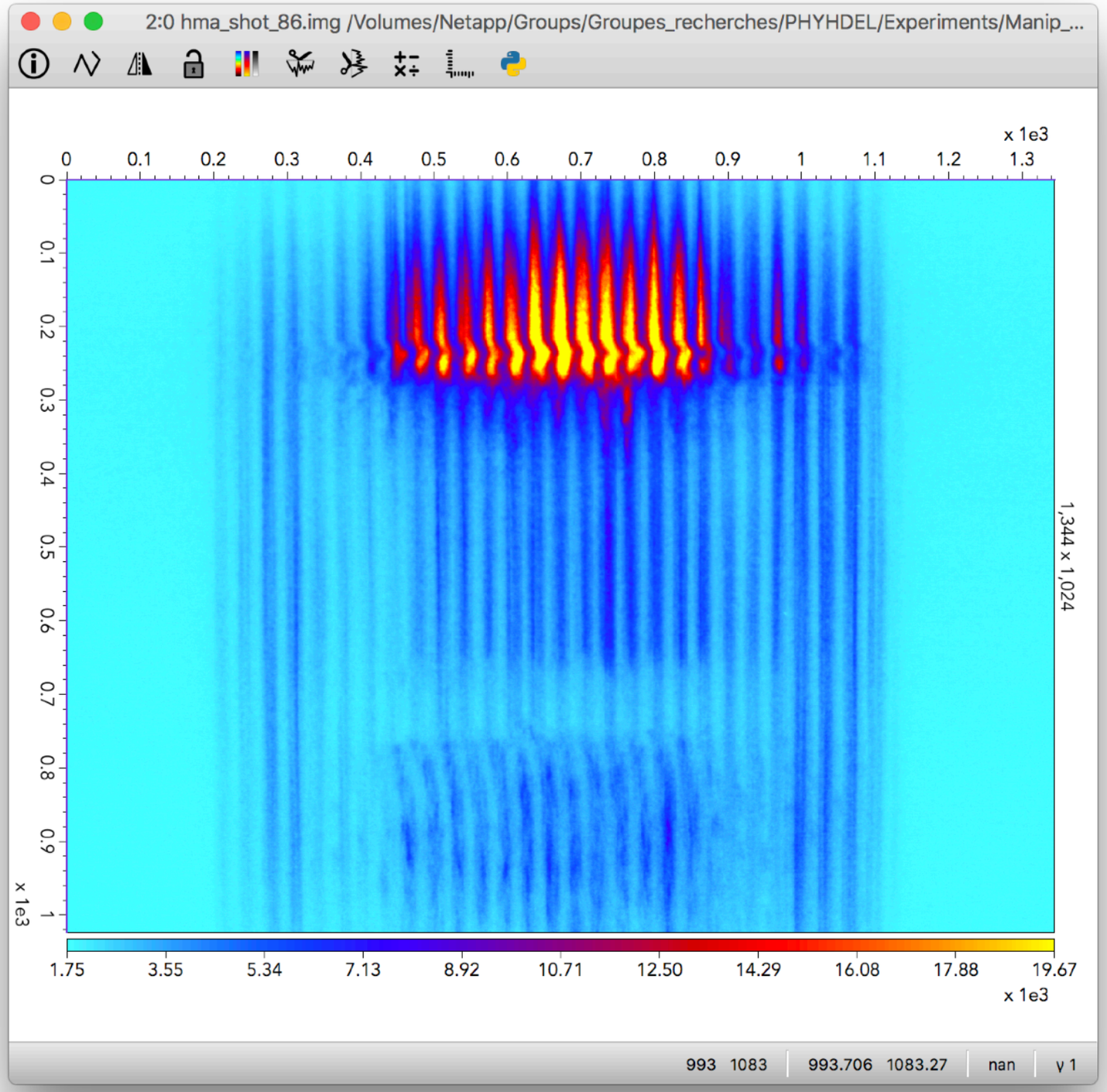
Linux



Windows



What it does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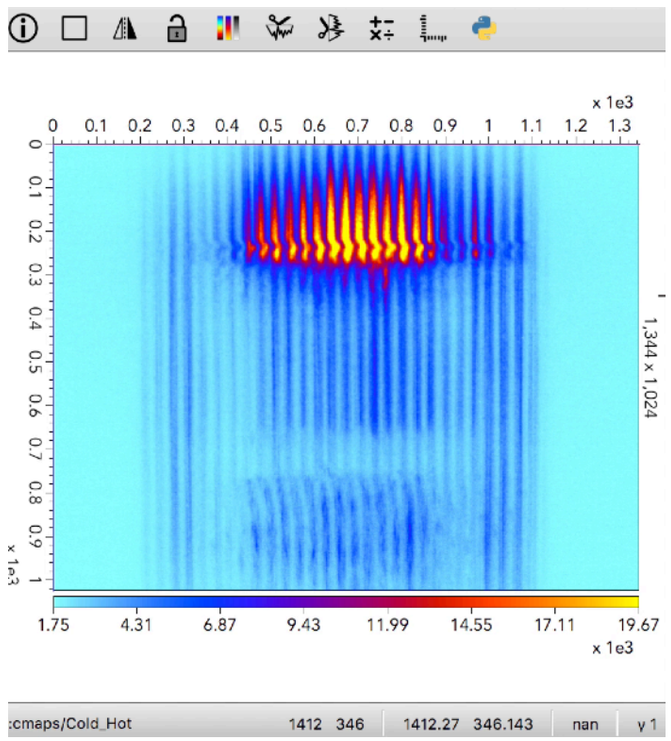
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
x 1e3
1,344 x 1,024
1.75 3.55 5.34 7.13 8.92 10.71 12.50 14.29 16.08 17.88 19.67
x 1e3
993 1083 993.706 1083.27 nan y 1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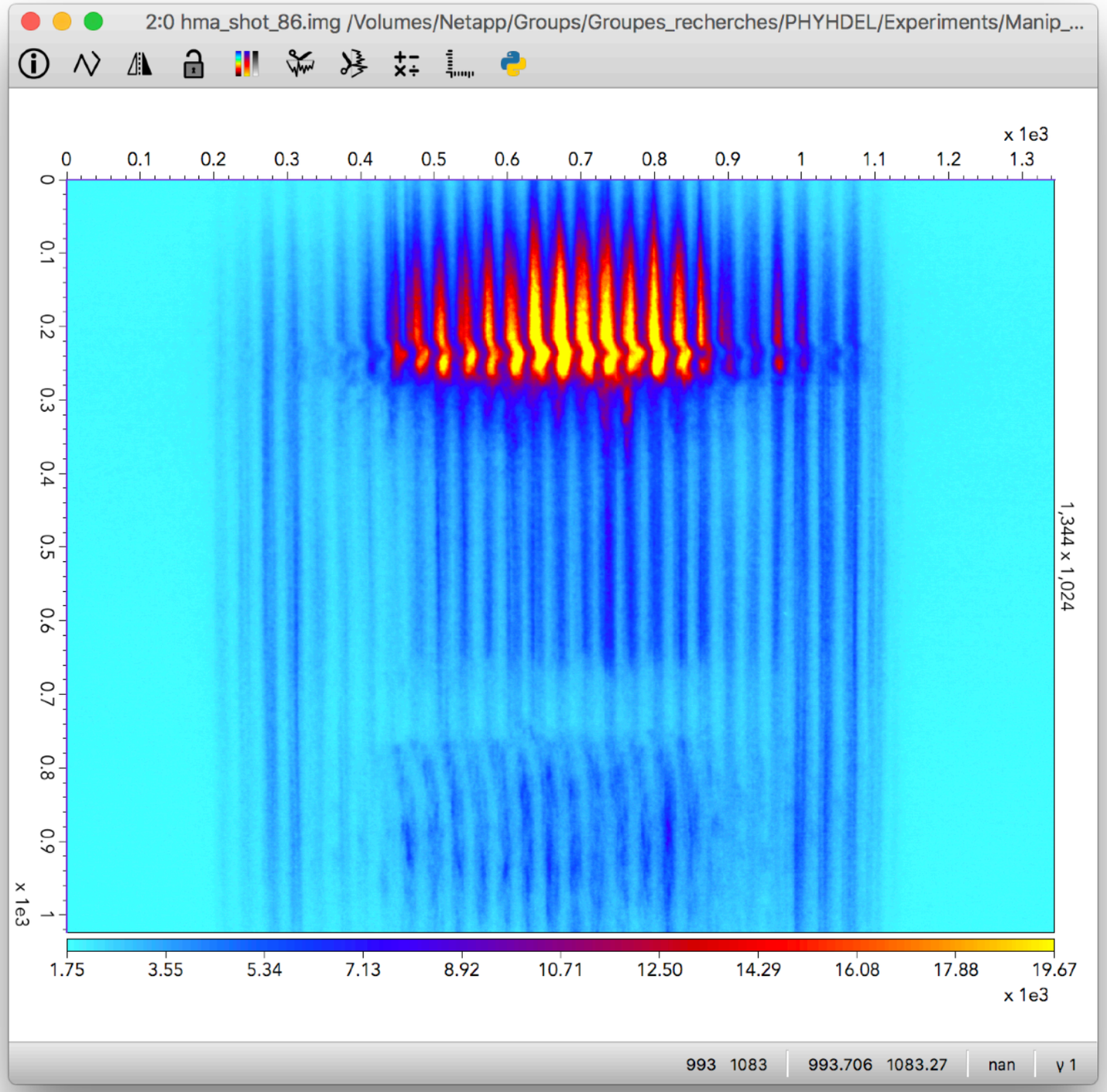
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
x 1e3
1,344 x 1,024
1.75 4.31 6.87 9.43 11.99 14.55 17.11 19.67
x 1e3
:cmaps/Cold_Hot 1412 346 1412.27 346.143 nan y 1

What it does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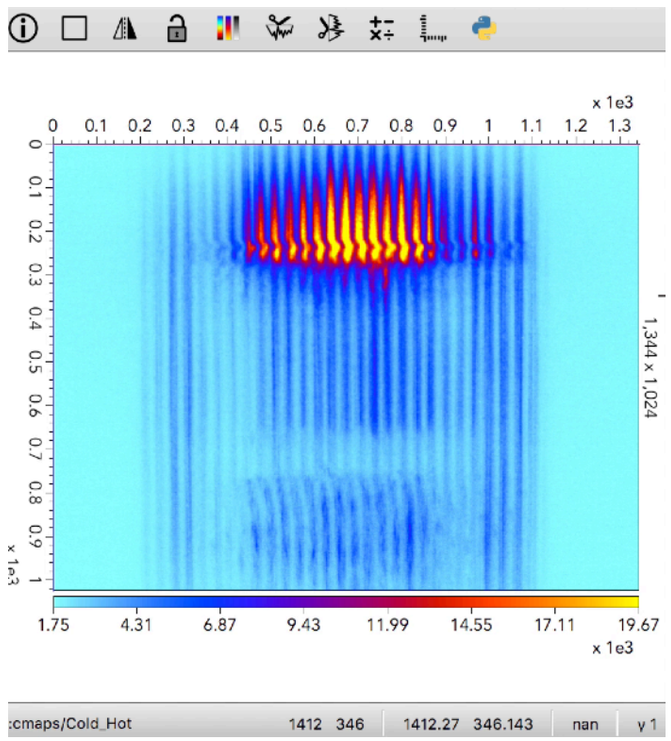
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0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3
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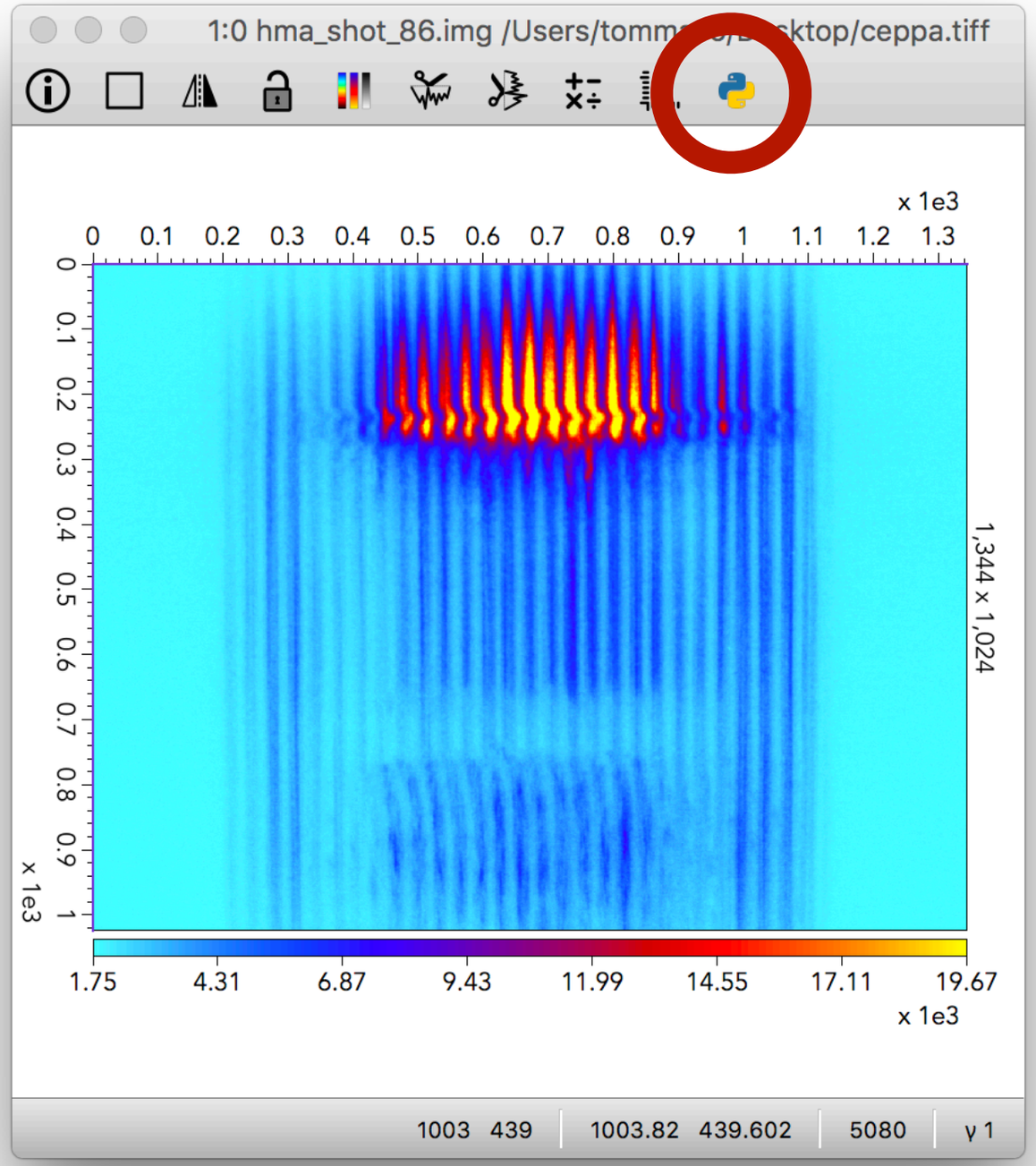
Python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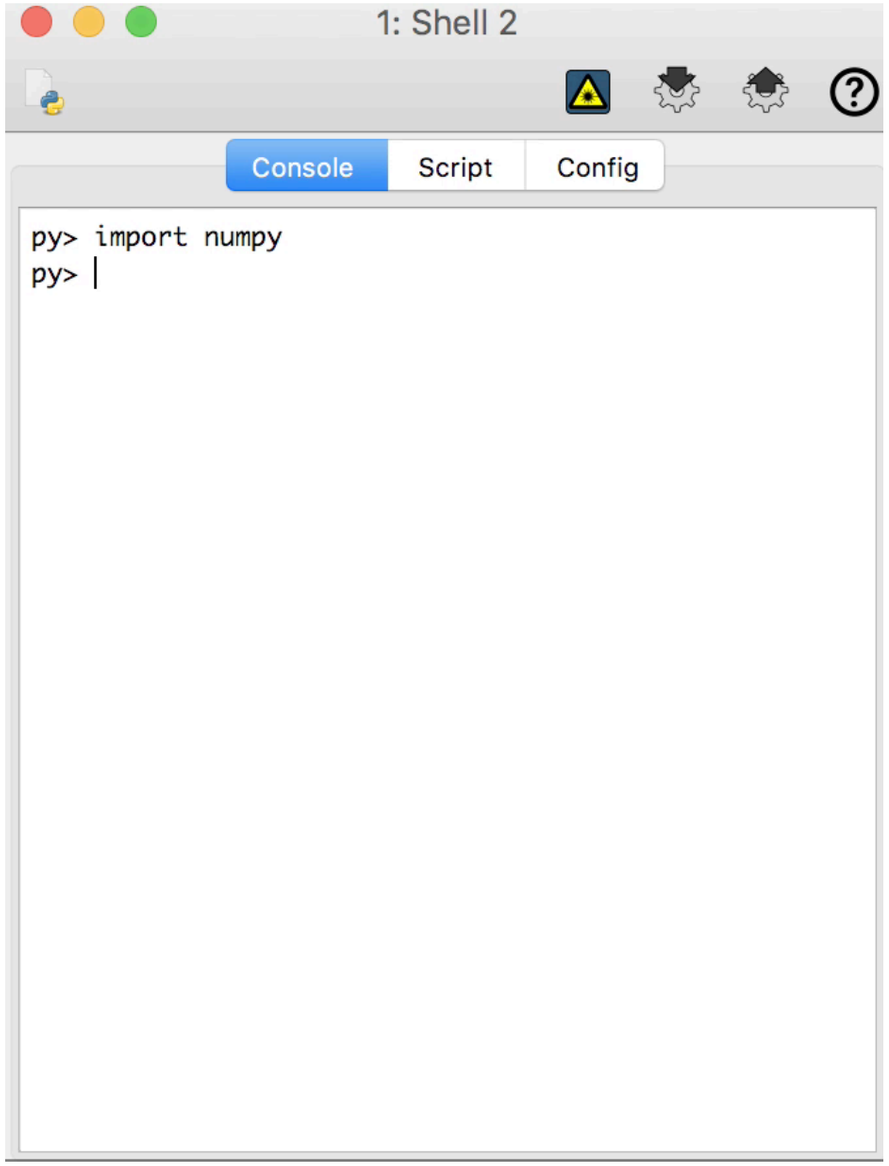
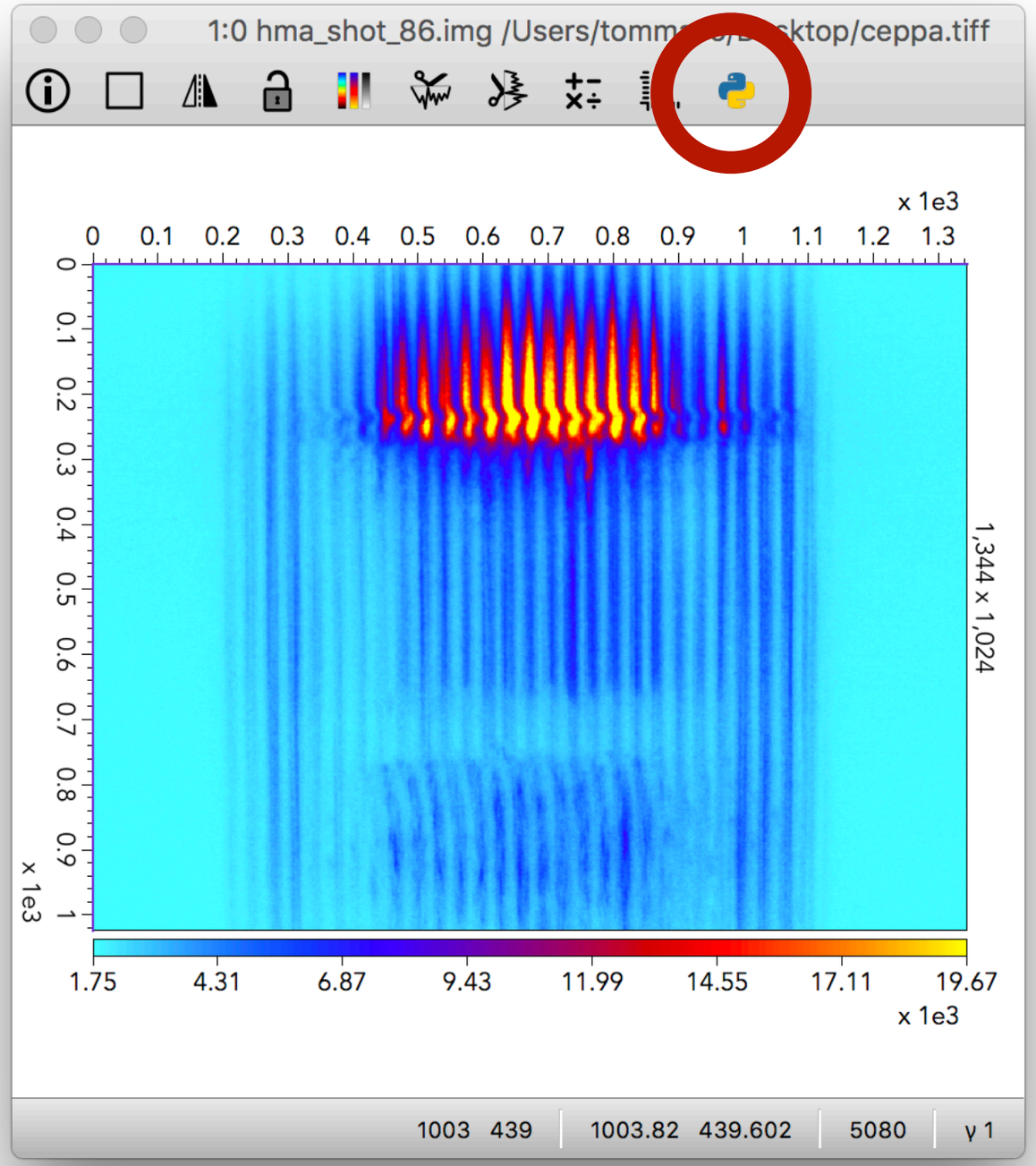
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
x 1e3
1,344 x 1,024
1.75 4.31 6.87 9.43 11.99 14.55 17.11 19.67
x 1e3
1003 439
1003.82 439.602
5080
γ 1


