GEOCHRONOLOGY

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Supplement of

Confined fission-track revelation in apatite:
how it works and why it matters

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Introduction

This file contains supplemental figures S-1 and S-2. It also contains model outputs for each data set fitted, using the diagrams demonstrated in Figures 6, 7, 10, and 11 of the manuscript, using the Constant-core model. Also included are the plots of the measured track length histograms for the earliest etching steps, for comparison with model predictions, and the command line to run the model in the IDL code (see statement on Code Availability), and the text output for each etching step, as: mean length (µm), standard deviation (µm), number of tracks selected, mean latent length of selected tracks, mean starting time of etching t_s (s), and mean impingement depth z_{int} (µm).
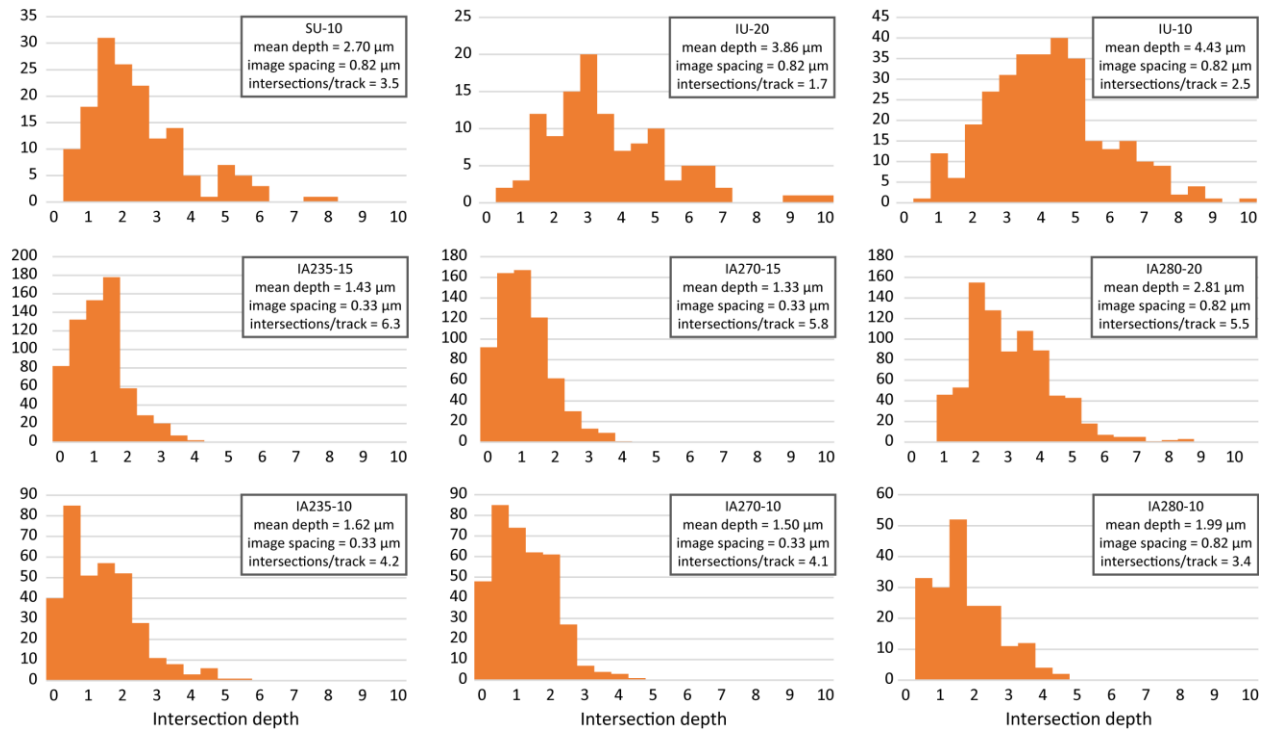
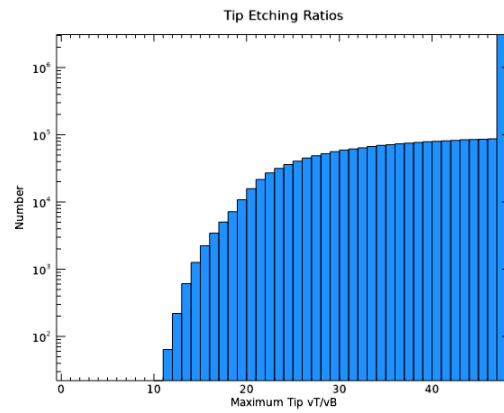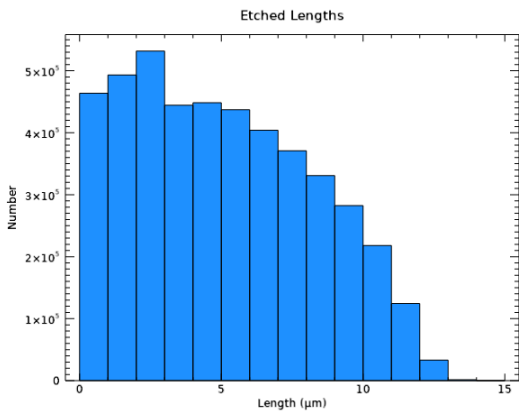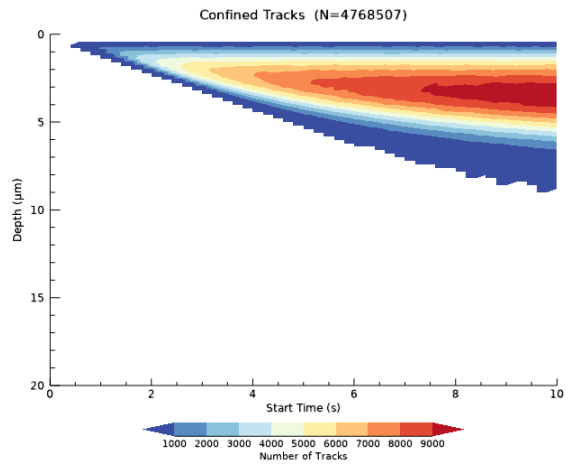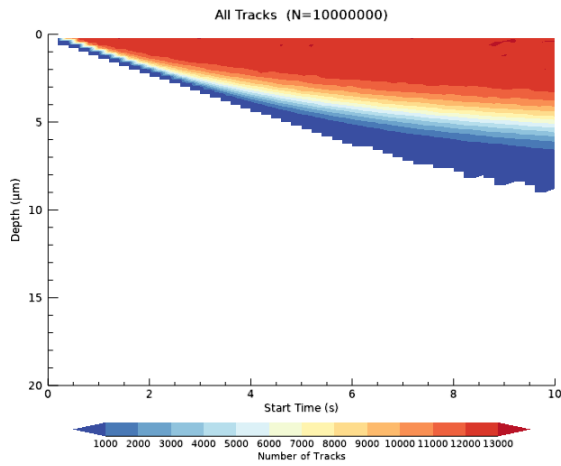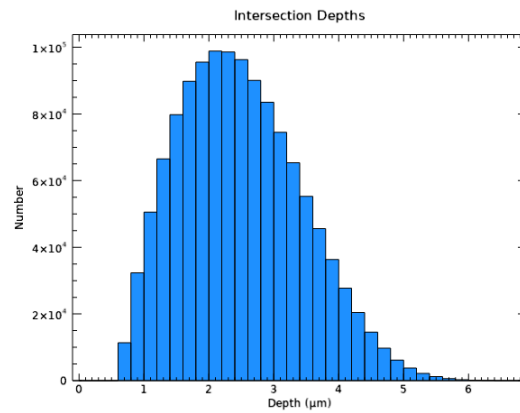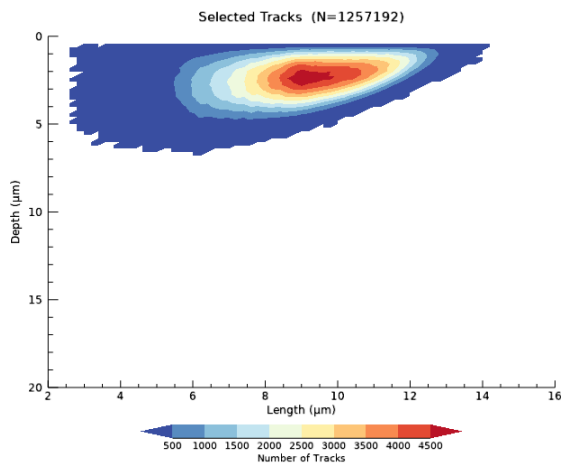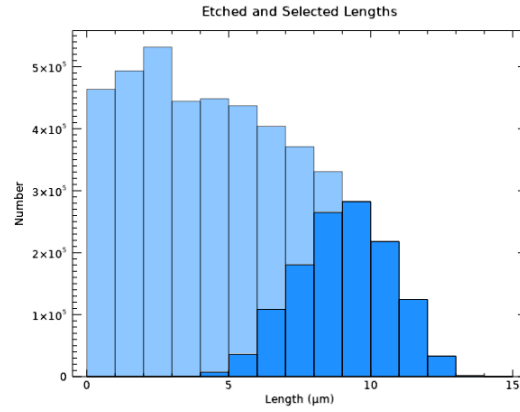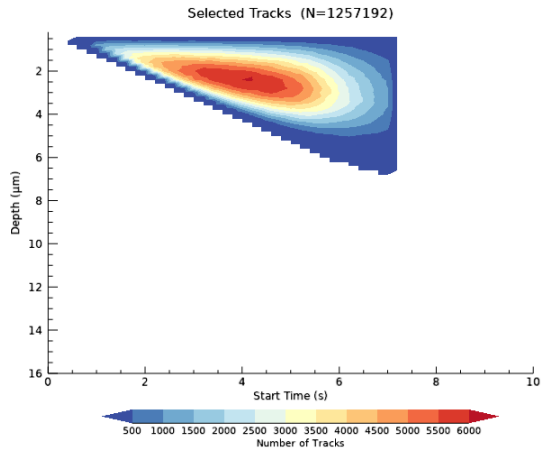**Figure S-1: Histograms of intersection depths measured in each step-etch and etch-anneal-etch experiment from Tamer and Ketcham (2020). Intersections measured from the final step in the step-etch experiments, and the first step of the etch-anneal-etch experiments (prior to post-etch annealing). Also reported on this figure are the mean depth, mean number of intersections per track, and the spacing of the images captured on the microscope system, from which the measurements were made. Spacings are corrected for the apatite refractive index. More closely spaced images (IA235 and IA270) may have aided in finding more shallow tracks, but also may have biased the measurement procedure against finding deeper ones.**
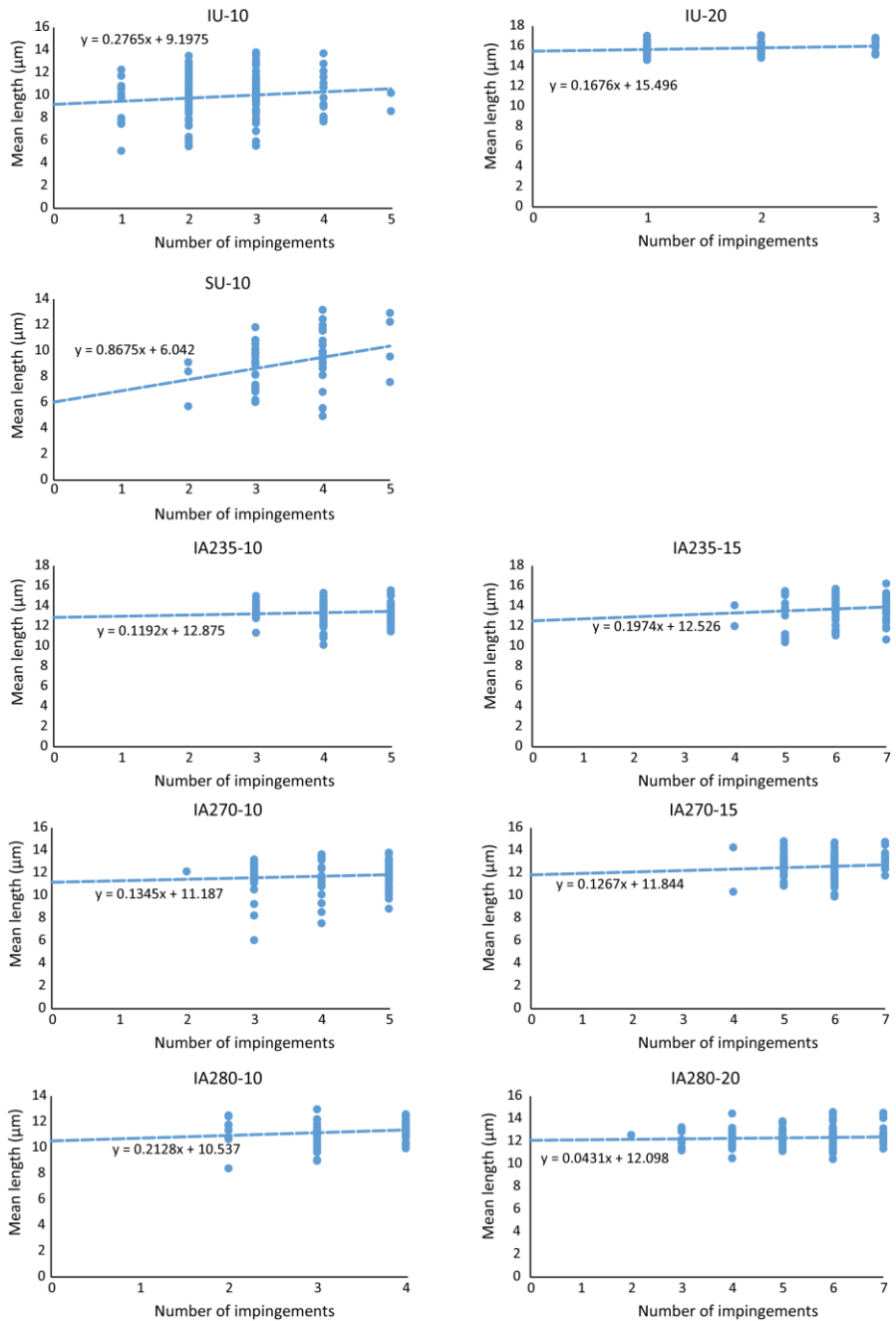
Figure S-2: Relationship between etched length after the first etching step, and number of impingements for each data set shown in Fig. S-1. All regressions have a positive slope, indicating that more intersections with etchant pathways is correlated with, and may have helped cause, slightly faster etching. Most of the slopes are low, however, indicating that this was probably at most a minor effect. The one experiment with a strong positive slope was SU-10, which features the slowest overall etching rates.
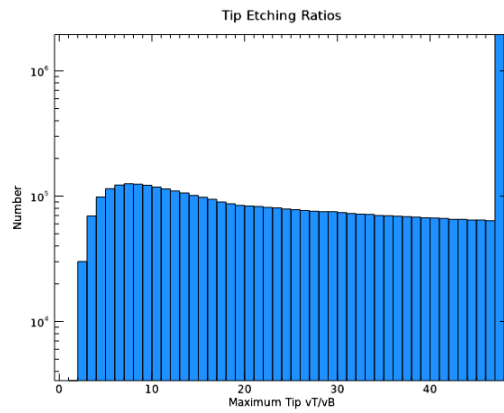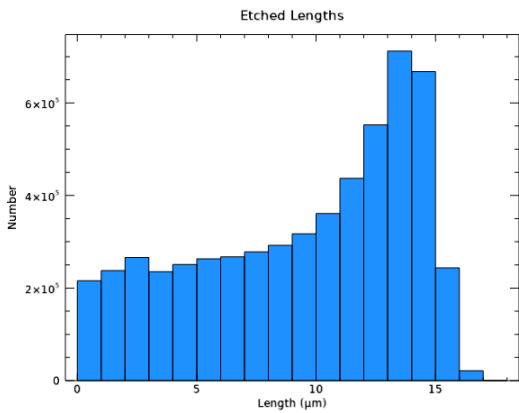
SU-10 model

