Hit rate and sample consumption for samples in liquid water.

Daniel DePonte

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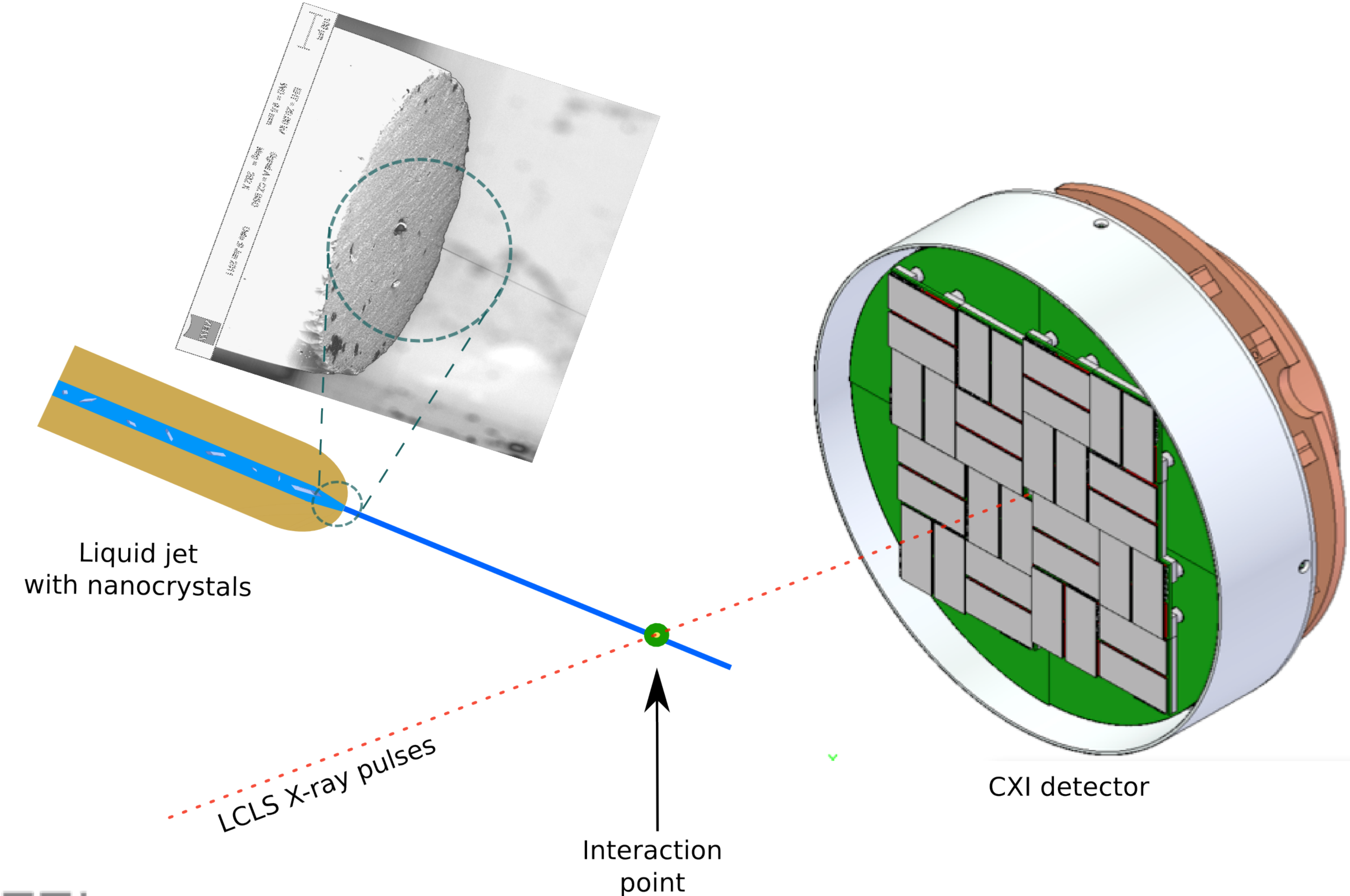
Sample injection



Hit Rate

FEL rep rate   x   probability of hitting a diffracting object (hits/s)

Fraction of X-ray pulses from which a diffraction pattern is recorded (%)

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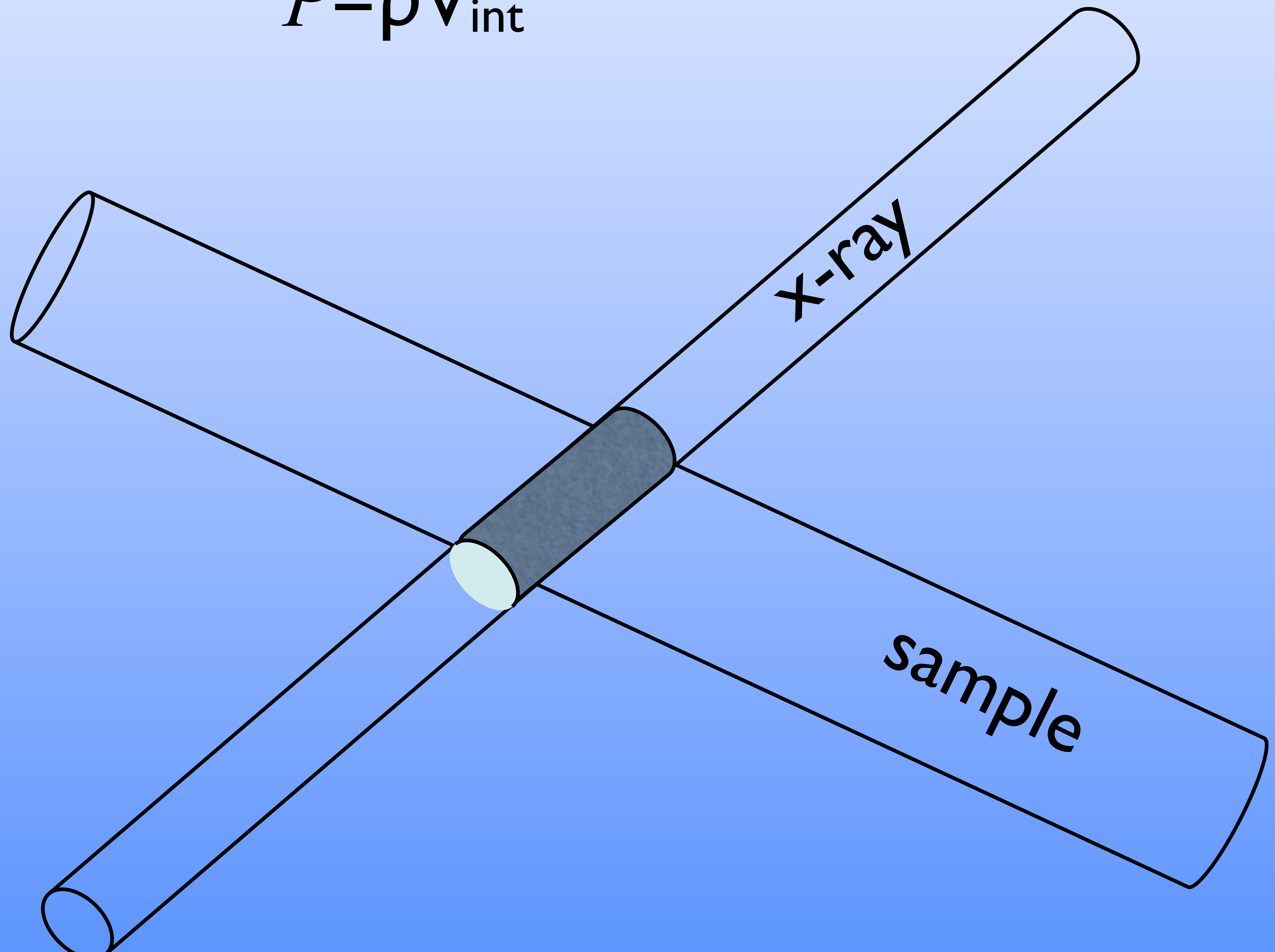
The probability of hitting a diffracting object with an x-ray pulse is given by the concentration of diffracting objects in the interaction volume.

$$P = \rho V_{int}$$

$$P = \frac{\dot{N} d_{fel}^2}{v d_s}$$



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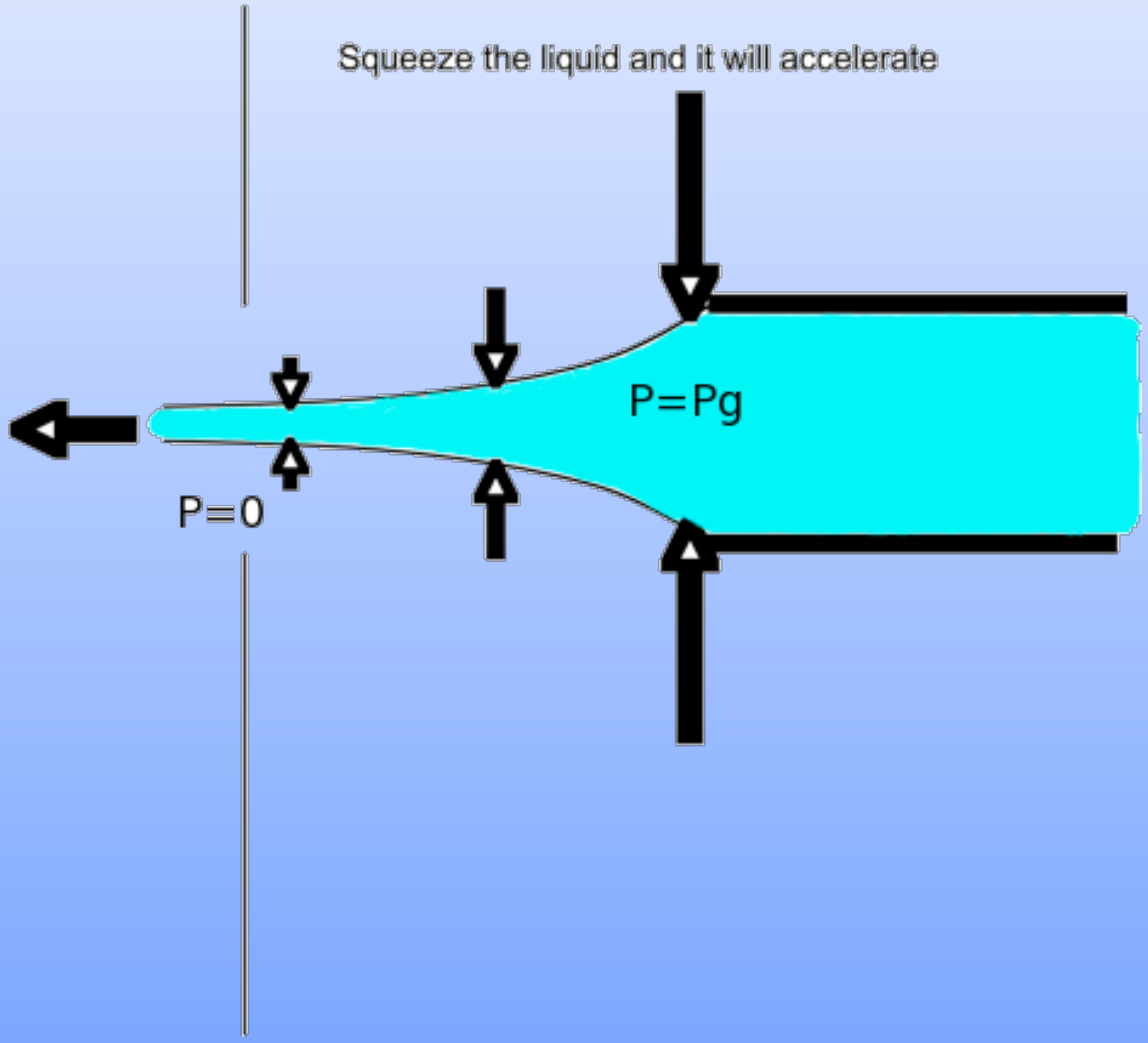
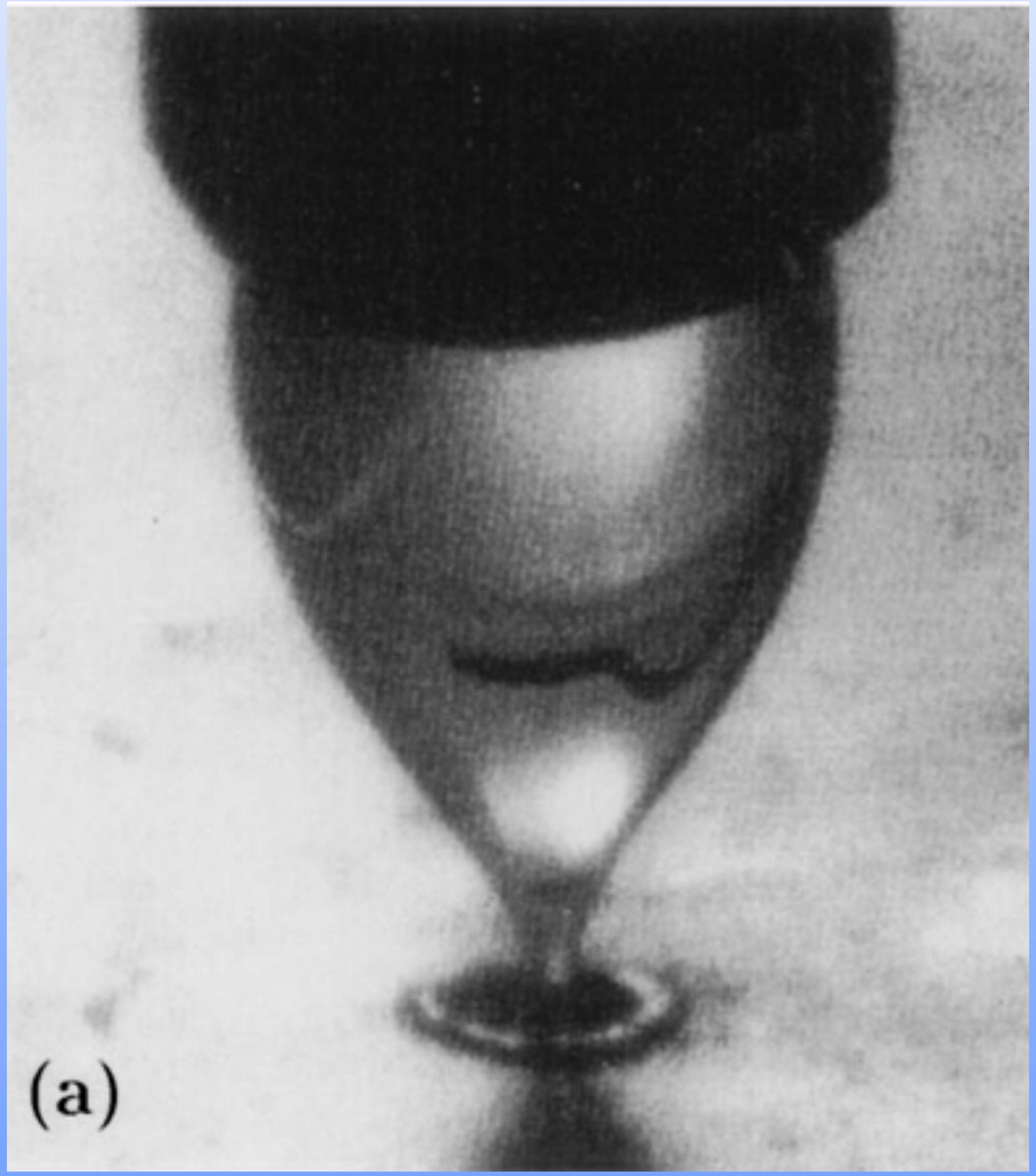
dripping vs jetting