1: Shell 2
Console
Script
Config
py> import numpy
py>

Python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0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
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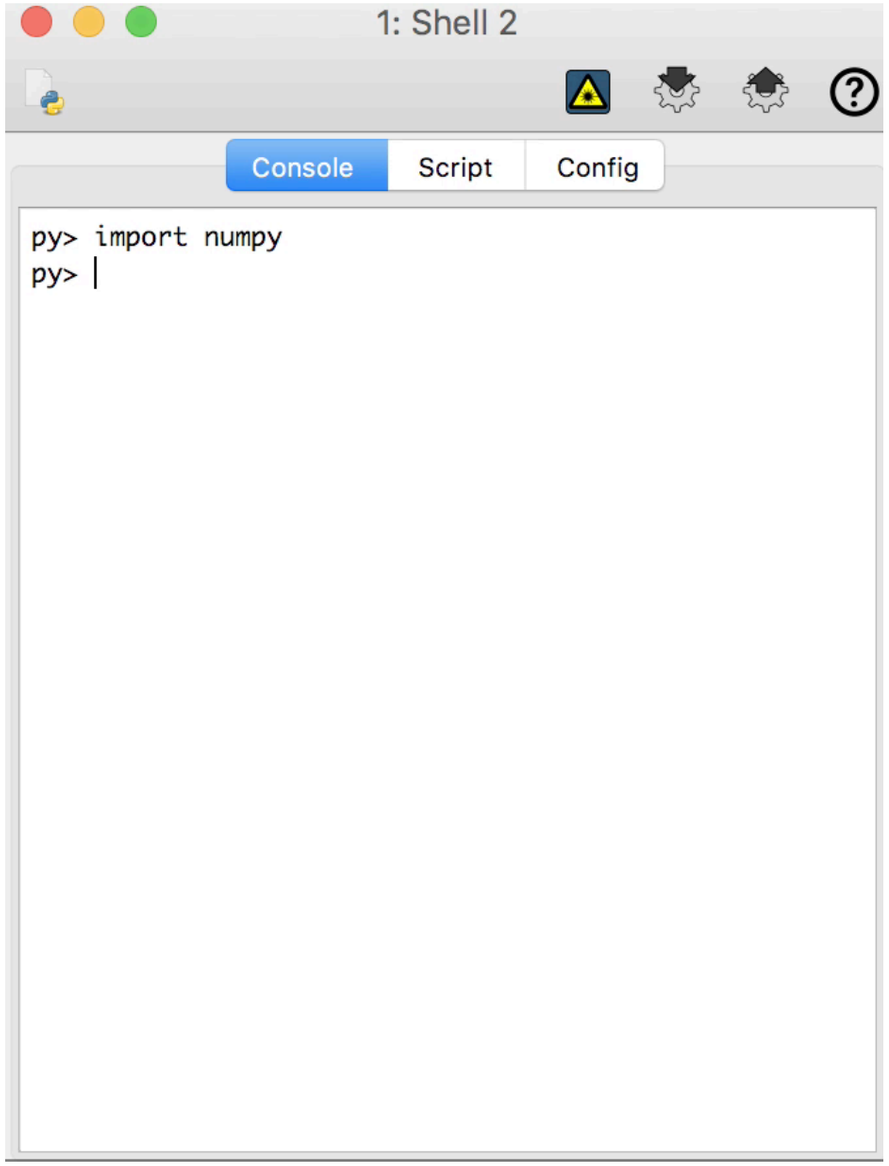
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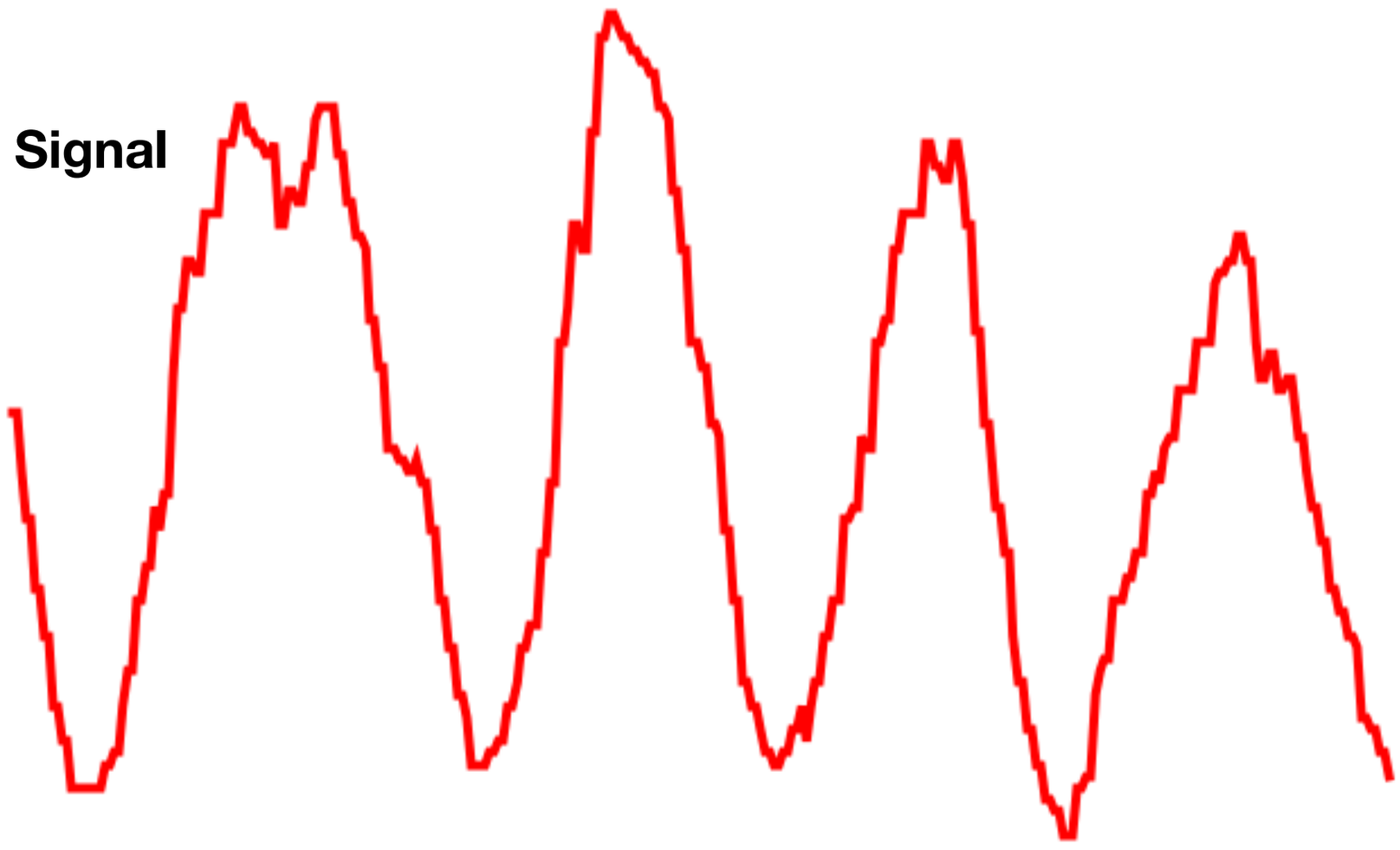
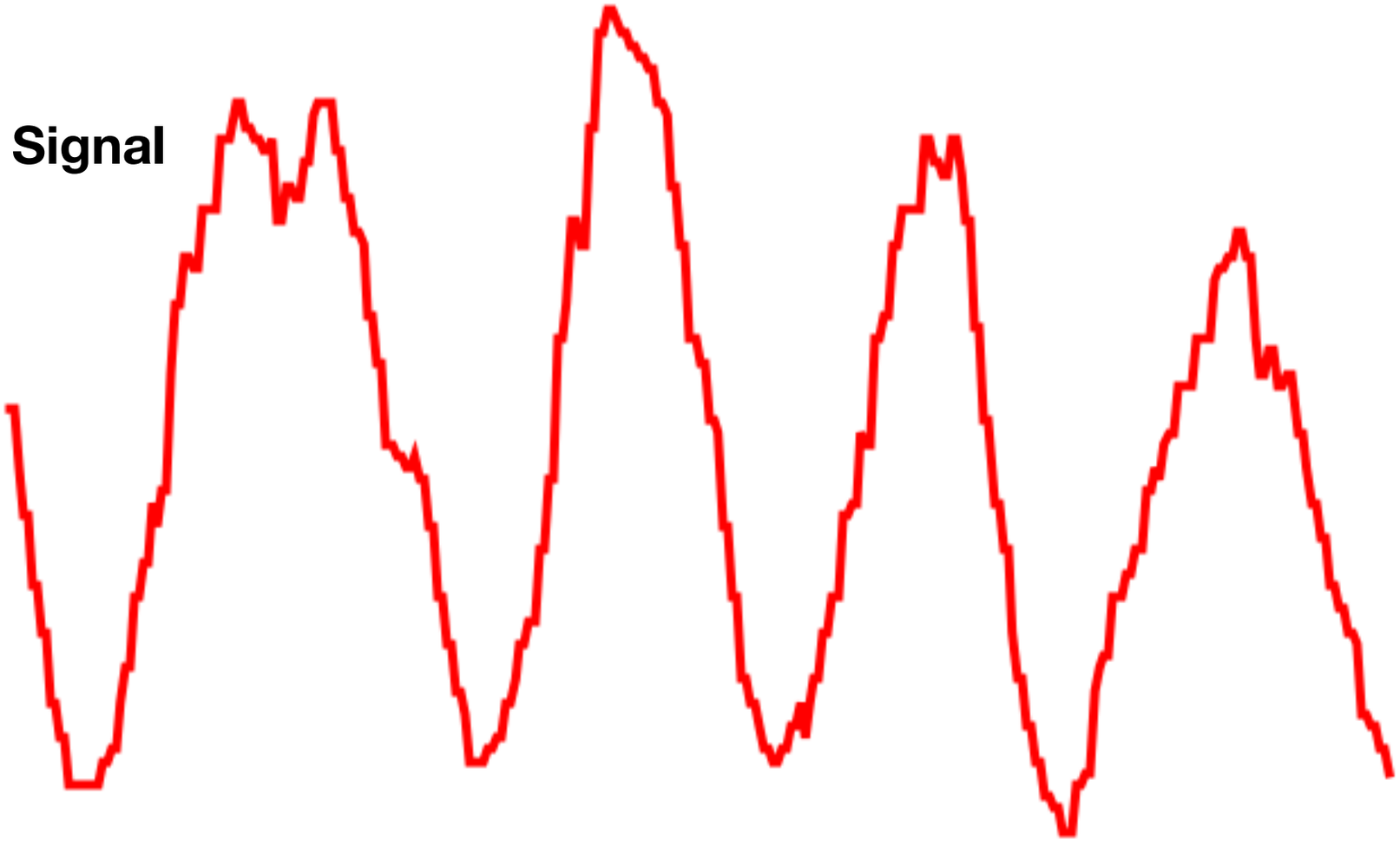
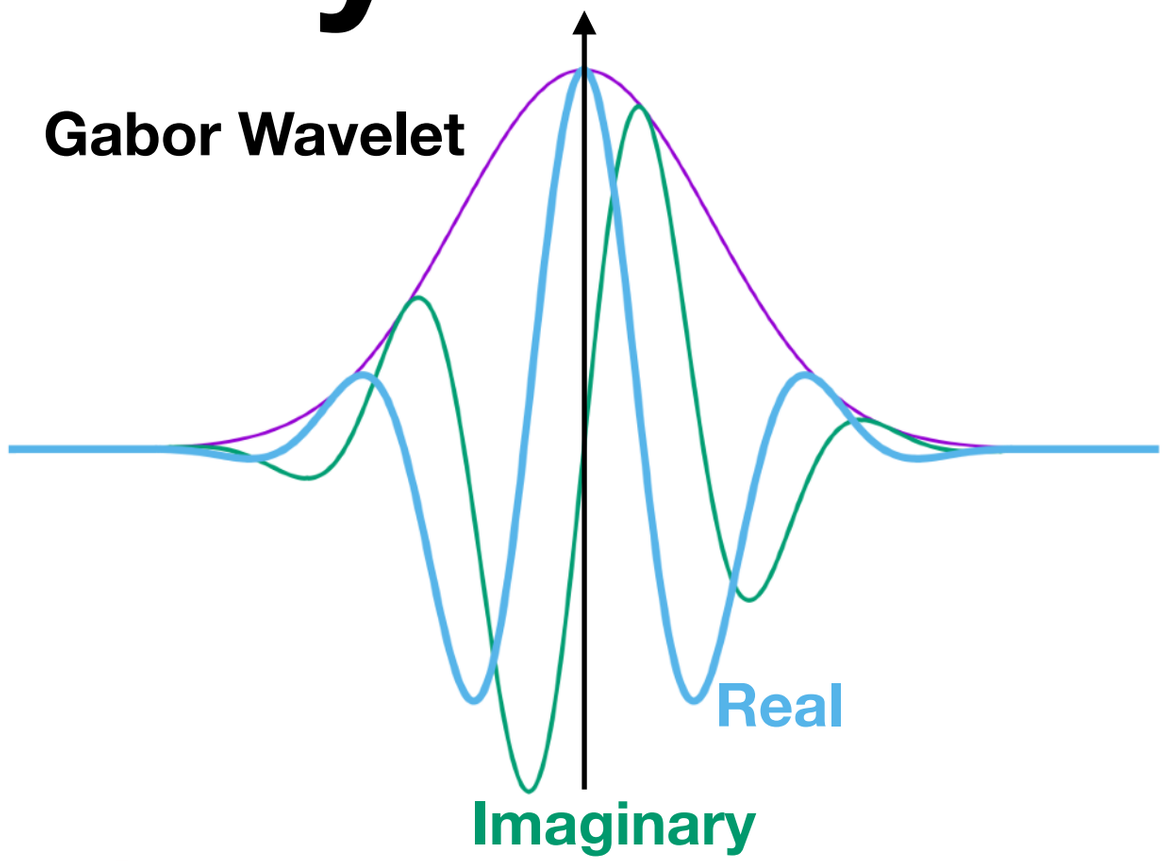
Wavelet analysis