Selected Tracks (N=1257192)

Etched and Selected Lengths

Selected Tracks (N=1257192)

Intersection Depths

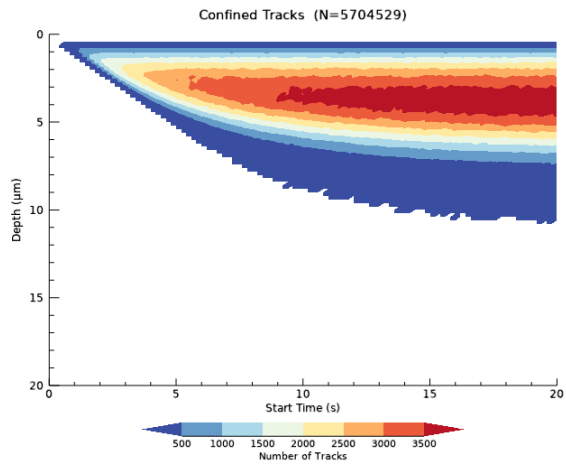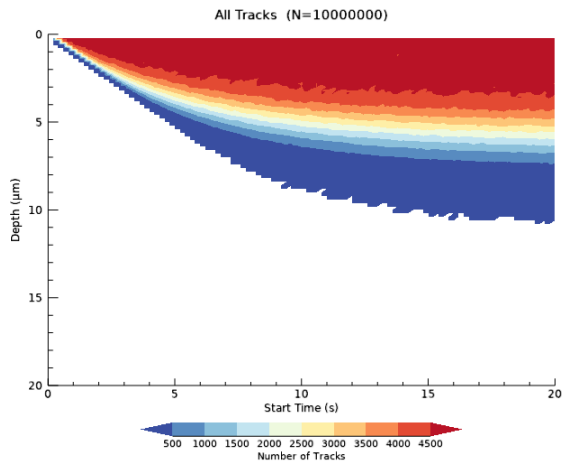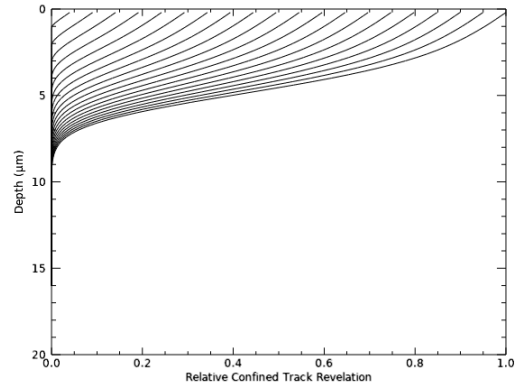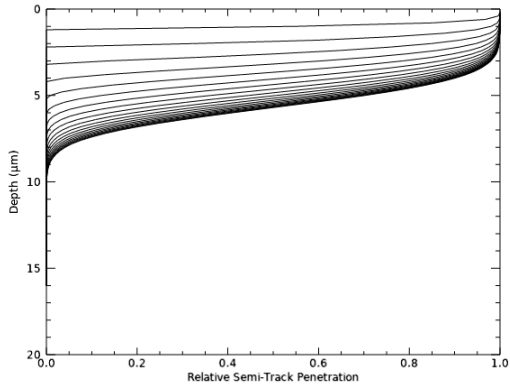Selected Lengths After 20 s

