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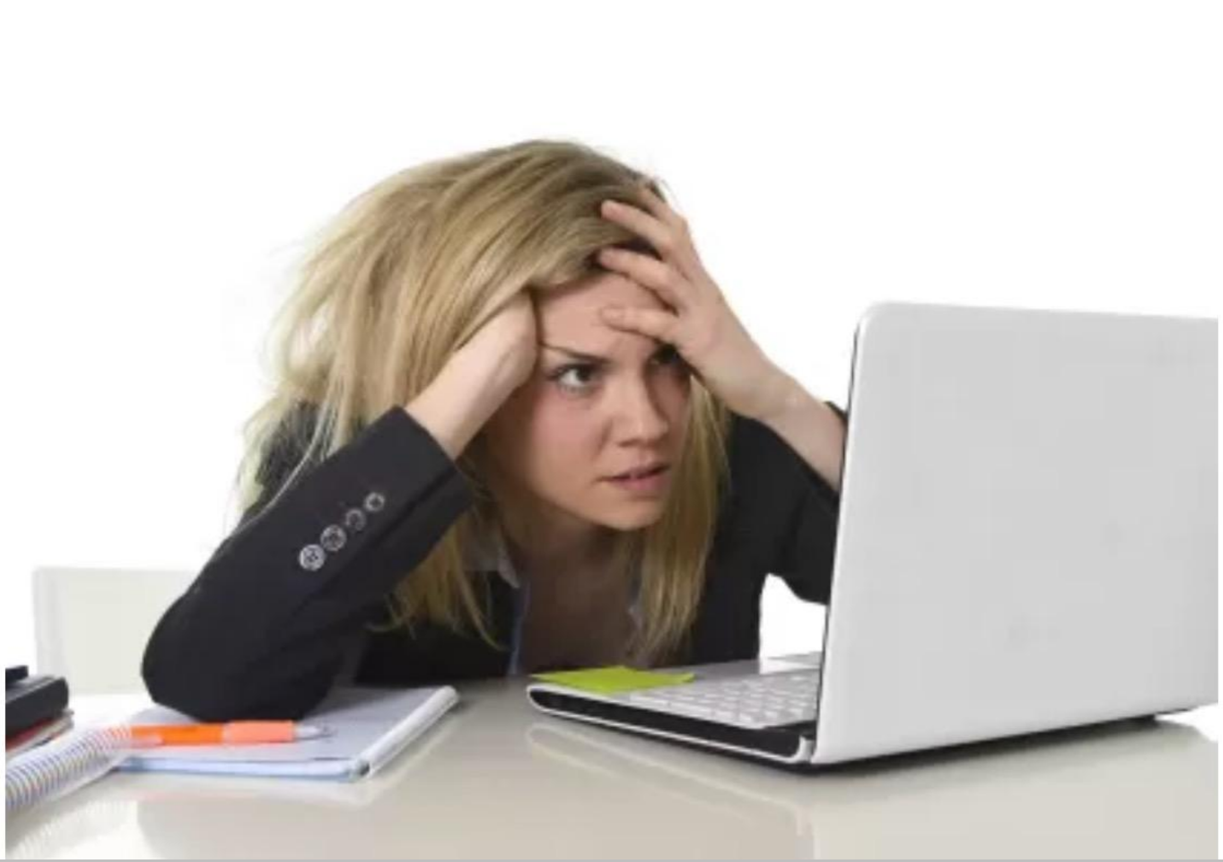
# The effects of microstructure on detonation wave spreading in nanoparticle TATB

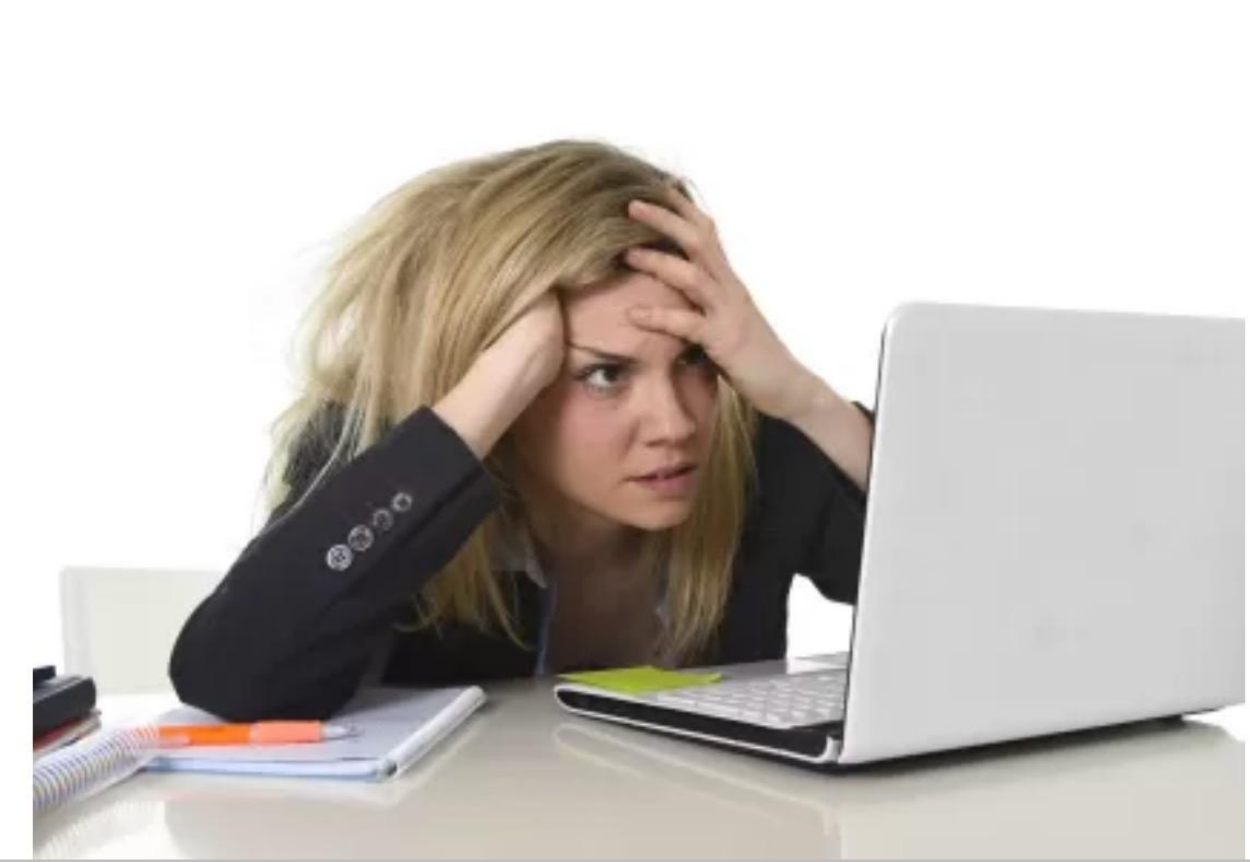
Presenter: Ryan R. Wixom

Contributors:
SNL: Joseph Olles, Robert Knepper, Cole Yarrington, David Damm, Pat Ball
ARDEC: Victor Stepanov, , Rajen Patel

# We need to talk about your performance….    !!!



# We need to talk about your performance….    !!!



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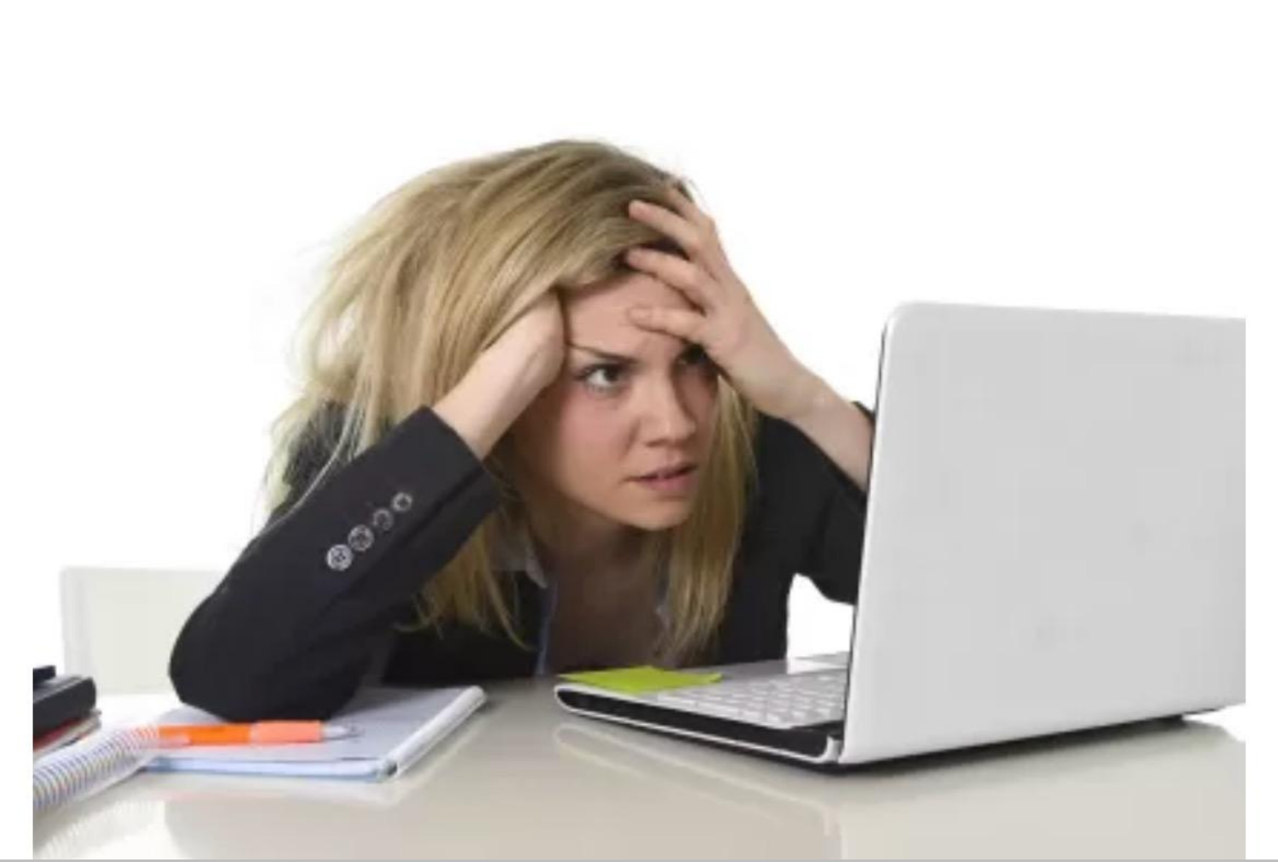
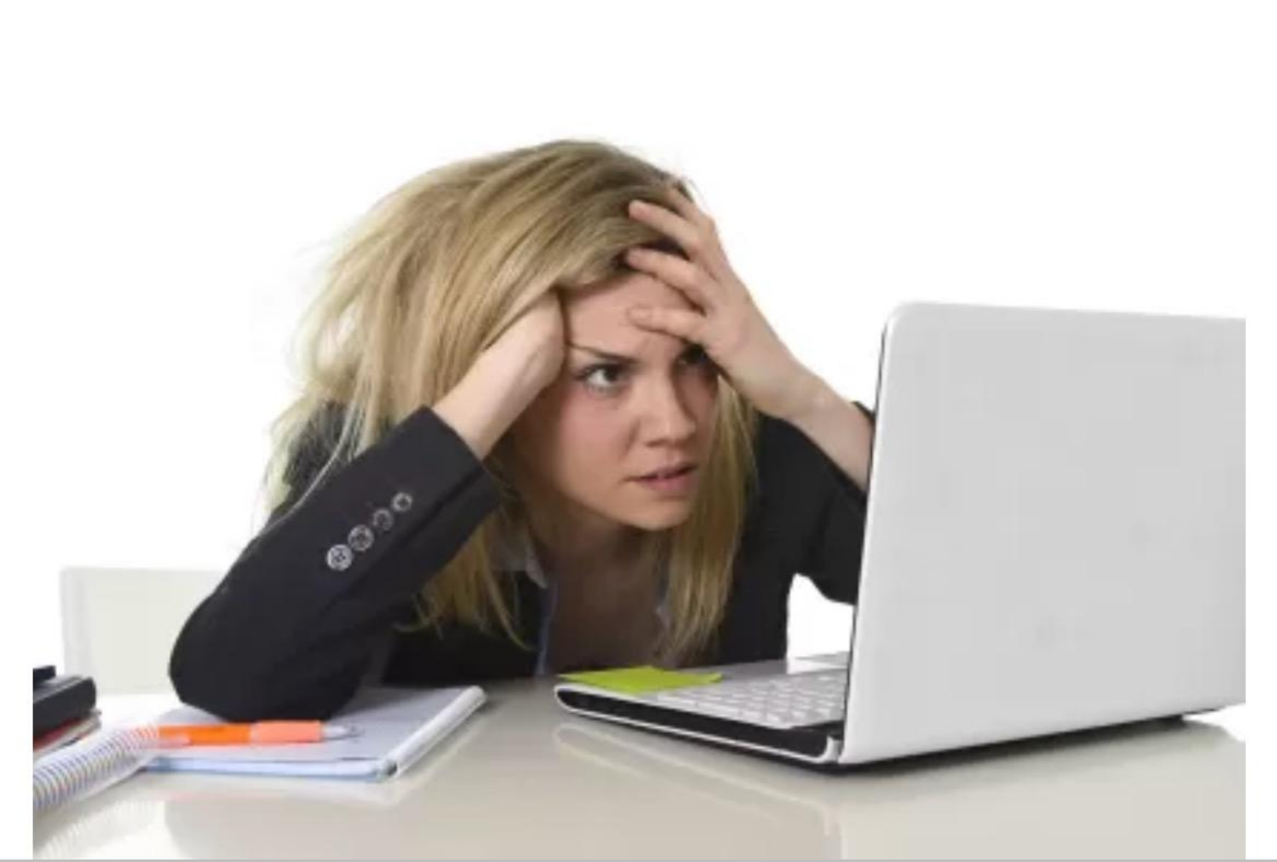
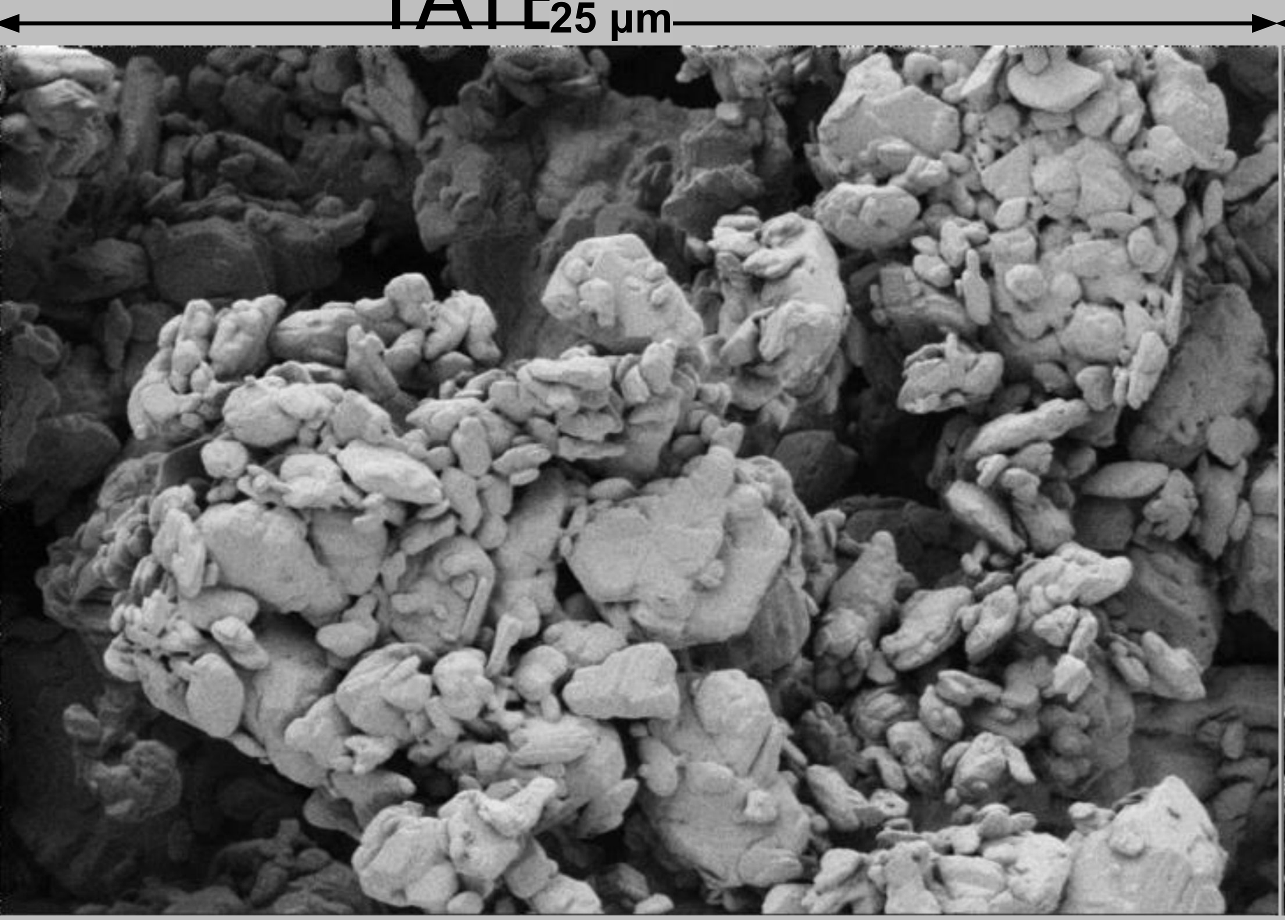