Wavelet analysis





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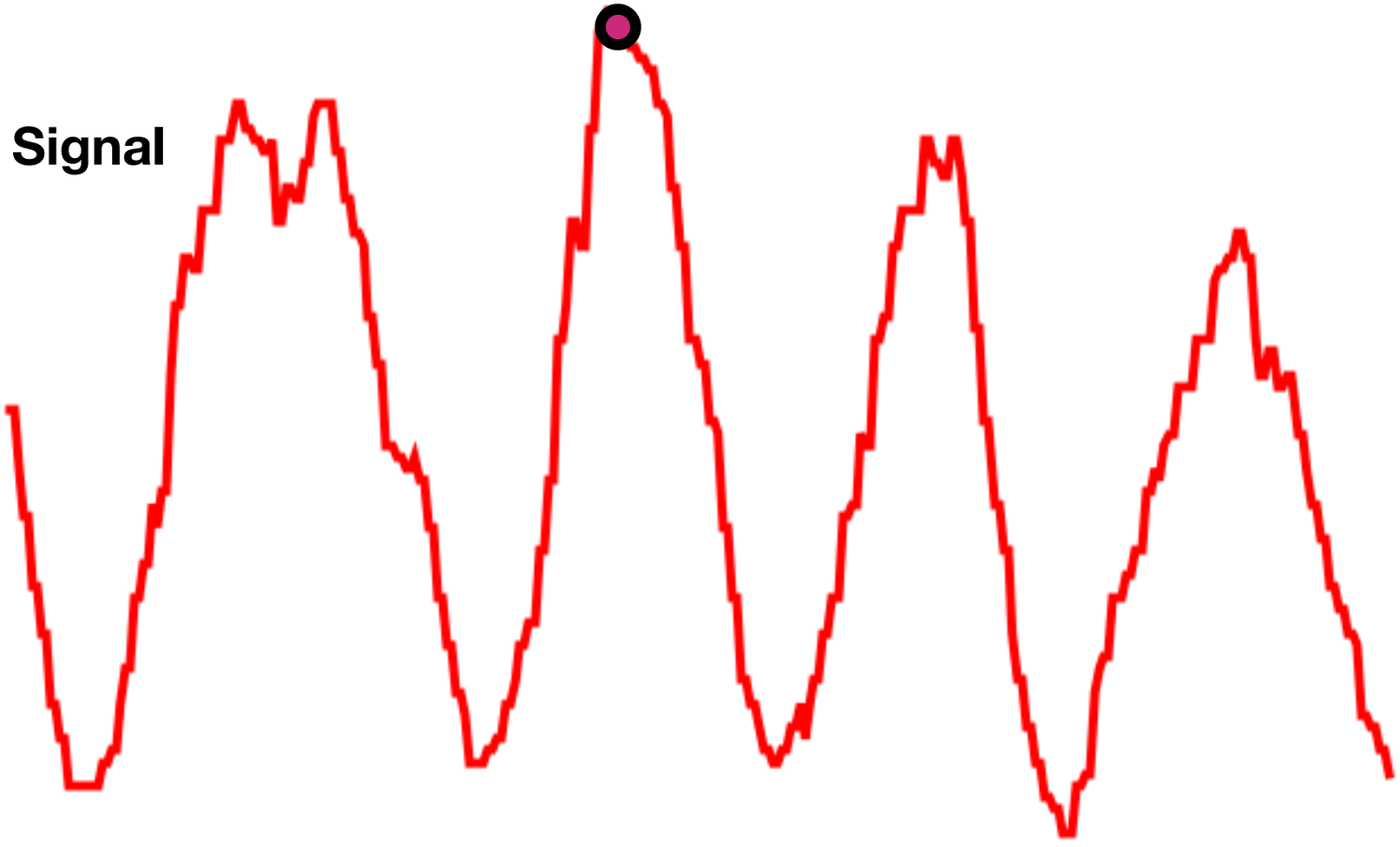