iphone driven breakup

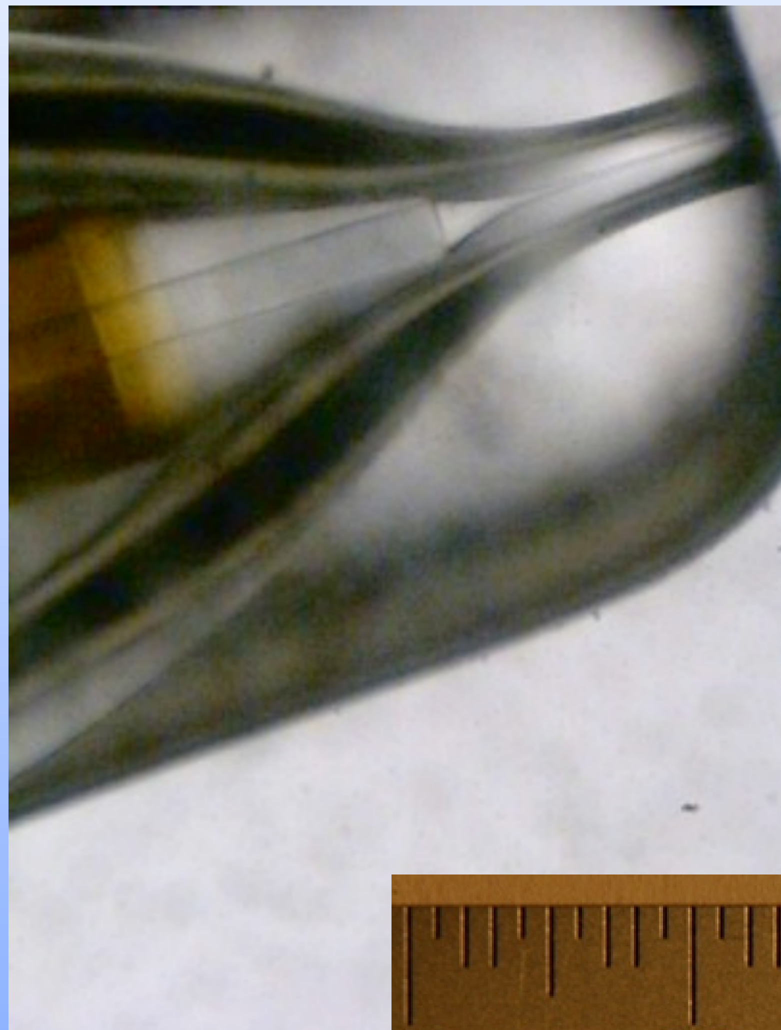
flow focusing

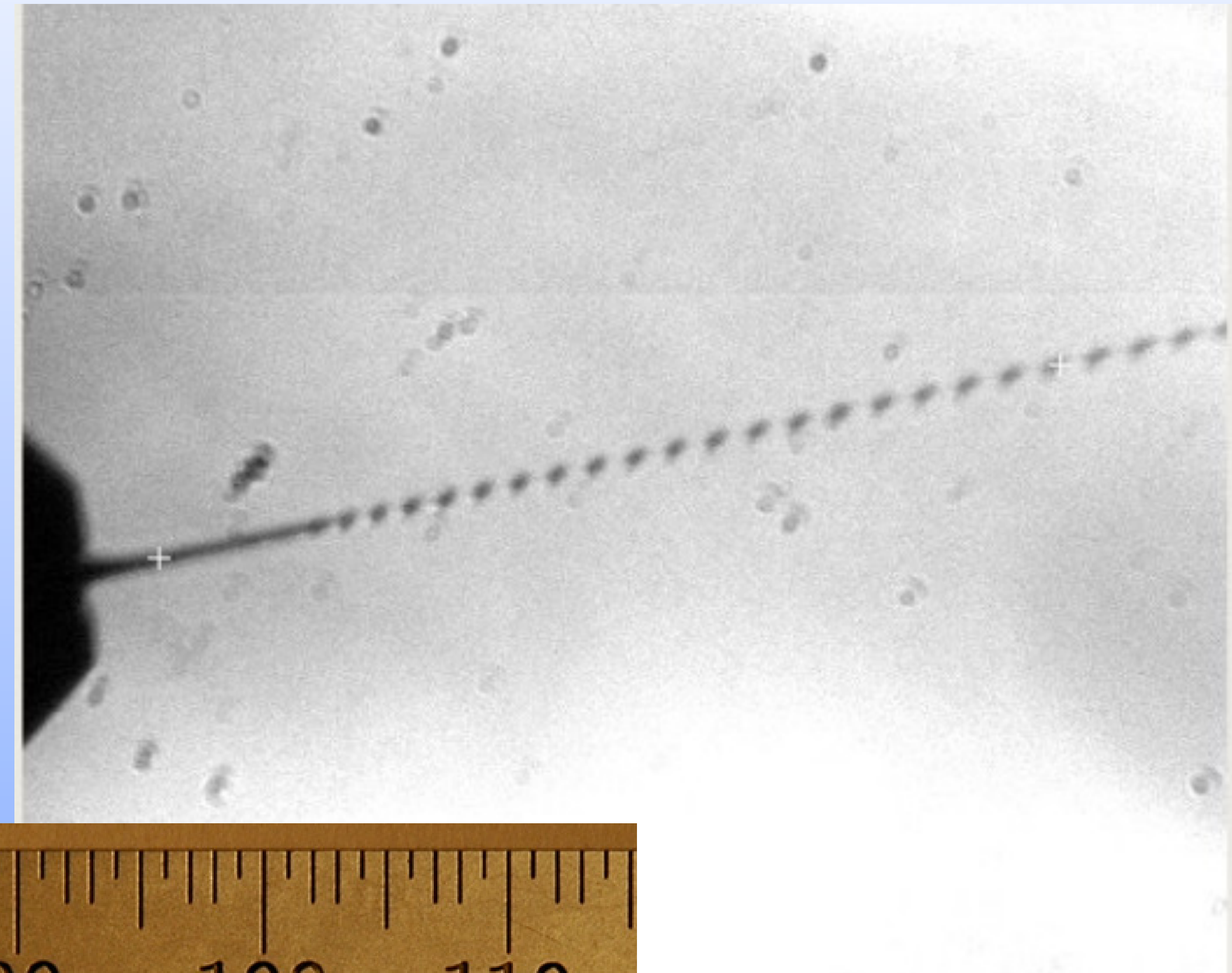


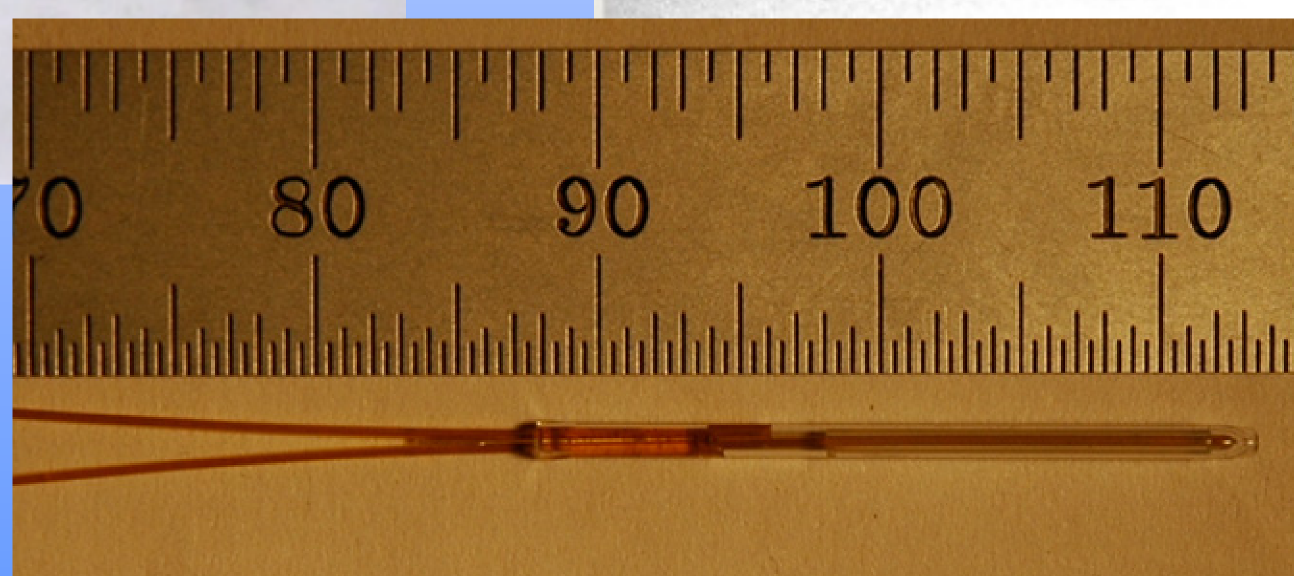


A. M. Ganan-Calvo Phys Rev Lett 80 p285 (1998)

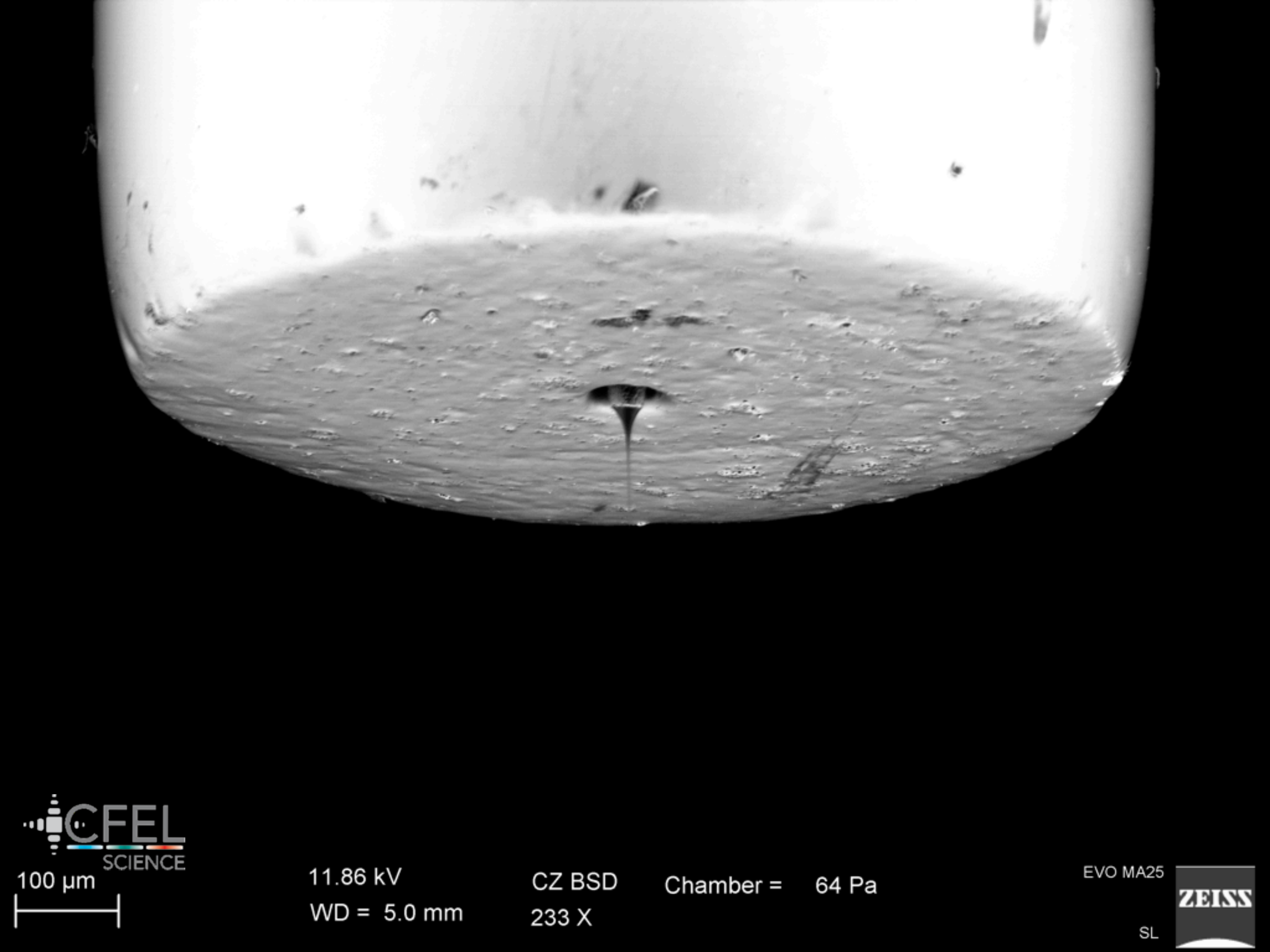
gas dynamic nozzle