# We need to talk about your performance…. !!!

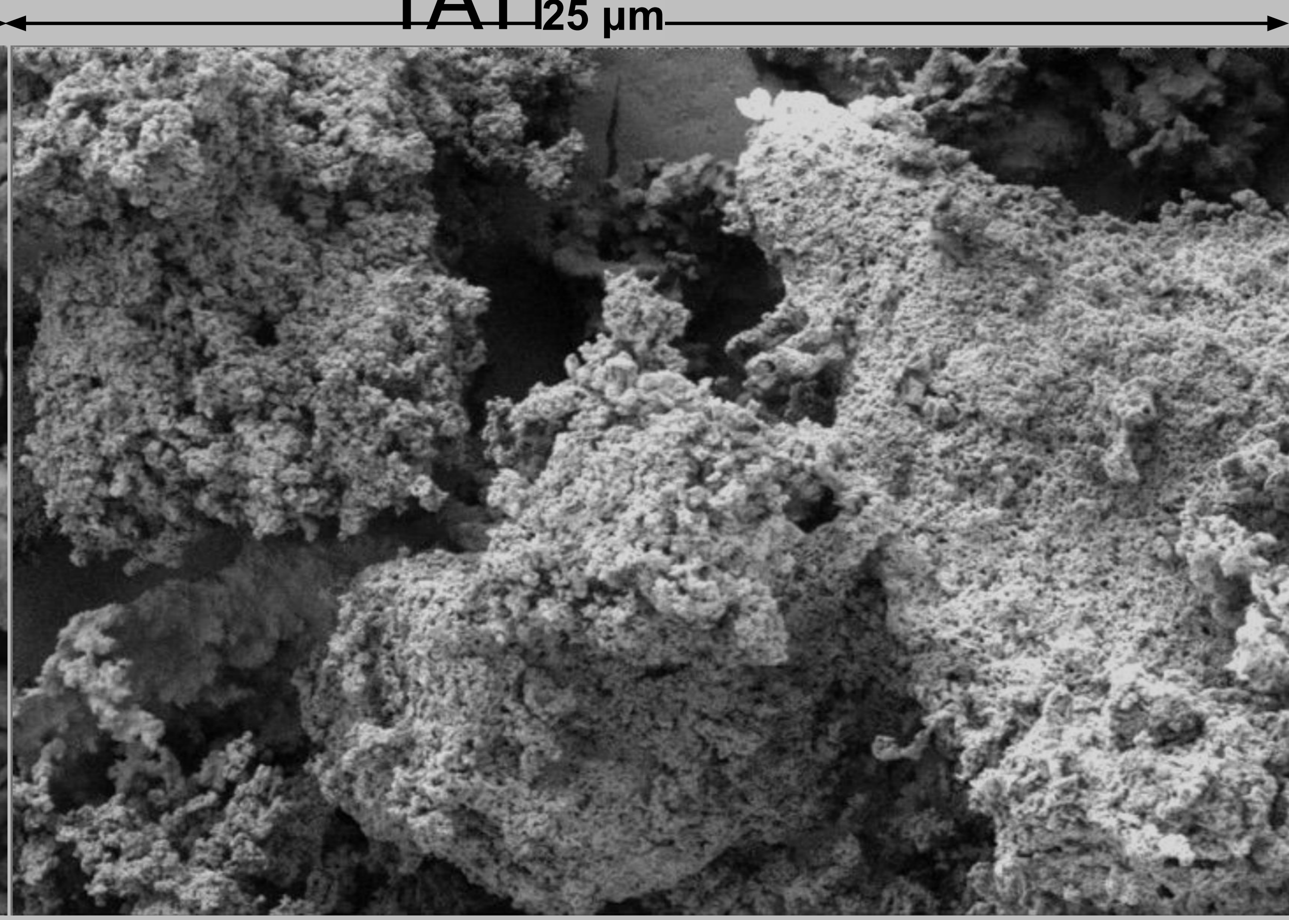


TATB of cars

ultrafine TATB




nano TATB




Buckets and buckets of this stuff

What can we do with **25 grams**?

# SYNTHESIS, DETONATION SPREADING AND REACTION RATE MODELING OF FINE TATB

*Eleventh International Detonation Symposium*. 1998.

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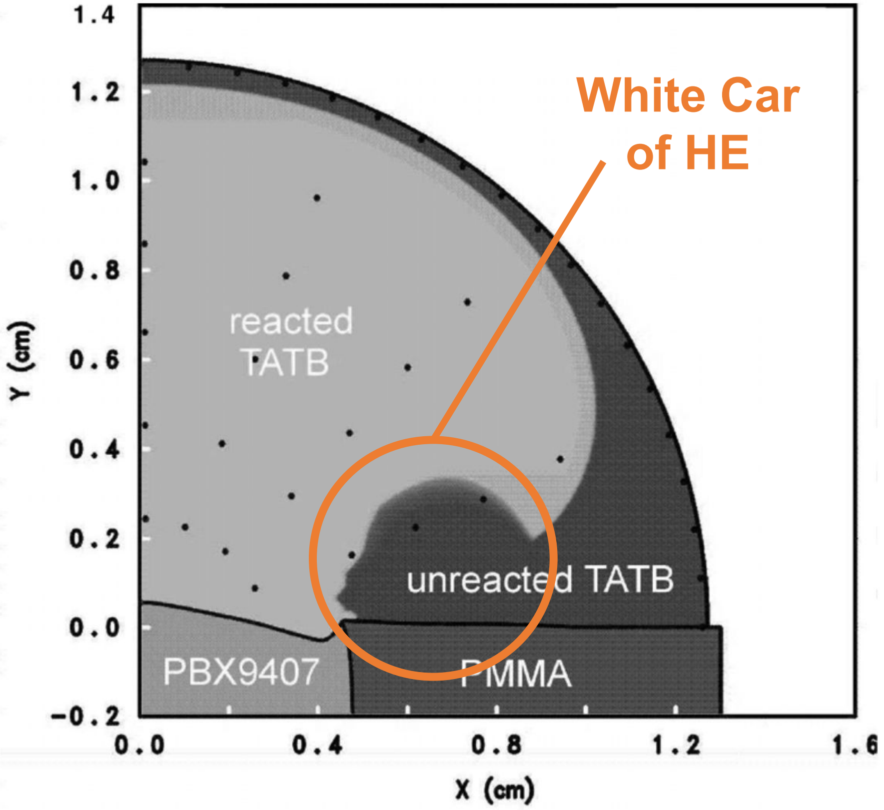
USA

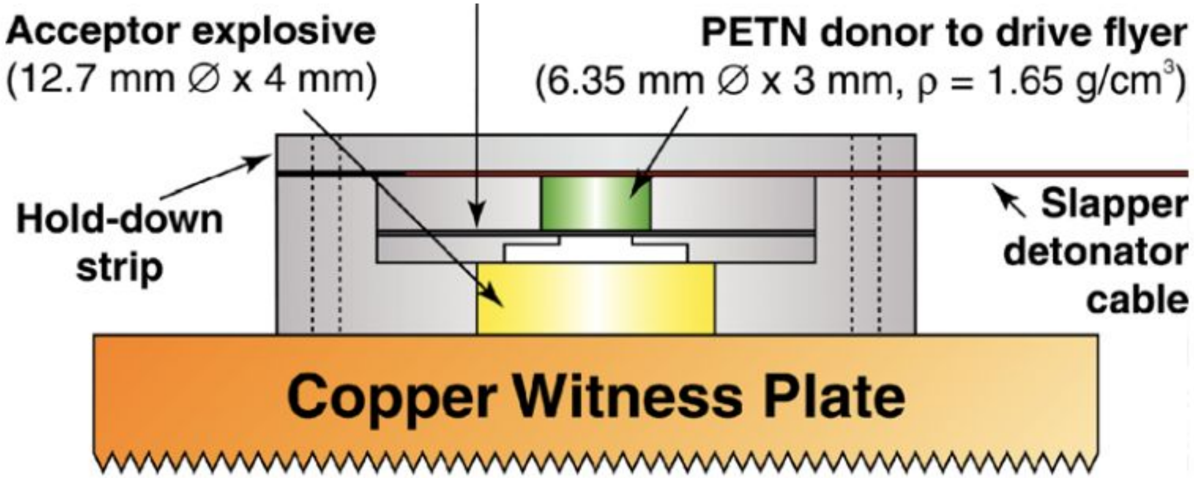
Development of fine TATB powders with improved detonation-spreading performance has been achieved by sonochemical amination and acid recrystallization. We report the performance of these powders in two types of detonation-spreading tests. The standard chosen for comparison was ultrafine TATB (UF-TATB). An Arrhenius reaction rate model was found to do a good job of simulating the detonation-spreading performance of UF-TATB in both tests, at different temperatures and densities. Some of the new TATB powders were better in detonation spreading than UF-TATB. The shock sensitivity of fine TATB may not be linked solely to powder particle size and porosity.