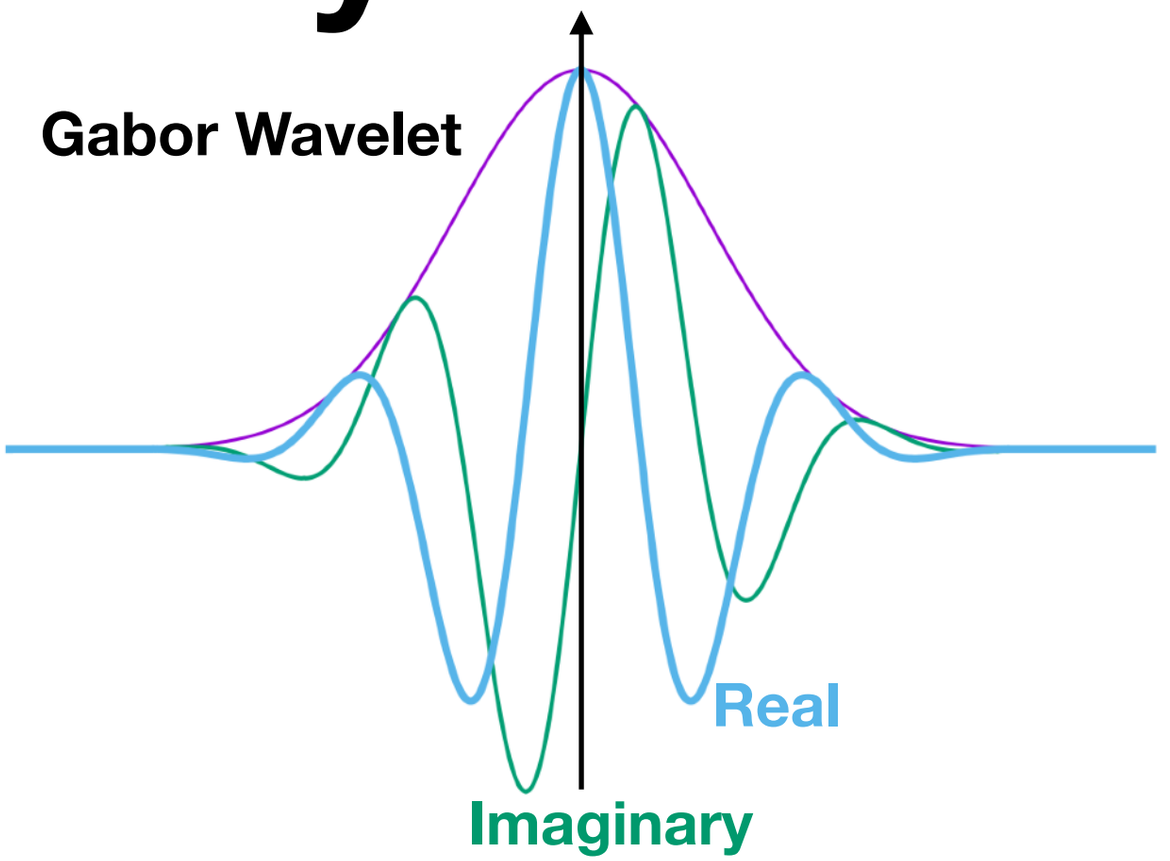

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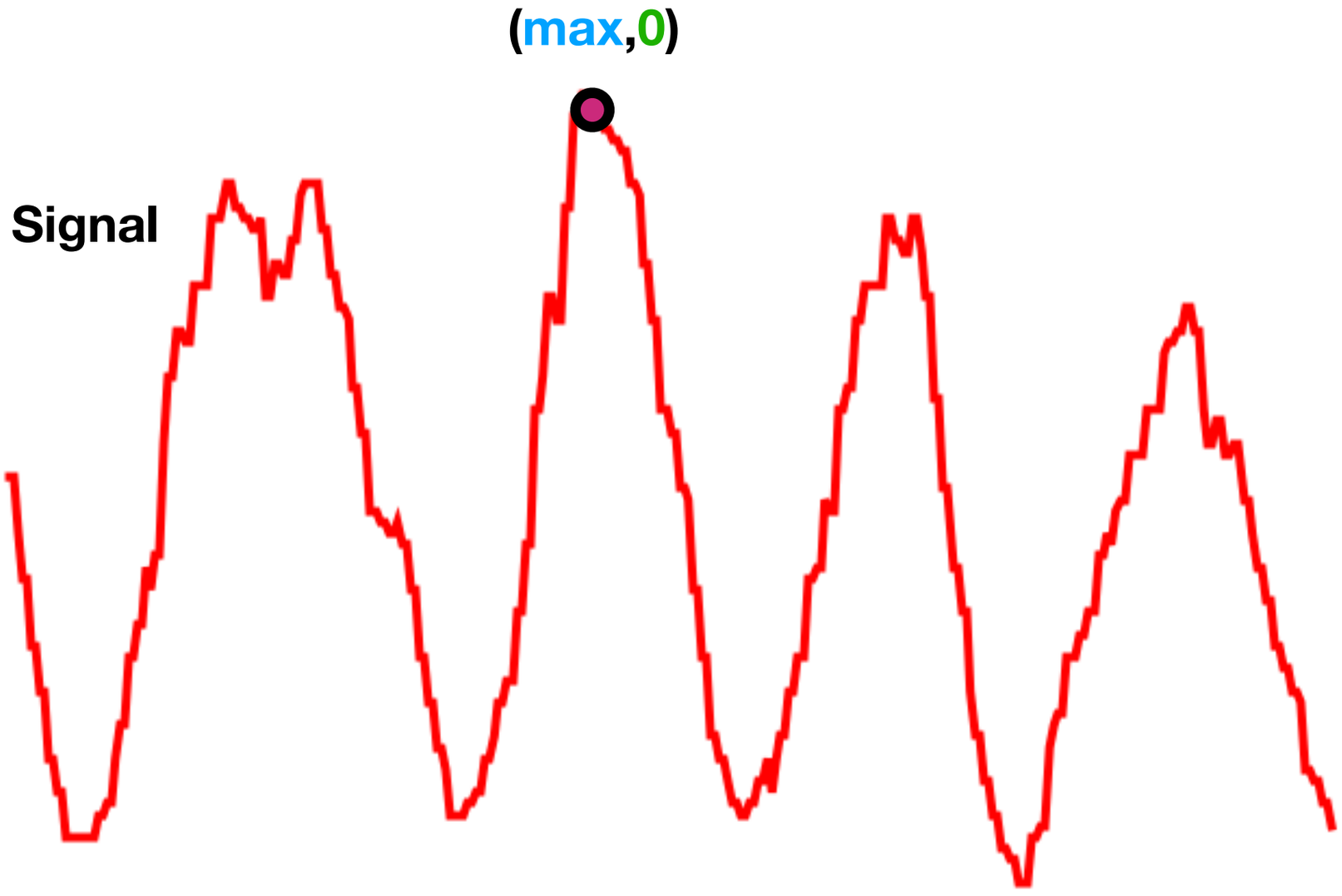
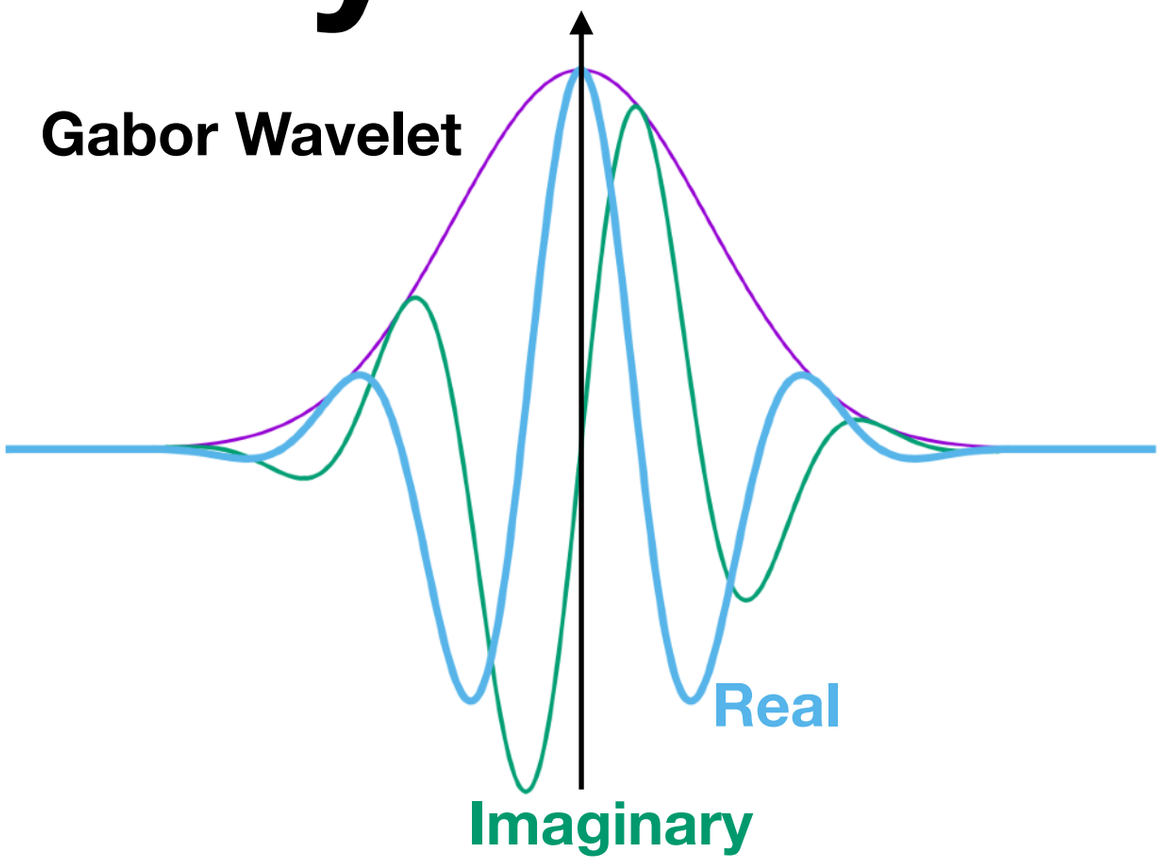
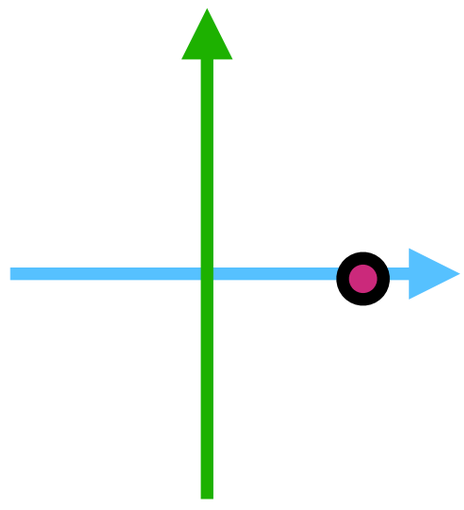
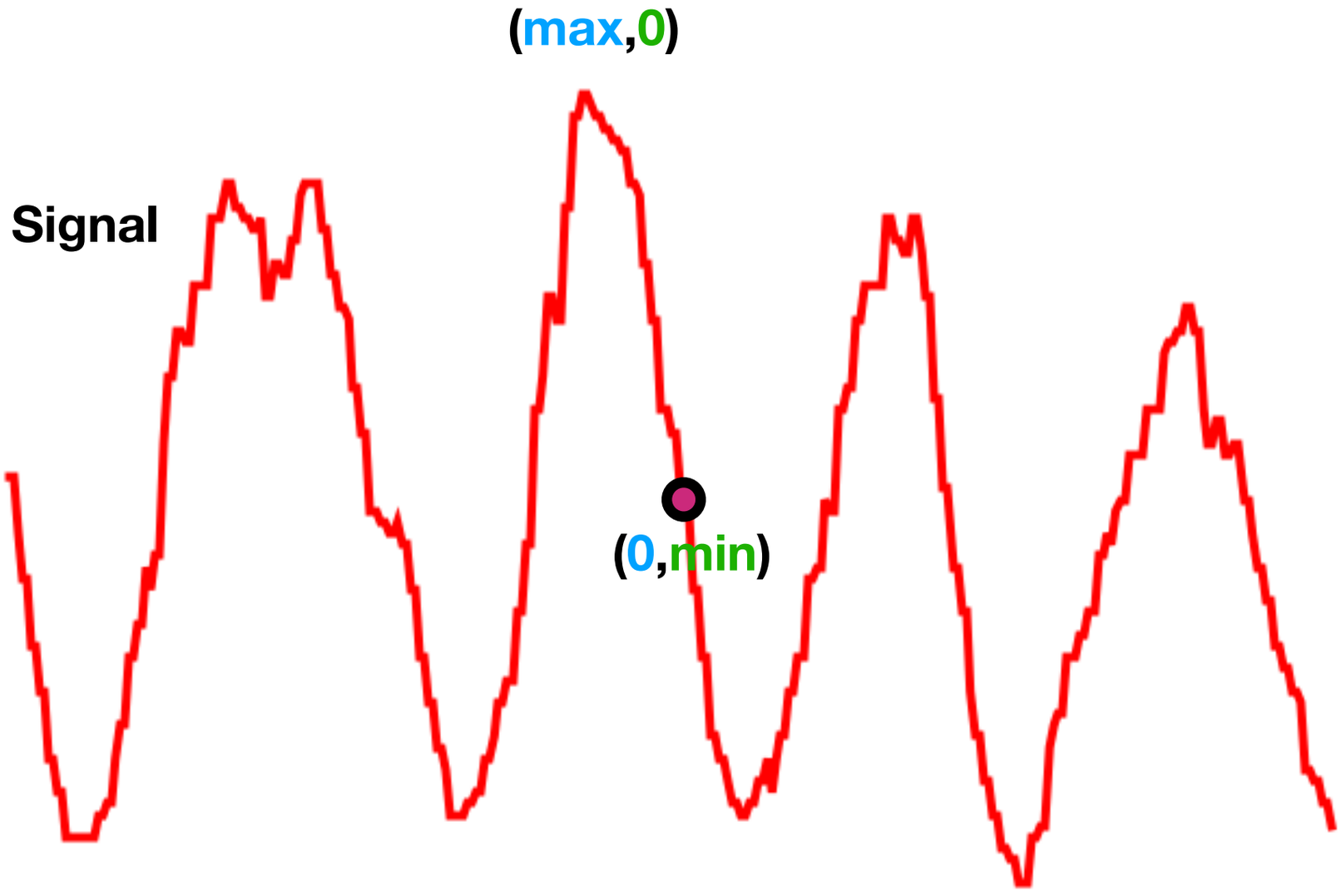
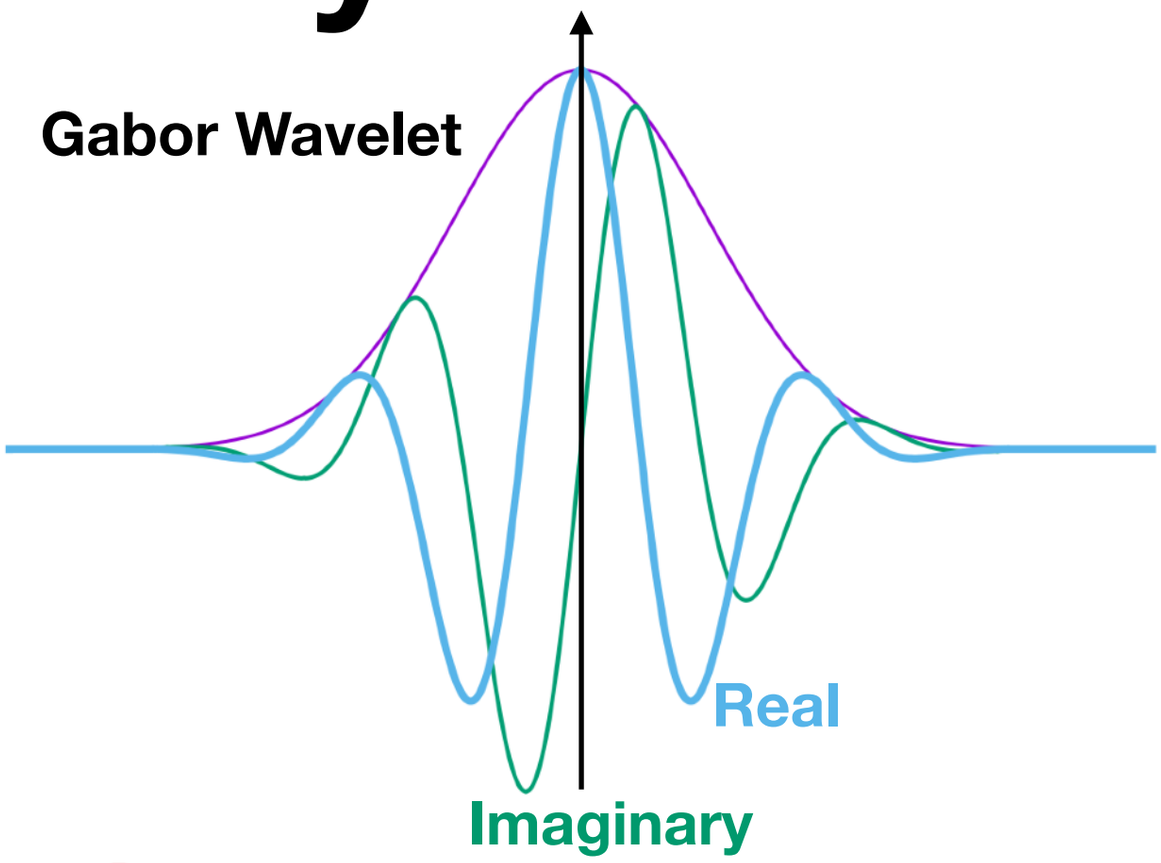