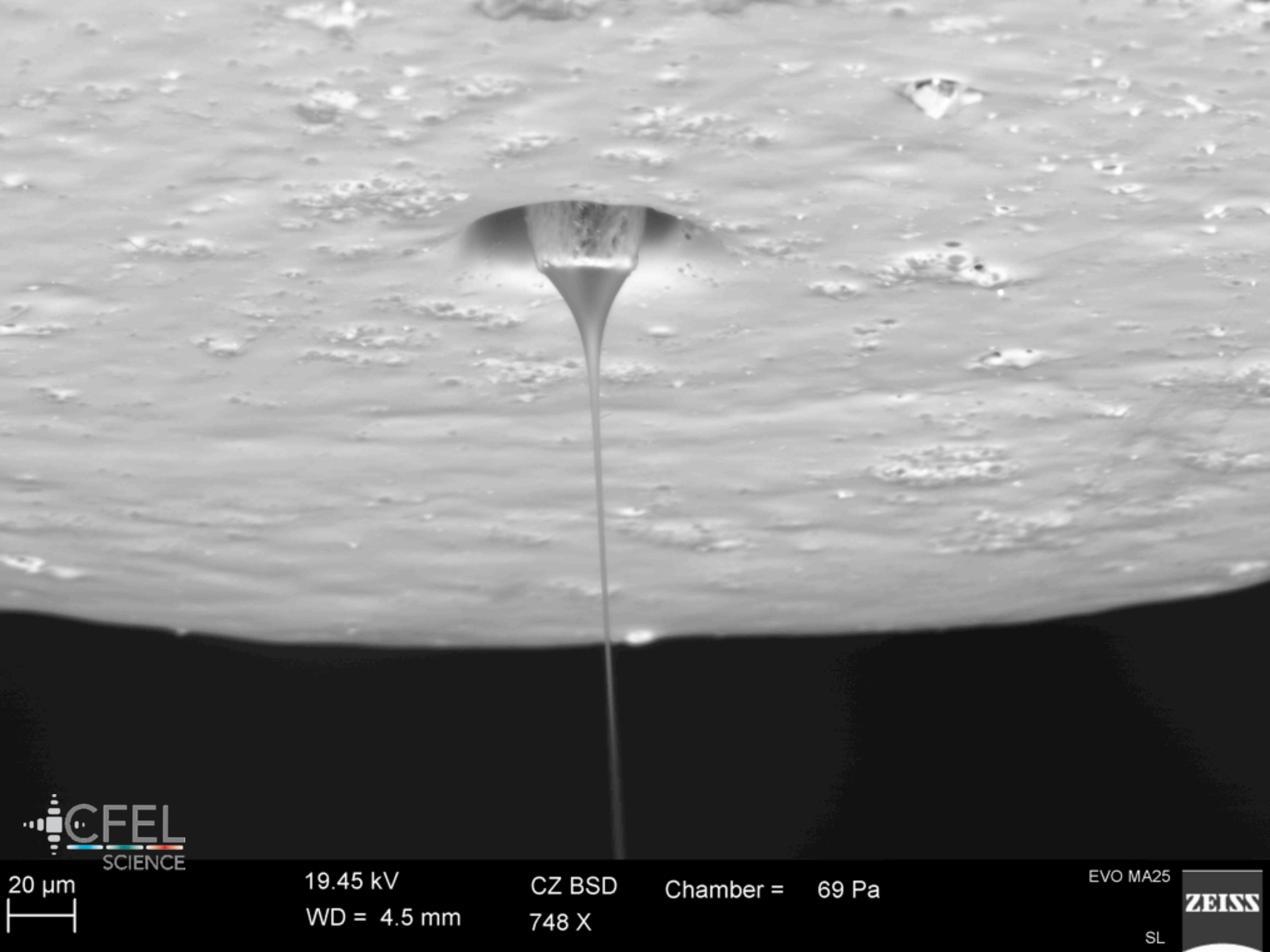


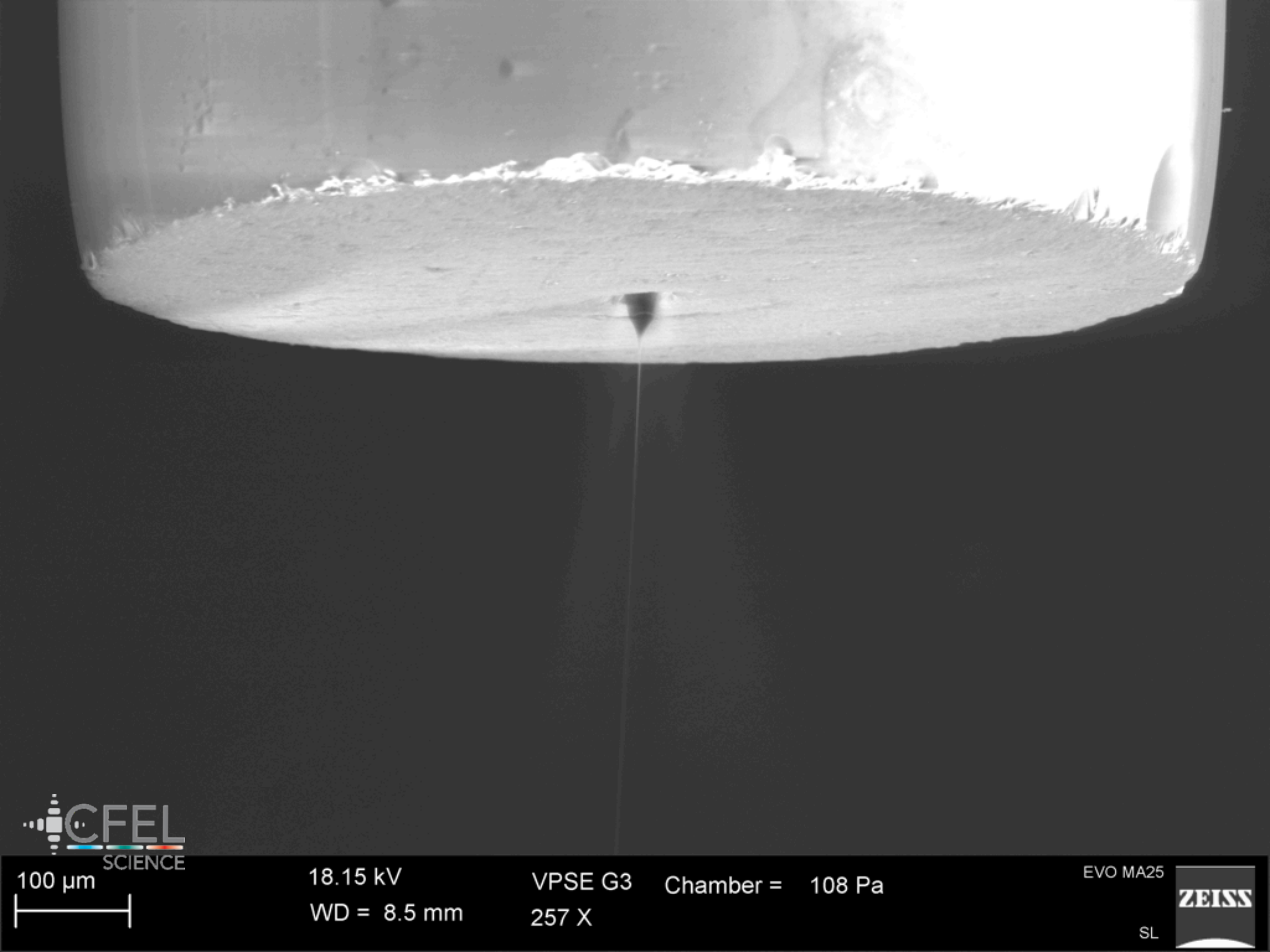


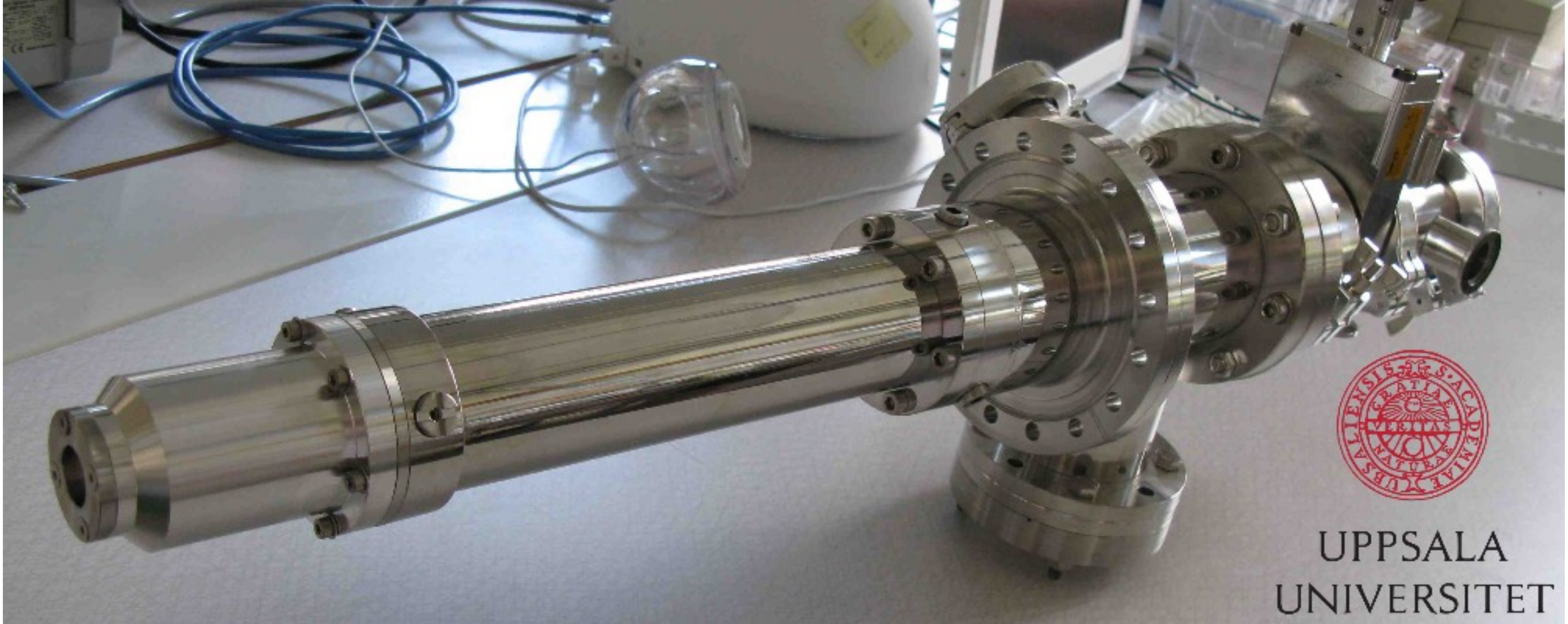


CFEL SCIENCE

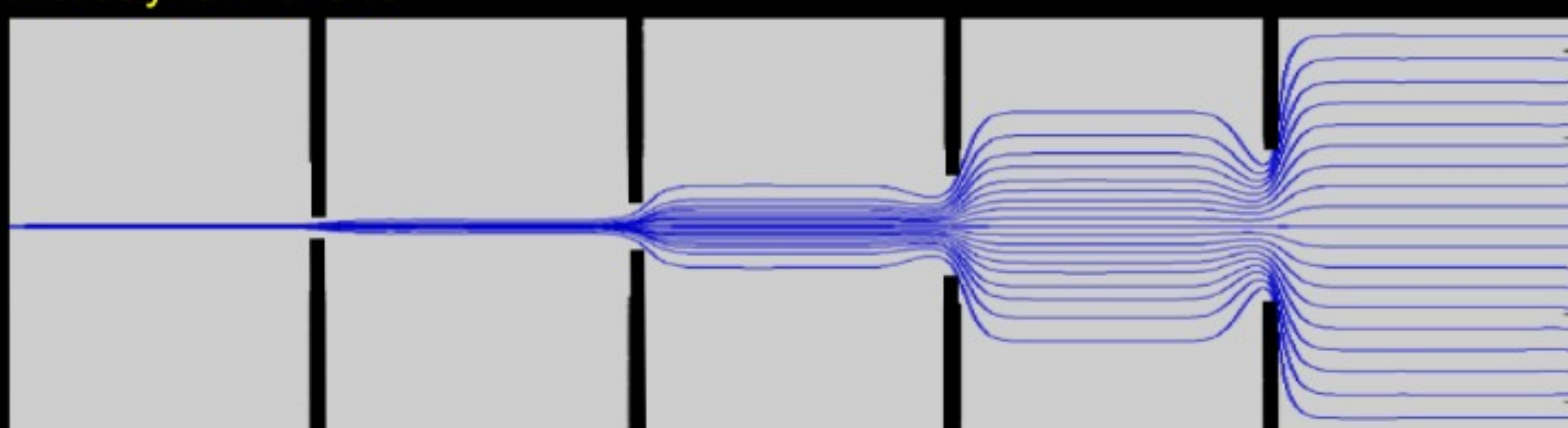

CFEL
SCIENCE
100 µm
11.86 kV
WD = 5.0 mm
CZ BSD
233 X
Chamber = 64 Pa
EVO MA25
SL
ZEISS