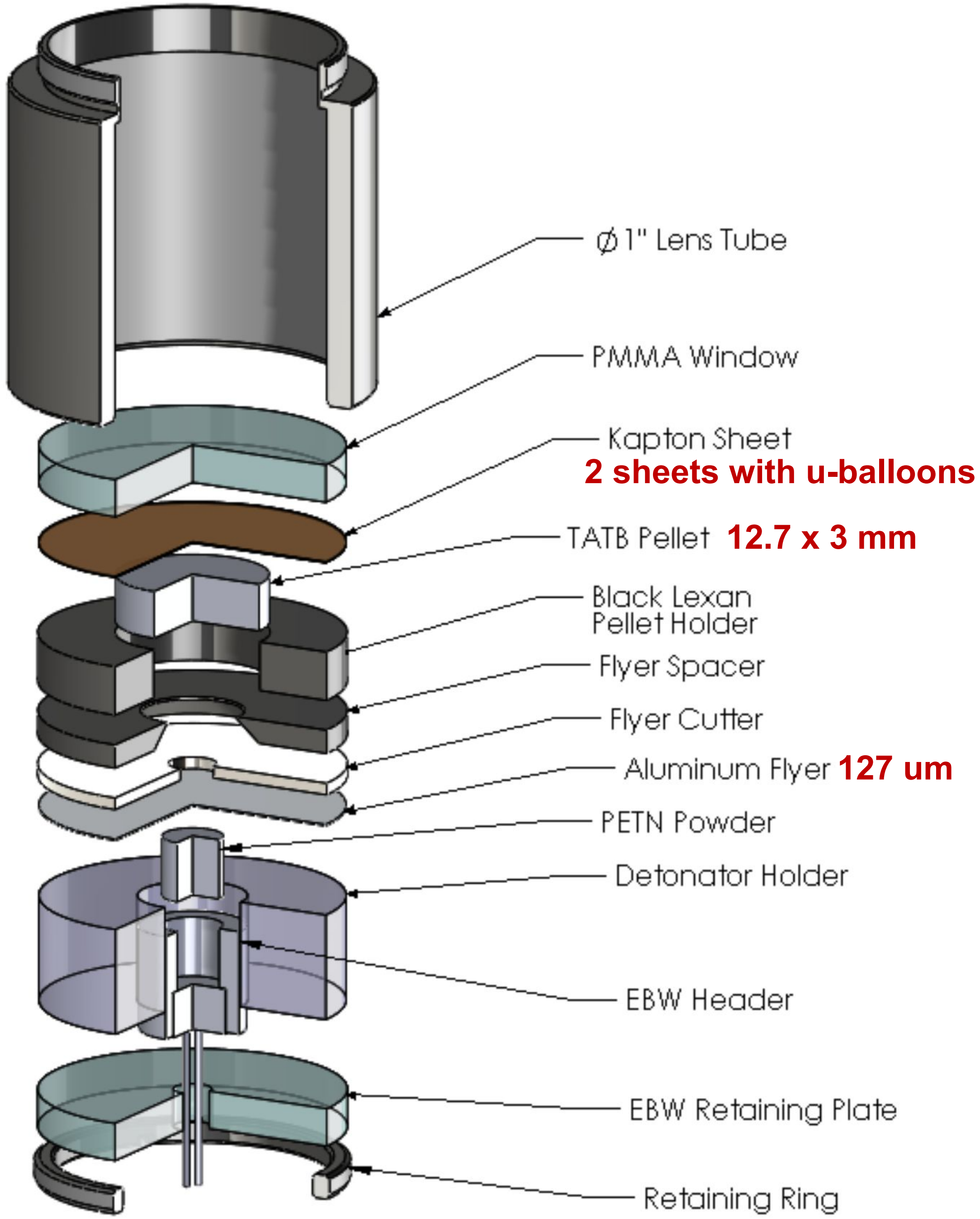
## INTRODUCTION

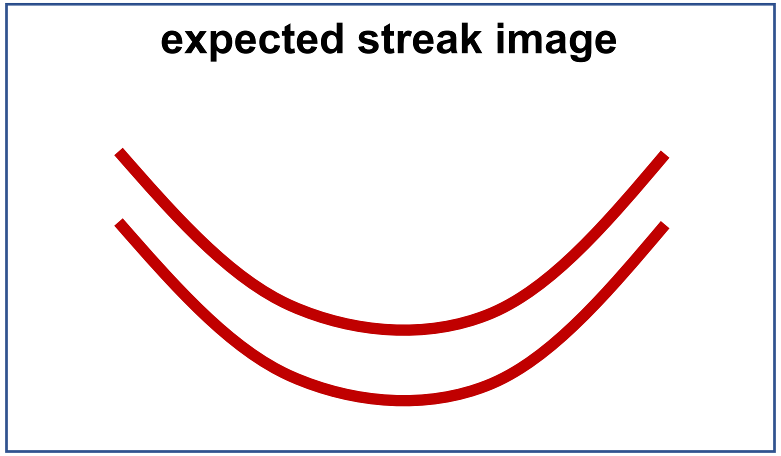
Insensitive high explosives (IHEs) such as triaminotrinitrobenzene (TATB) and formulations based upon TATB exhibit extended reaction zones.[1–4] As a result of this, the detonation of TATB exhibits a relatively large detonation failure diameter and protracted corner turning.[2,5] This type of behavior also is manifested in relatively slow lateral spreading of detonation from a finite initiation source.

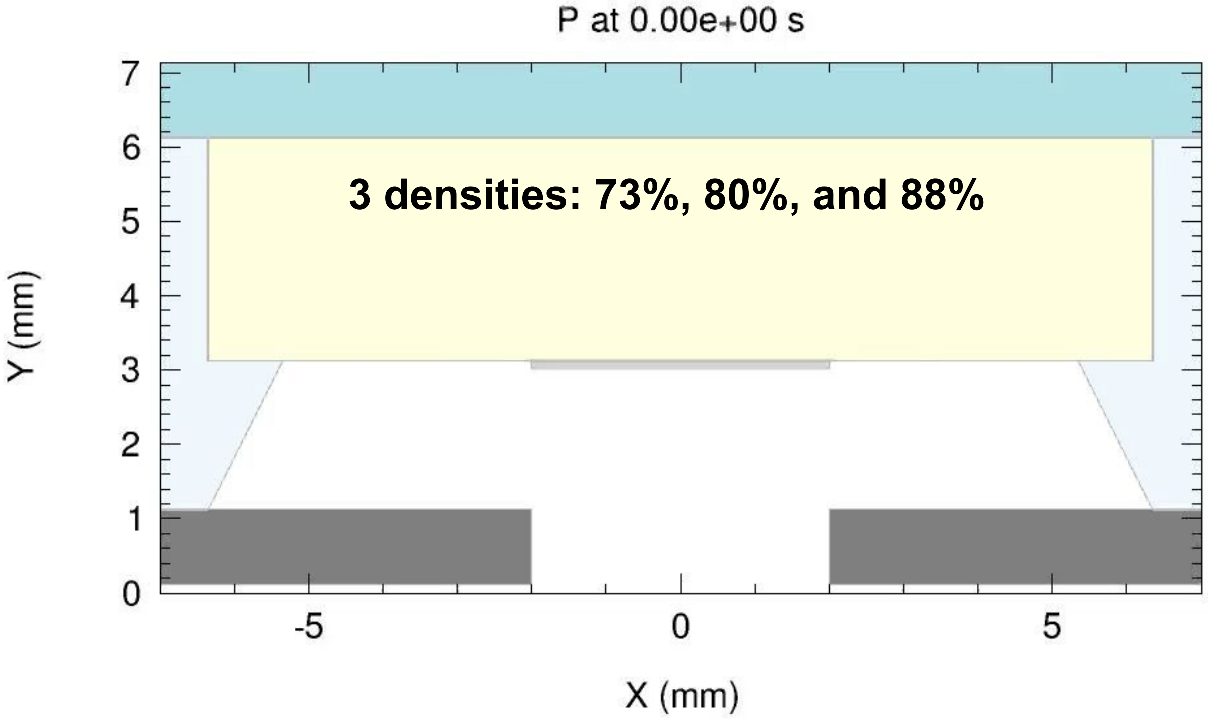
Our motivation in this work has been to develop a pure fine TATB powder that has improved detonation-spreading performance. This has been approached by developing new, simpler methods that produce fine TATB directly, including synthesis of TATB by sonochemical amination and acid recrystallization of a sodium salt of TATB. We evaluated the powders through their performance in two types of detonation-spreading tests. The Mushroom test utilizes a streak camera to measure the breakout profile of the detonation front in a hemispherical sample driven by a detonating donor. A new detonation-spreading spot-size test, herein named the Floret test, was developed that requires only a small amount of sample explosive, can be performed quickly, and involves no dynamic instrumentation measurements. The standard chosen for comparison was ultrafine TATB (UF-TATB), which was developed by LLNL and Pantex.[6] A new Arrhenius reaction rate model was found to do a good job of simulating the detonation-spreading performance of UF-TATB in both types of tests, at different temperatures and densities. The new TATB powders were found to be better in detonation spreading than UF-TATB, particularly at low density. More work remains to be done in formulation of the fine TATB materials and in determining whether a formulation can be certified as an IHE.