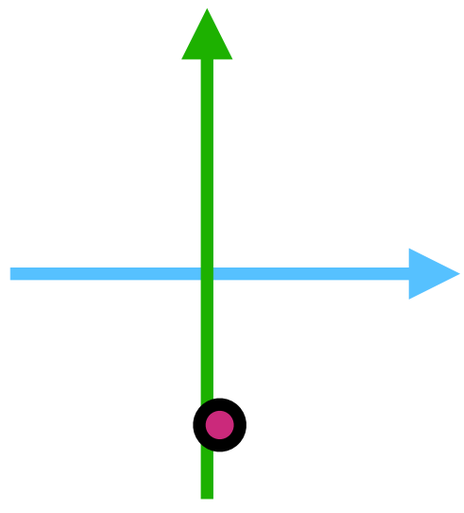




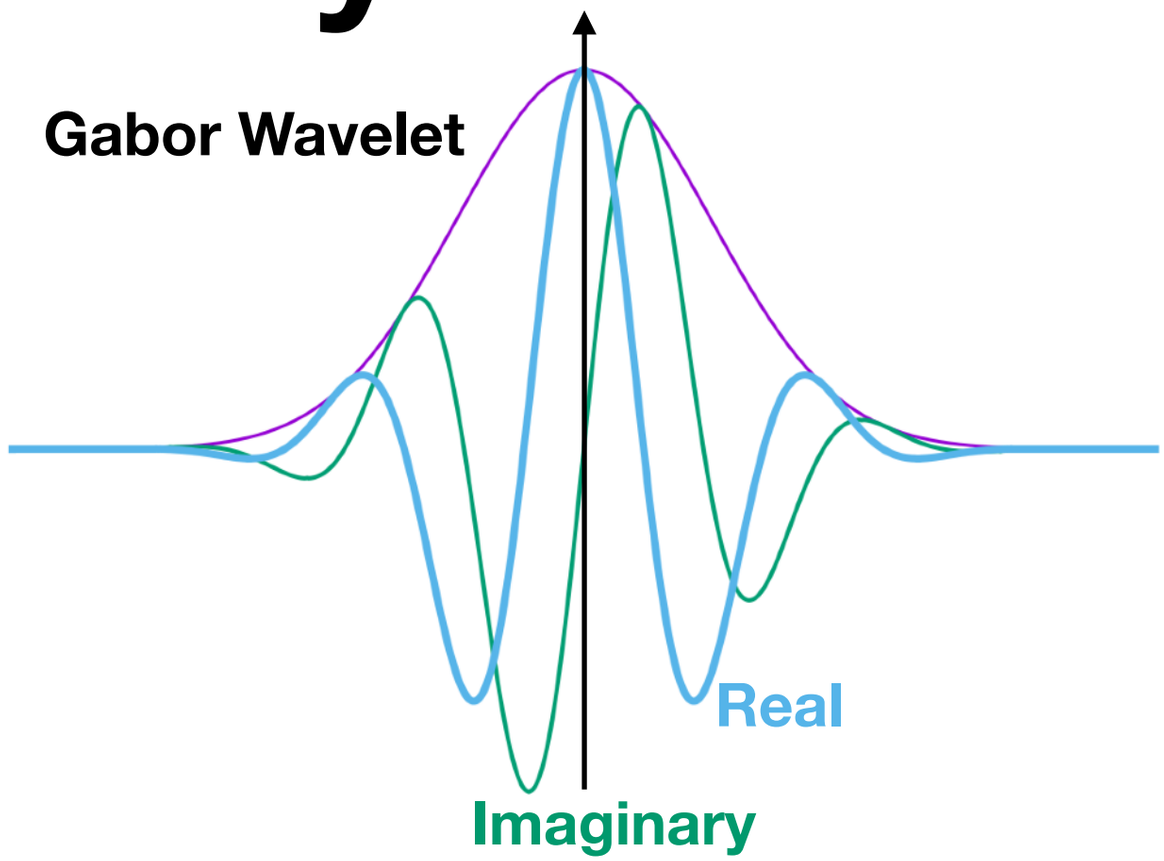
Wavelet analysis

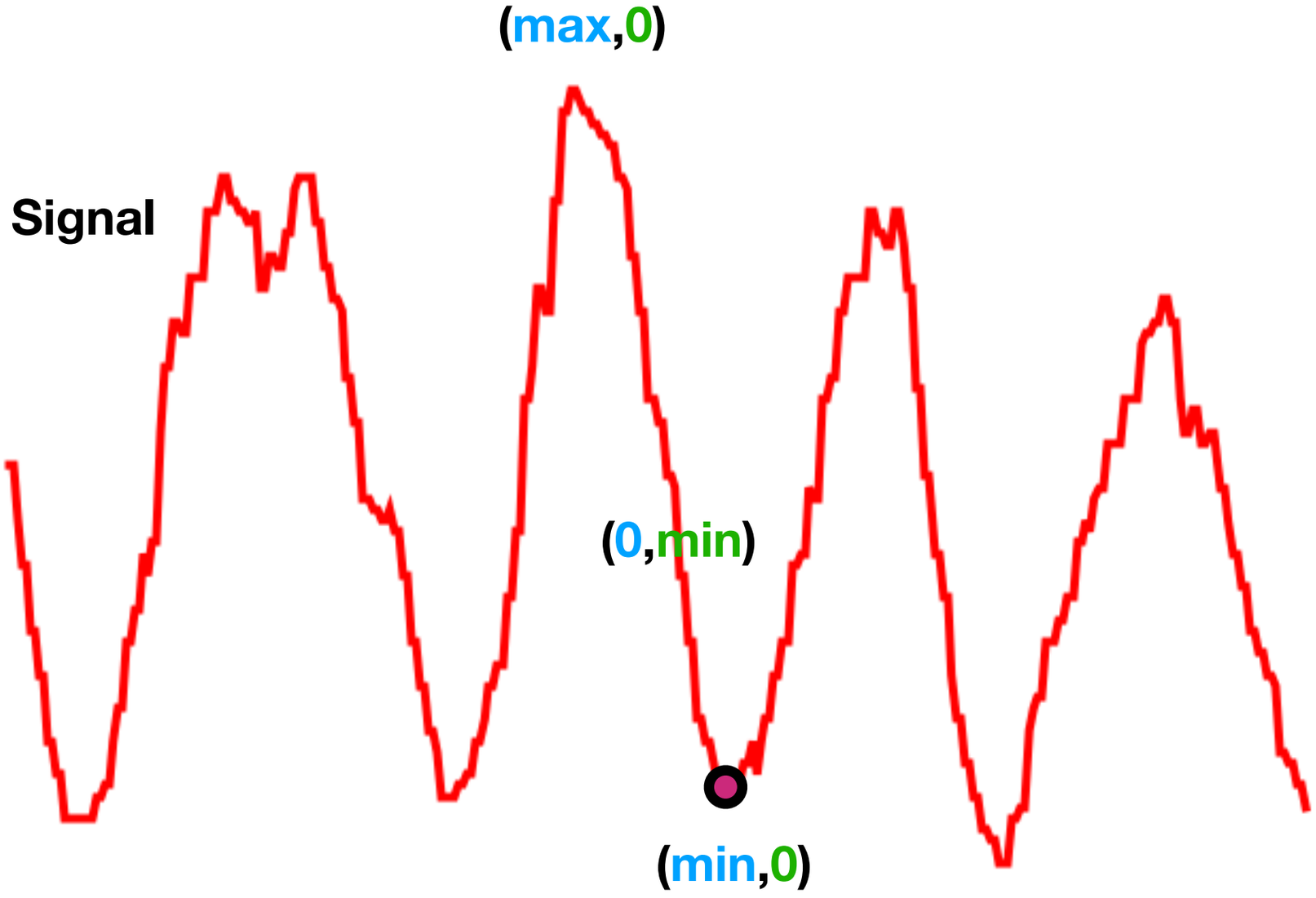


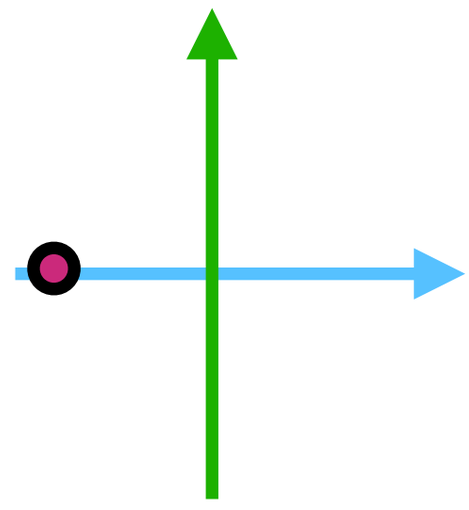




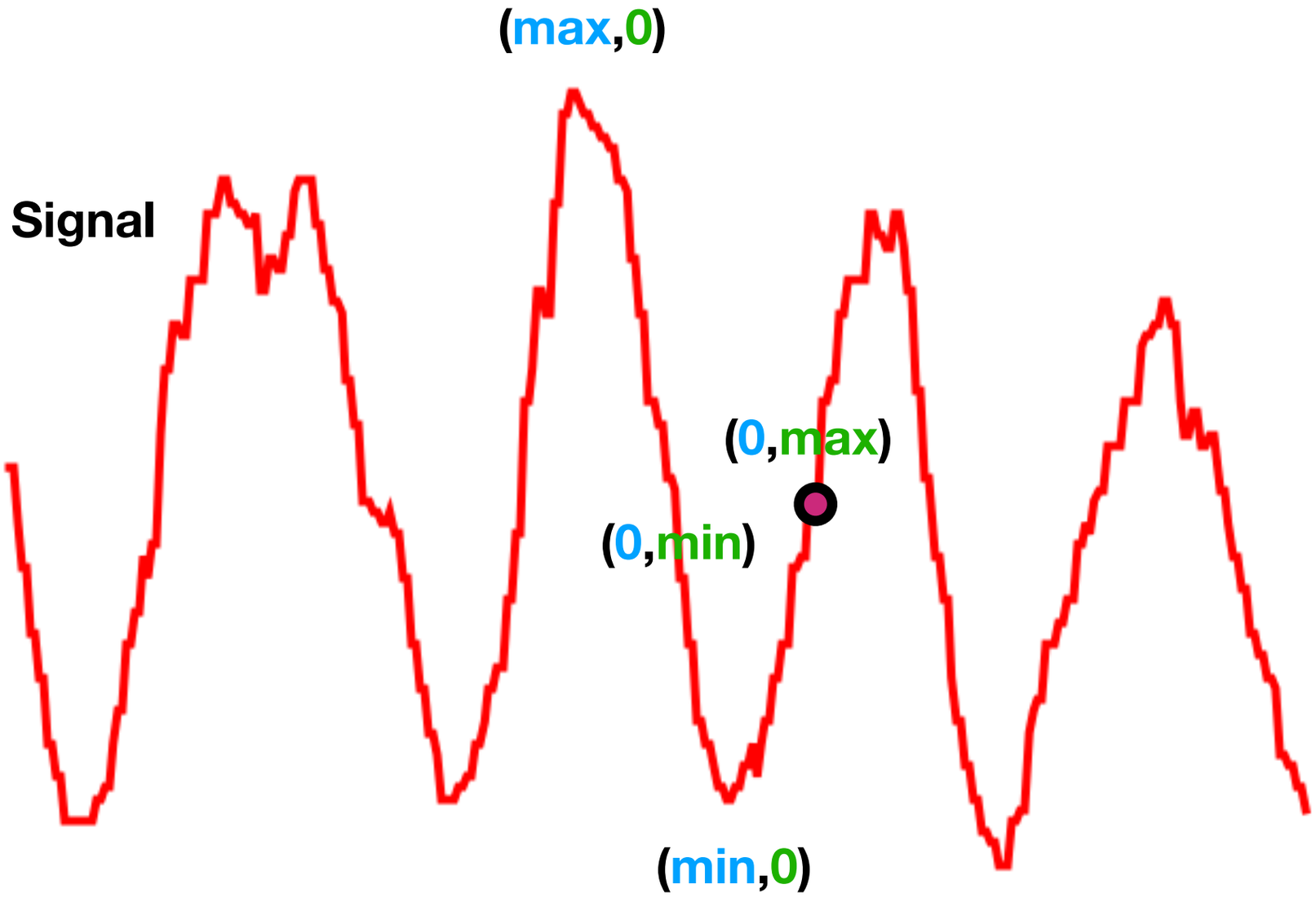
Wavelet analysis

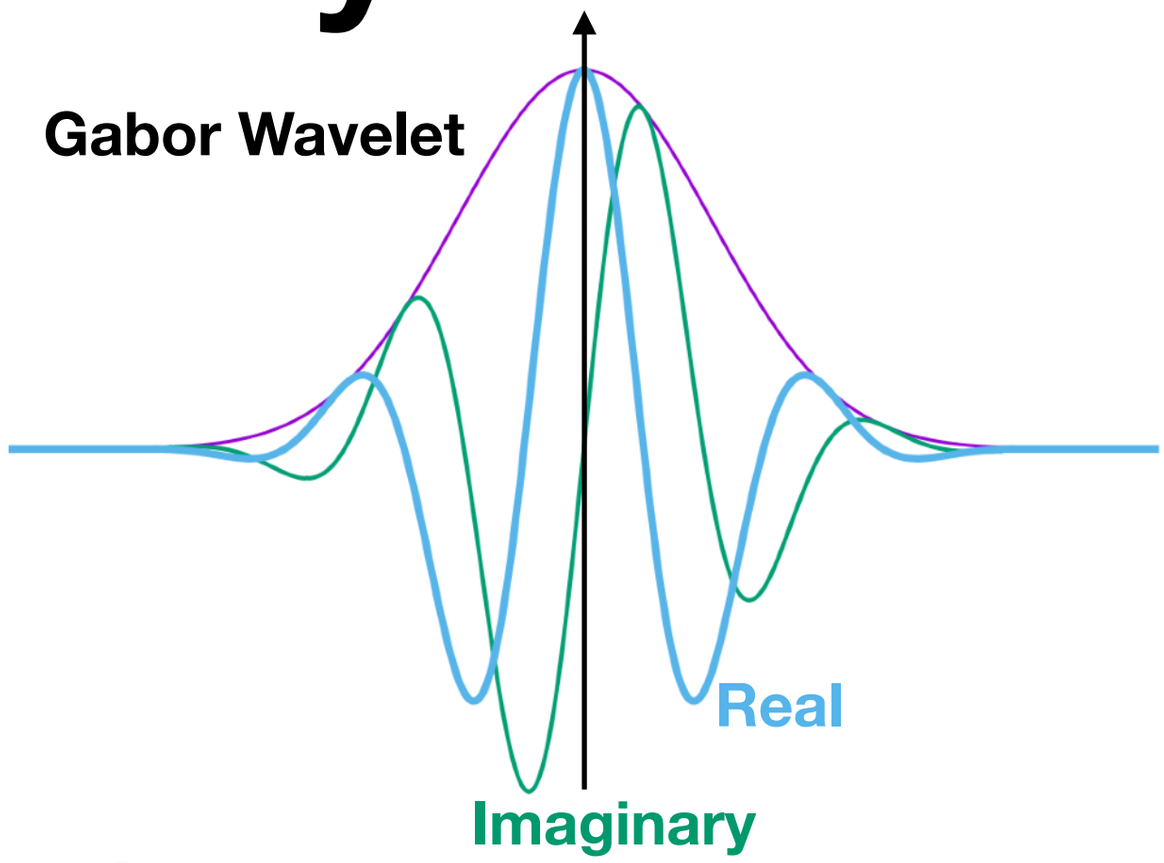


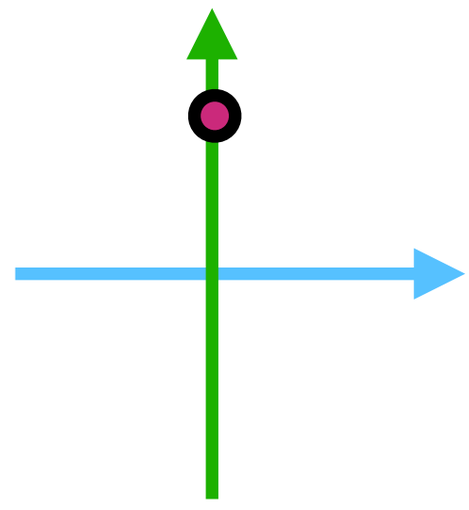




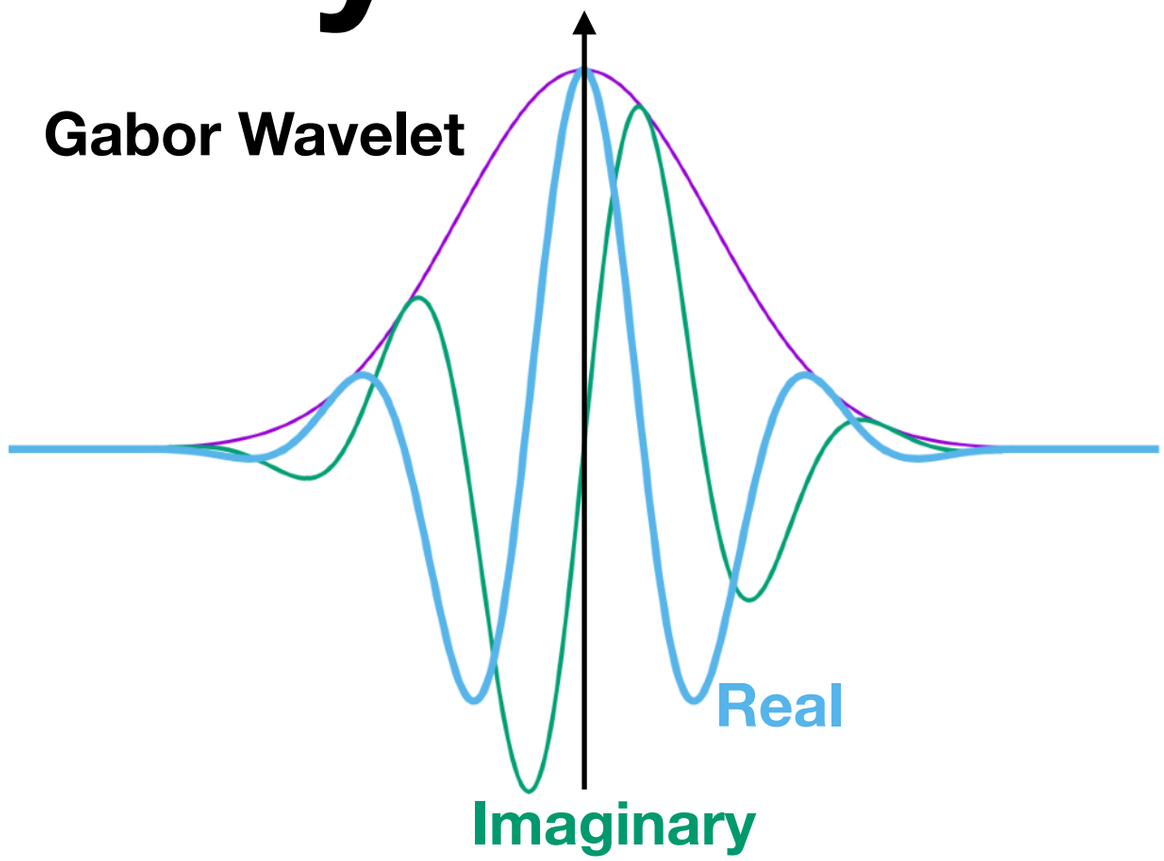
Wavelet analysis

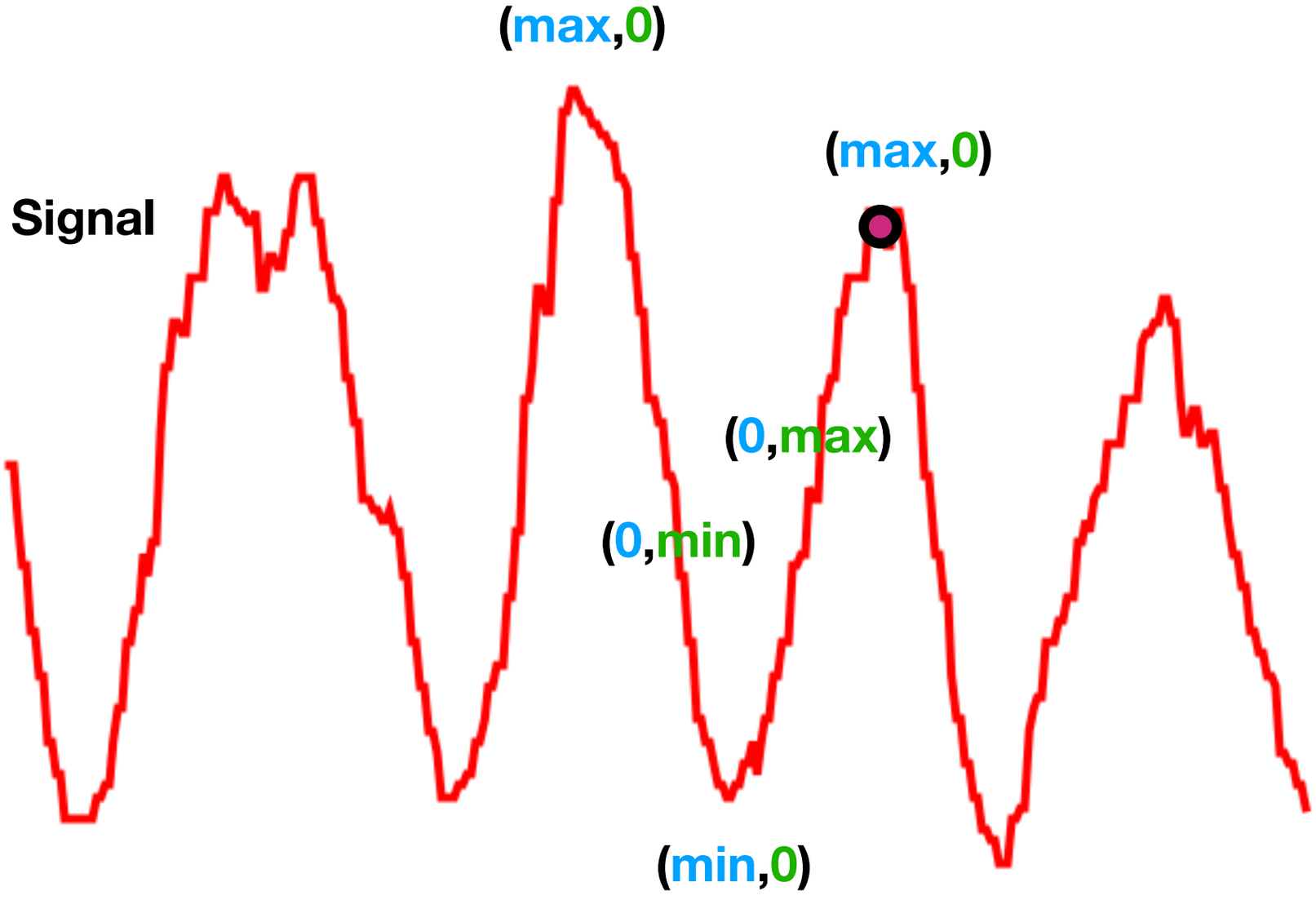


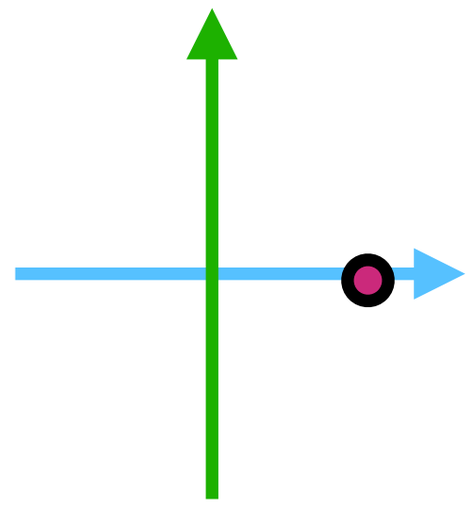




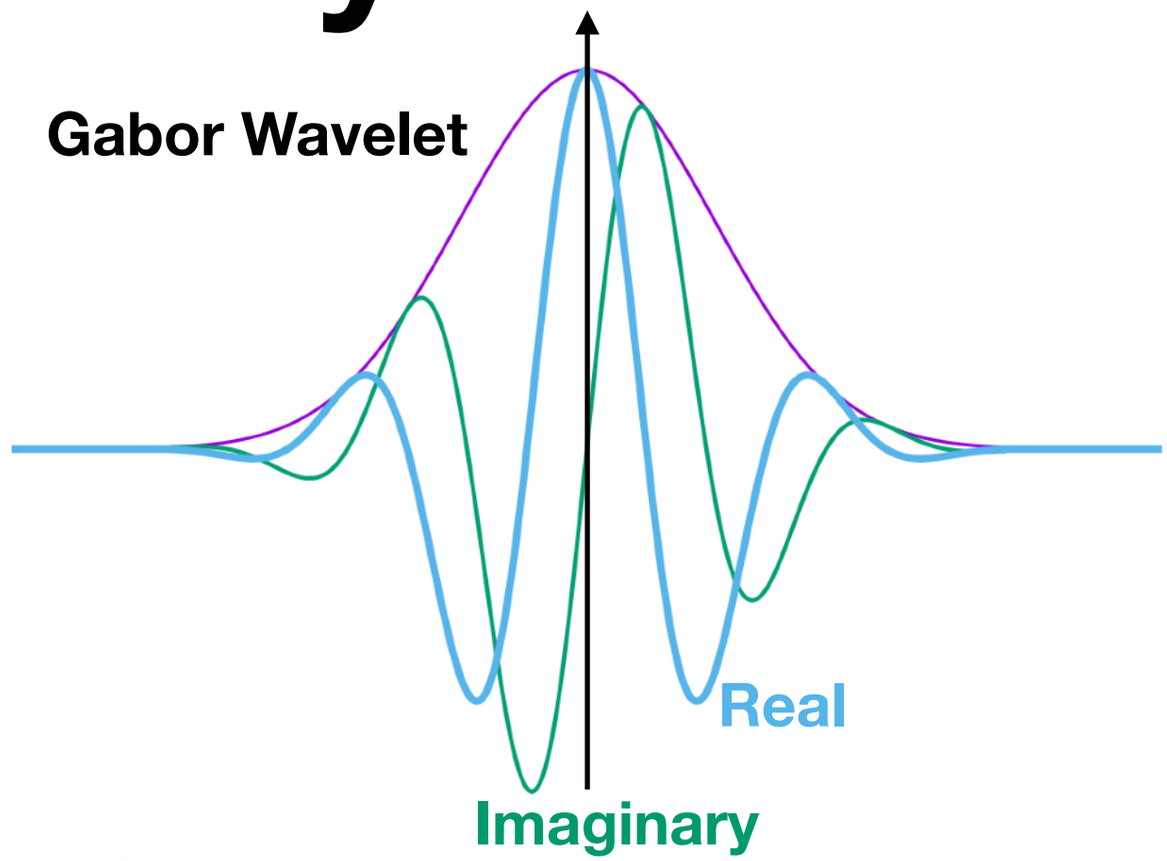
Wavelet analysis

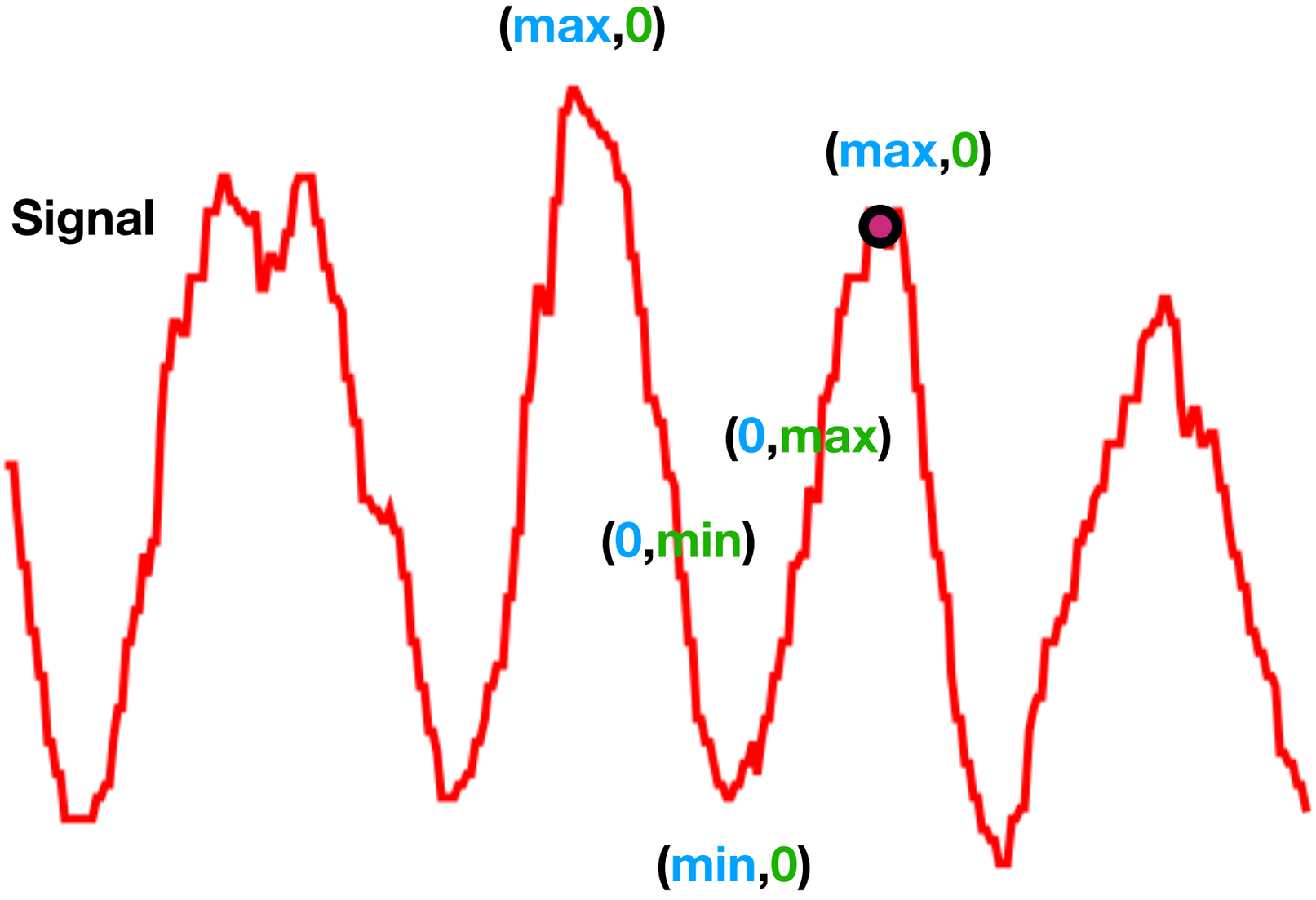