CFEL
SCIENCE
20 µm
19.45 kV
WD = 4.5 mm
CZ BSD
748 X
Chamber = 69 Pa
EVO MA25
ZEISS
SL


CFEL
SCIENCE
100 µm
18.15 kV
WD = 8.5 mm
VPSE G3
257 X
Chamber = 108 Pa
EVO MA25
SL
ZEISS



Aerodynamic lens



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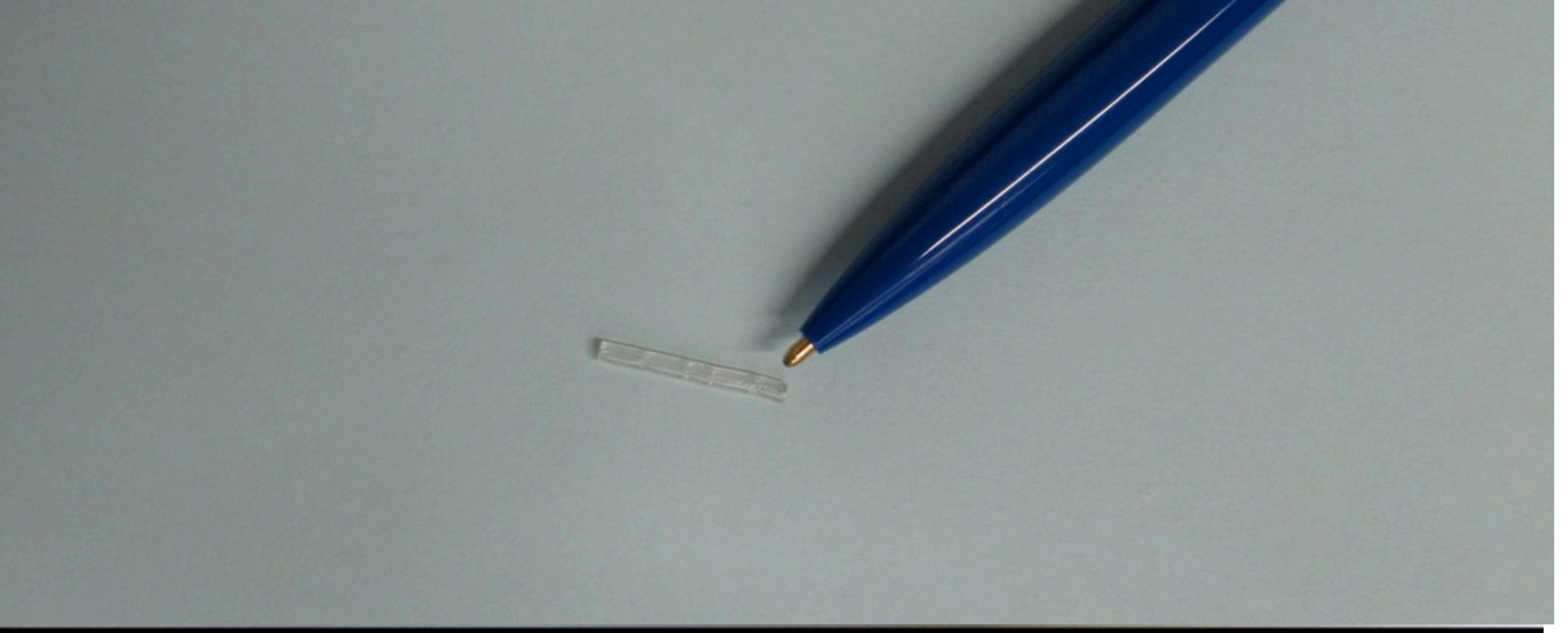
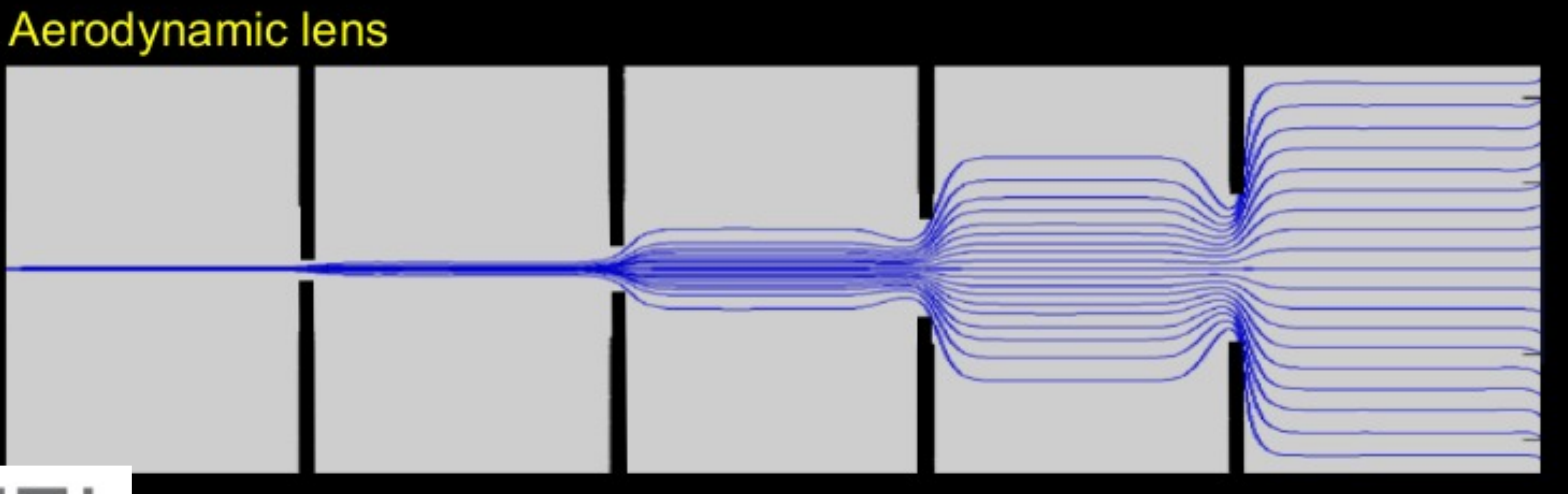
Aerodynamic lens

1D compression
high sample consumption
high hit rate
variable degree of hydration
lower gas load

CFEL SCIENCE



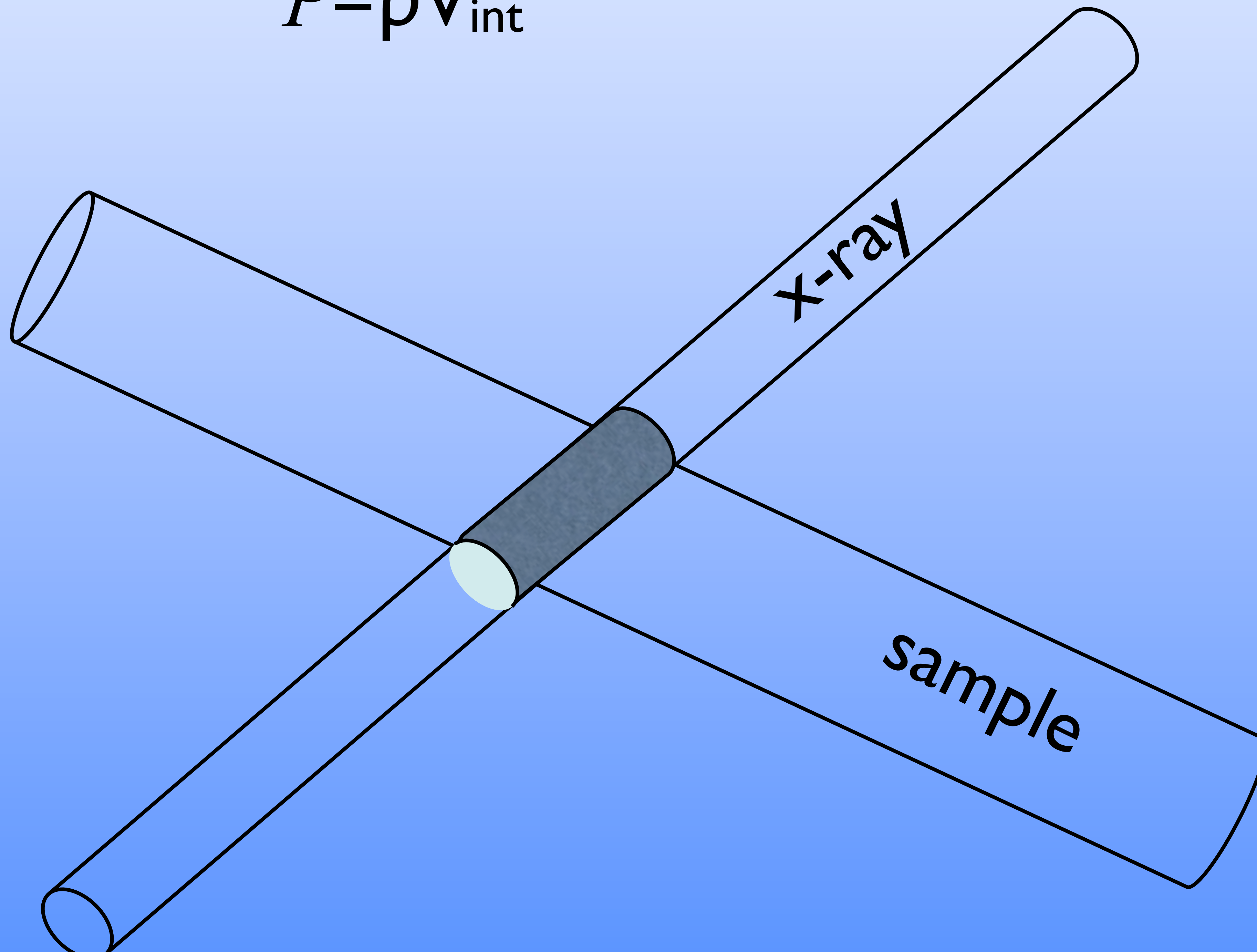


Aerodynamic lens

The probability of hitting a diffracting object with an x-ray pulse is given by the concentration of diffracting objects in the interaction volume.

$$P = \rho V_{int}$$

$$P = \frac{\dot{N} d_{fel}^2}{v d_s}$$



The probability of hitting a diffracting object with an x-ray pulse is given by the concentration of diffracting objects in the interaction volume.