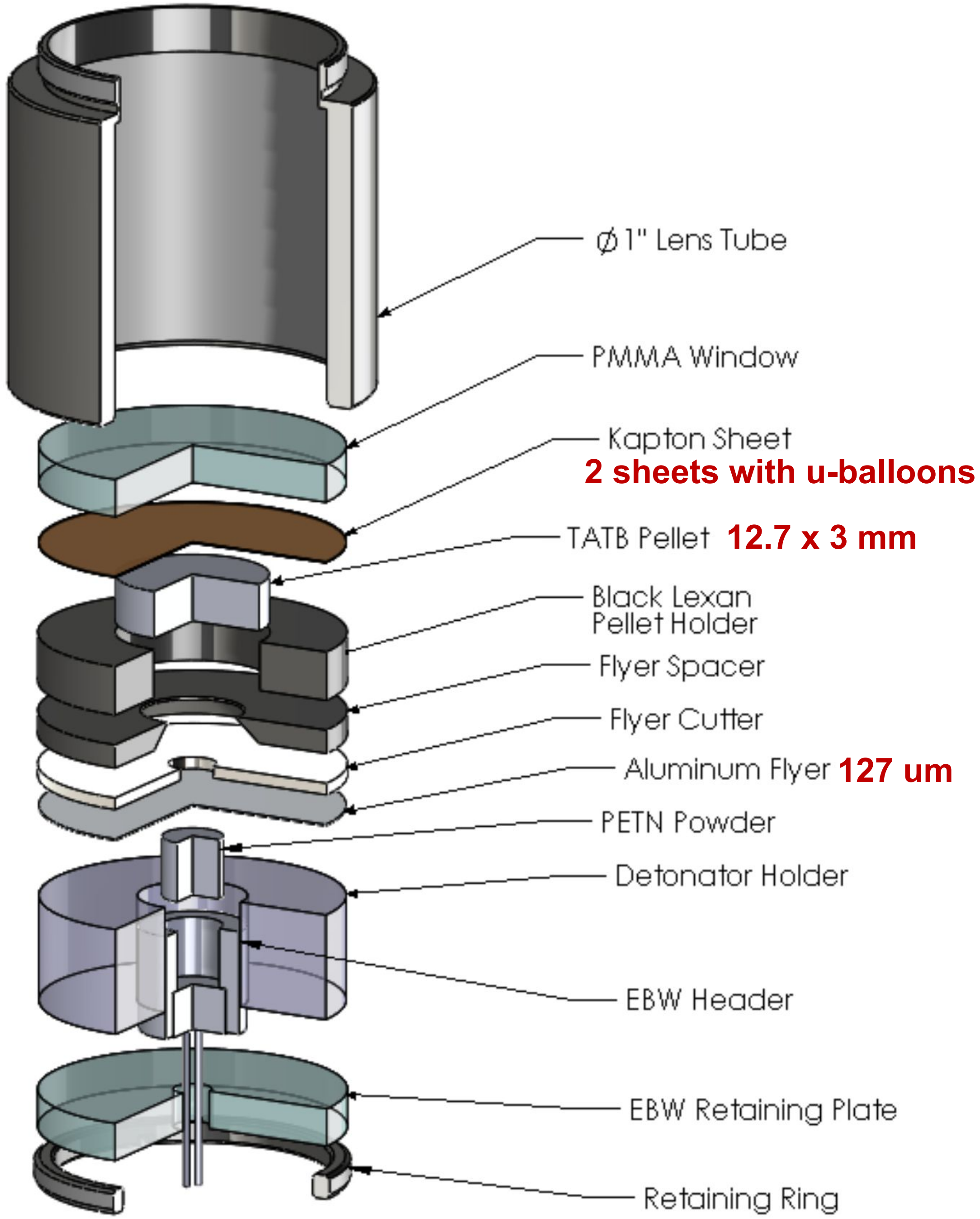



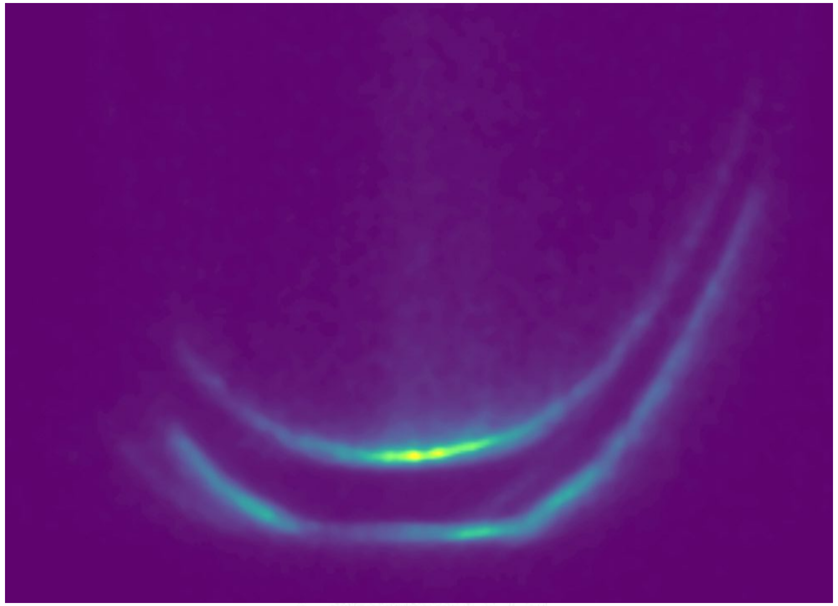


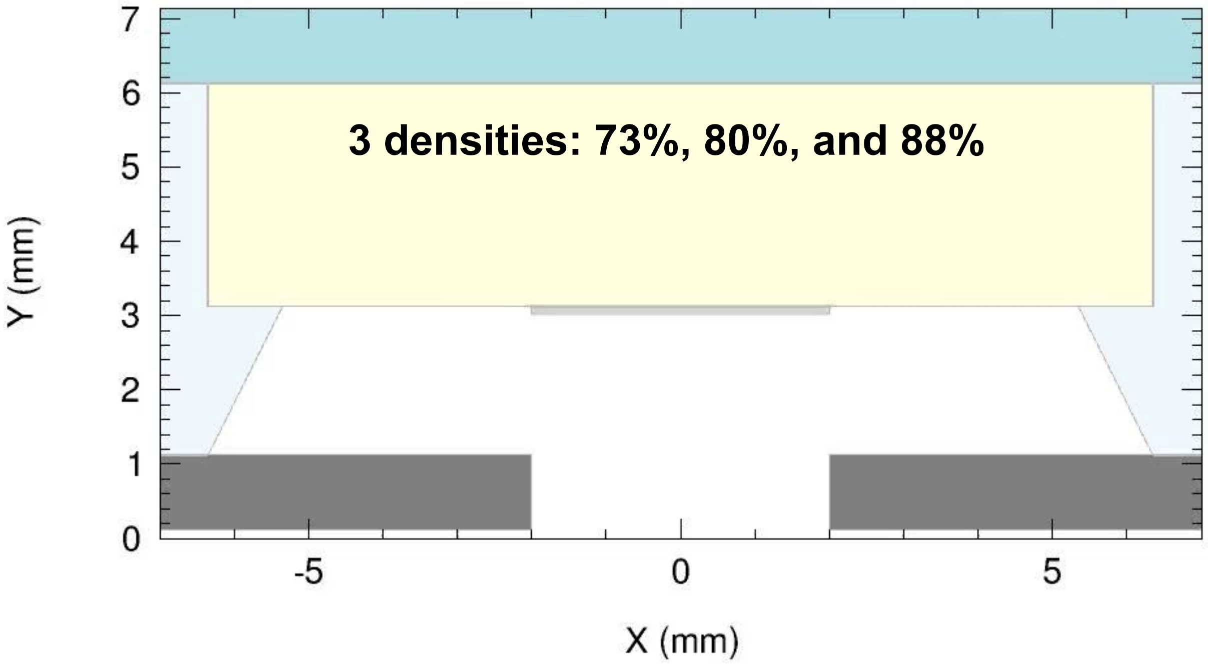



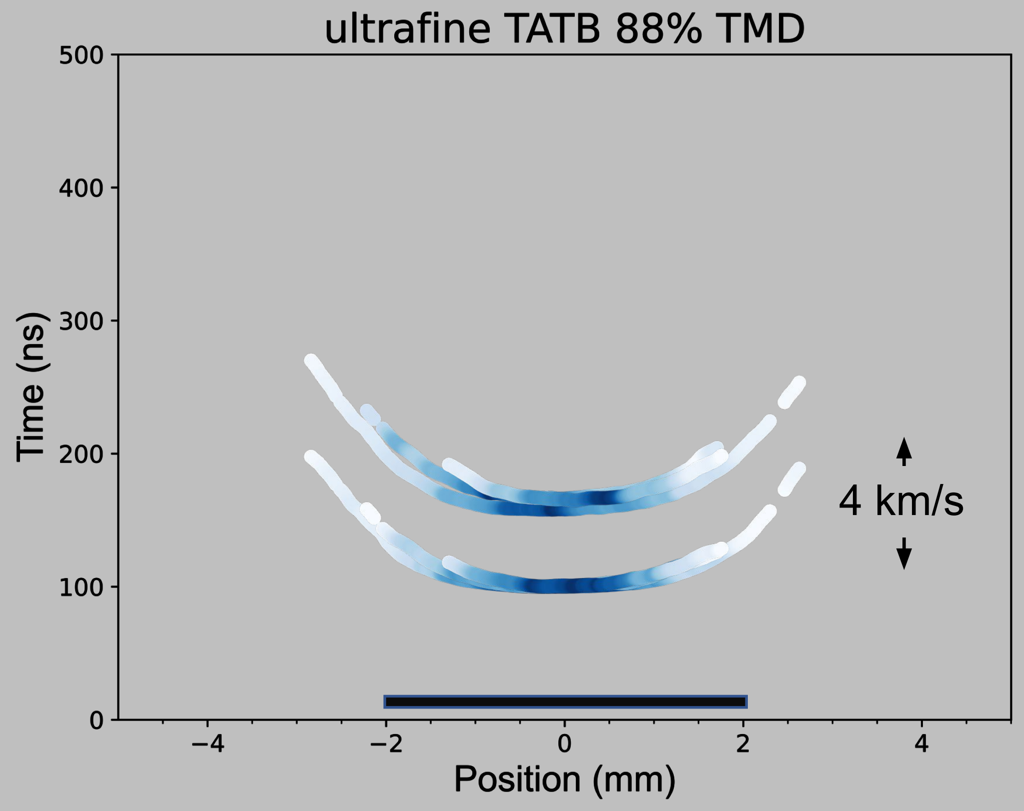

Flyer impact at >4 km/s

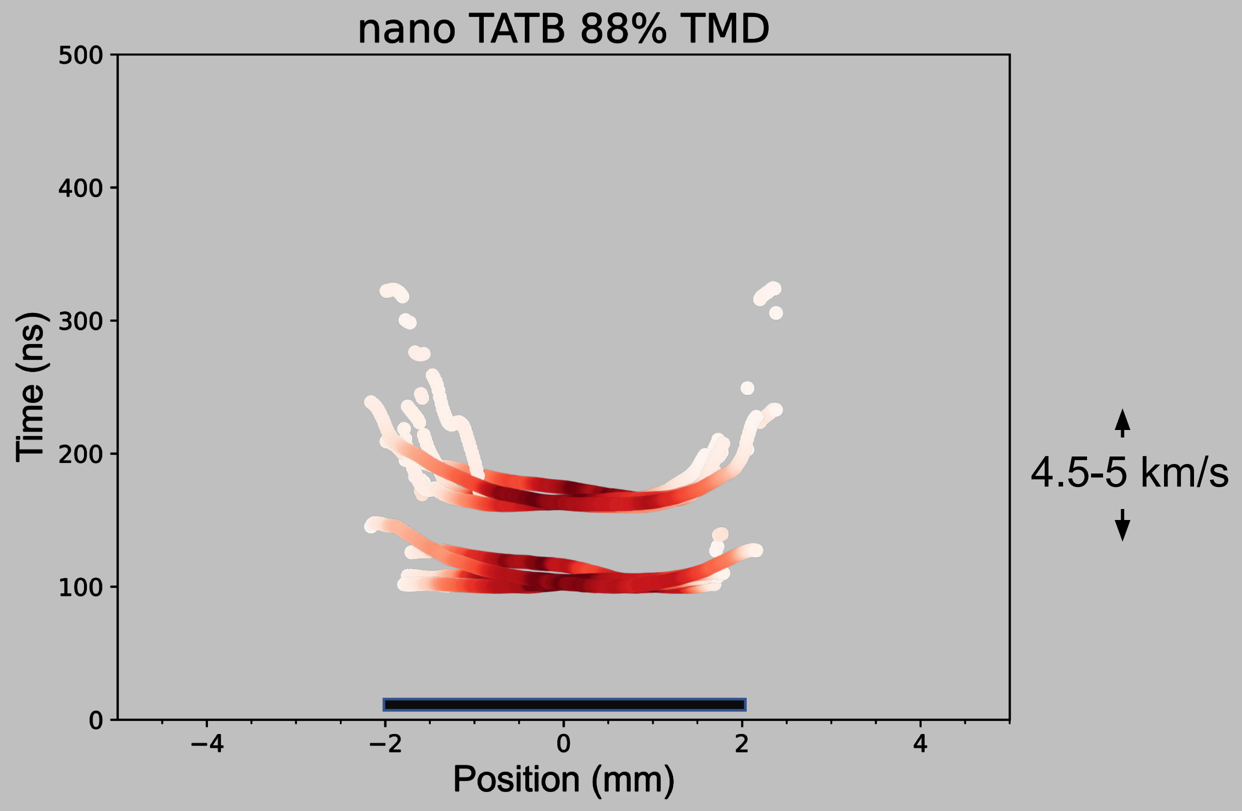




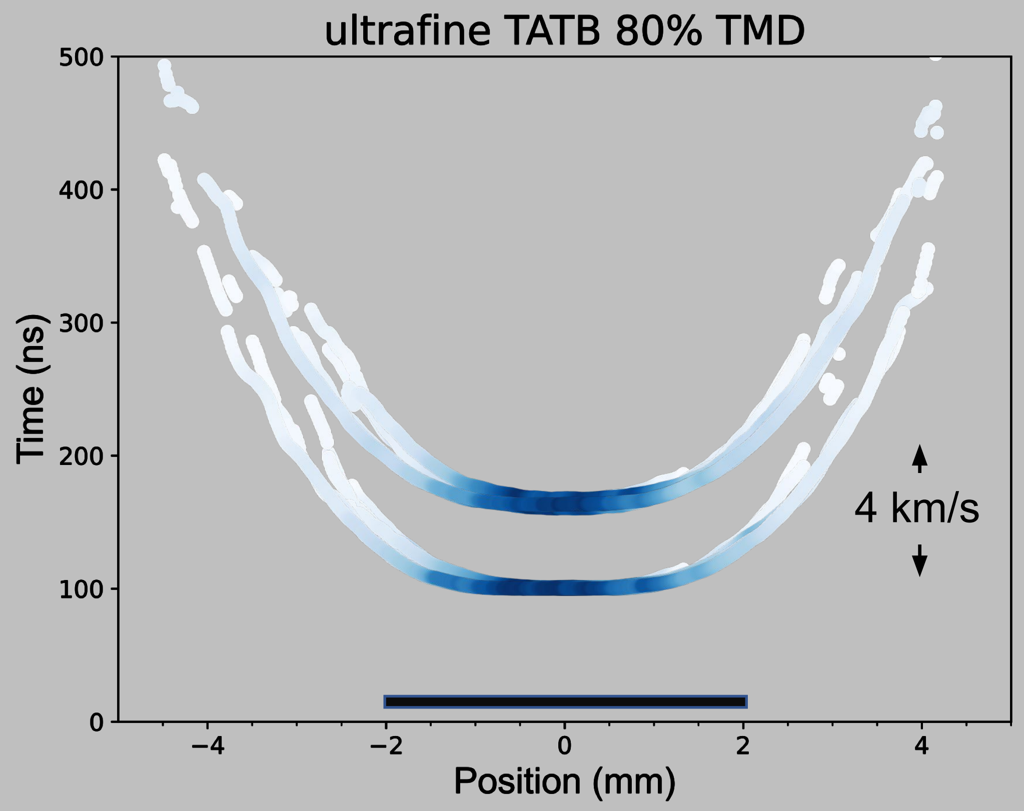

Flyer impact at >4 km/s



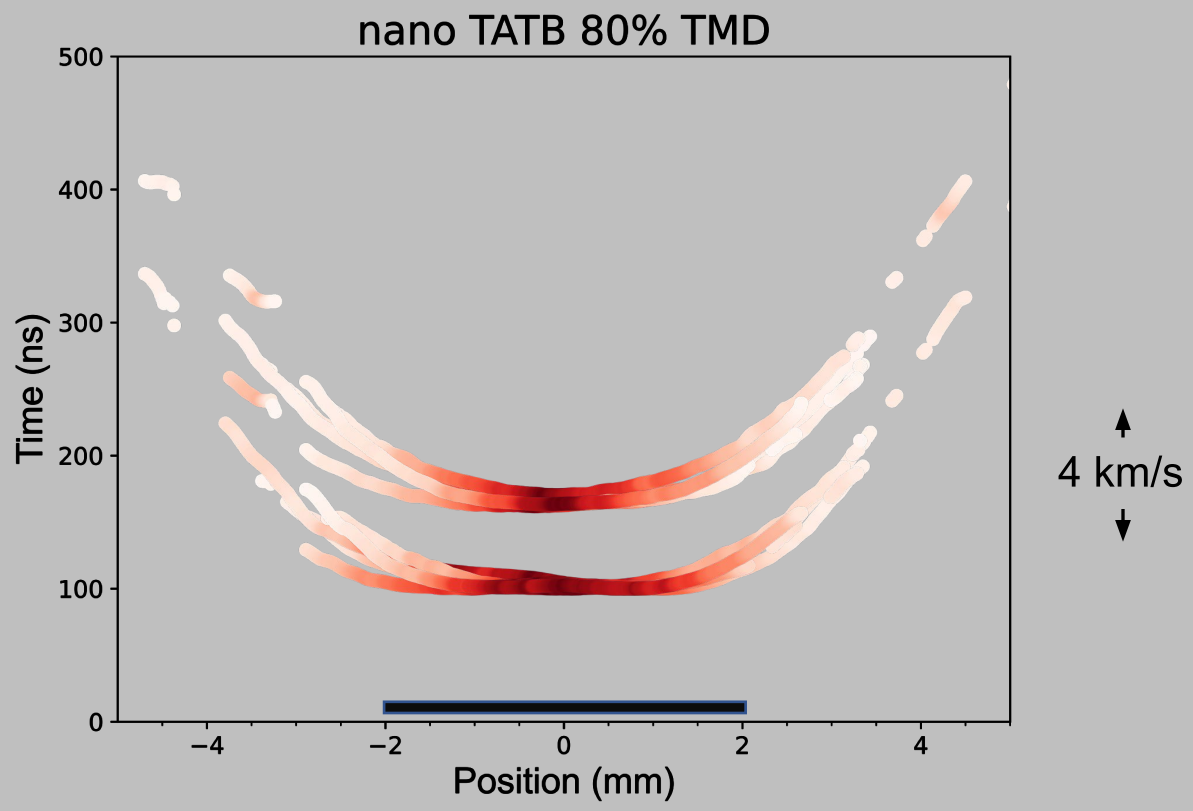




See what I'm saying? I believe you can do better than this.