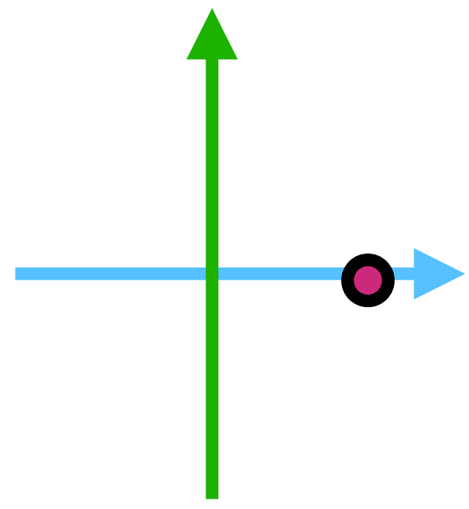




Wavelet analysis







Find the best by changing the Gabor interfringe

Real

Imaginary

2D

α

λ

Real

Imaginary

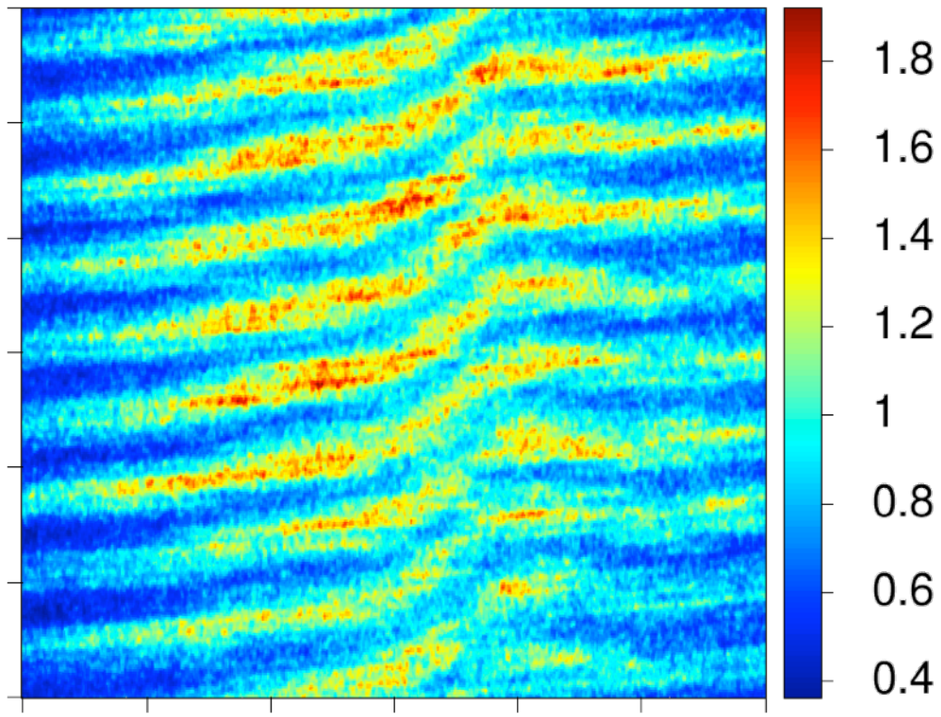
2D

α

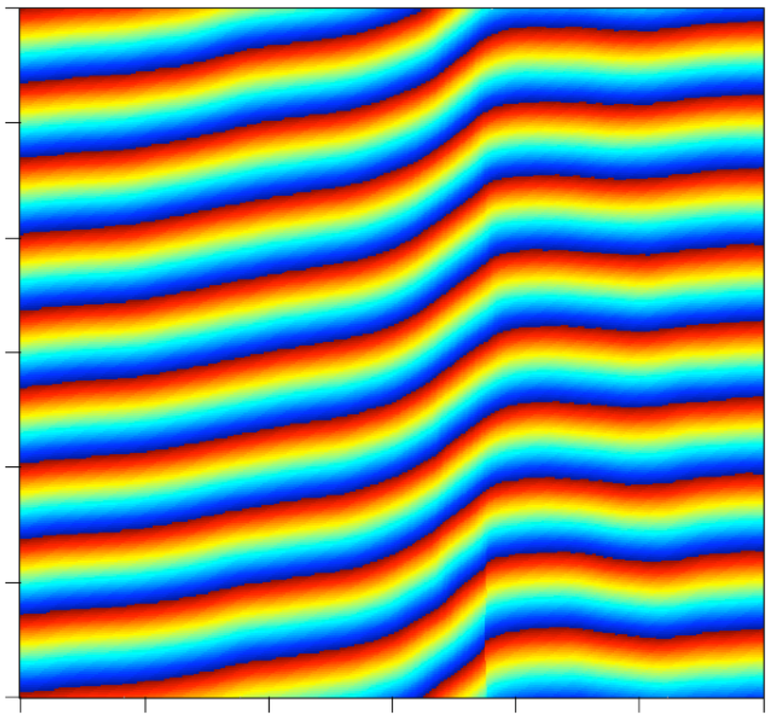
λ

results

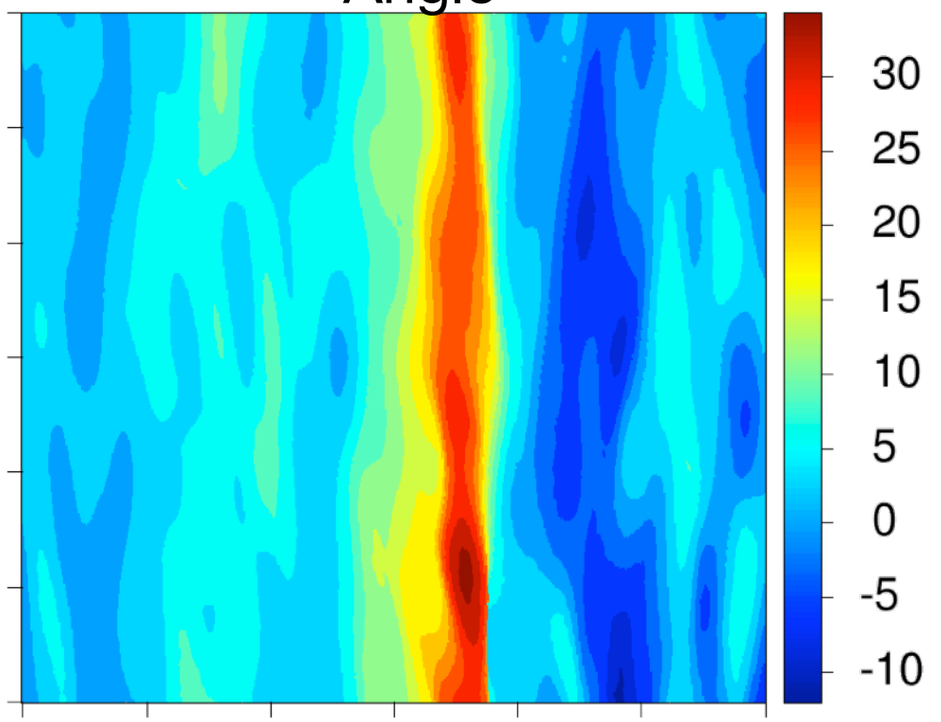
Shot



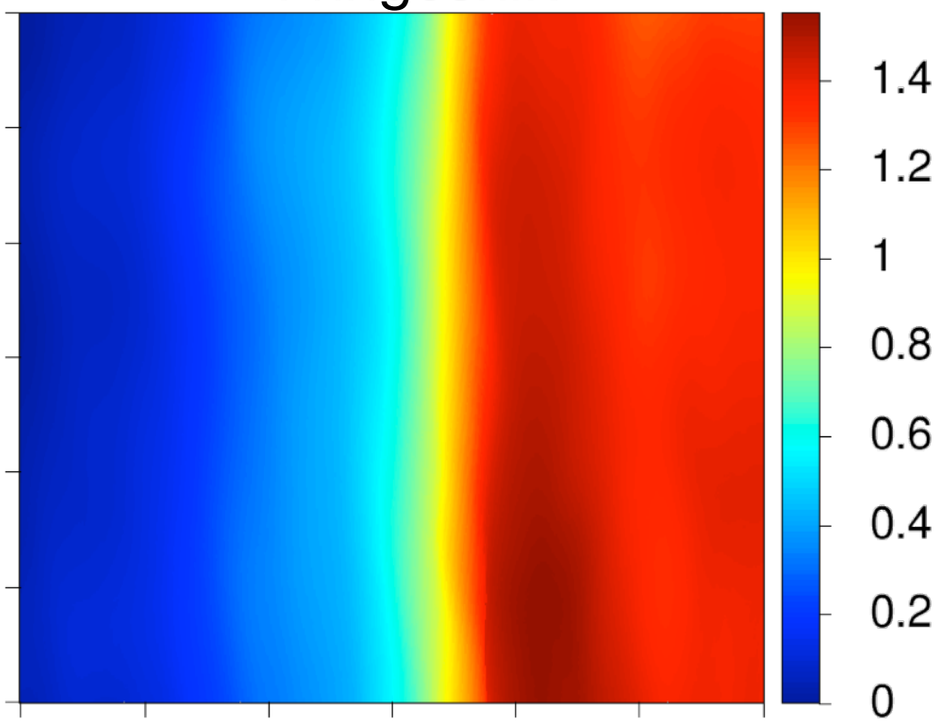
Phase



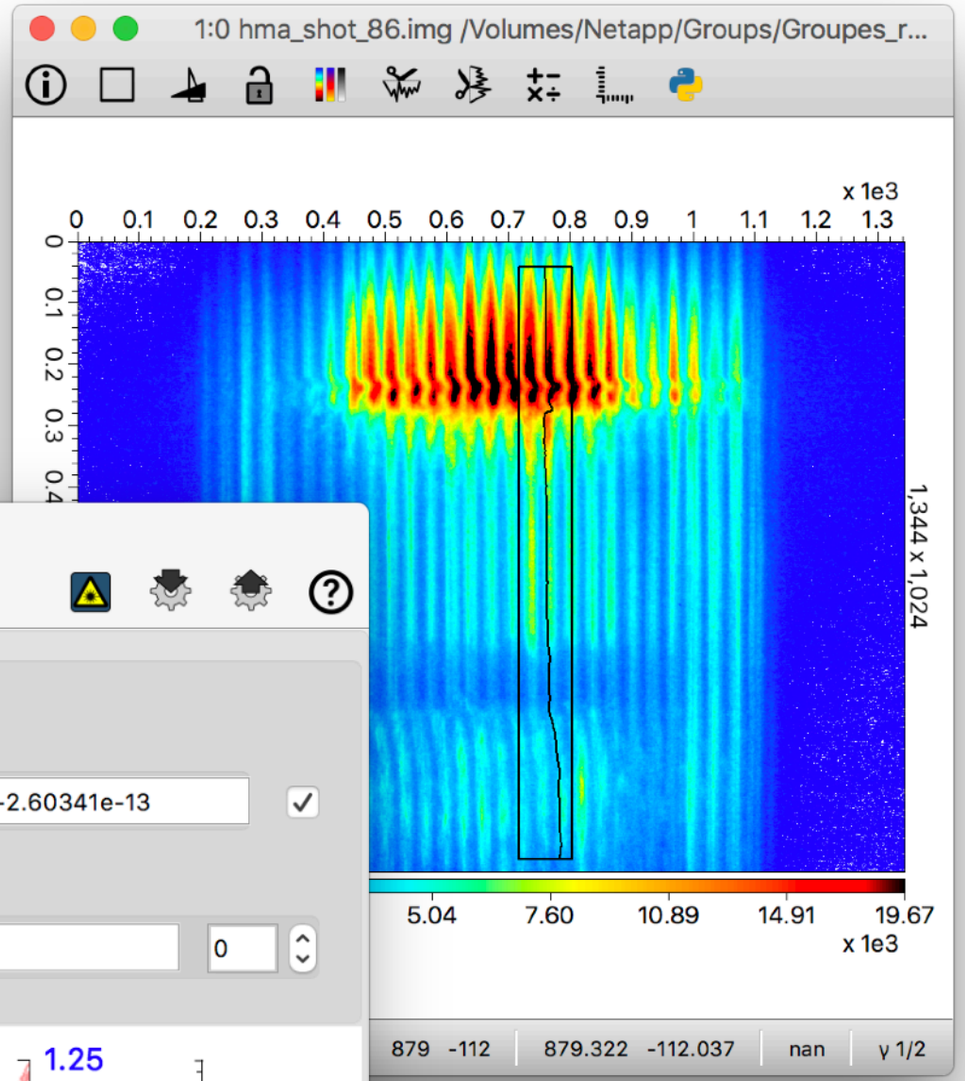
Angle

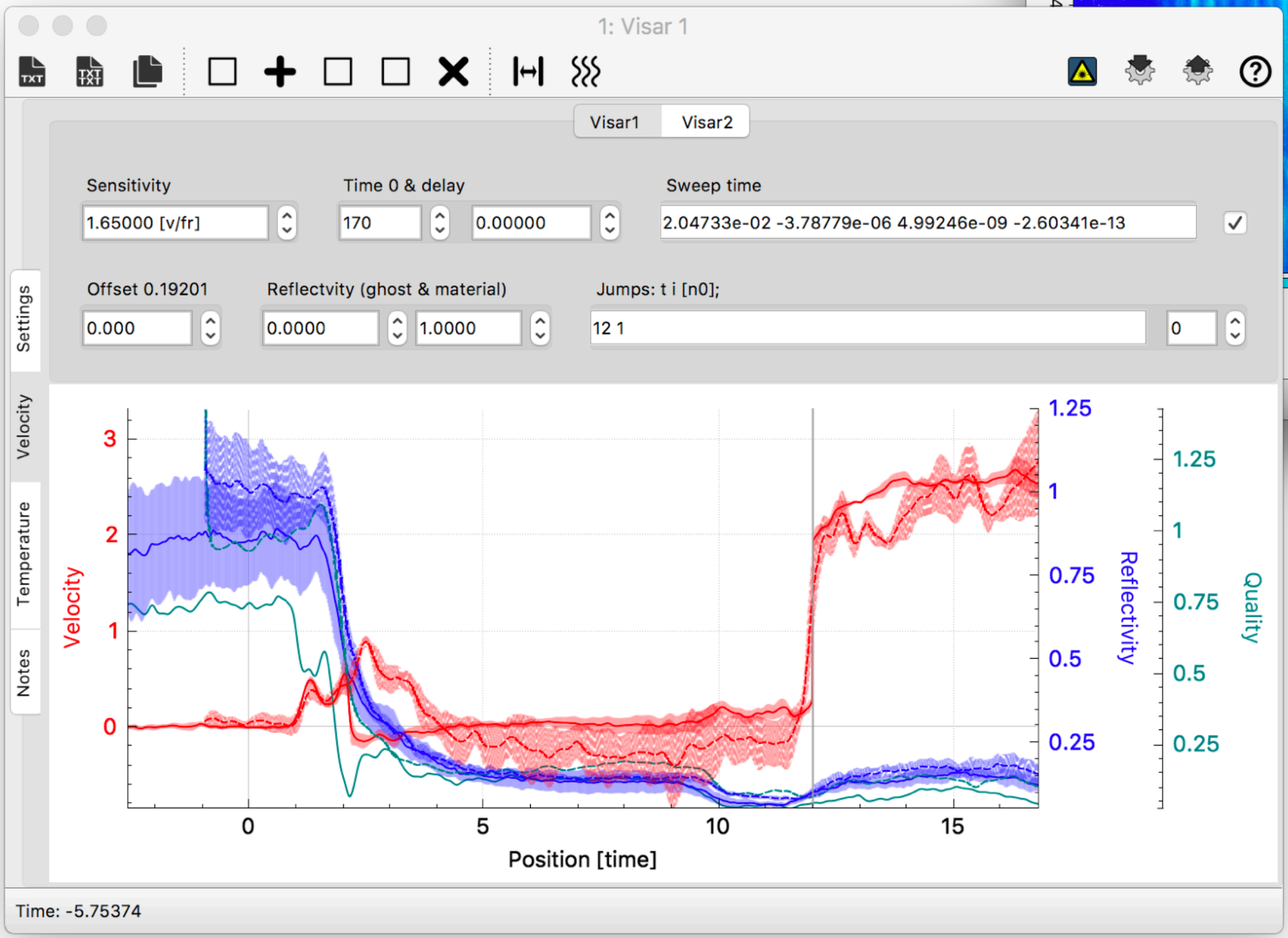


Fringeshift

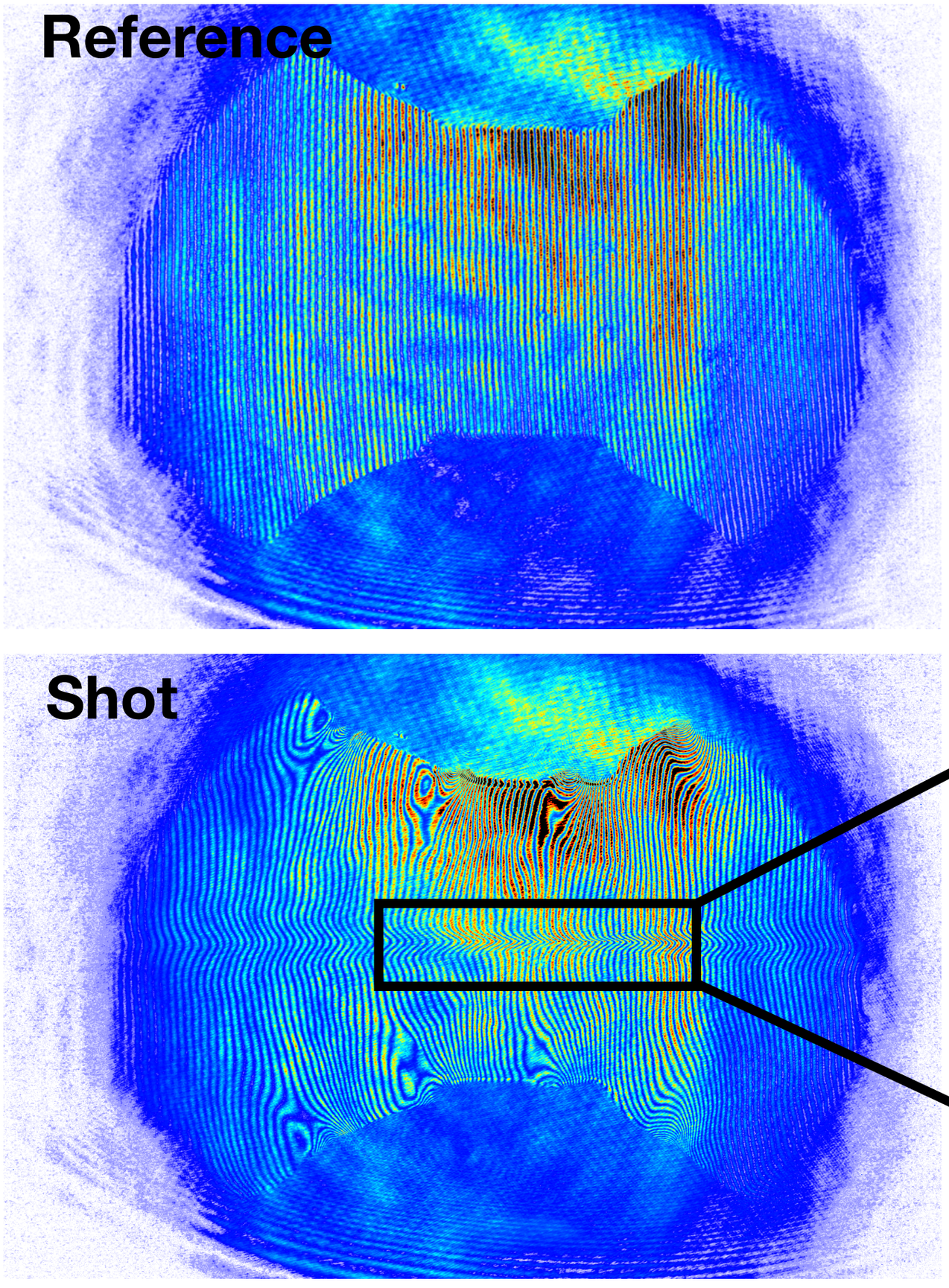


VISAR (EOS)

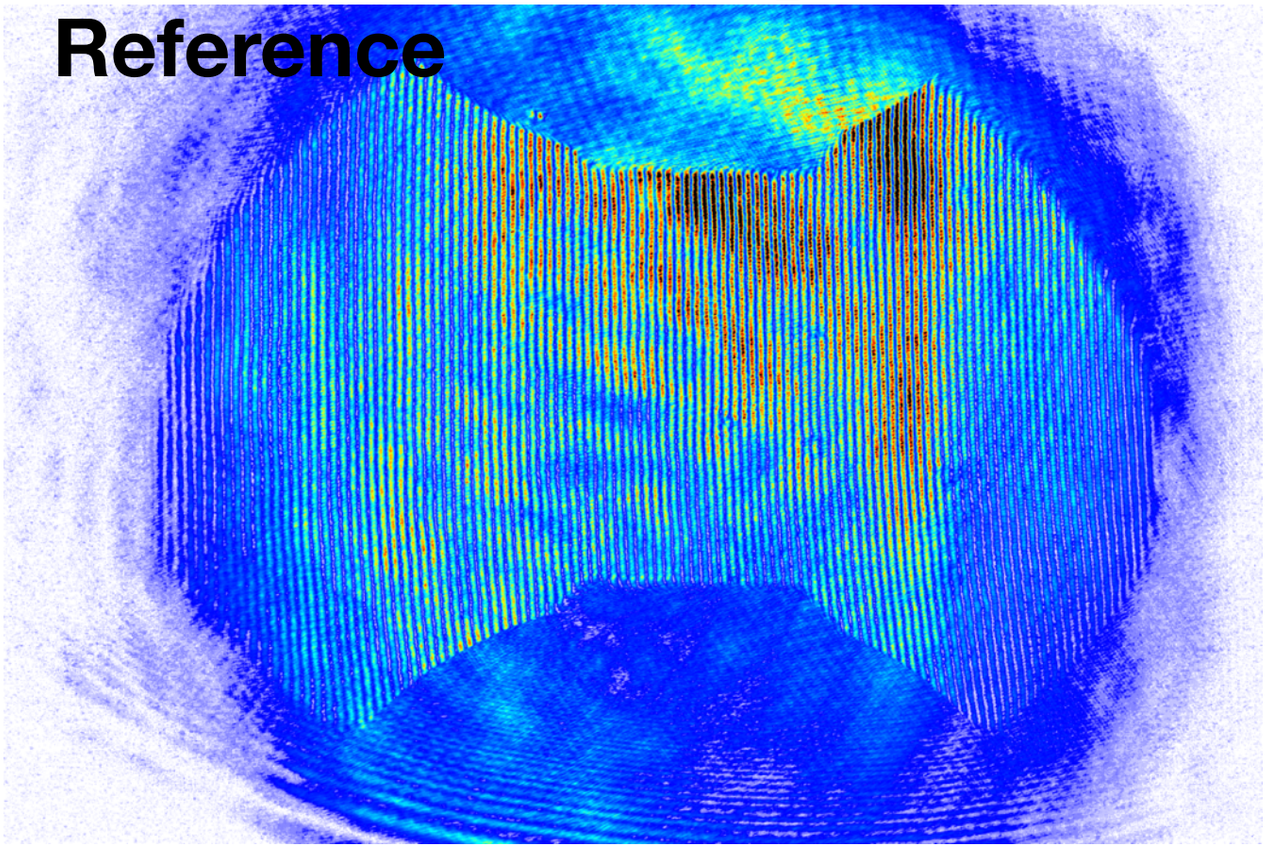