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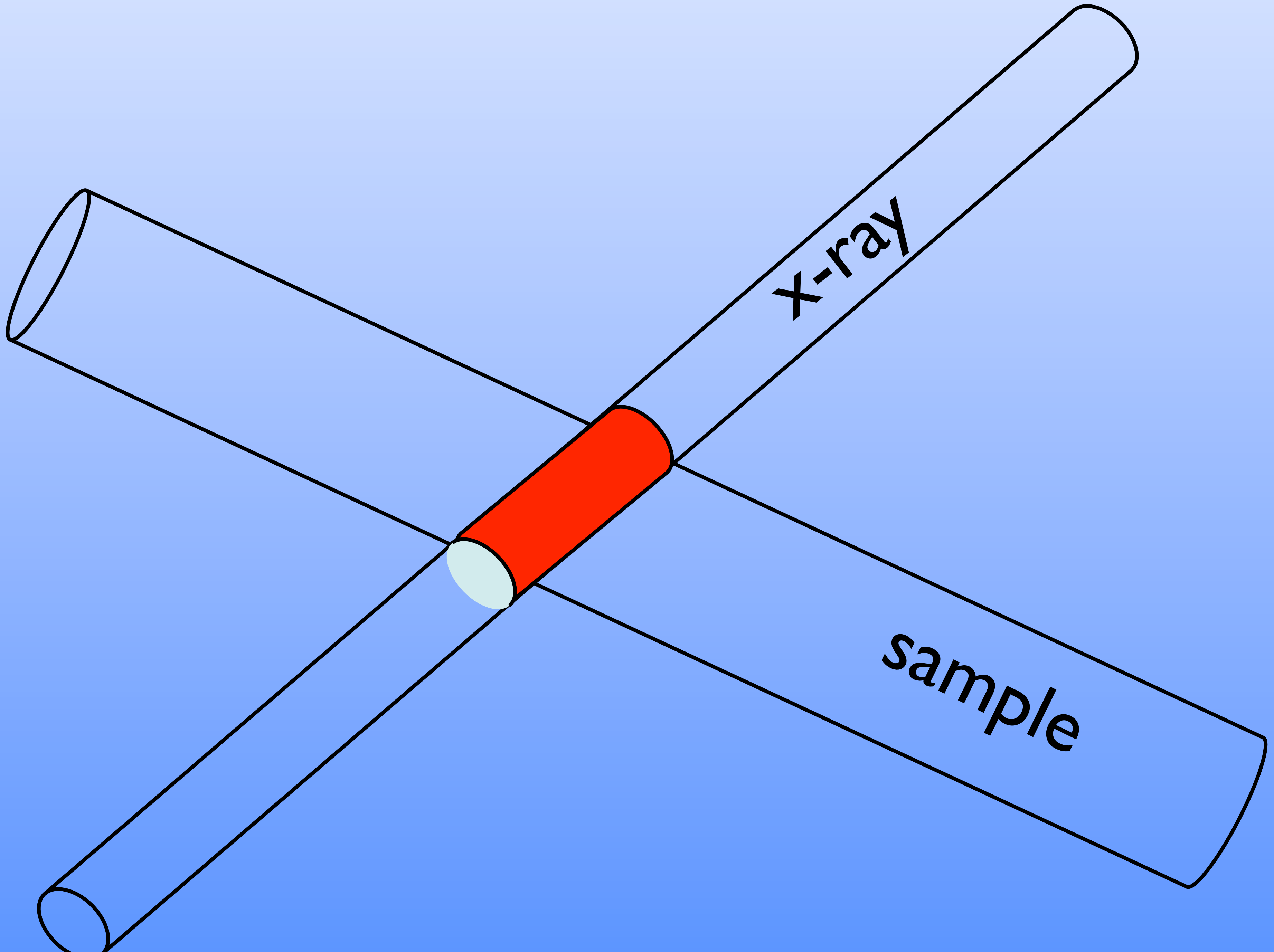
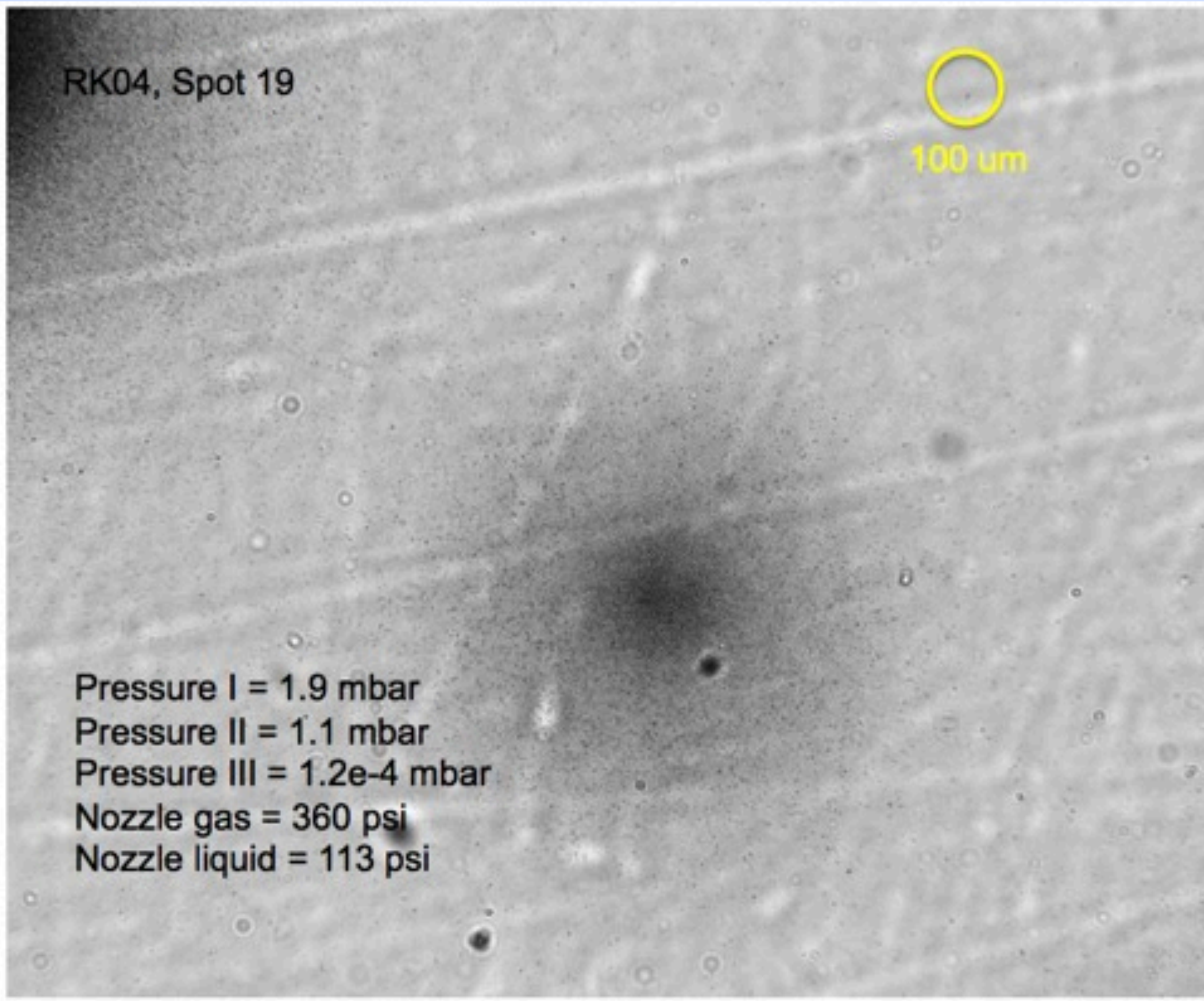
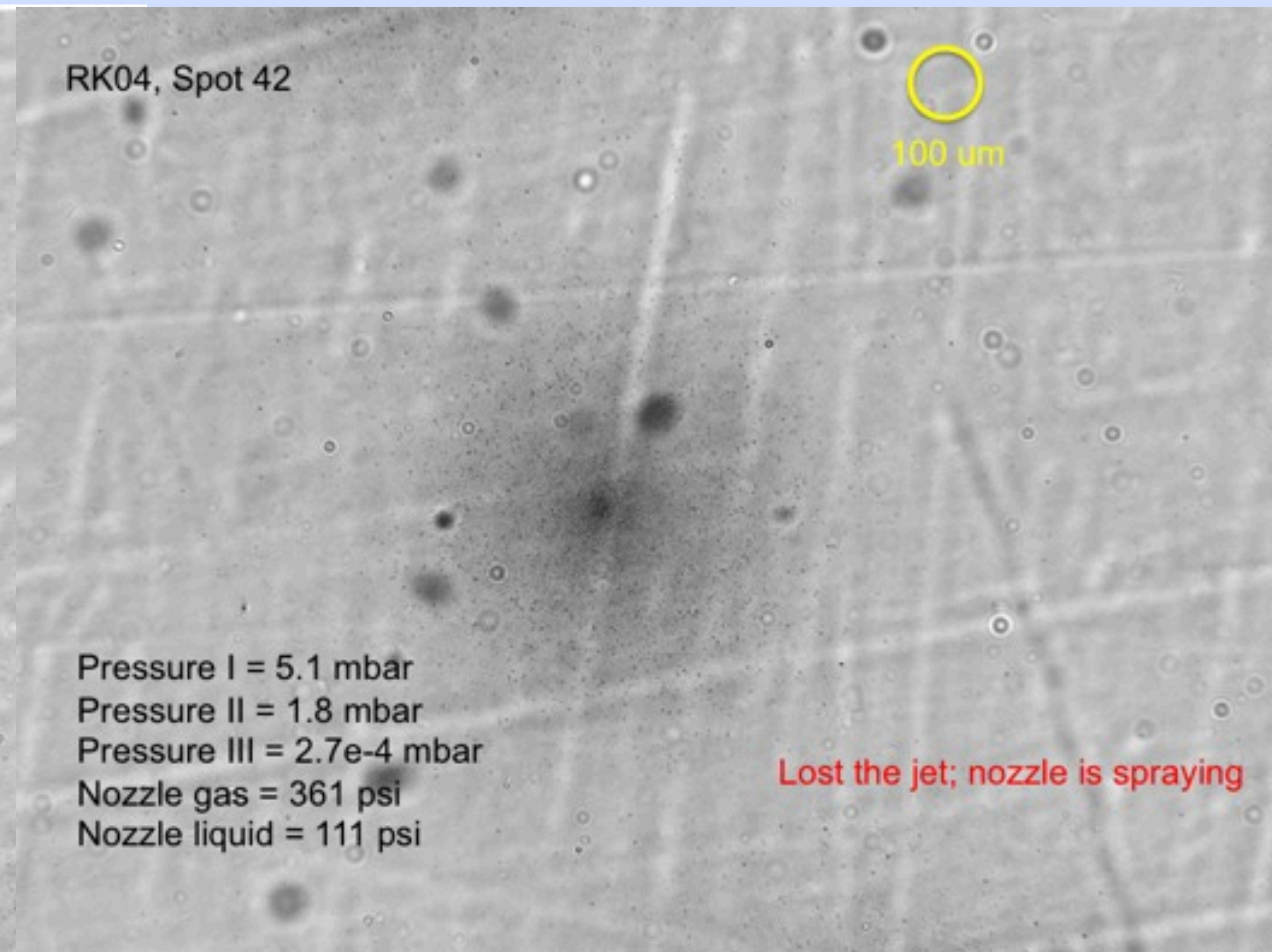
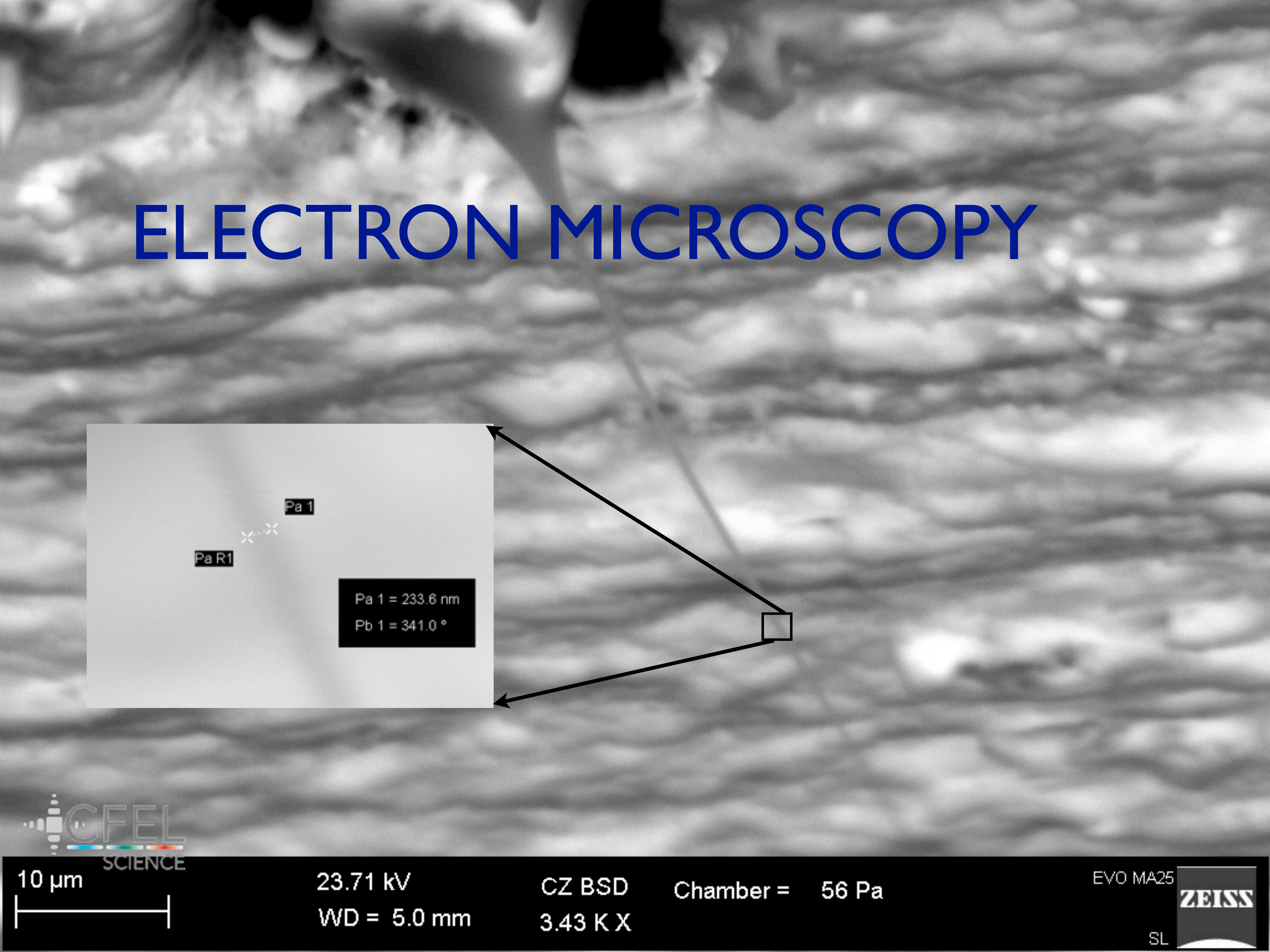