SE3 10 s measurements
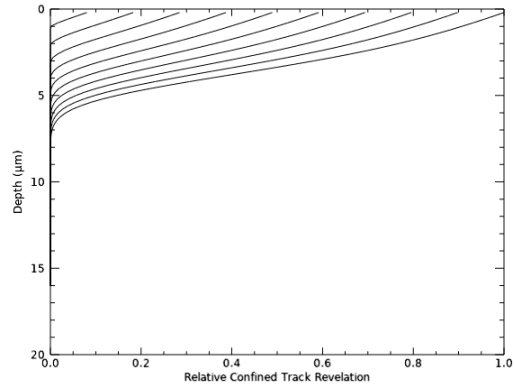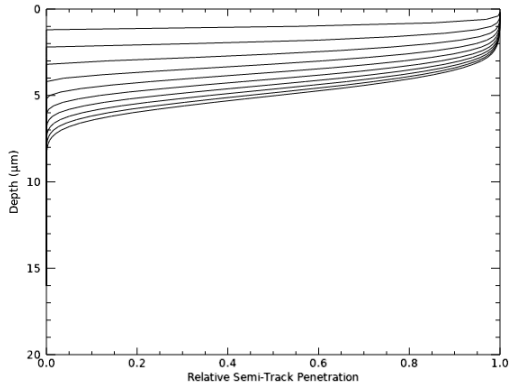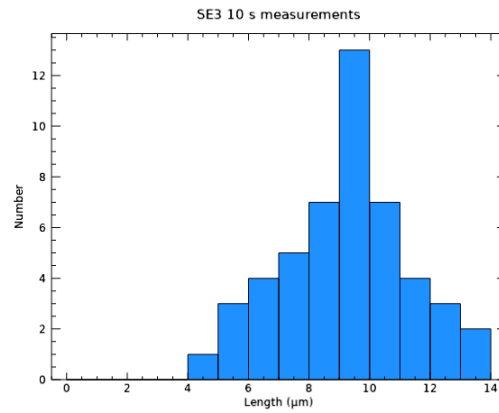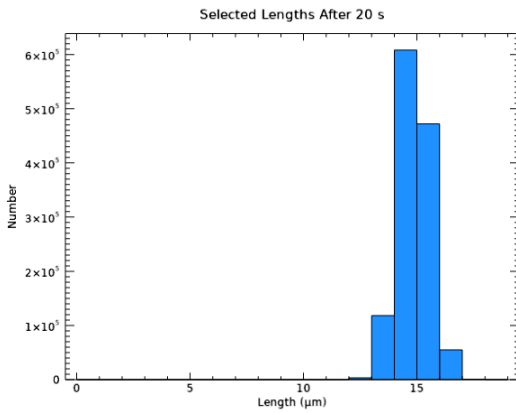
GenerateTrackSet, 0.022, 1.054, 5.48, 5.047, STEPS = [10,15,20,25,30], DEPTH_INC=0.2, TIME_INC=0.2, EX_TIP=2., NUM_TRACKS=10000000,MAX_DIP=25., MAX_TIP_VTVB=12., SD_LEN=0.8, UNDERETCH_BIAS=3., /CF
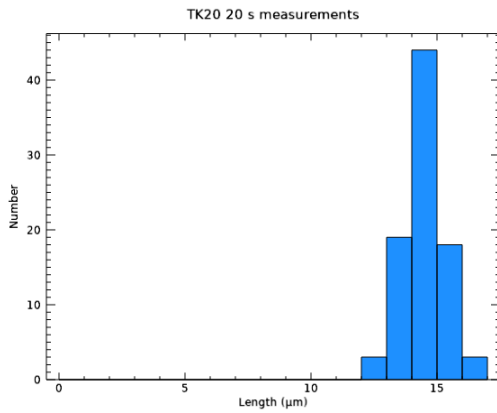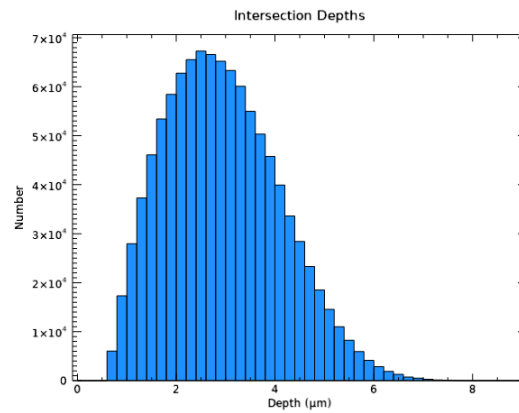
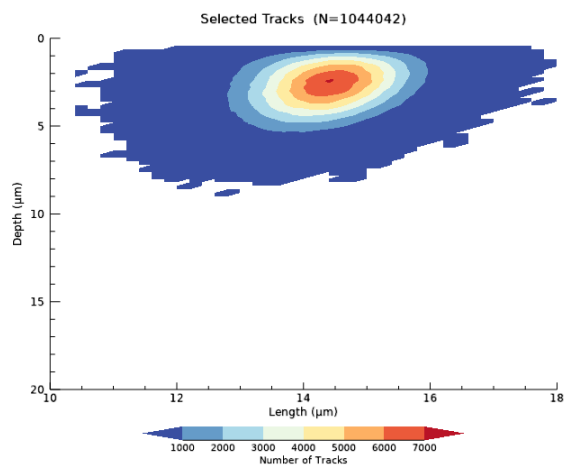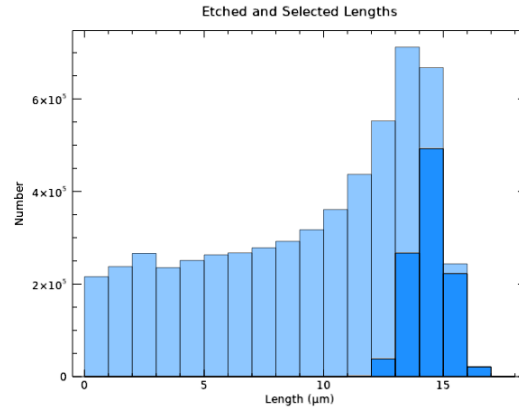| Etch step | 1 | 9.05054 | 1.65280 | 1257192 | 15.5448 | 4.40585 |
| 2.39043 |
| Etch step | 2 | 13.2873 | 0.801895 | 1257192 | 15.5448 | 4.40585 |
| 2.39043 |

Etch step	3	14.8659	0.666287	1257192	15.5448	4.40585
2.39043						
Etch step	4	15.4496	0.723828	1257192	15.5448	4.40585
2.39043						
Etch step	5	15.7238	0.750228	1257192	15.5448	4.40585
2.39043						

SU-20 model

All Tracks (N=10000000)

Confined Tracks (N=5704529)

Number of Tracks

Etched Lengths

Tip Etching Ratios

Selected Tracks (N=1044042)

Etched and Selected Lengths

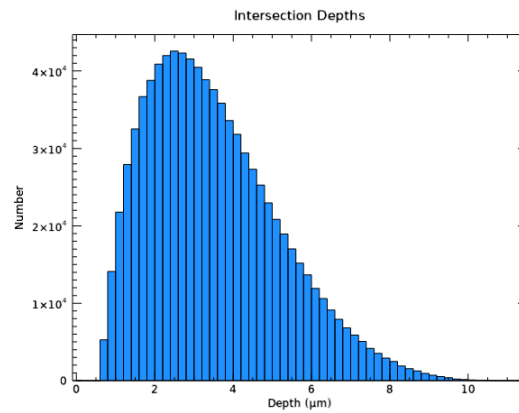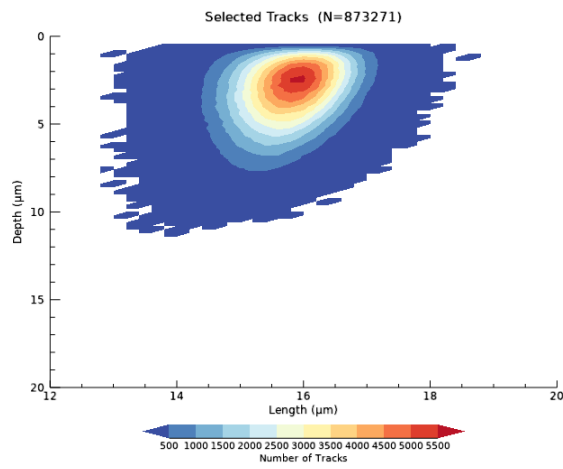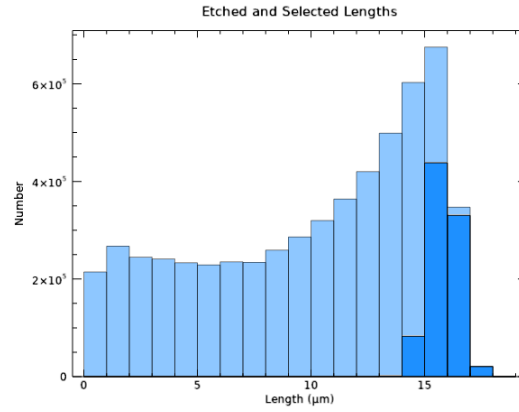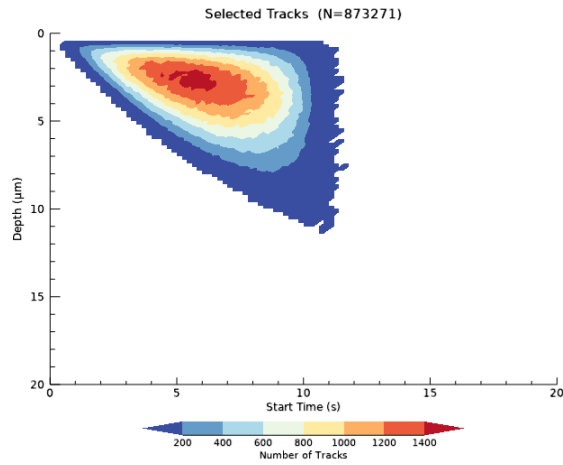Selected Tracks (N=1044042)

Intersection Depths

TK20 20 s measurements
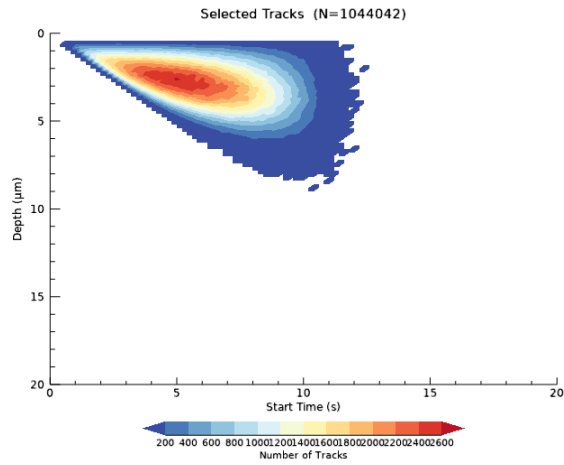
GenerateTrackSet, 0.022, 1.054, 5.48, 5.047, STEPS = [20], DEPTH_INC=0.2,
TIME_INC=0.2, EX_TIP=2., NUM_TRACKS=10000000,MAX_DIP=25., MAX_TIP_VTVB=12.,
SD_LEN=0.8, UNDERETCH_BIAS=3., /CF

Etch step   1   14.4208   0.789111   1044042   15.4058   6.10189
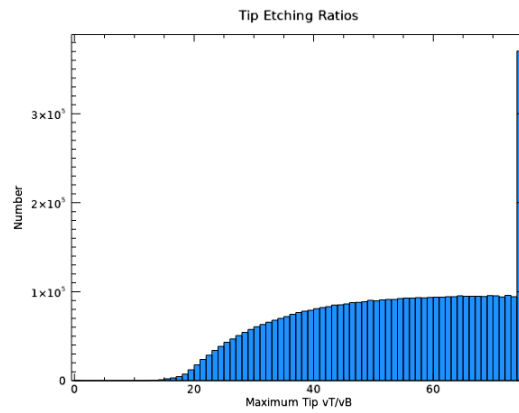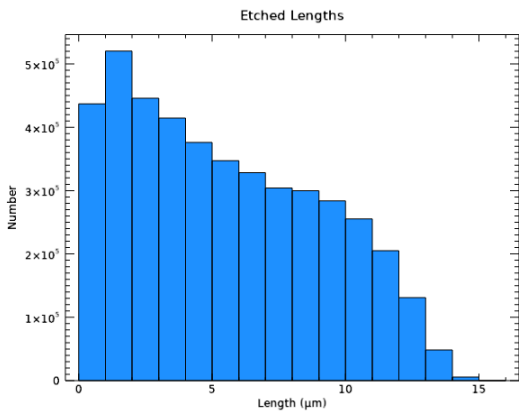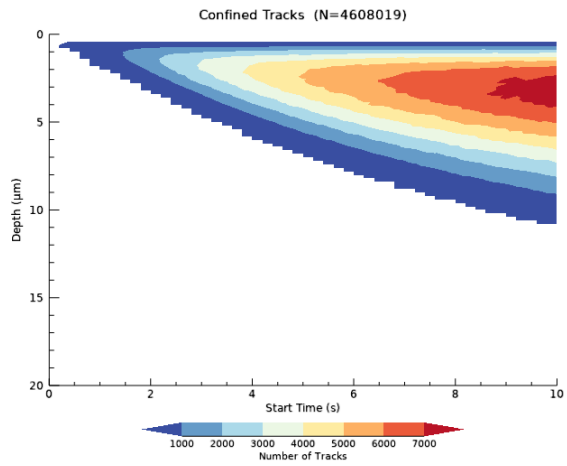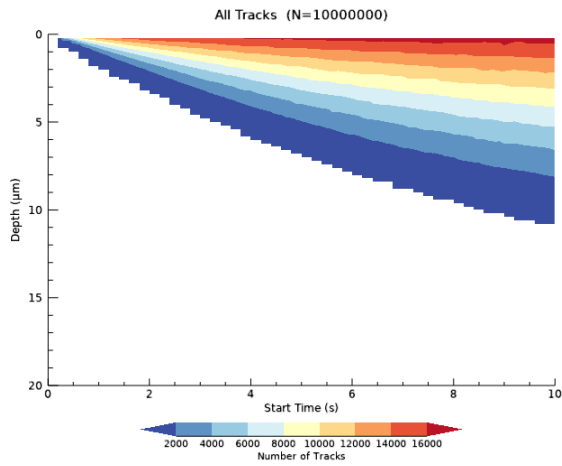2.83534