1:0 hma_shot_86.img /Volumes/Netapp/Groups/Groupes_r...
x 1e3
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3
1,344 x 1,024
5.04 7.60 10.89 14.91 19.67
x 1e3
879 -112 879.322 -112.037 nan y 1/2

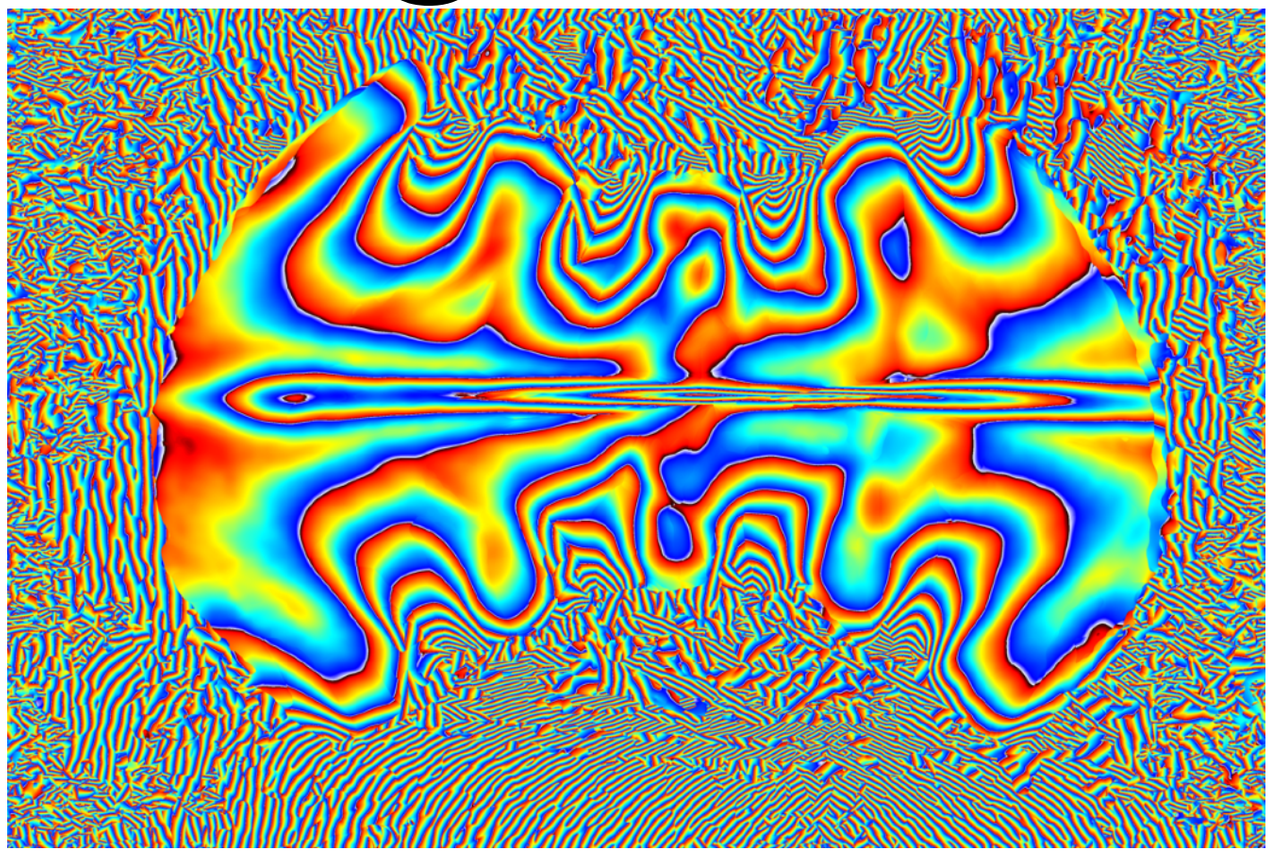

1: Visar 1
Visar1
Visar2
Sensitivity
1.65000 [v/fr]
Time 0 & delay
170
0.00000
Sweep time
2.04733e-02 -3.78779e-06 4.99246e-09 -2.60341e-13
Offset 0.19201
0.000
Reflectvity (ghost & material)
0.0000
1.0000
Jumps: t i [n0];
12 1
0
Settings
Velocity
Temperature
Notes
Velocity
Reflectivity
Quality
Position [time]
Time: -5.75374