Aerolens Dusting

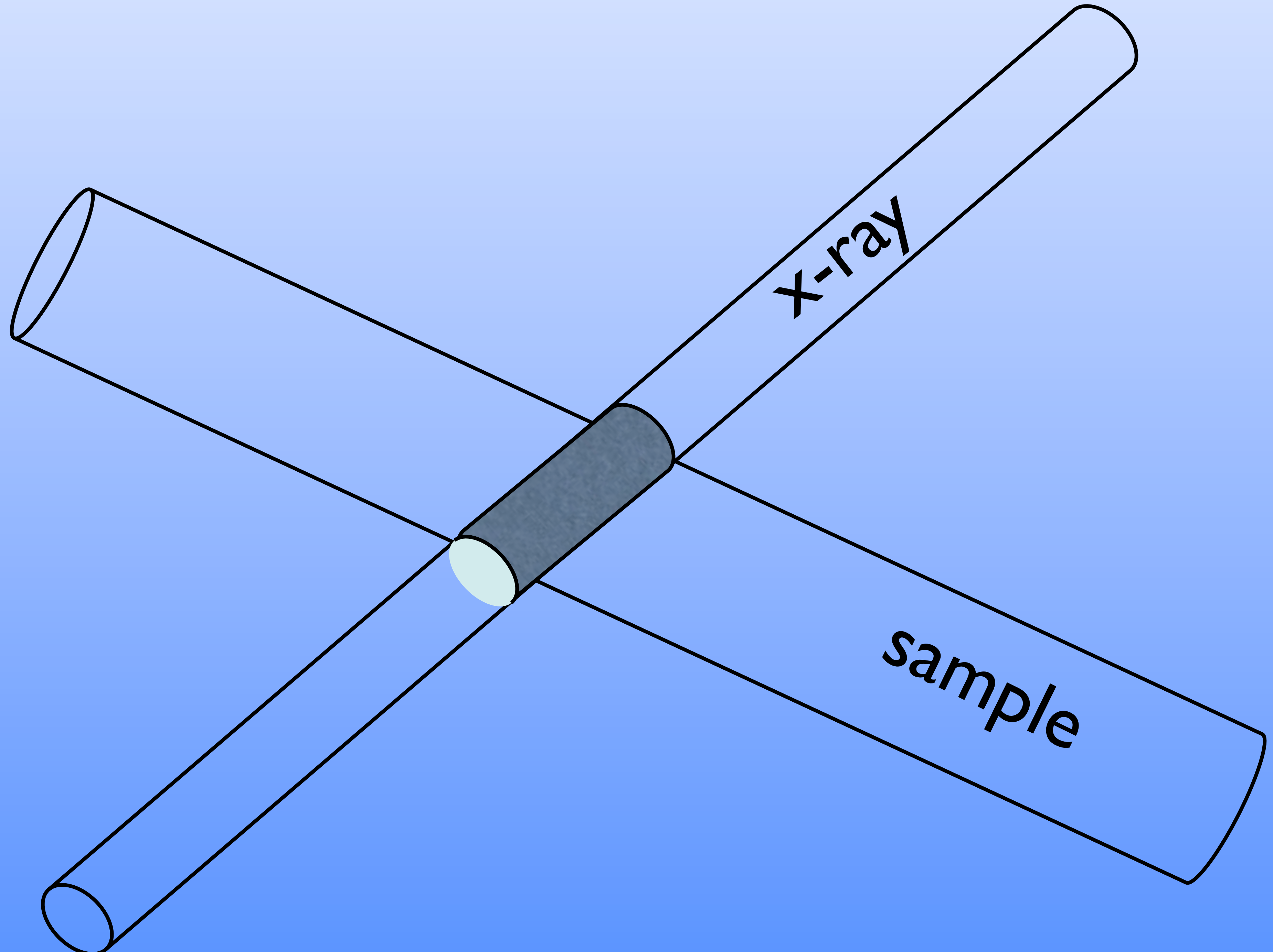




ELECTRON MICROSCOPY



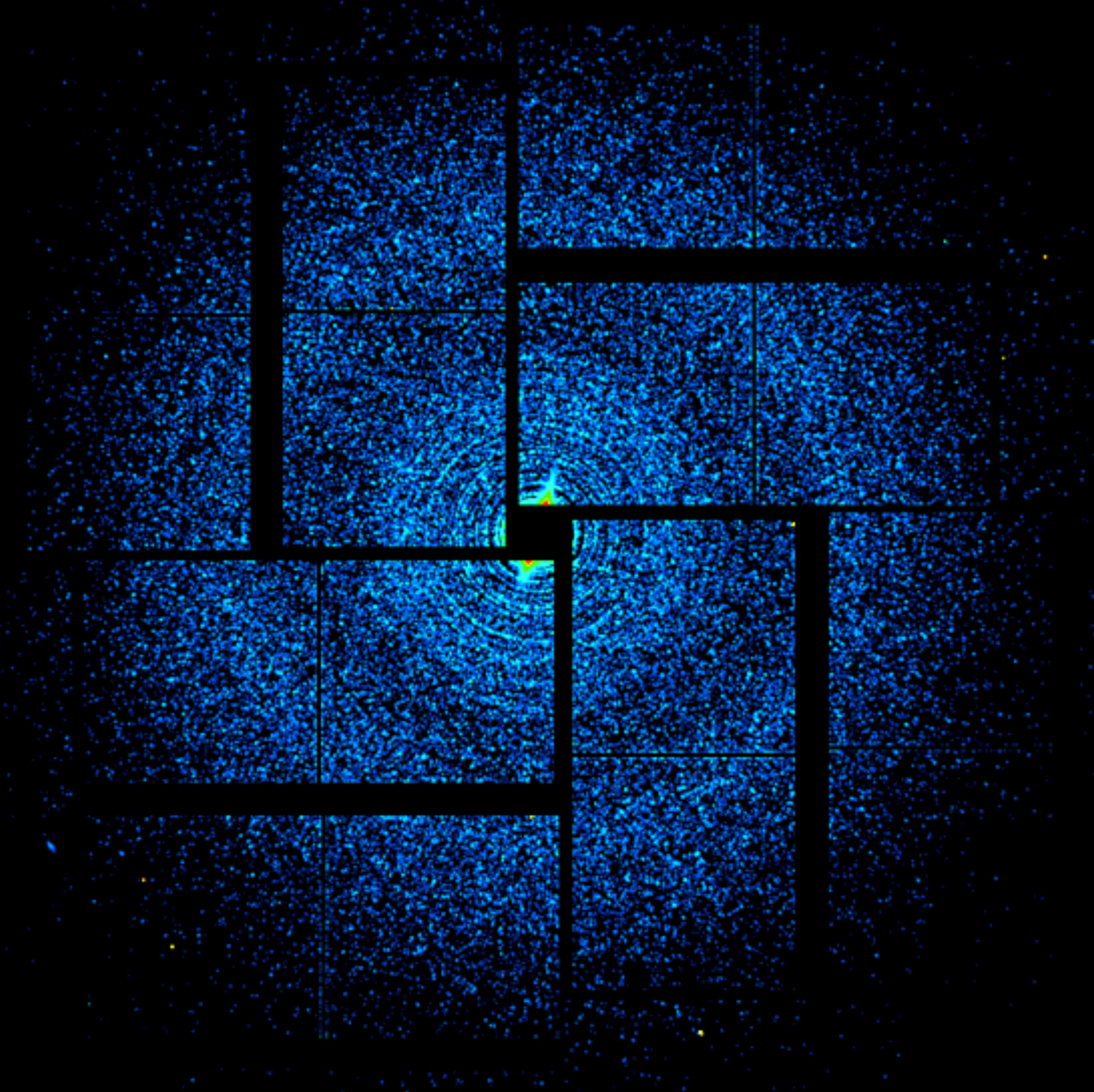
The probability of hitting a diffracting object with an x-ray pulse is given by the concentration of diffracting objects in the interaction volume.



Will it diffract?

SONICC

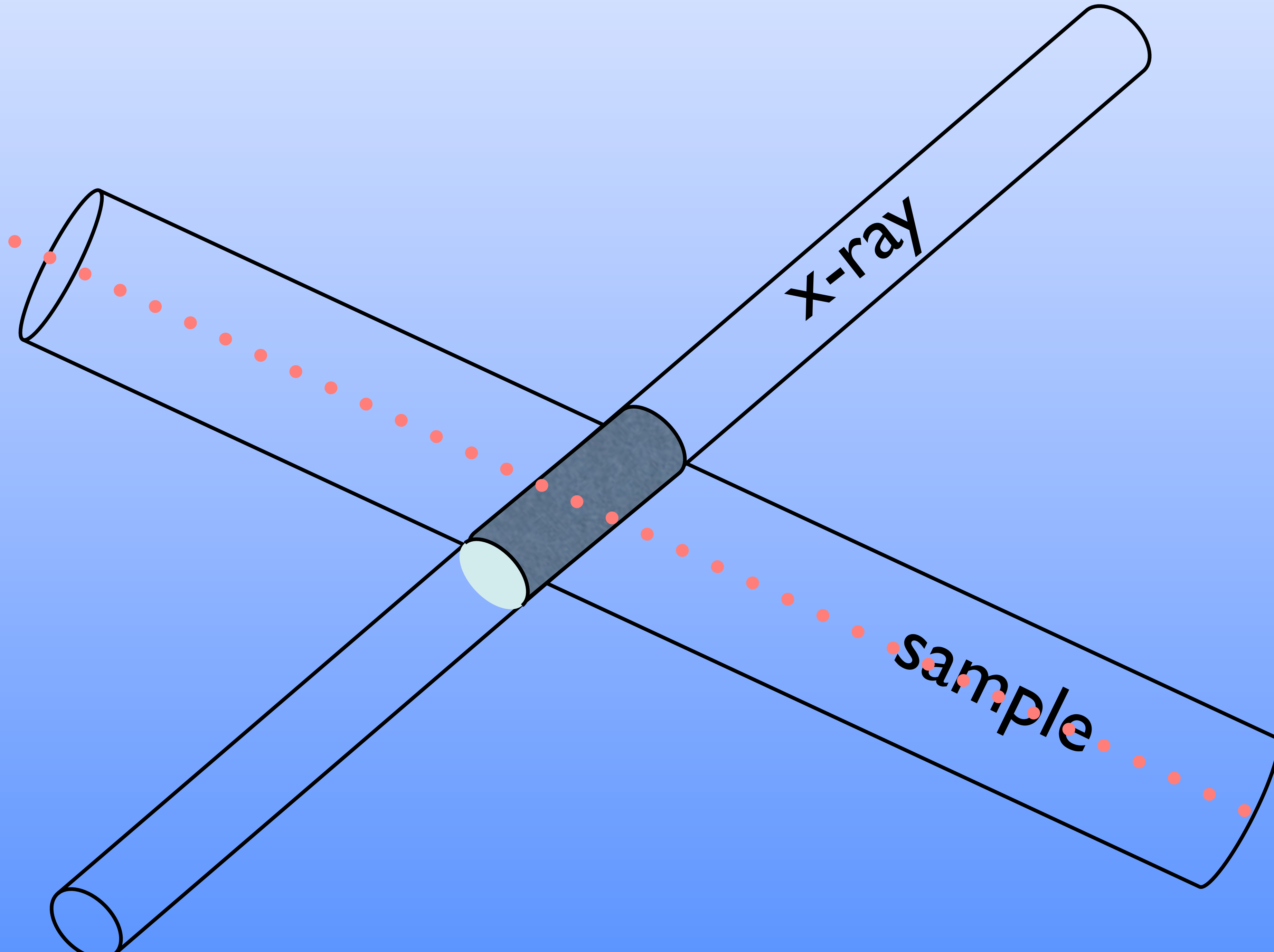
synchrotron



Cathepsin B

The probability of hitting a diffracting object with an x-ray pulse is given by the concentration of diffracting objects in the interaction volume.