IU-20 model

Selected Tracks (N=873271)

Etched and Selected Lengths

Selected Tracks (N=873271)

Intersection Depths

SE1 20 s measurements
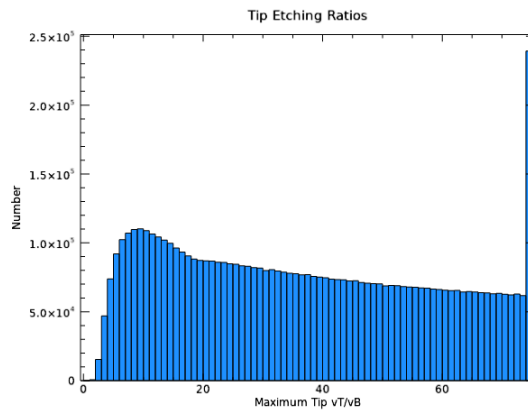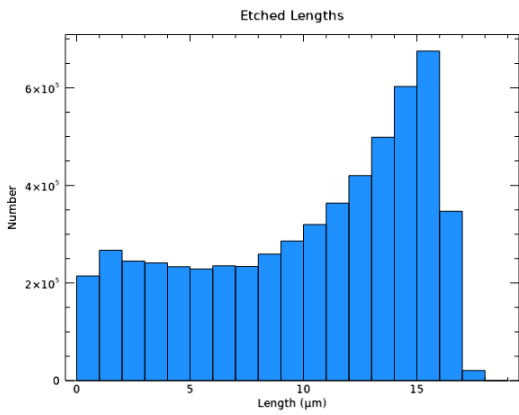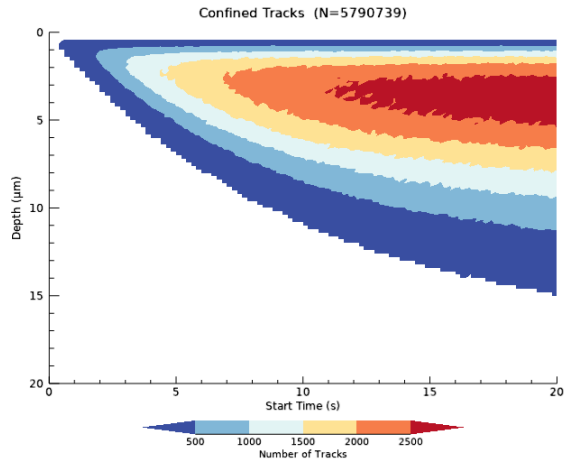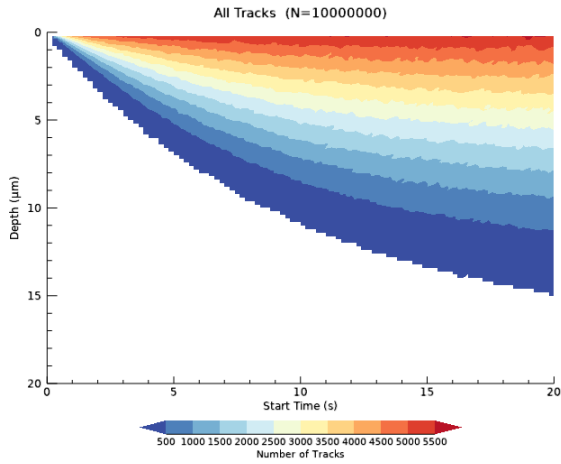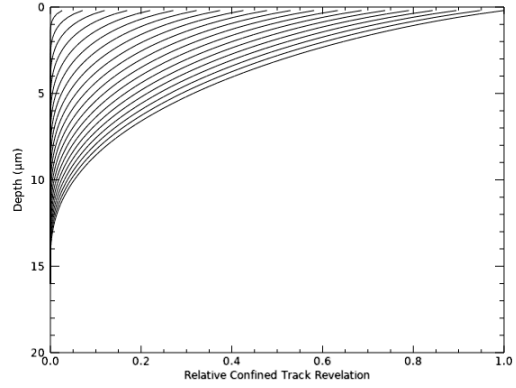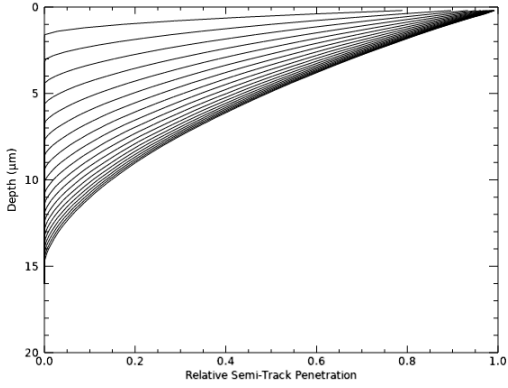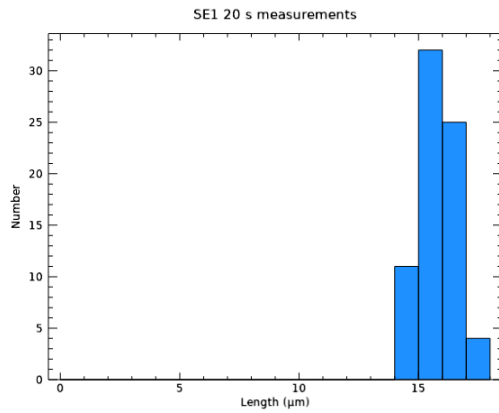
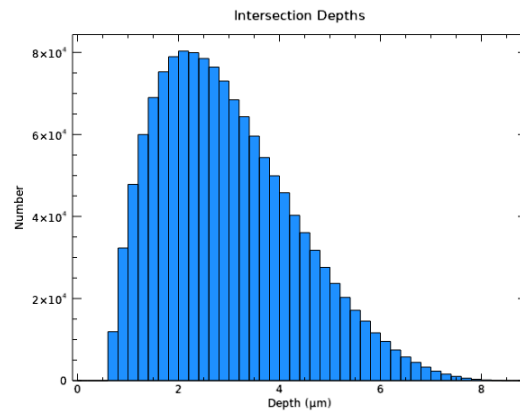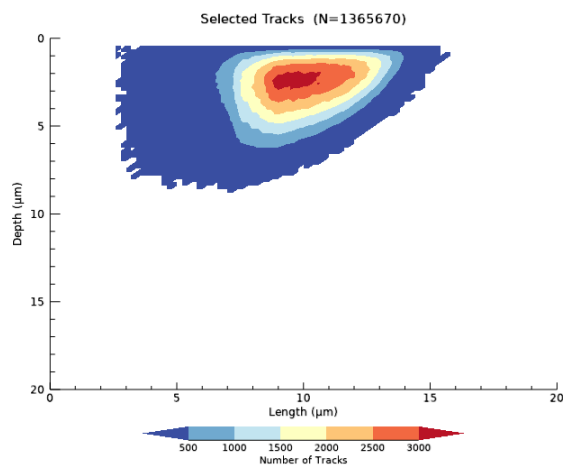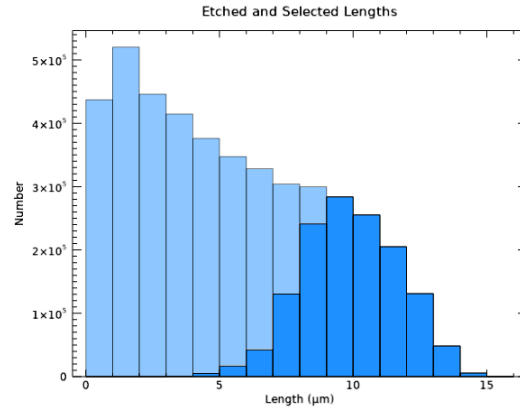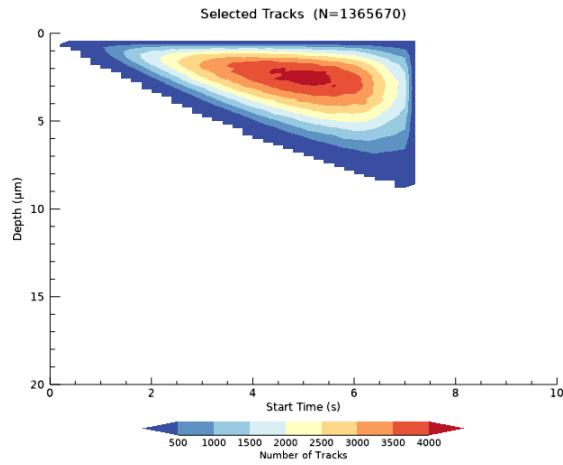GenerateTrackSet, 0.022, 1.639, 0.74, 8.136, STEPS = [20], DEPTH_INC=0.2, TIME_INC=0.2, EX_TIP=2., NUM_TRACKS=10000000,MAX_DIP=25., MAX_TIP_VTVB=12., SD_LEN=0.5, UNDERETCH_BIAS=3

Etch step	1	15.8290	0.618133	873271	16.9511	6.41710
		3.40764				
Etch step	2	16.6801	0.489372	873271	16.9511	6.41710
		3.40764				

```
Etch step      3      17.0241      0.485083      873271      16.9511      6.41710
3.40764
```

IU-10 model

Selected Tracks (N=1365670)

Depth (μm)

Start Time (s)

Number of Tracks

Etched and Selected Lengths

Number

Length (μm)

Selected Tracks (N=1365670)

Depth (μm)

Length (μm)

Number of Tracks

Intersection Depths

Number

Depth (μm)

Selected Lengths After 20 s

Number

Length (μm)