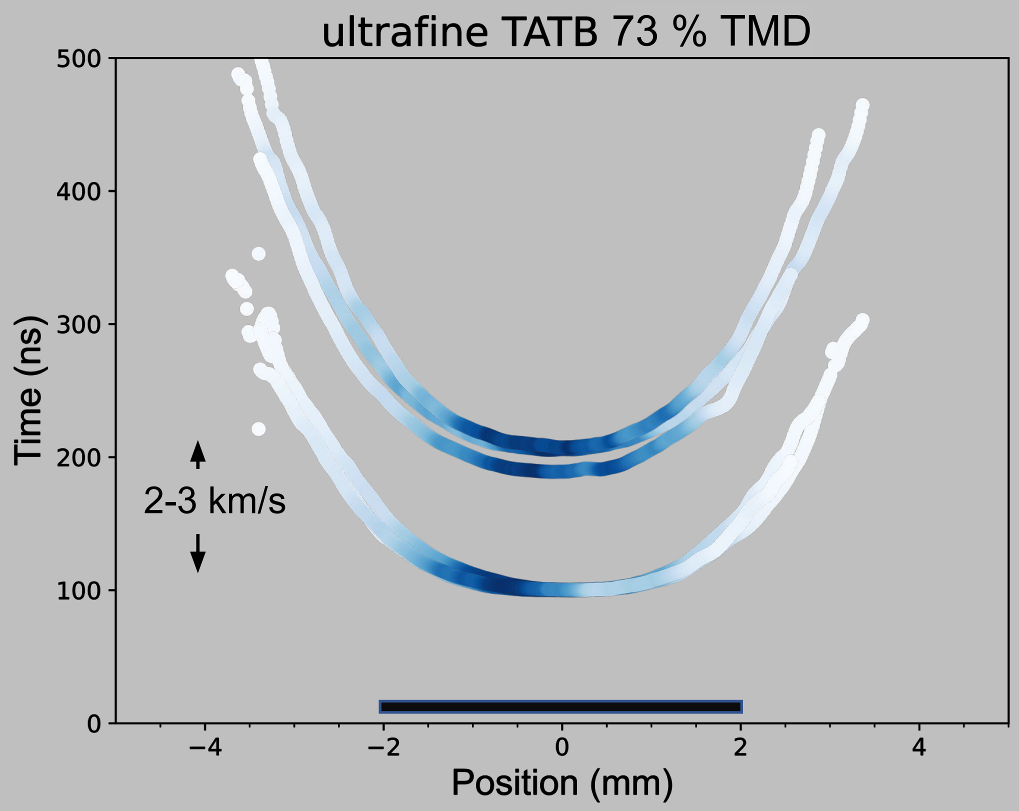
Wow! So it can actually be worse?!



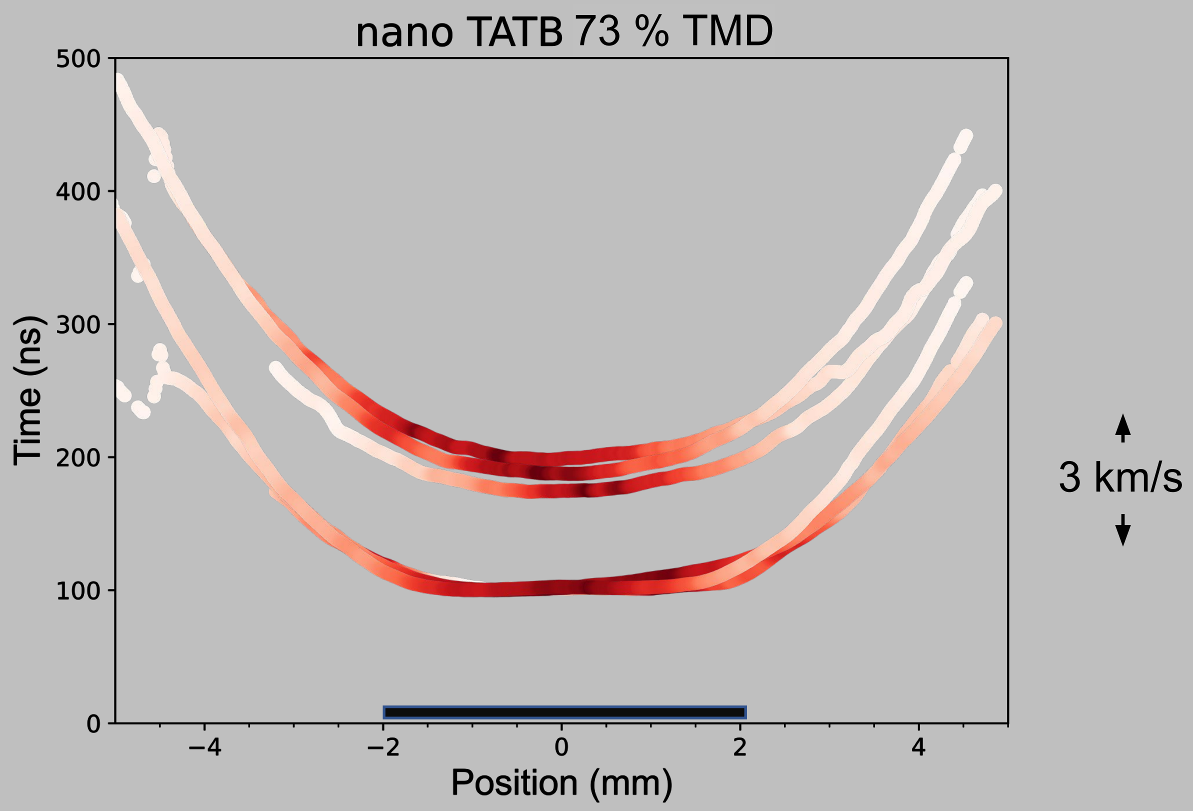

Still poor… but consistent




Hey… you are improving. Nice!



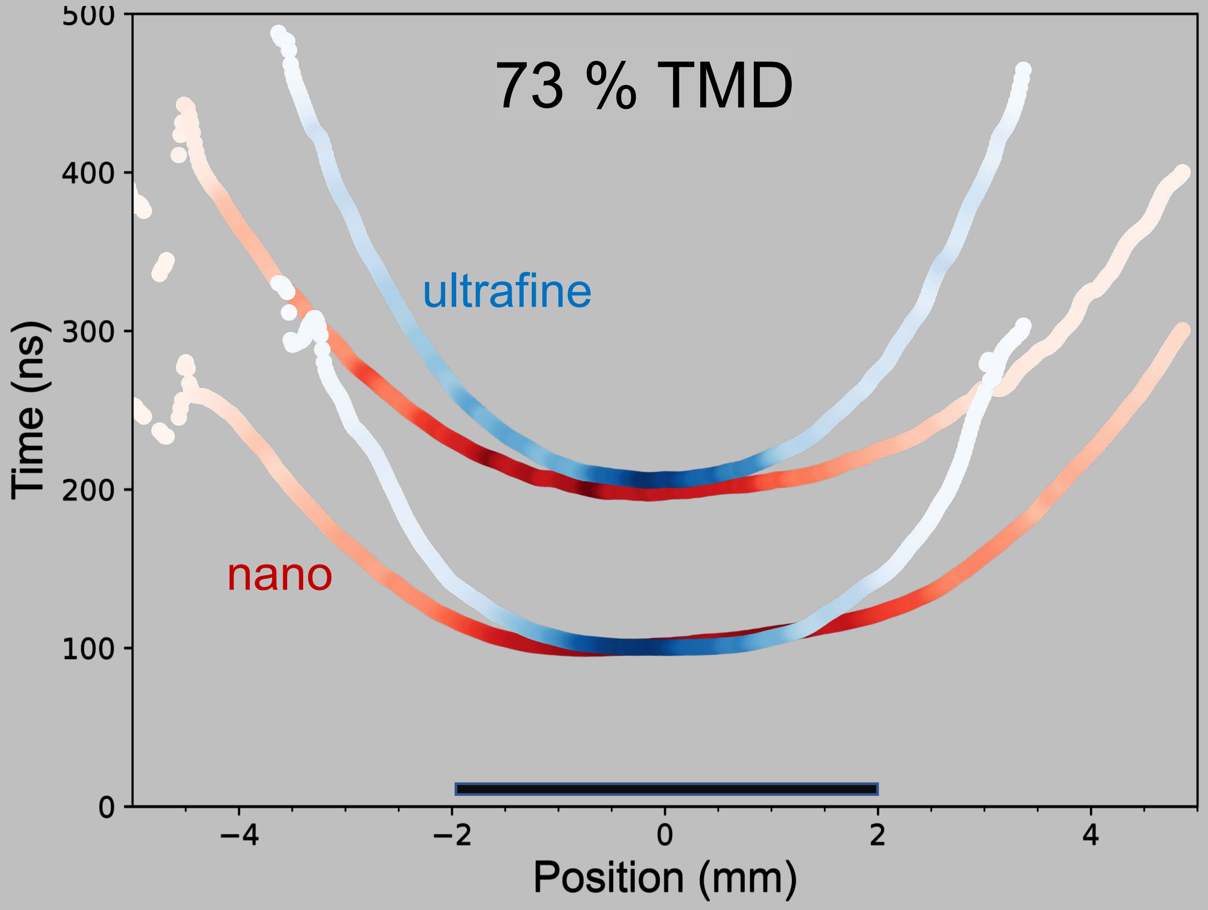

It is like you aren’t even trying!



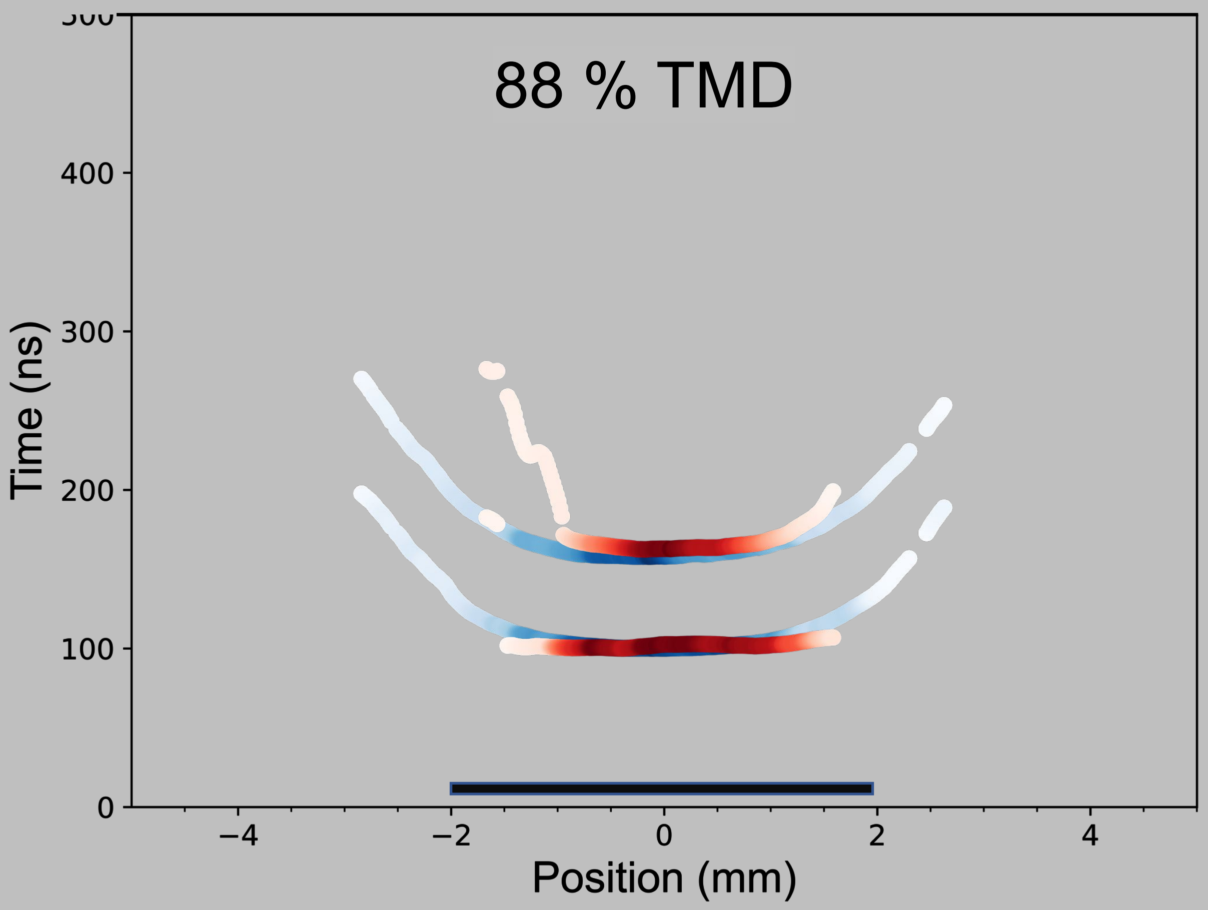

Nicely done. Way to spread, you!