DLS
Video Tracking



Hit Rates

14% RC_{vir} in sponge phase (CXI, jet)
1% PSI (CXI, jet)
10% PSII (CXI, jet)
10% catB (CXI, jet)
40% Mimi (AMO, lens)
2% (FLASH, lens)
30% maximum possible (single)

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Sample consumption =

flow rate x concentration x hits needed/hit rate

Sample consumption =
flow rate x conc x hits needed / hit rate

Approximately:

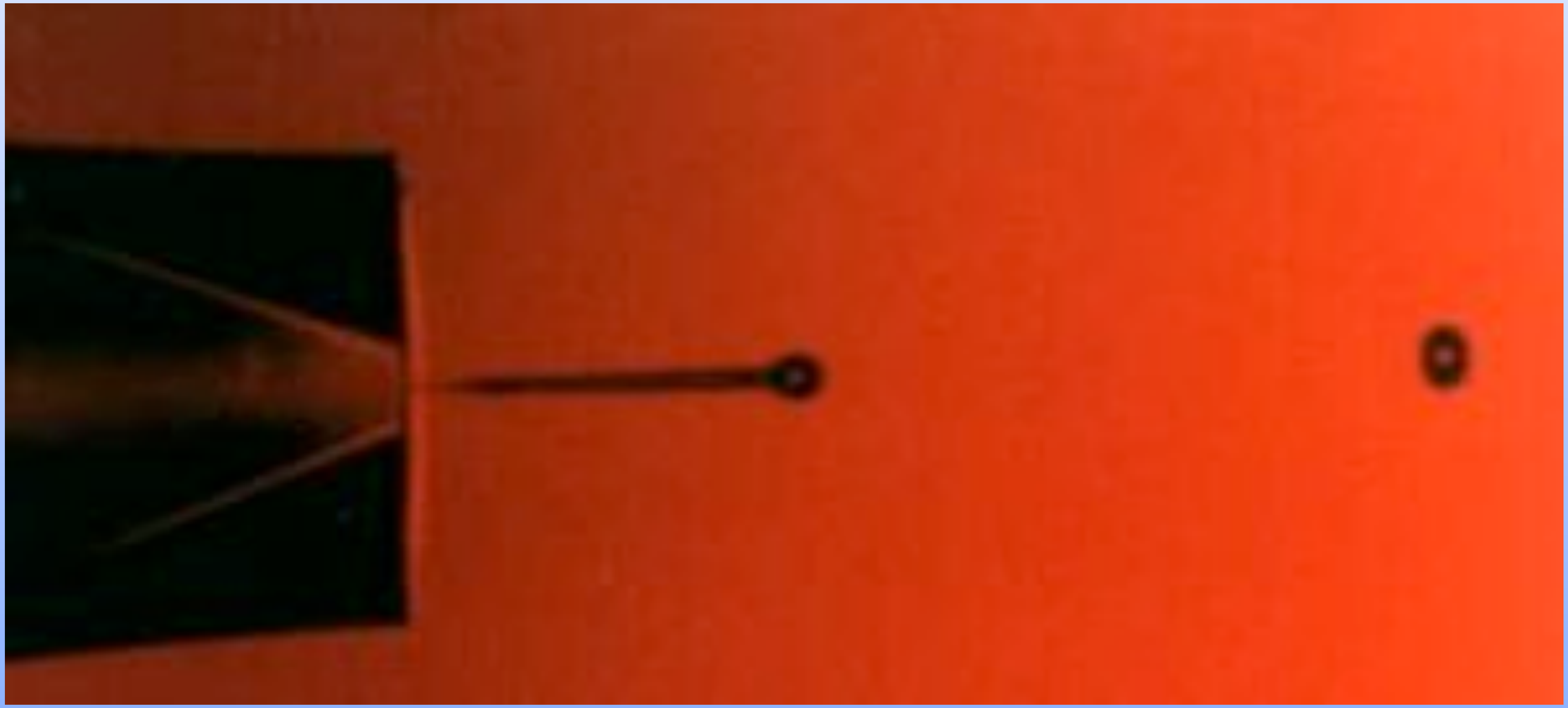
$100 \mu l/min$ Rayleigh jet

1-15 µl/min for PSI with PEG

1 µl/min for a ~1µm jet

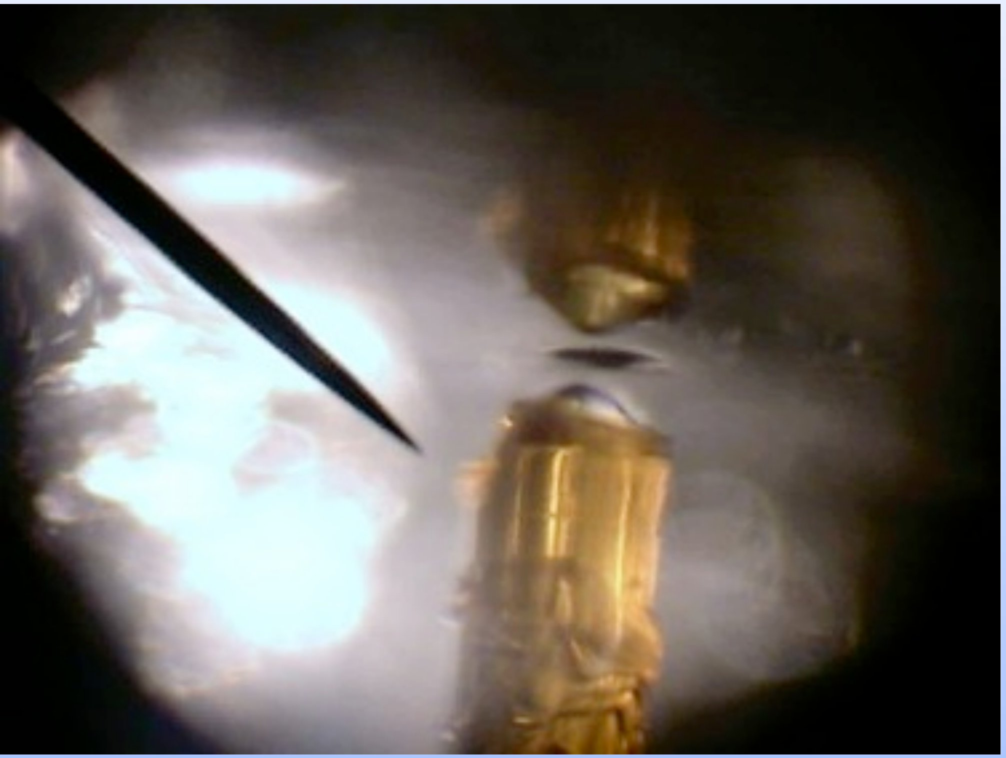
0.1µm/min for DOD 120Hz

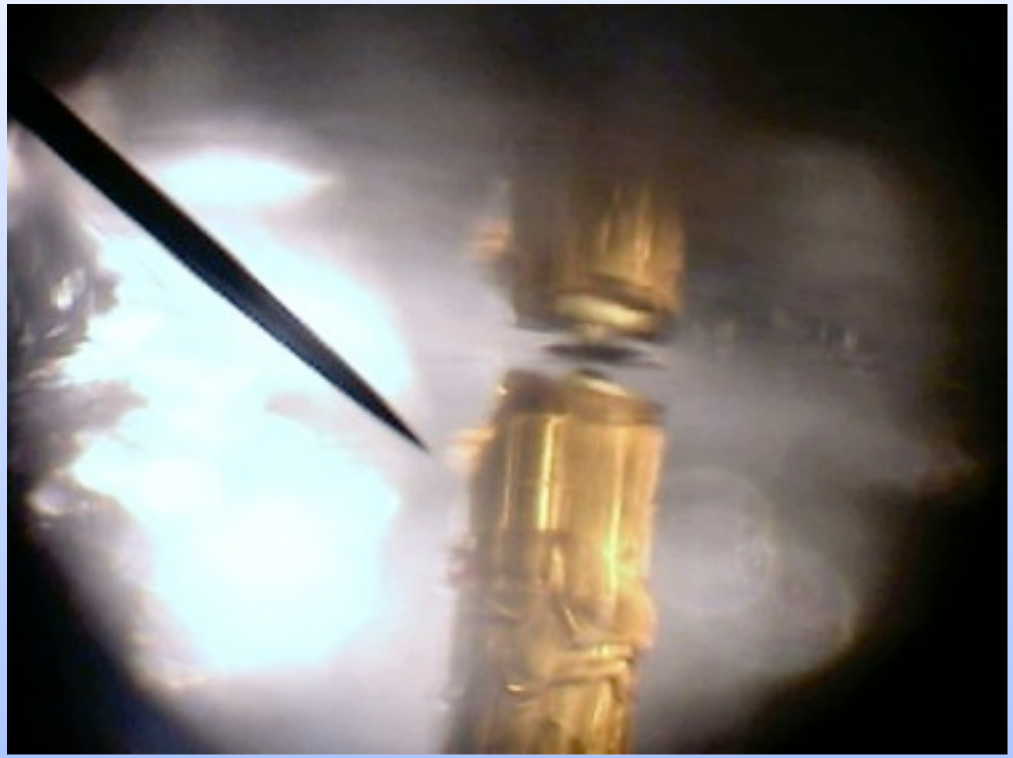
Drop on Demand

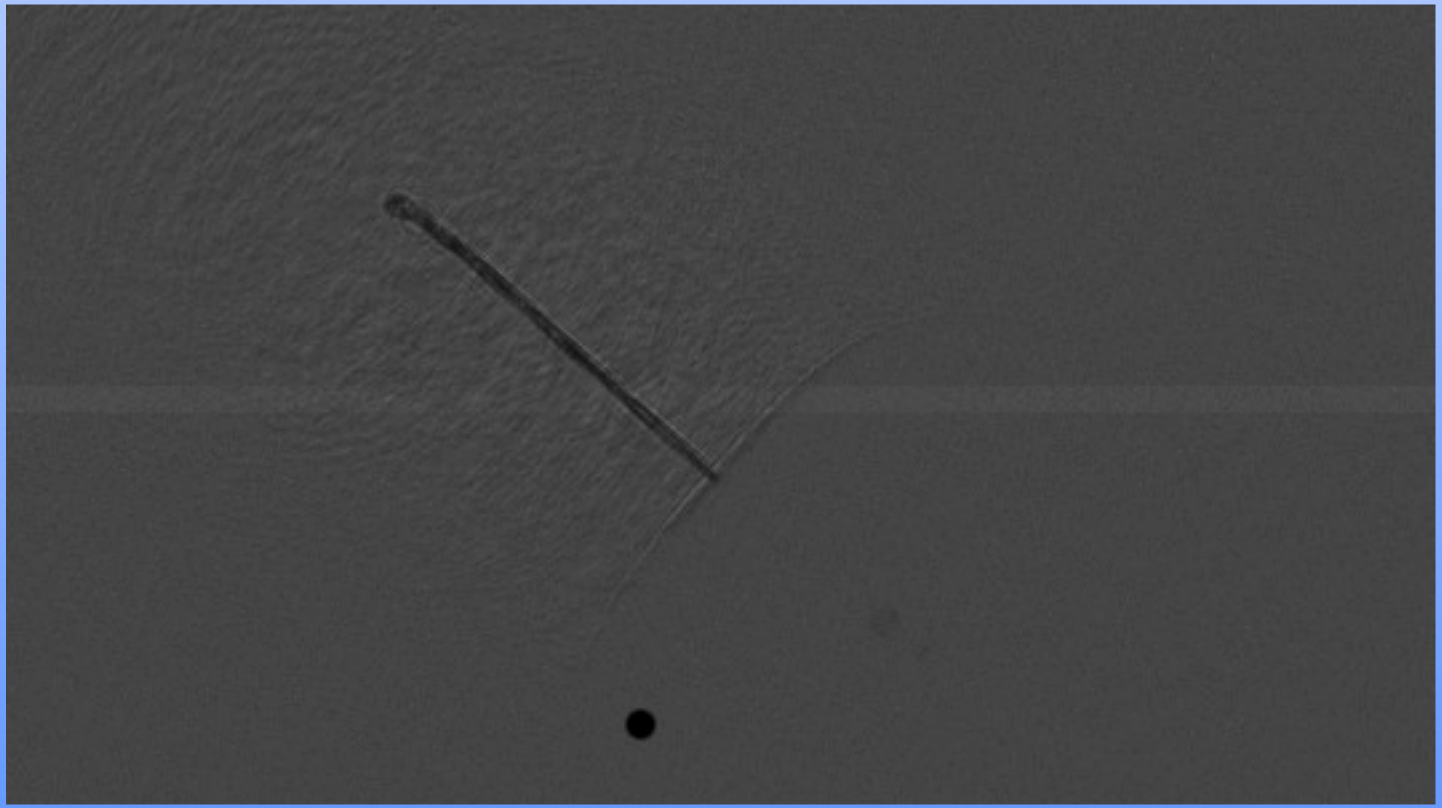


Microfab Technologies Inc.