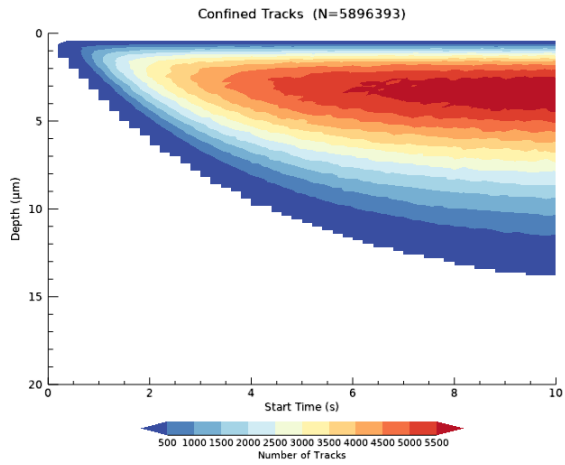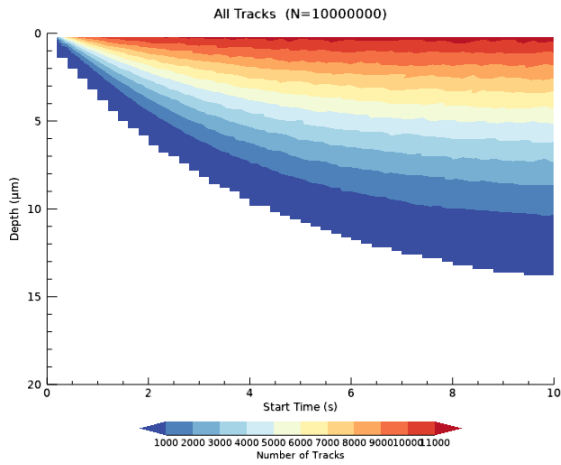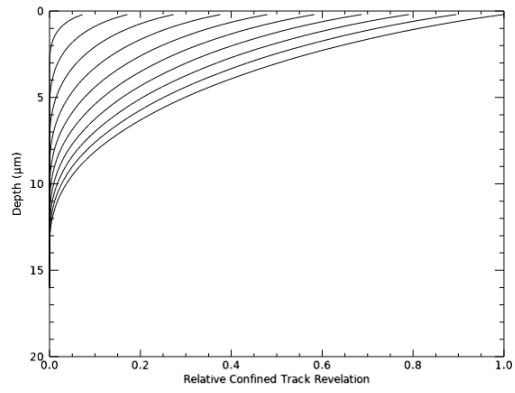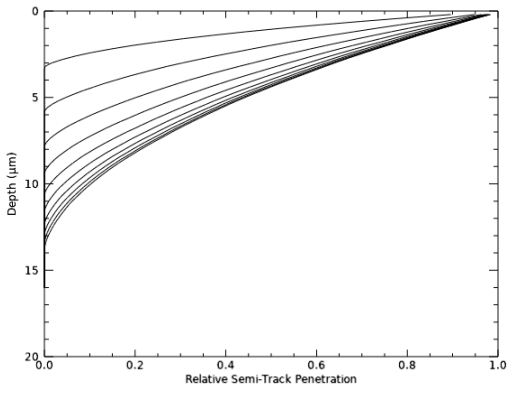SE2 10 s measurements

Number

Length (μm)
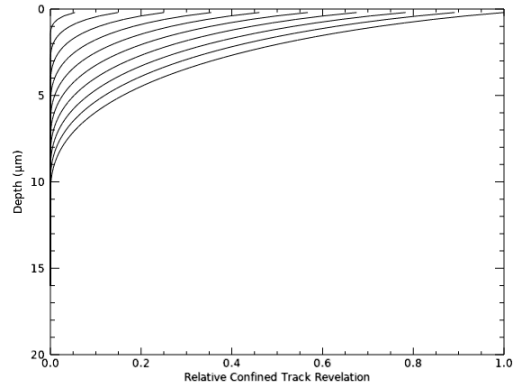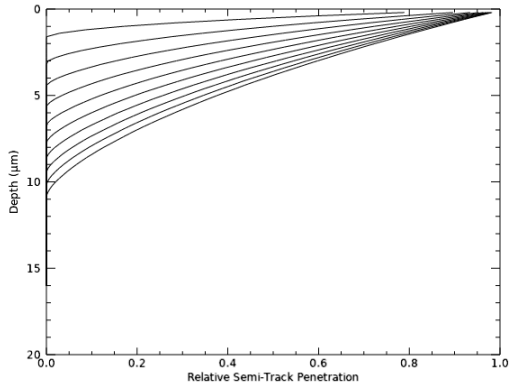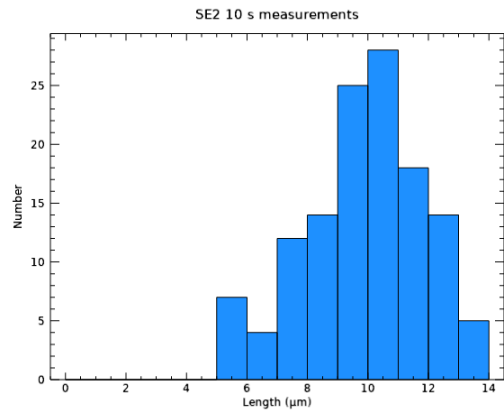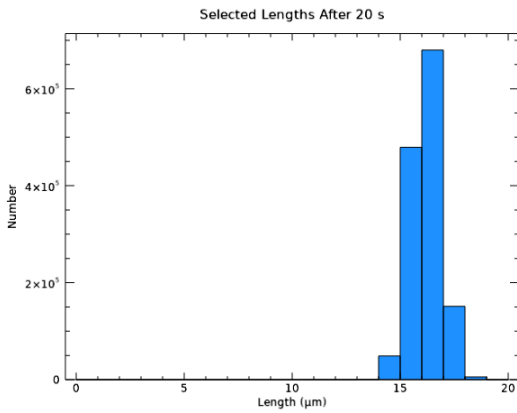
GenerateTrackSet, 0.022, 1.639, 0.74, 8.136, STEPS = [10,20,25,30], DEPTH_INC=0.2,
TIME_INC=0.2, EX_TIP=2., NUM_TRACKS=10000000,MAX_DIP=25., MAX_TIP_VTVB=12.,
SD_LEN=0.8, UNDERETCH_BIAS=3.

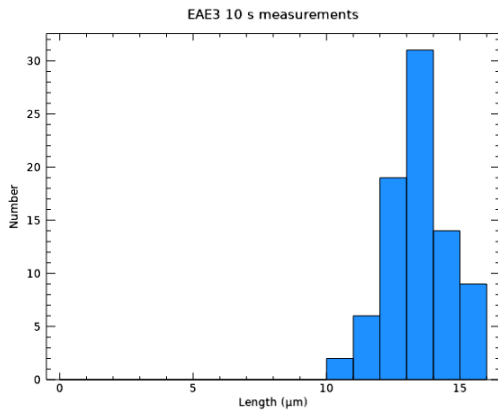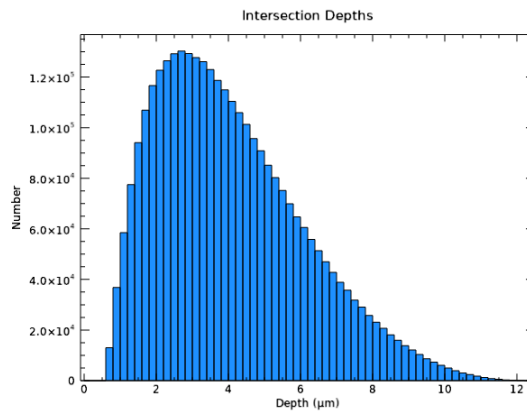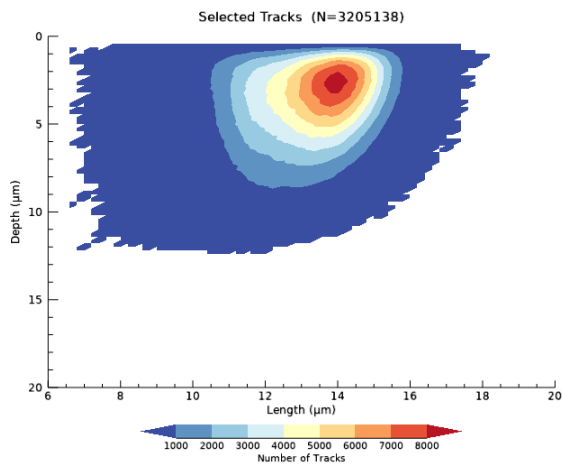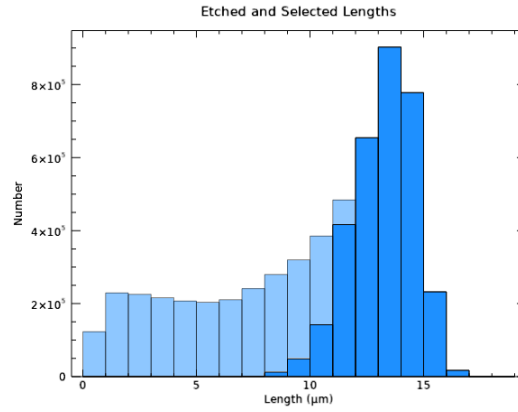| Etch step | 1 | 9.90717 | 1.79459 | 1365670 | 16.9808 | 4.83815 |
		2.87876				
Etch step	2	16.1950	0.670720	1365670	16.9808	4.83815
		2.87876				

Etch step	3	16.8354	0.725324	1365670	16.9808	4.83815
2.87876						
Etch step	4	17.1230	0.753539	1365670	16.9808	4.83815
2.87876						

IA235-10 model

Selected Tracks (N=3205138)

Etched and Selected Lengths

Selected Tracks (N=3205138)