# Nano is better and worse

nano TATB is ~200ns faster at the edges

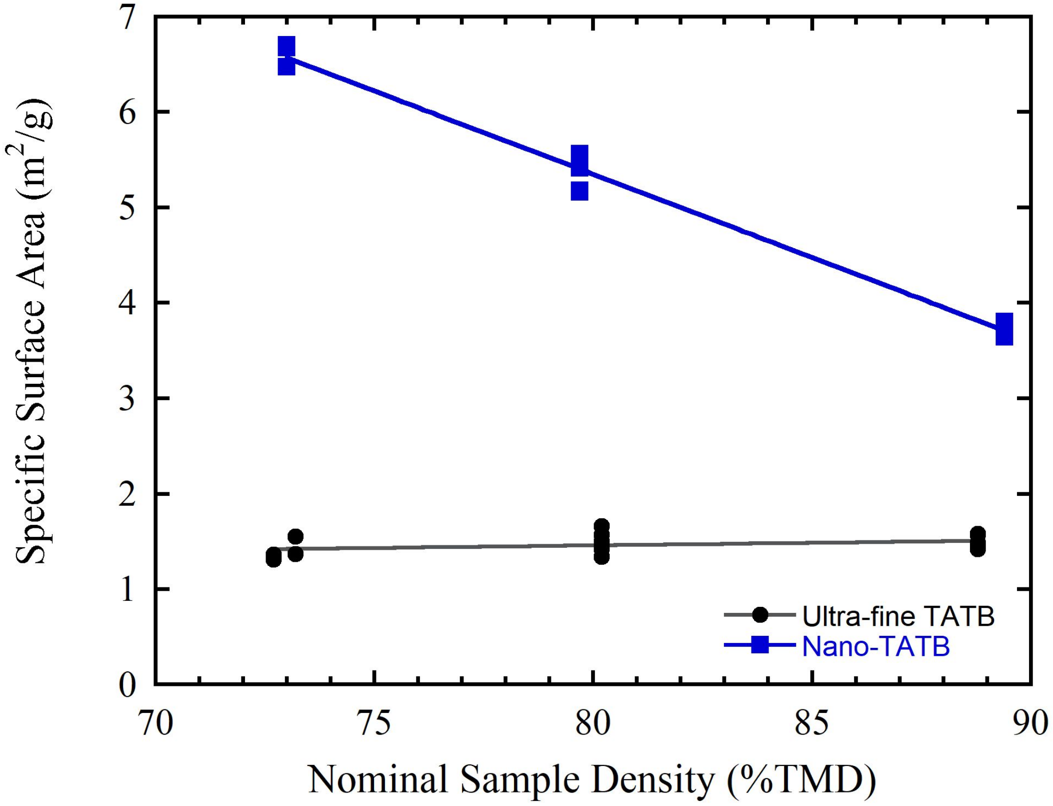


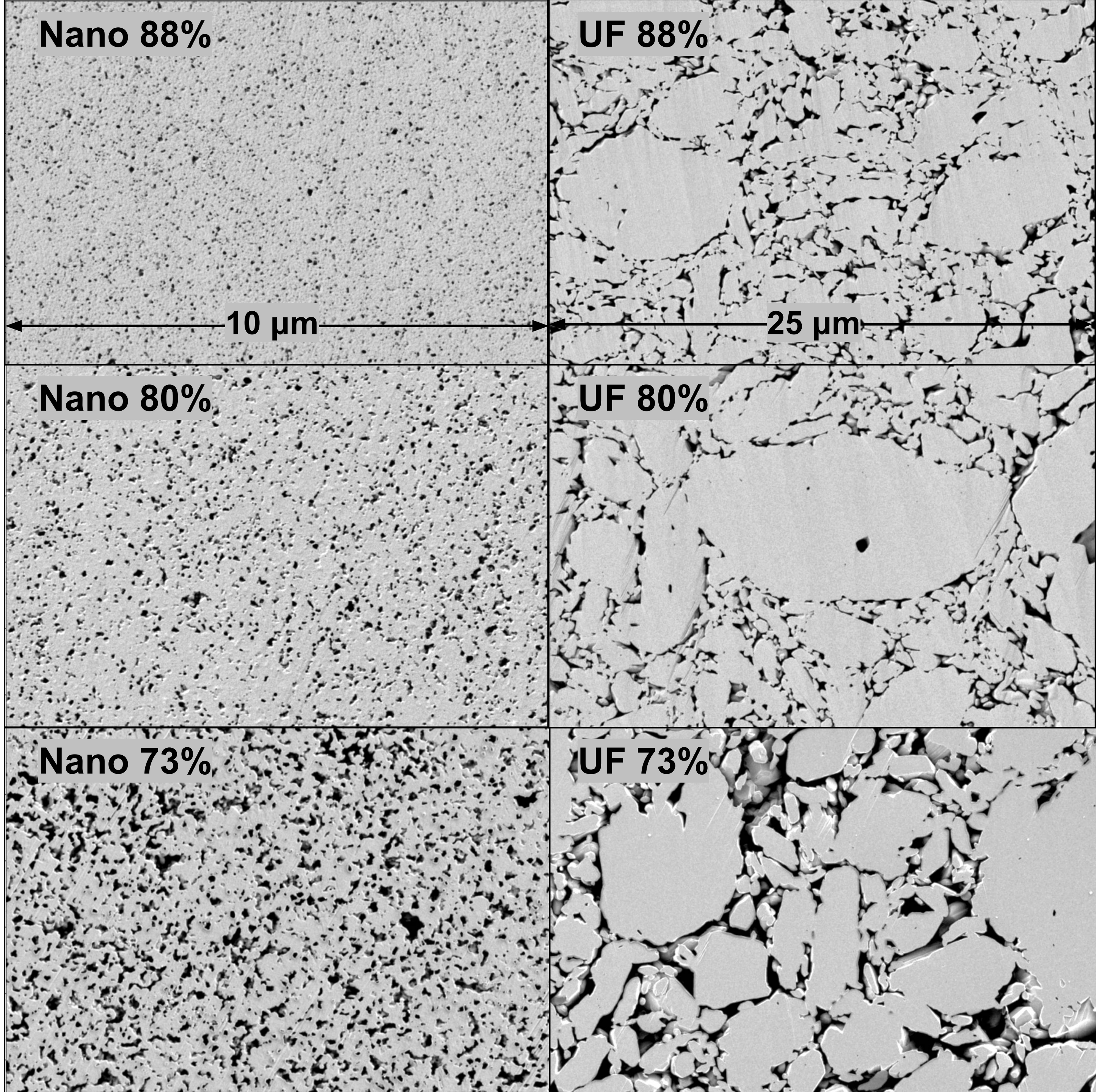

nano TATB just tunnels

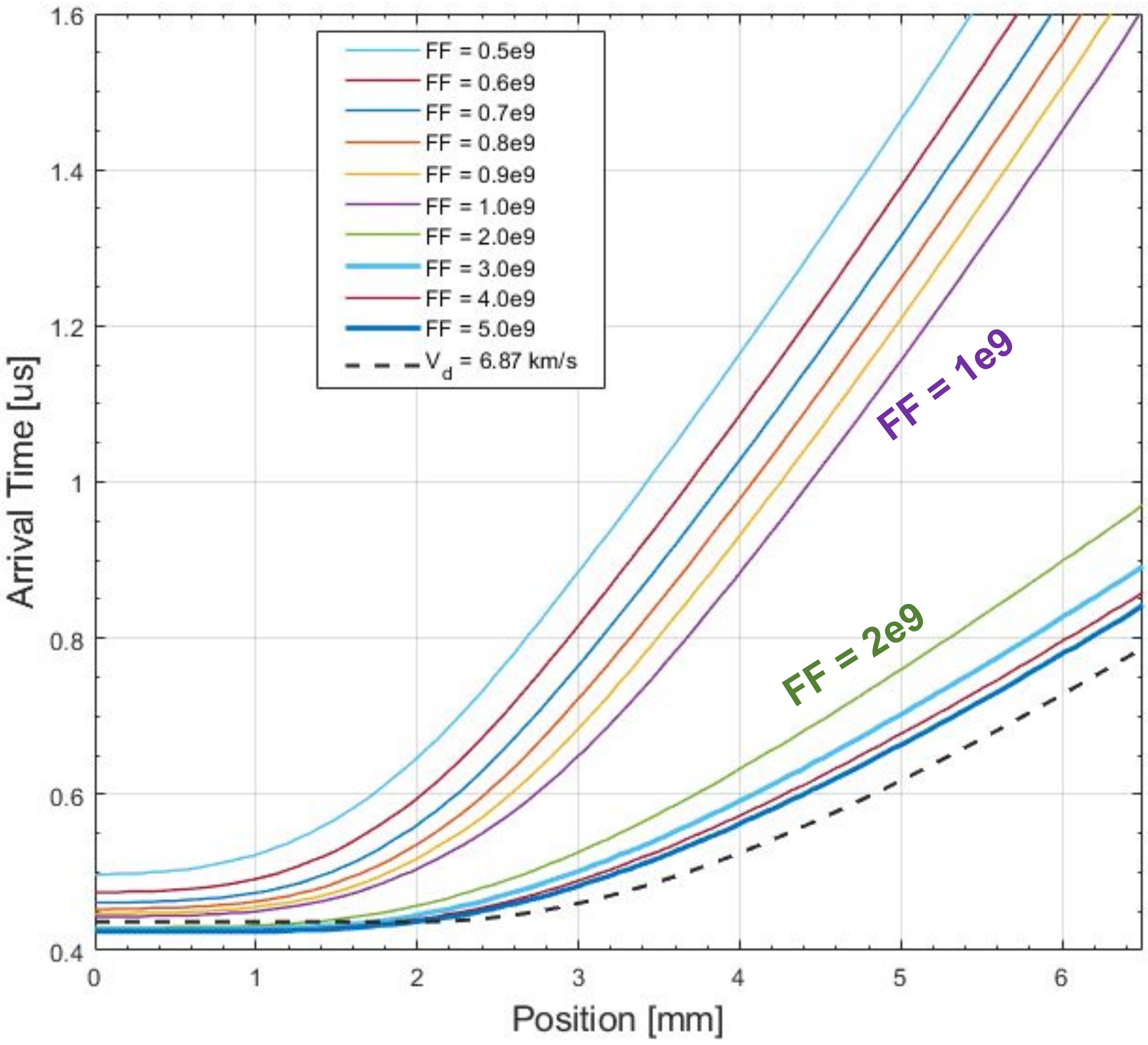


Specific **interface** area enhances the burn rate

Pores are too small in high-density nano to act as efficient hot-spots



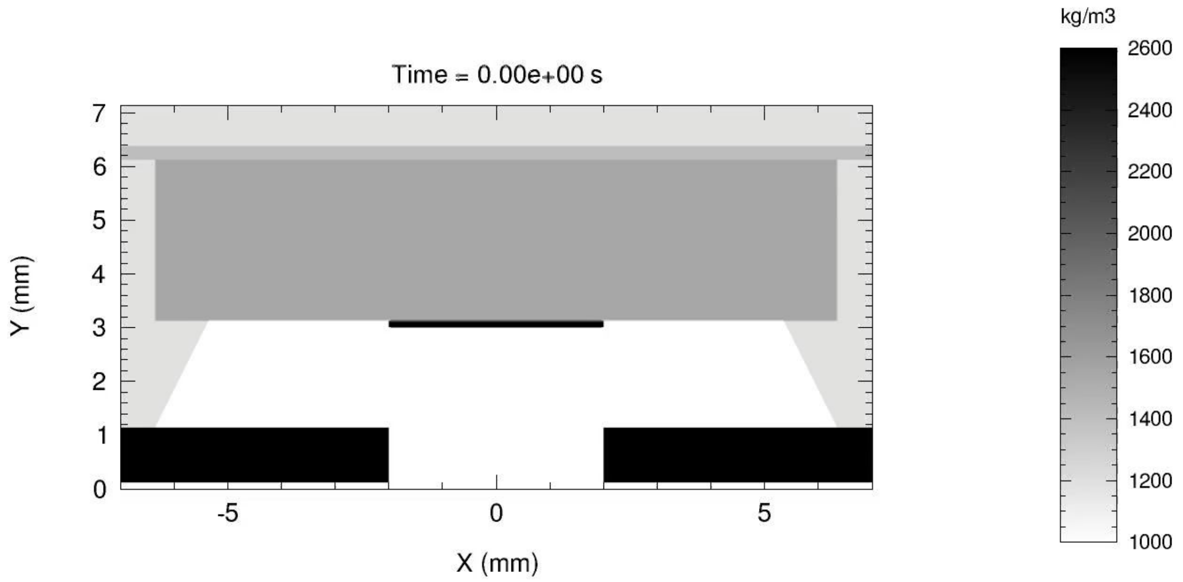





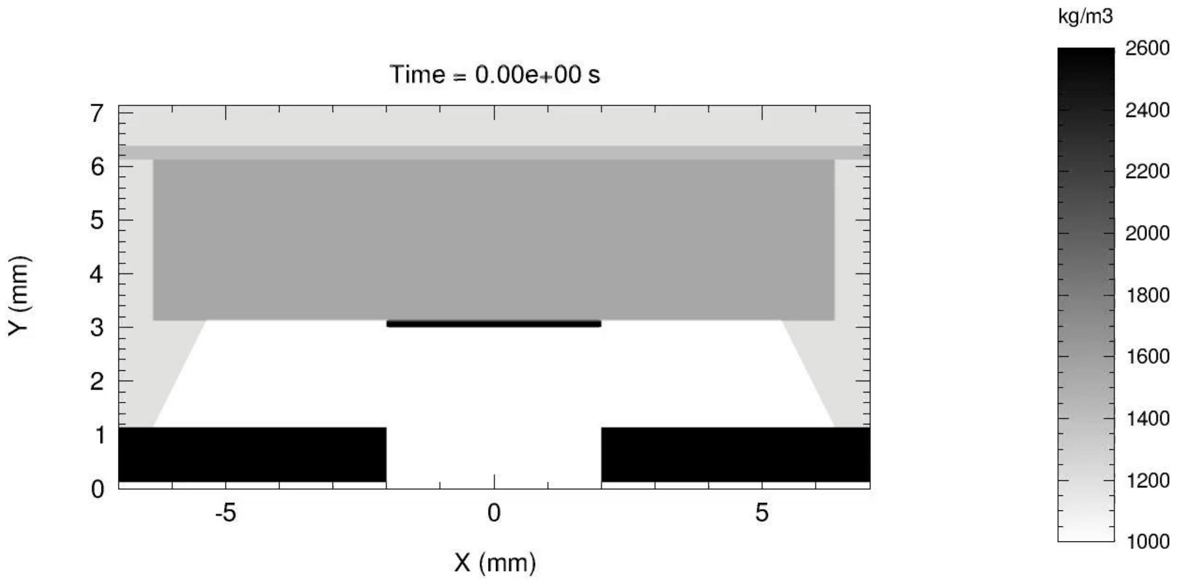
FF = 0.5e9
FF = 0.6e9
FF = 0.7e9
FF = 0.8e9
FF = 0.9e9
FF = 1.0e9
FF = 2.0e9
FF = 3.0e9
FF = 4.0e9
FF = 5.0e9
$V_d$ = 6.87 km/s
FF = 1e9
FF = 2e9
Arrival Time [us]
Position [mm]
0.4
0.6
0.8
1
1.2
1.4
1.6
0
1
2
3
4
5
6