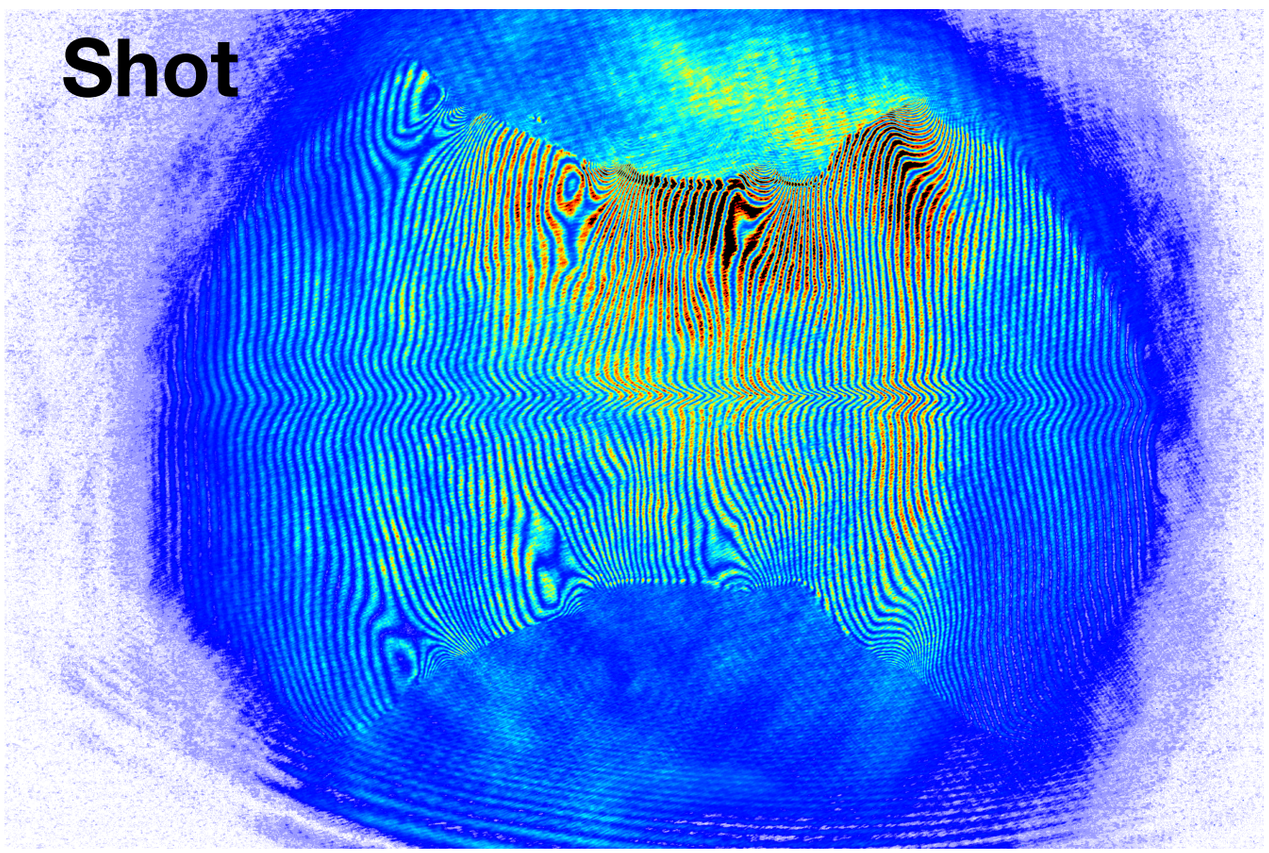
Z-pinch images

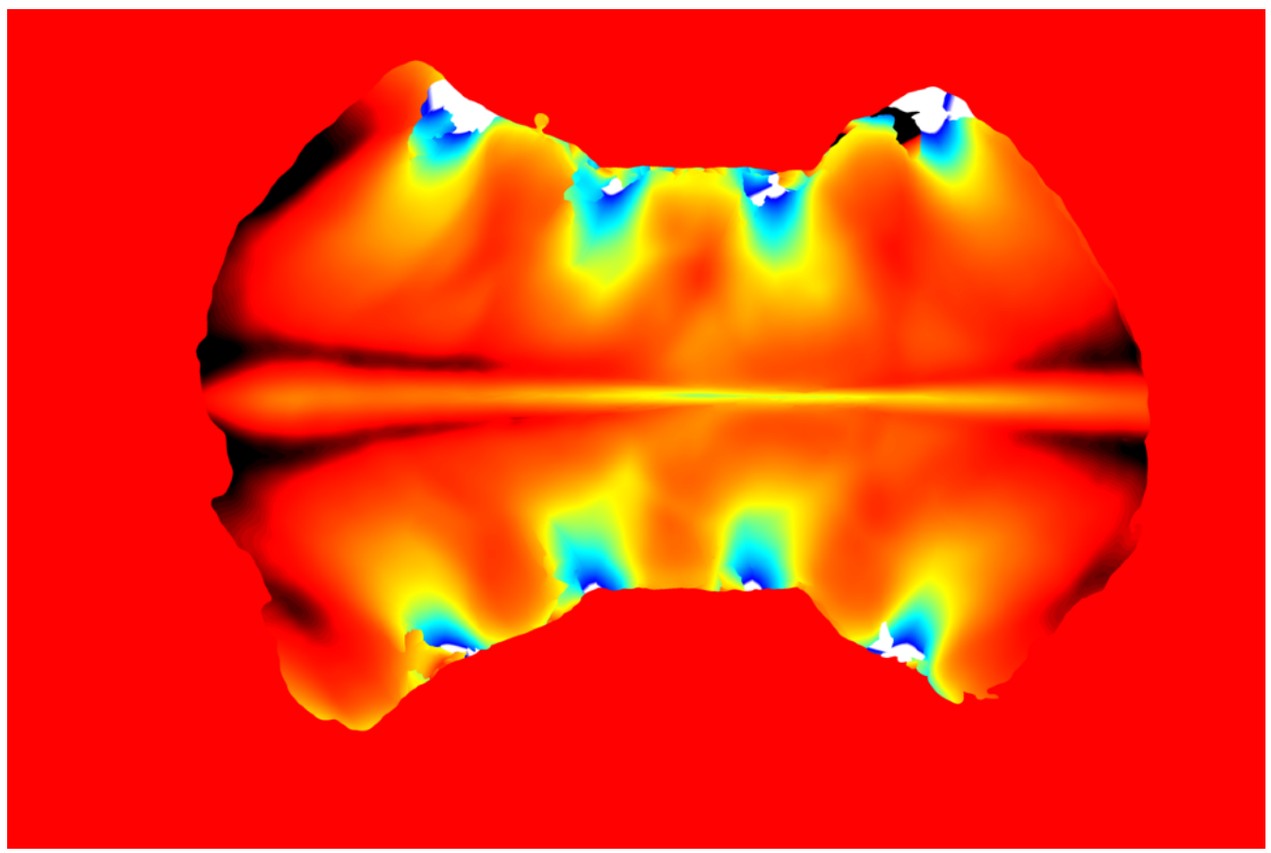


Z-pinch images



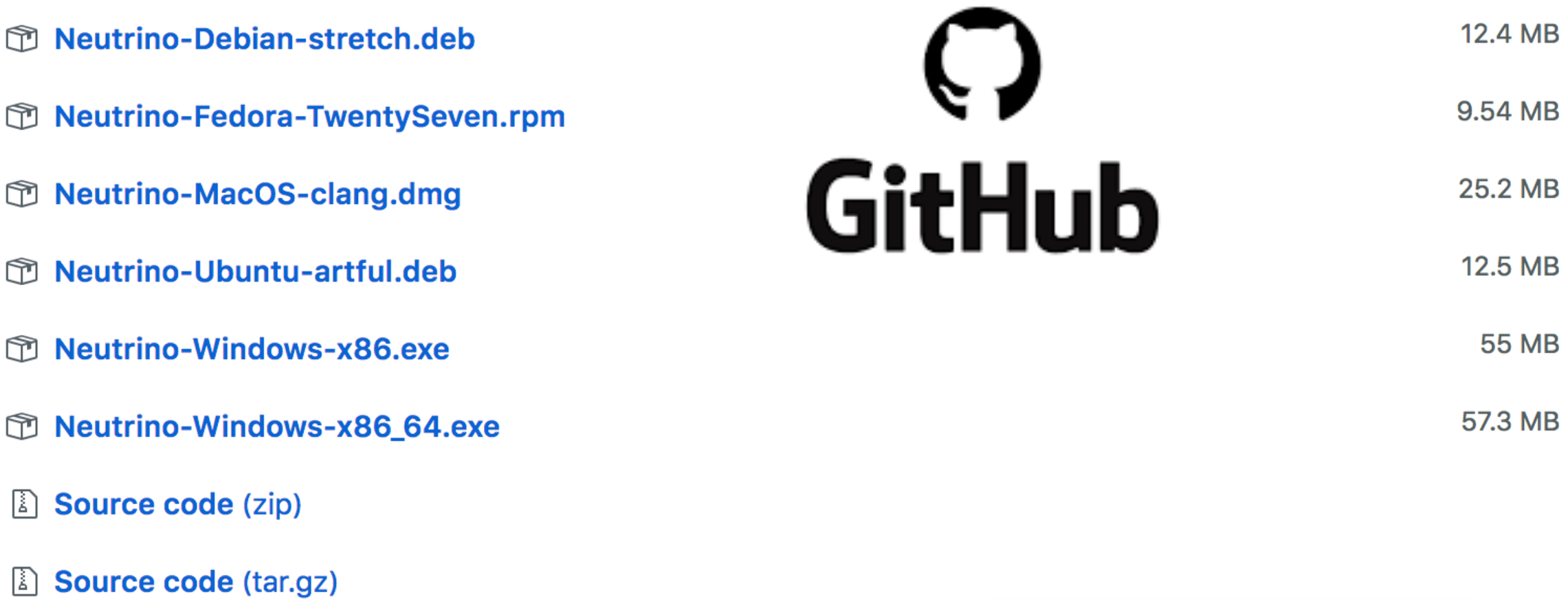


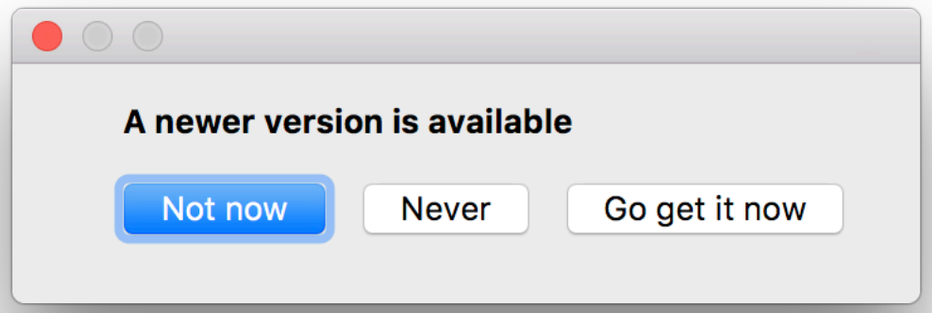




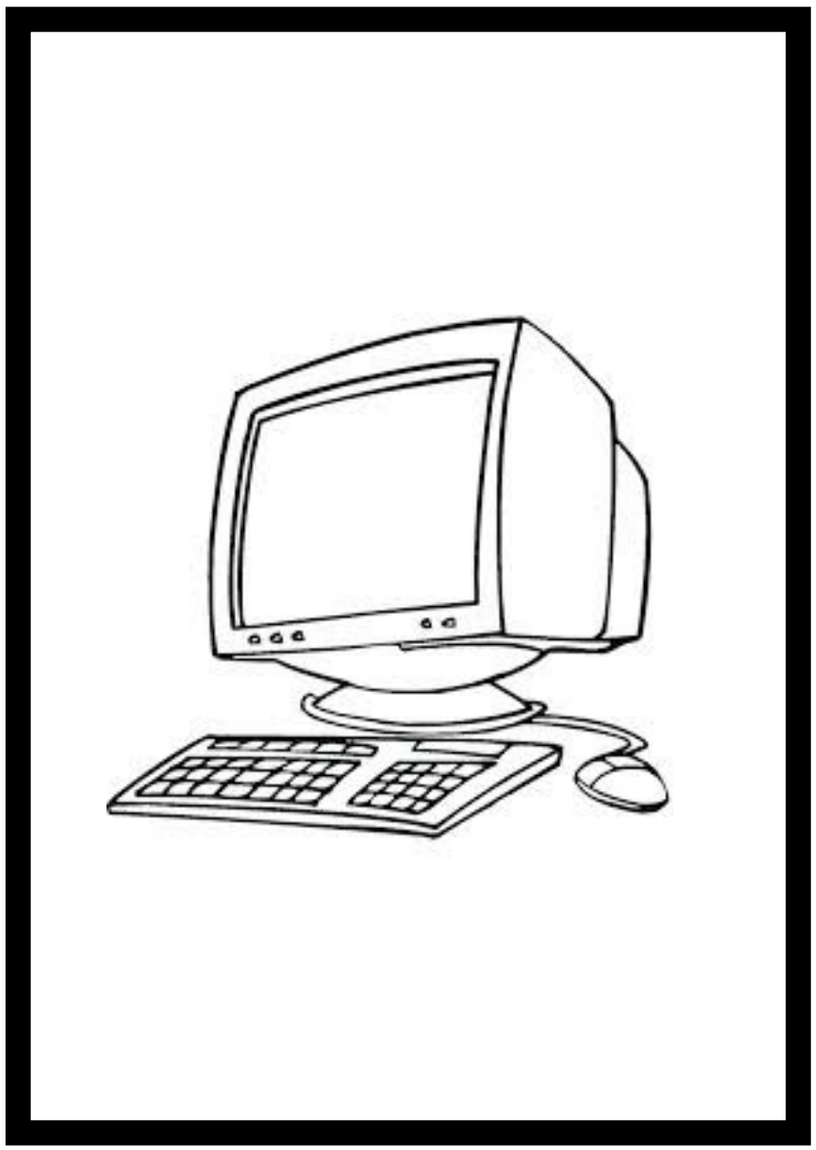
Where is it?

https://github.com/NeutrinoToolkit/Neutrino/releases

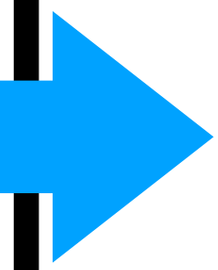




Build chain



Build chain



GitHub

Build chain

GitHub

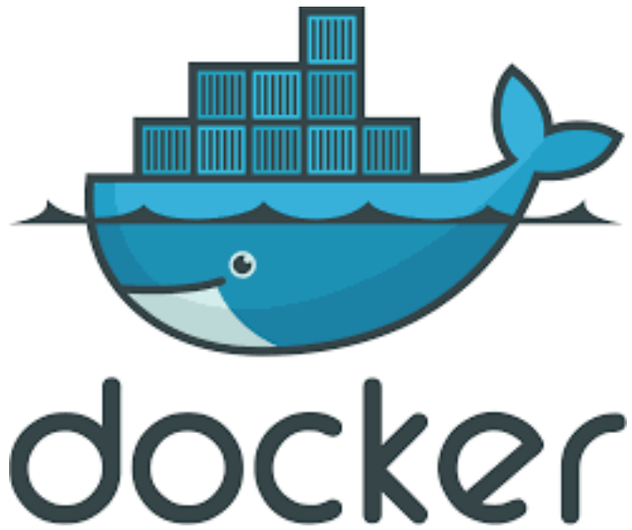
docker

Build chain

GitHub

Win Linux Mac
executables

docker



FROM ubuntu:17.10

RUN *apt-get* update -qq && *apt-get* install -yy git pandoc cmake qt5-default libnetpbm10-dev libhdf5-dev libfftw3-dev python-dev libhdf4-dev g++ build-essential libtiff5-dev libgsl-dev qtmultimedia5-dev qttools5-dev libqt5svg5-dev libqt5scripttools5 qtscript5-dev libqt5multimediawidgets5 qttools5-dev-tools lsb-release libcfitsio-dev libhdf4-dev libhdf5-dev libhdf5-100 python-numpy

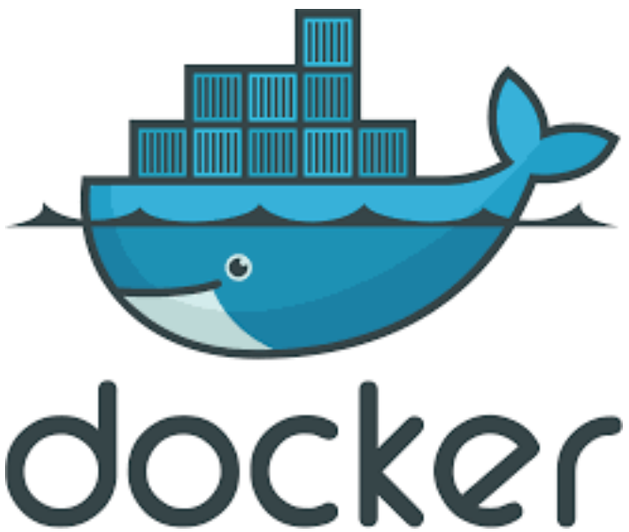
RUN *apt-get* install -yy opencl-clhpp-headers libclfft2 libclc-dev opencl-c-headers ocl-icd-libopencl1 libclc-dev beignet opencl-headers ocl-icd-opencl-dev libclfft-dev

RUN git clone --recursive https://github.com/NeutrinoToolkit/Neutrino.git

RUN cd Neutrino/PythonQt && mkdir Linux && cd Linux && cmake -UQT_QMAKE_EXECUTABLE -DPythonQt_Wrap_QtAll=TRUE -DQt5_DIR=/usr/lib/x86_64-linux-gnu/cmake .. && make -j$(nproc) install && cd ../..

RUN cd Neutrino && mkdir Linux && cd Linux && cmake .. && make -j$(nproc) package

Unknow to experimentalists



OpenCL

https://github.com/NeutrinoToolkit/Neutrino