Intersection Depths

EAE3 10 s measurements
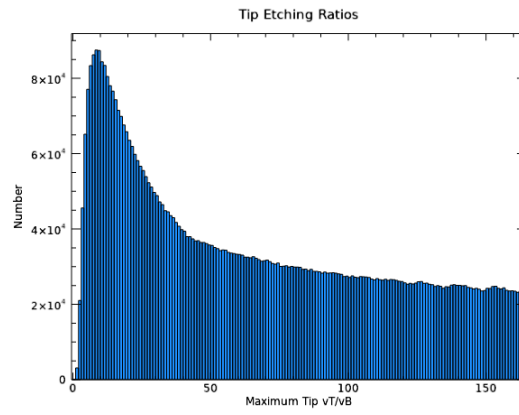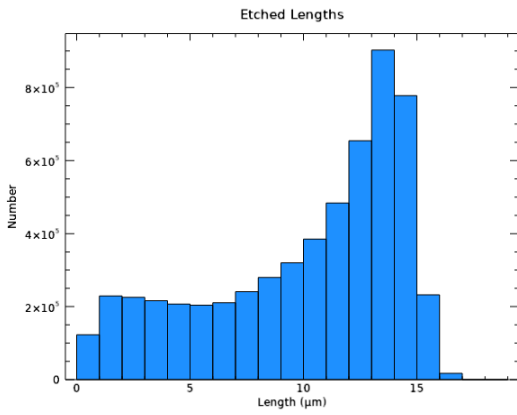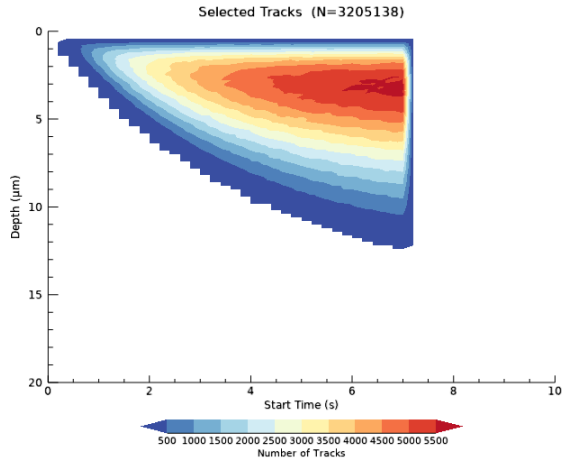
GenerateTrackSet, 0.022, 3.592, 0.26, 7.418, STEPS = [10], DEPTH_INC=0.2, TIME_INC=0.2, EX_TIP=2., NUM_TRACKS=10000000,MAX_DIP=25., MAX_TIP_VTVB=12., SD_LEN=0.8, UNDERETCH_BIAS=3.
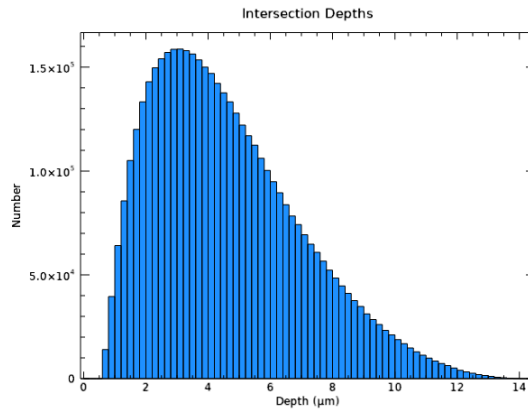
| Etch step | 1 | 13.2255 | 1.37634 | 3205138 | 15.0789 | 4.82783 |
| 3.97398 | | | | | | |

IA235-15 model

All Tracks (N=10000000)

Confined Tracks (N=6216483)

Etched Lengths

Tip Etching Ratios

Selected Tracks (N=4535511)

Etched and Selected Lengths

Selected Tracks (N=4535511)

Intersection Depths

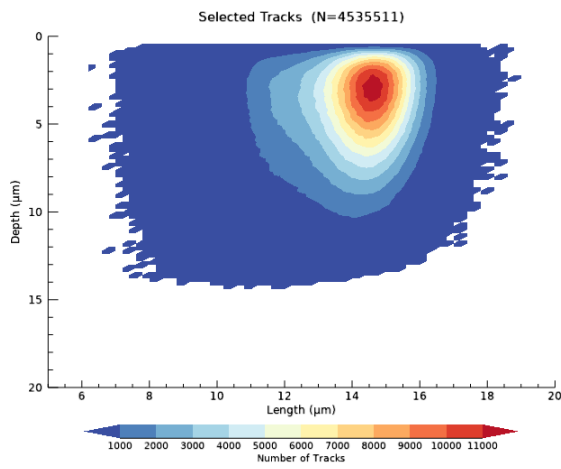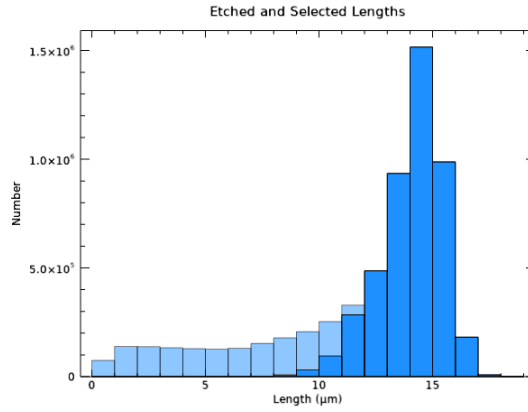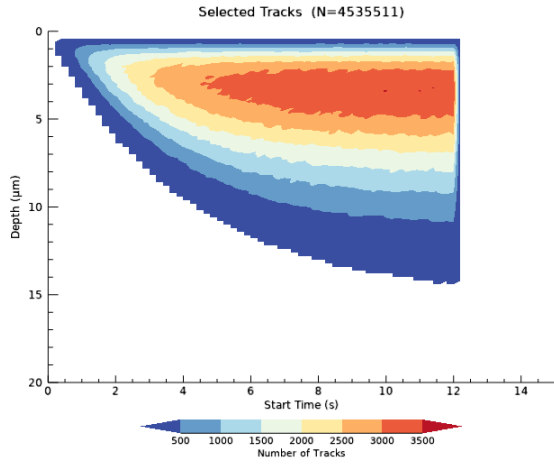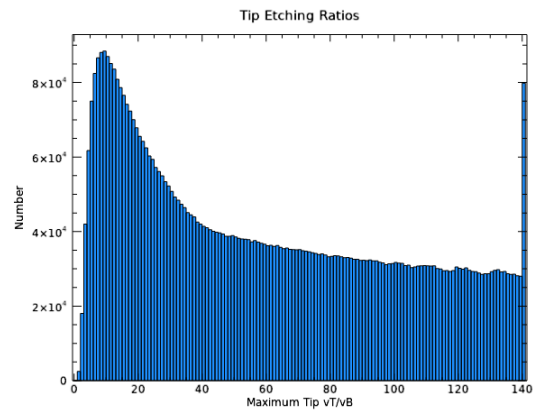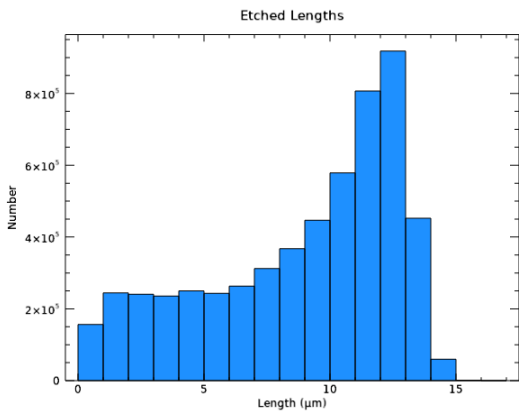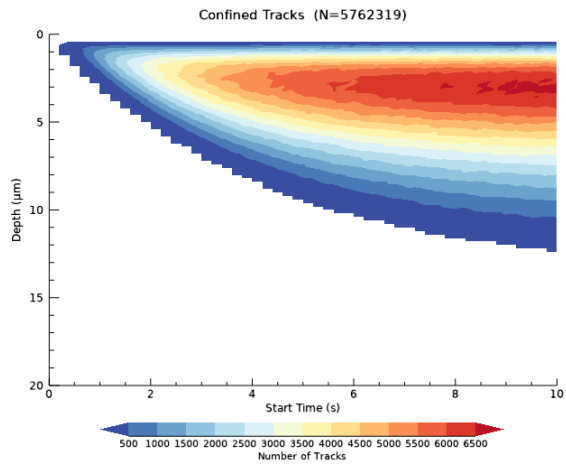Selected Lengths After 20 s

SE6 15 s measurements
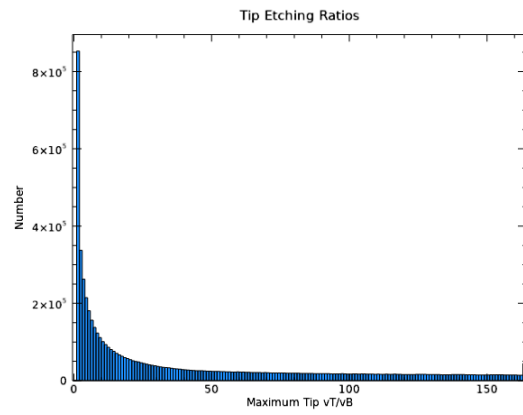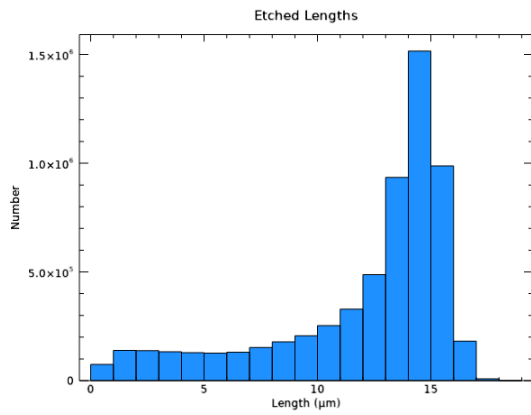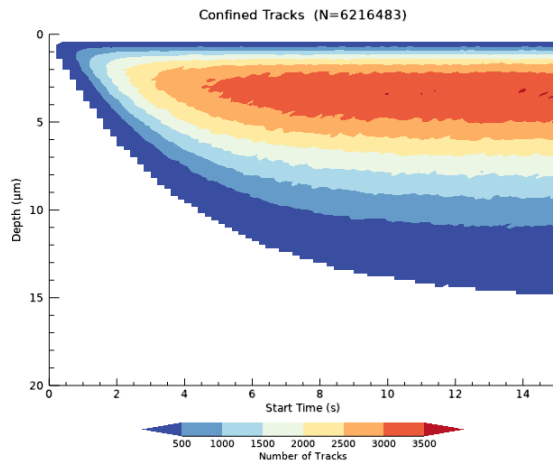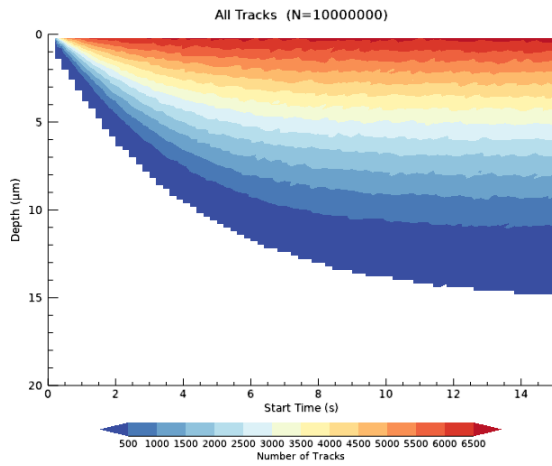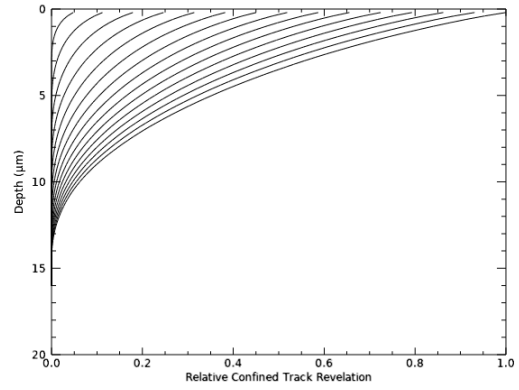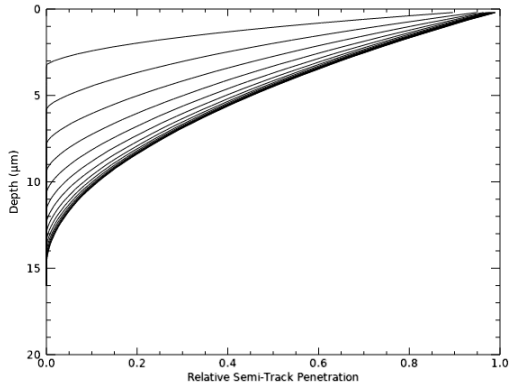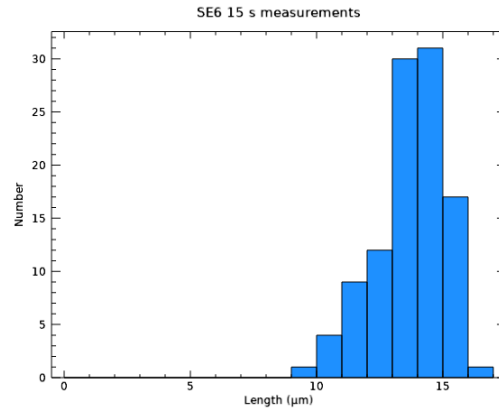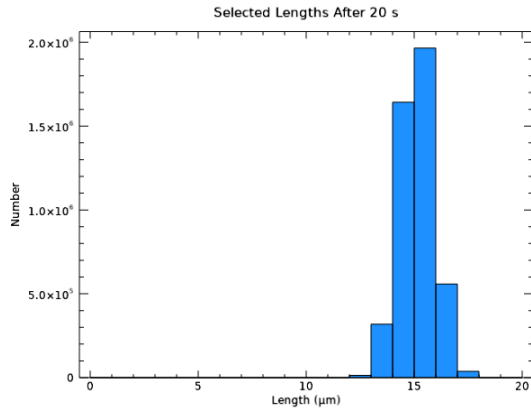
GenerateTrackSet, 0.022, 3.592, 0.26, 7.418, STEPS = [15,20,25,30], DEPTH_INC=0.2, TIME_INC=0.2, EX_TIP=2., NUM_TRACKS=10000000,MAX_DIP=25., MAX_TIP_VTVB=12., SD_LEN=0.8, UNDERETCH_BIAS=3.