# For the Arrhenius burn model (ARB) the pre-exponential frequency factor governs burn-rate/reaction-zone

Lower interface area
FF = 1e9




Higher interface area
FF = 2e9



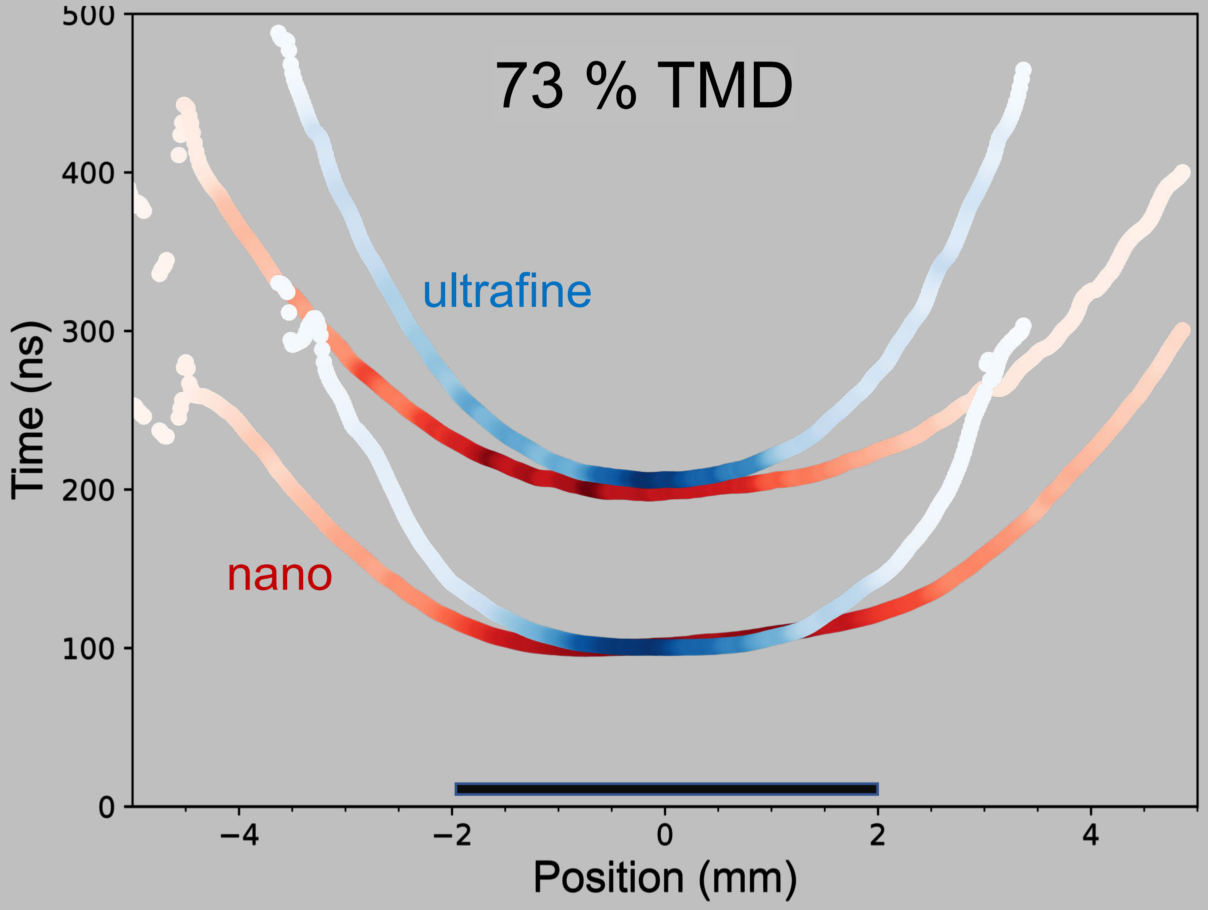
## TATB is has terrible performance, but…

**A bit of optimism:**

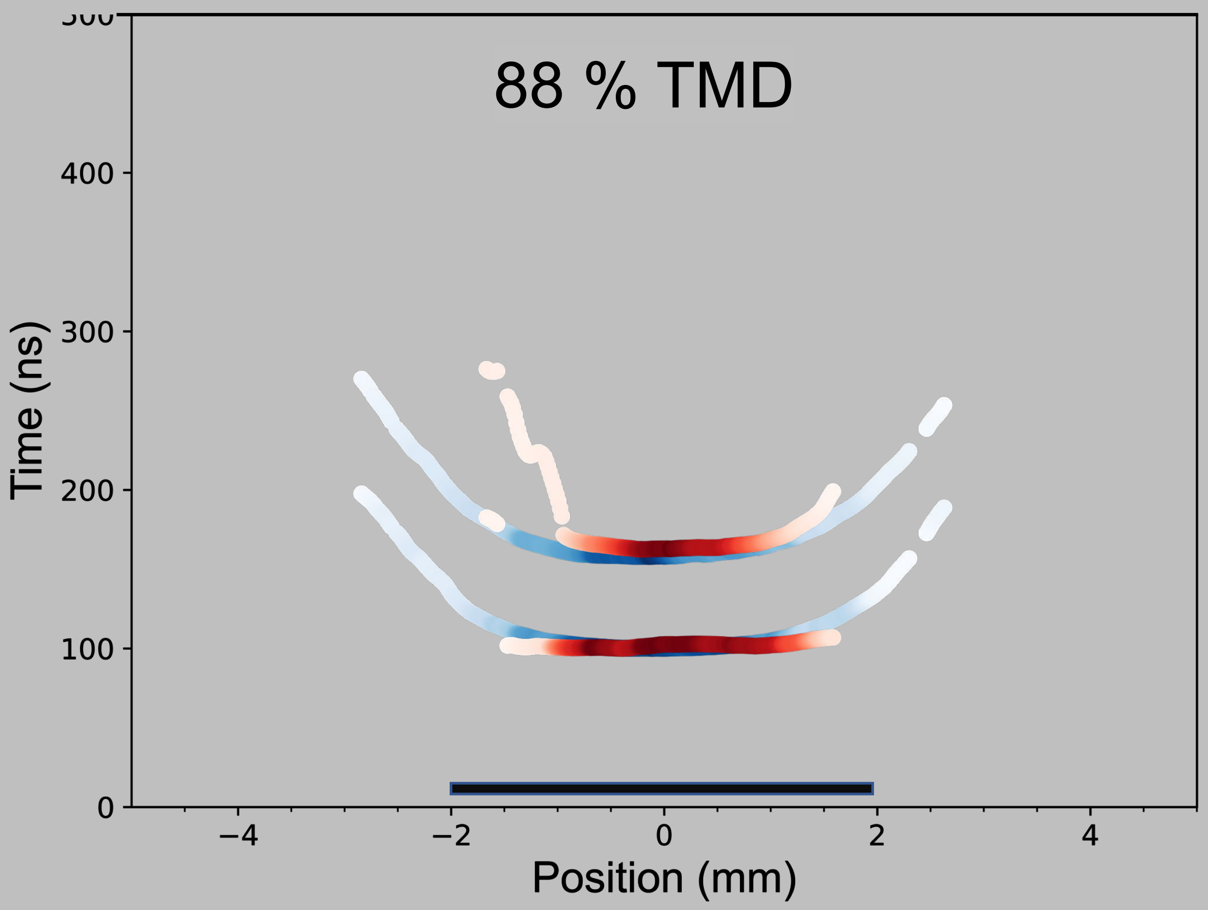
**It should be possible to design a TATB formulation that turns corners and somewhat retains its other "desirable" properties**