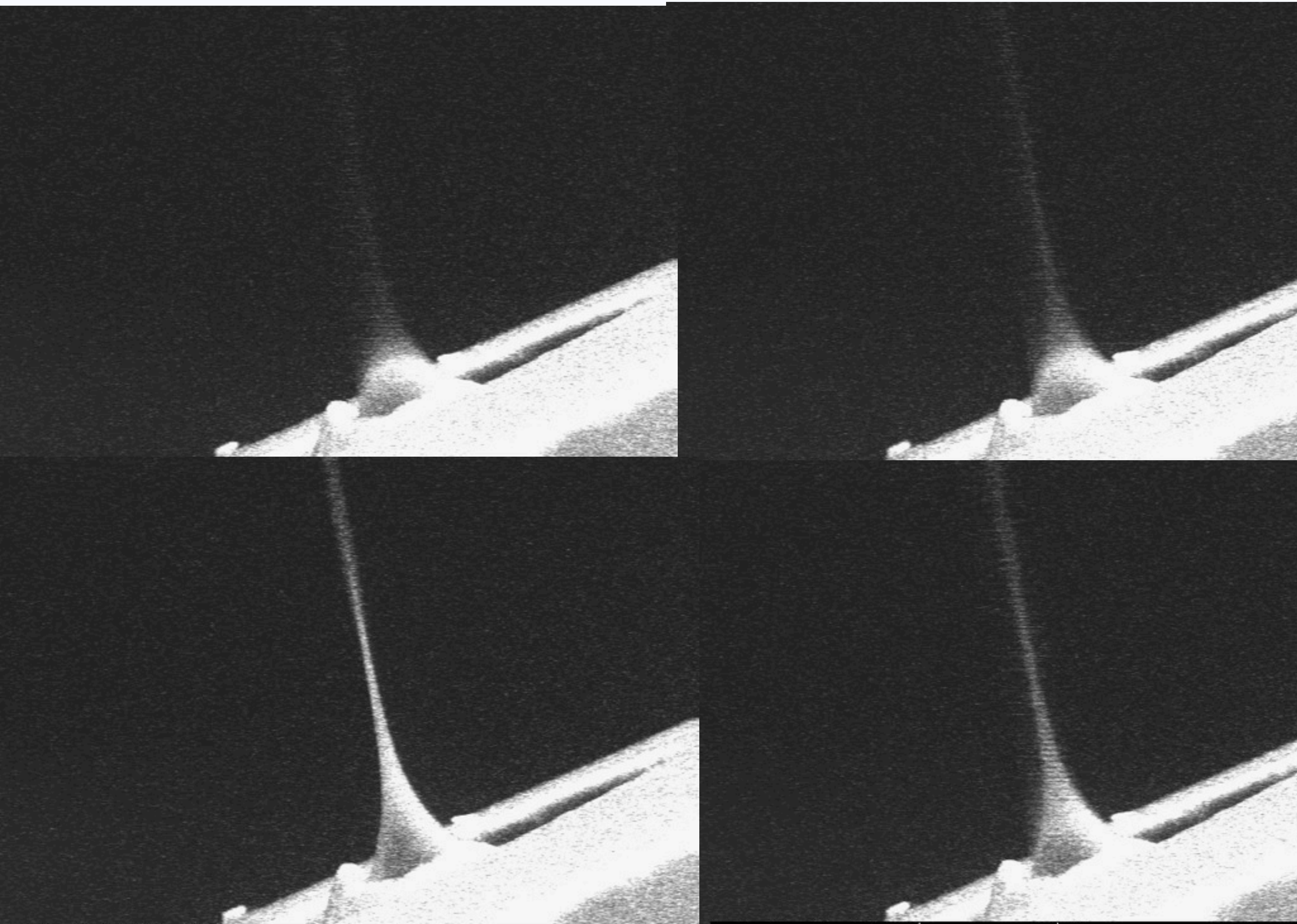
Complex dripping







DePonte, Weierstall, Doak   ASU 2007



Sample consumption =
flow rate x conc x hits needed / hit rate

small crystals F x S $\otimes$ L

single shot => partials

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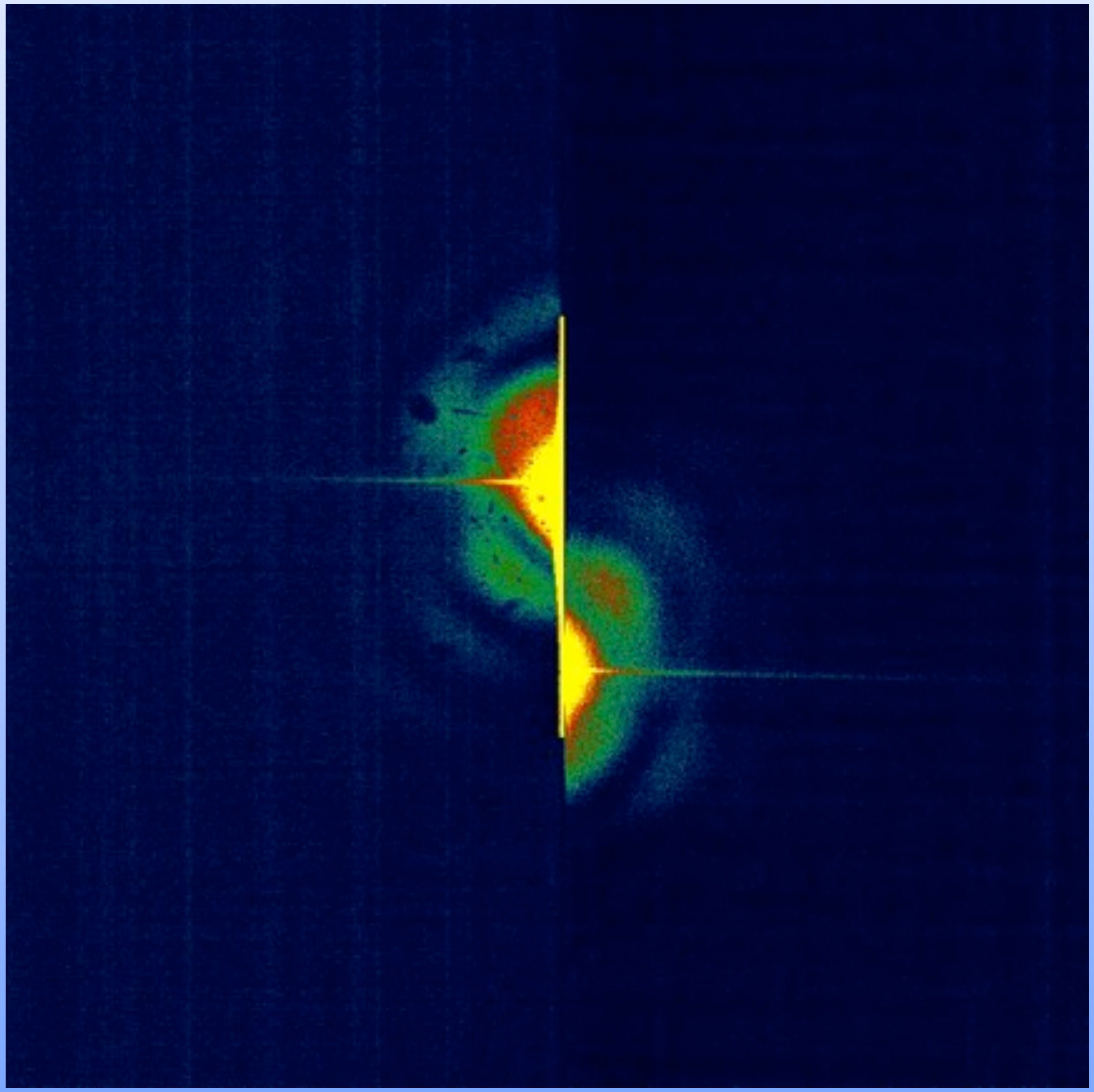
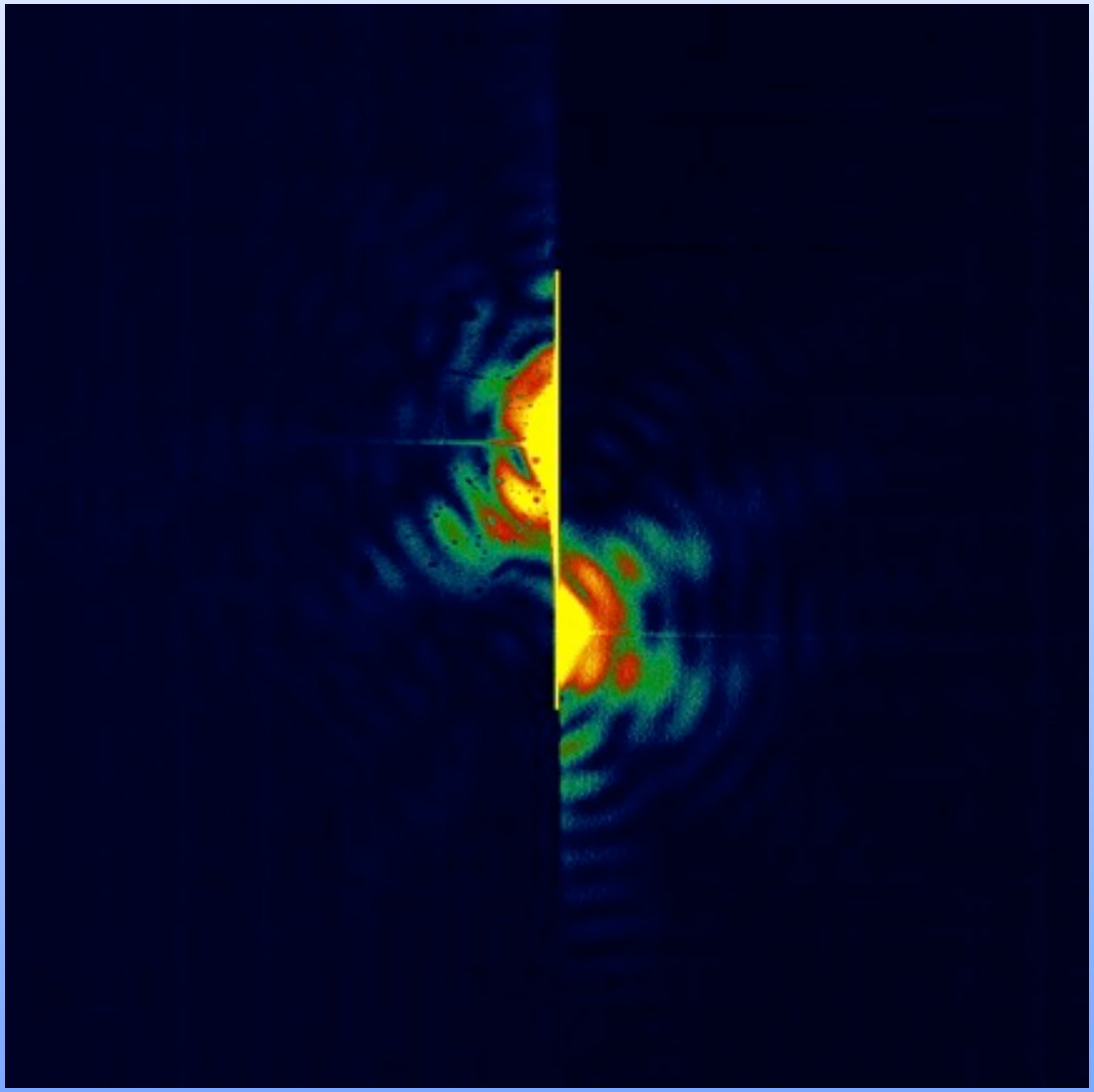
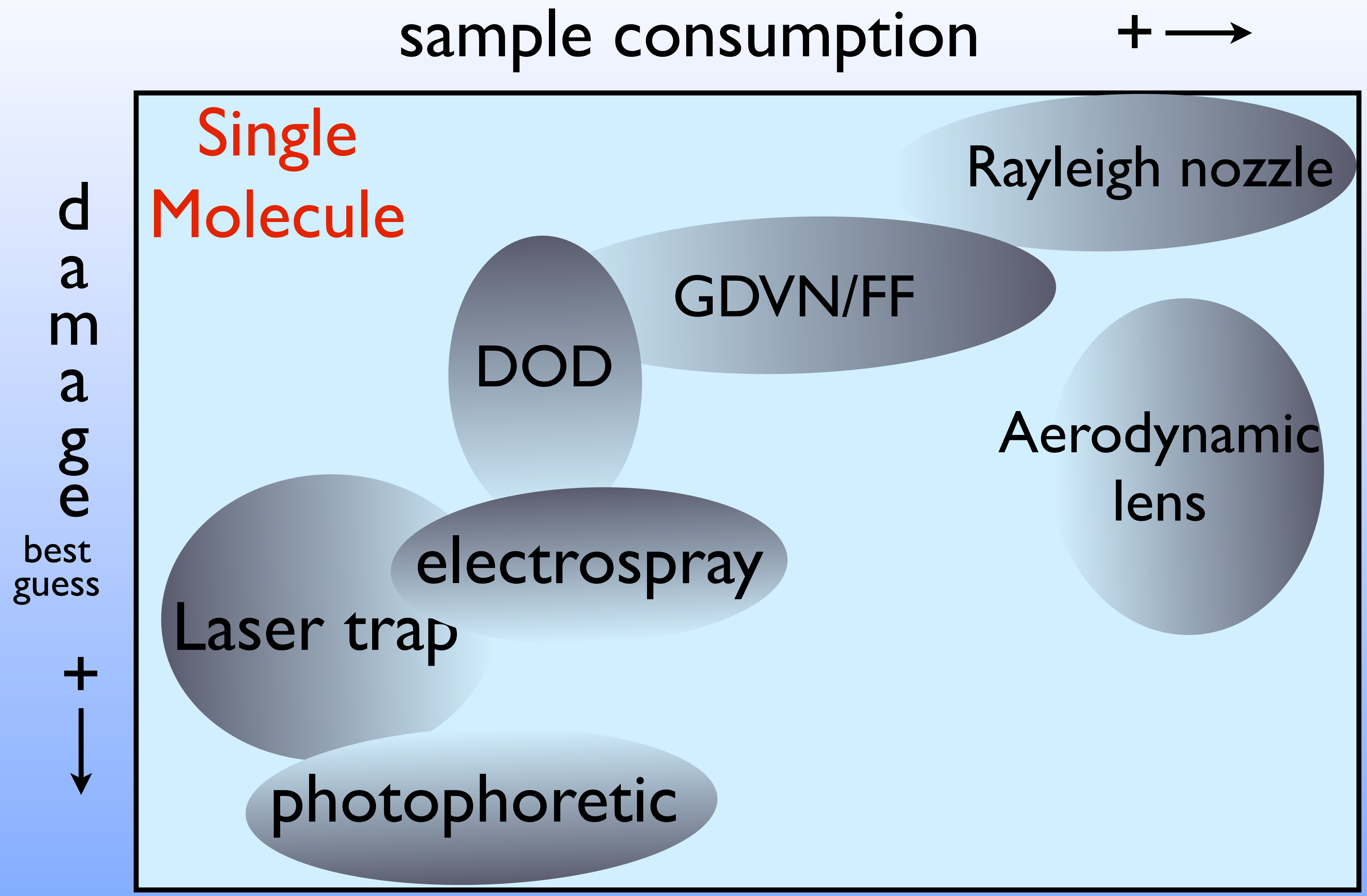
Sample homogeneity





Mimi at FLASH 2011


sample consumption
+ ⟶
d
a
m
a
g
e
best
guess
+
↓
Single
Molecule
Rayleigh nozzle
GDVN/FF
DOD
Aerodynamic
lens
electrospray
Laser trap
photophoretic