Etch step   1   14.0627   1.37989   4535511   15.0806   7.66058
4.52818

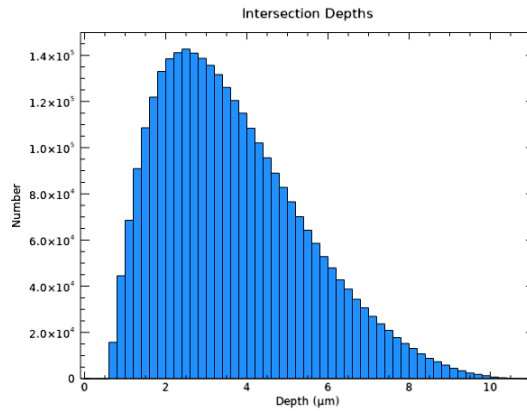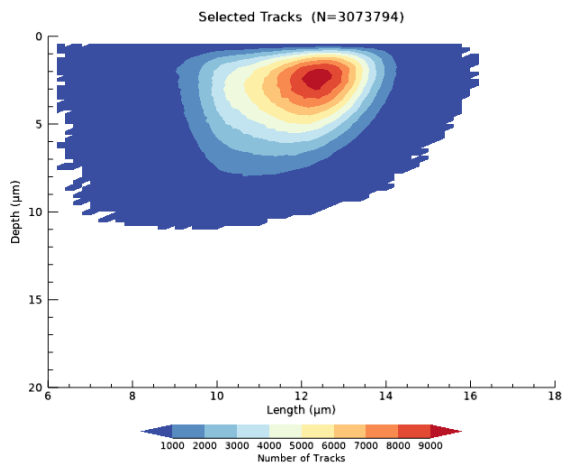| Etch step | 2 | 15.1282 | 0.778208 | 4535511 | 15.0806 | 7.66058 |
4.52818						
Etch step	3	15.3774	0.784190	4535511	15.0806	7.66058
4.52818						
Etch step	4	15.5980	0.784217	4535511	15.0806	7.66058
4.52818						

IA270-10 model

Relative Semi-Track Penetration — Depth (µm)

Relative Confined Track Revelation — Depth (µm)

All Tracks (N=10000000)

Start Time (s) — Depth (µm)

1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000 12000 13000
Number of Tracks

Confined Tracks (N=5762319)

Start Time (s) — Depth (µm)

500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500
Number of Tracks

Etched Lengths

Length (µm) — Number

Tip Etching Ratios

Maximum Tip vT/vB — Number

Selected Tracks (N=3073794)

Etched and Selected Lengths

Selected Tracks (N=3073794)

Intersection Depths

EAE2 10 s measurements

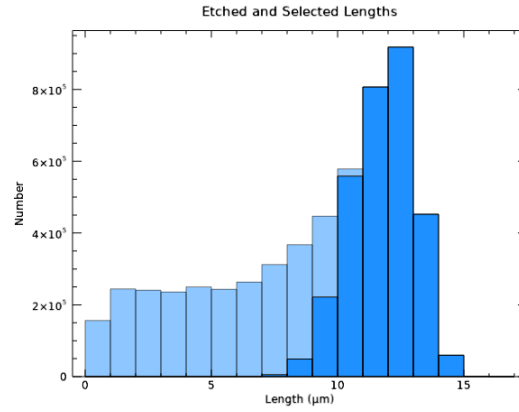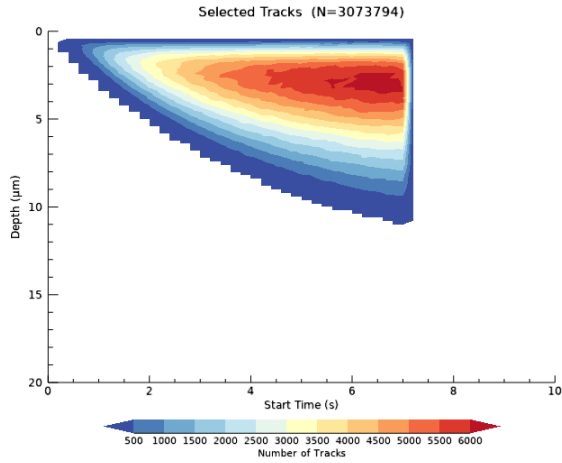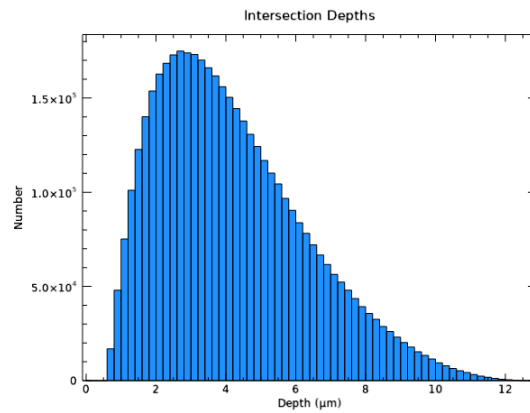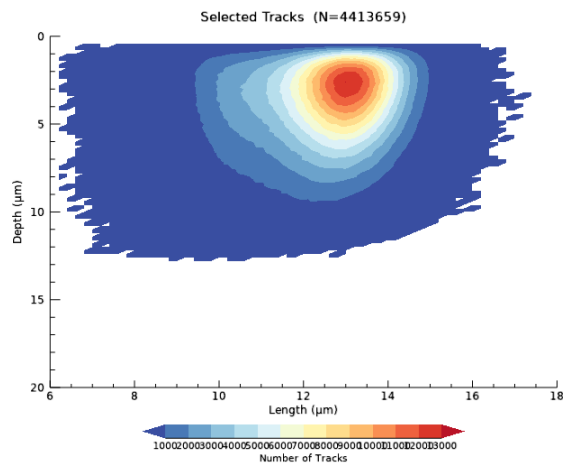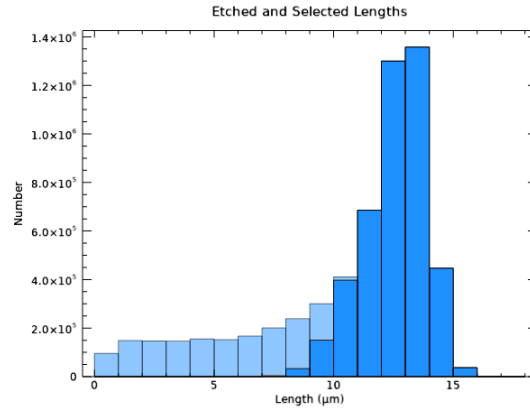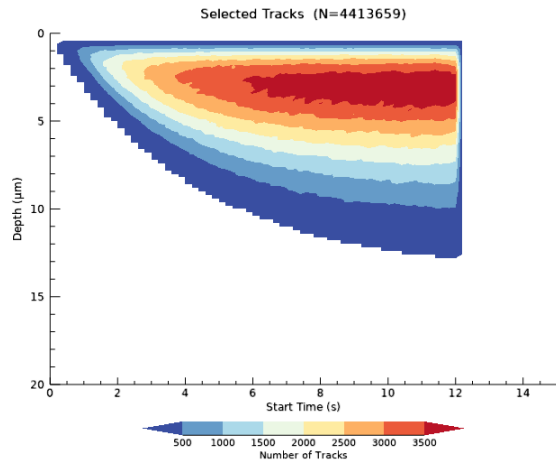**GenerateTrackSet**, 0.022, 3.083, 0.26, 6.659, STEPS = [10], DEPTH_INC=0.2, TIME_INC=0.2, EX_TIP=2., NUM_TRACKS=10000000,MAX_DIP=25., MAX_TIP_VTVB=12., SD_LEN=0.8, UNDERETCH_BIAS=3.