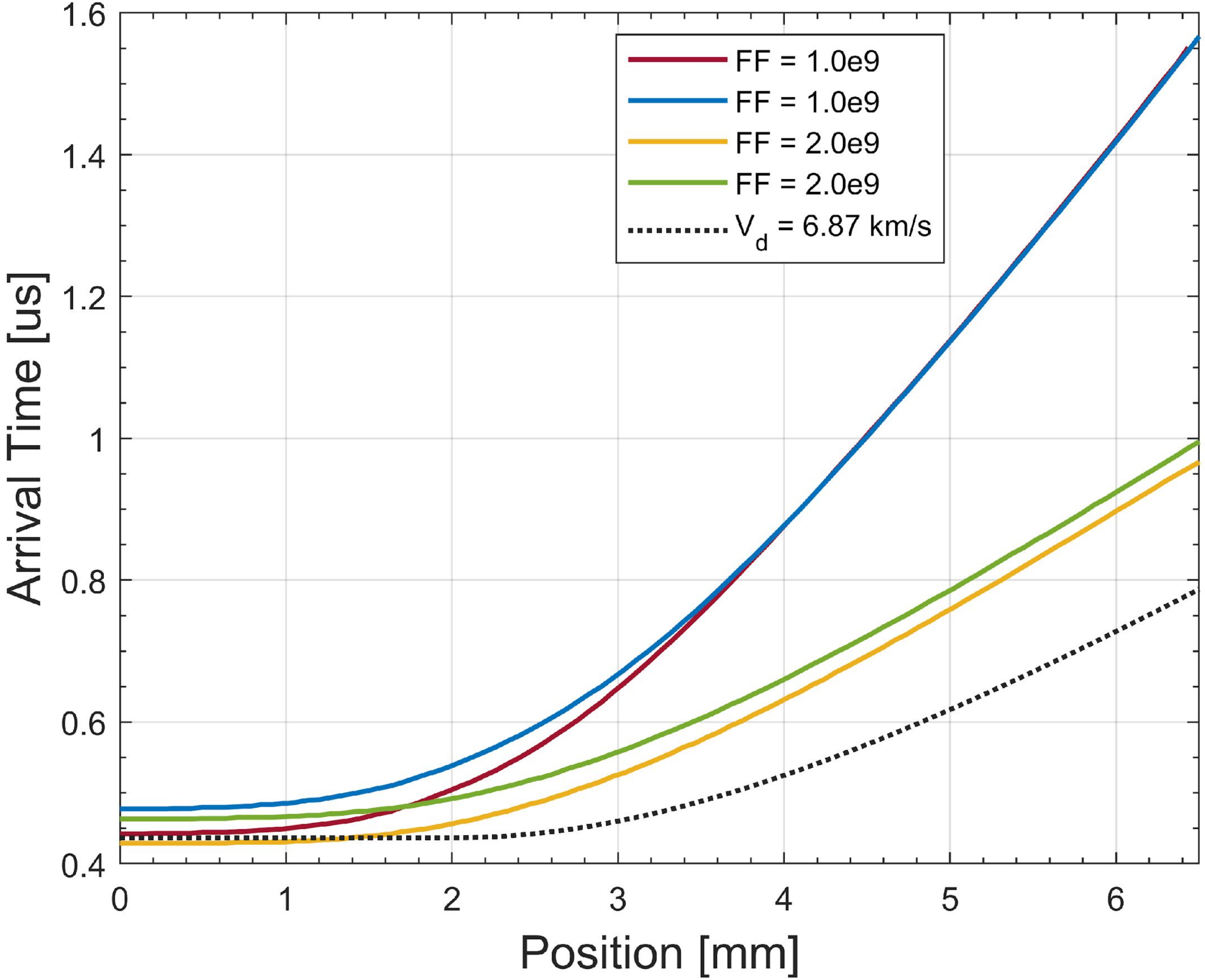
# Nano is better and worse

nano TATB is ~200ns faster at the edges

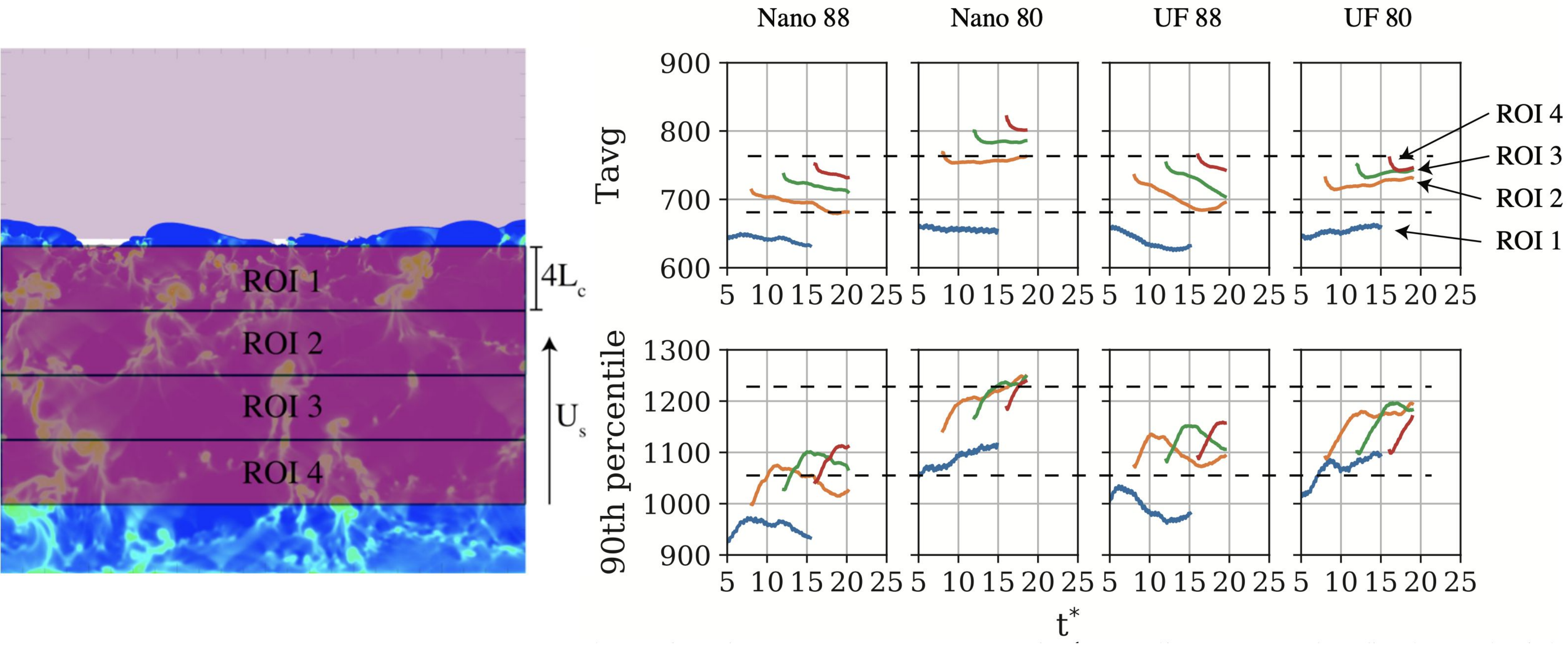



nano TATB just tunnels

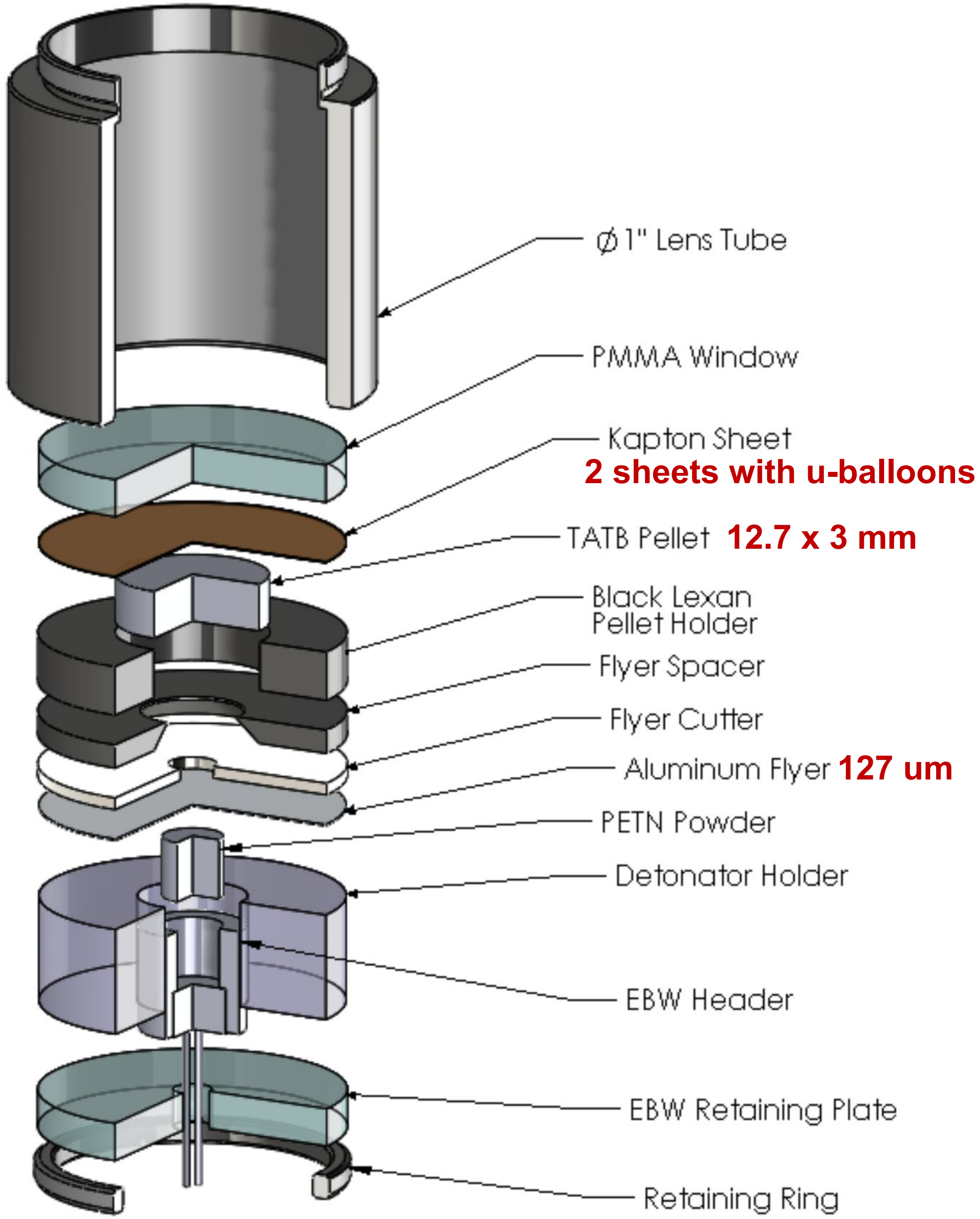




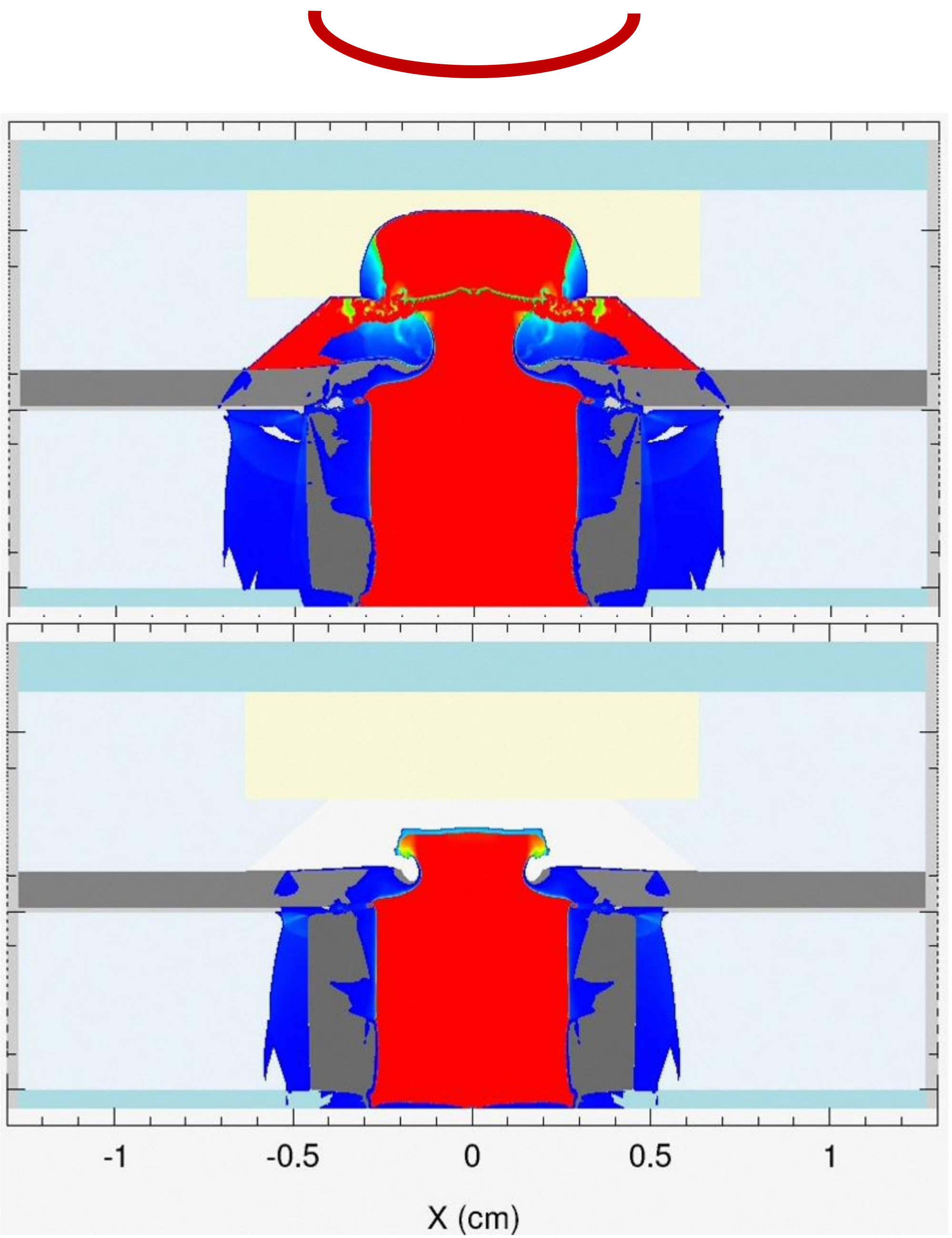
FF = 1.0e9
FF = 1.0e9
FF = 2.0e9
FF = 2.0e9
V_d = 6.87 km/s
Arrival Time [us]
Position [mm]
1.6
1.4
1.2
1
0.8
0.6
0.4
0
1
2
3
4
5
6

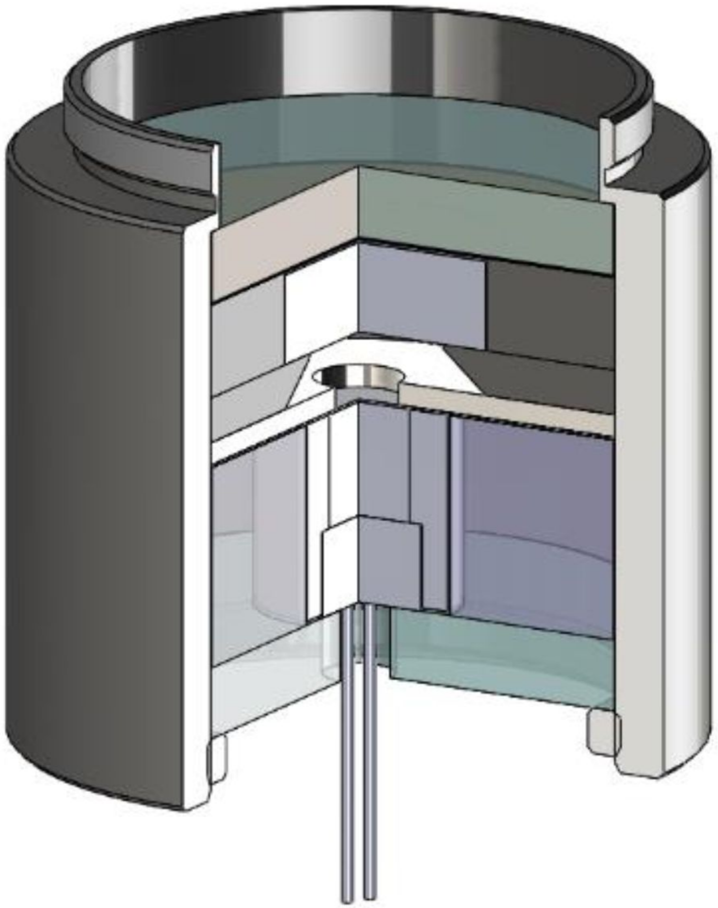


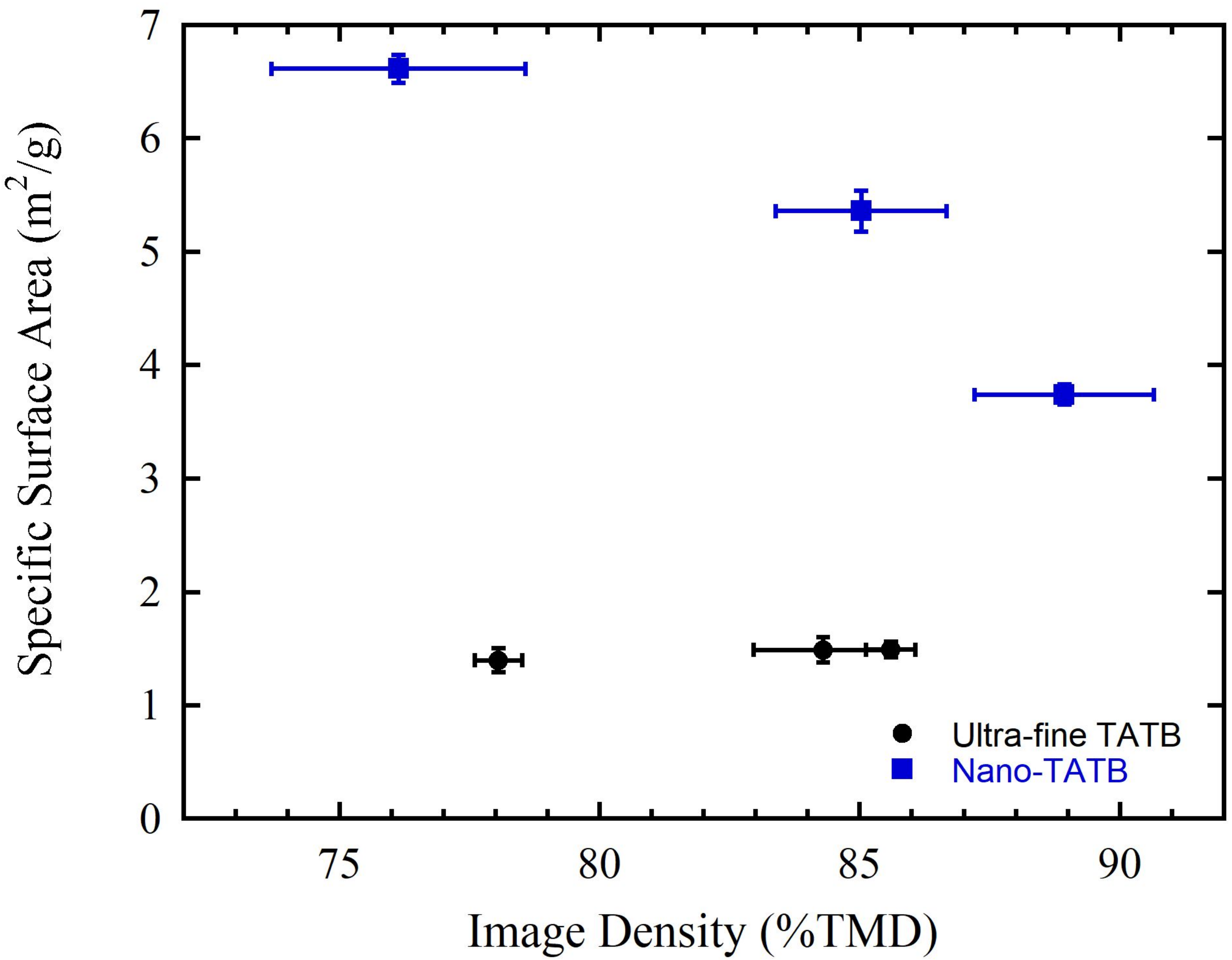
ROI 1
ROI 2
ROI 3
ROI 4
4L_c
U_s
Nano 88
Nano 80
UF 88
UF 80
Tavg
90th percentile
t*
ROI 4
ROI 3
ROI 2
ROI 1




expected streak image







Specific Surface Area (m2/g)
Image Density (%TMD)
Ultra-fine TATB
Nano-TATB
0
1
2
3
4
5
6
7
75
80
85
90