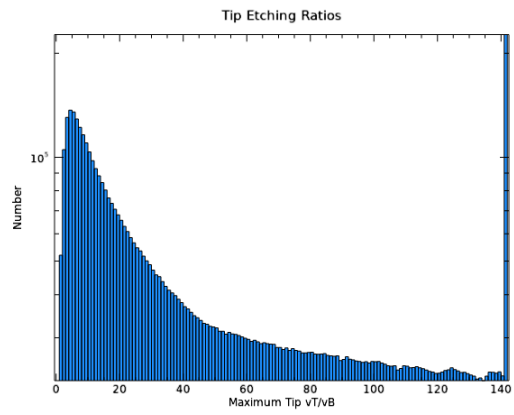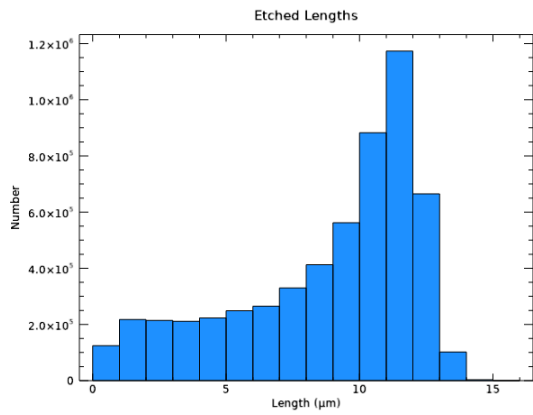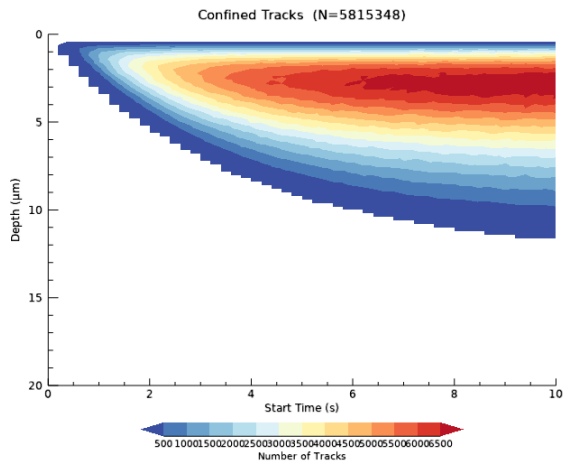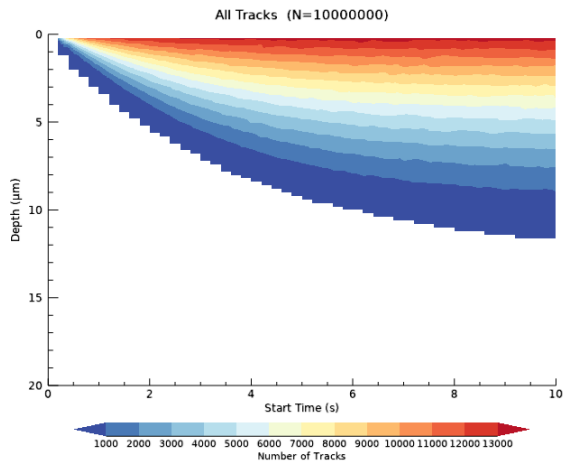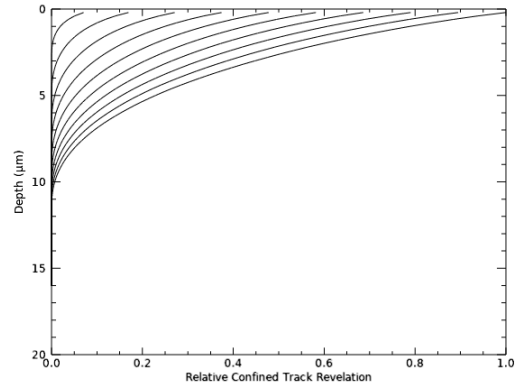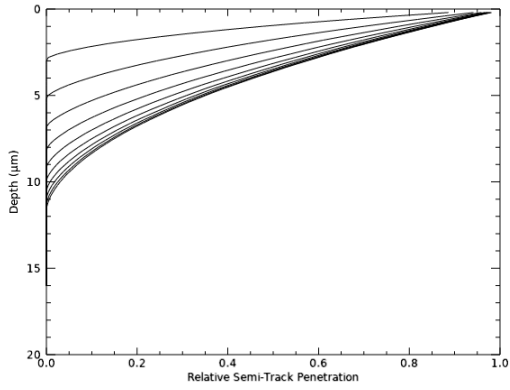| Etch step | 1 | 11.7698 | 1.24949 | 3073794 | 13.5570 | 4.85649 |
| 3.56681 | | | | | | |

IA270-15 model

Selected Tracks (N=4413659)

Etched and Selected Lengths

Selected Tracks (N=4413659)

Intersection Depths

Selected Lengths After 20 s

SE5 15 s measurements
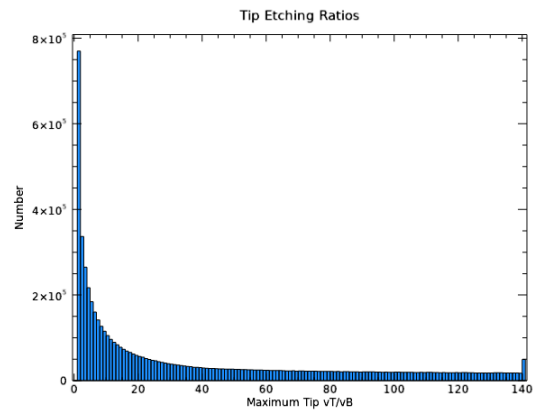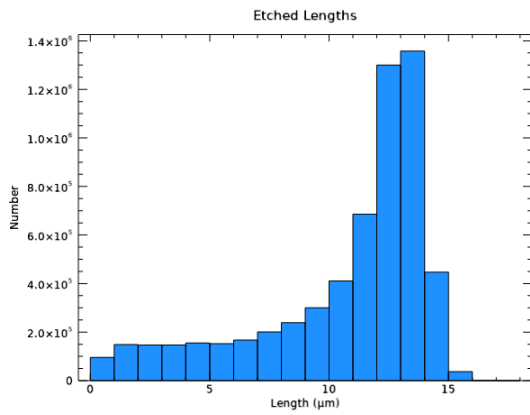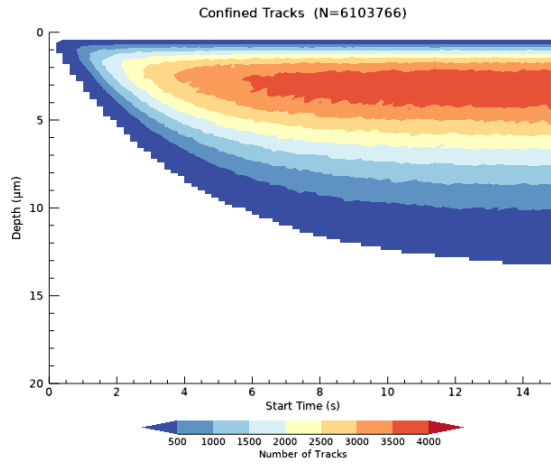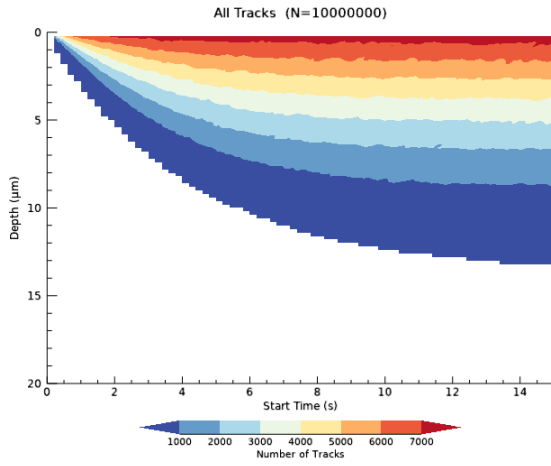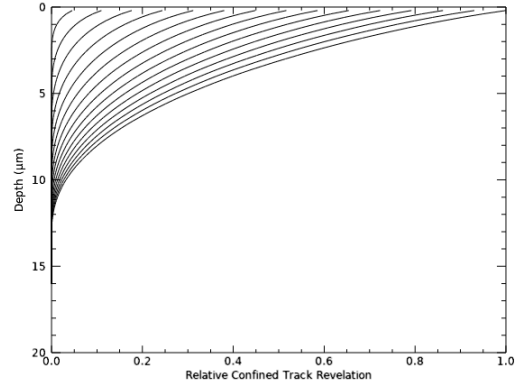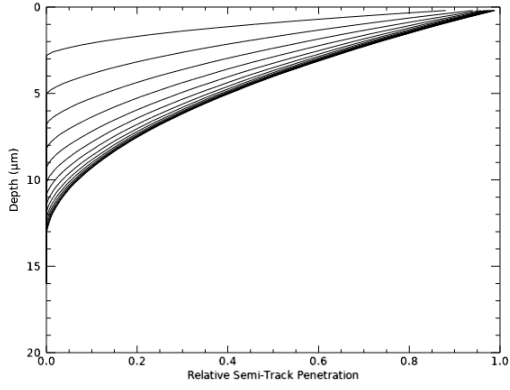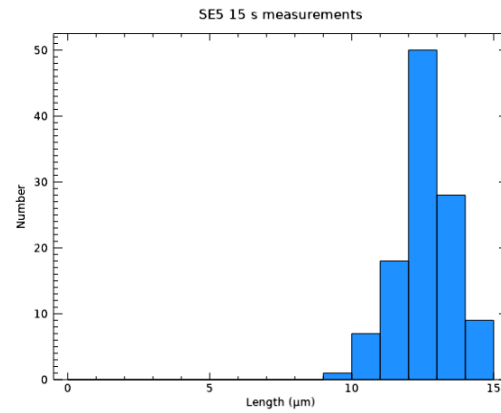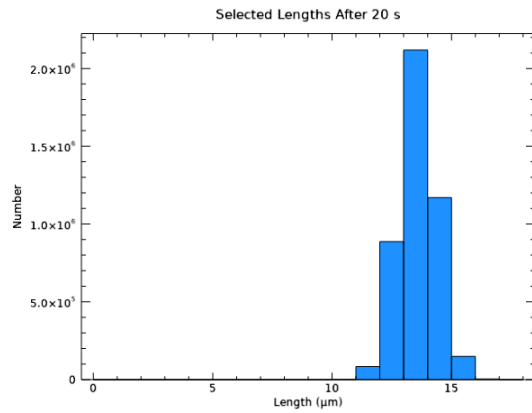
GenerateTrackSet, `0.022`, `3.083`, `0.26`, `6.659`, STEPS = [`15`,`20`,`25`,`30`], DEPTH_INC=`0.2`,
TIME_INC=`0.2`, EX_TIP=`2.`, NUM_TRACKS=`10000000`,MAX_DIP=`25.`, MAX_TIP_VTVB=`12.`,
SD_LEN=`0.8`, UNDERETCH_BIAS=`3.`

Etch step	1	12.5617	1.29227	4413659	13.5603	7.71907
4.09157						
Etch step	2	13.5957	0.772601	4413659	13.5603	7.71907
4.09157						

Etch step	3	13.8464	0.780455	4413659	13.5603	7.71907
4.09157						
Etch step	4	14.0661	0.780500	4413659	13.5603	7.71907
4.09157						

IA280-10 model

Selected Tracks (N=3219828)

Etched and Selected Lengths

Selected Tracks (N=3219828)

Intersection Depths

EAE1 10 s measurements
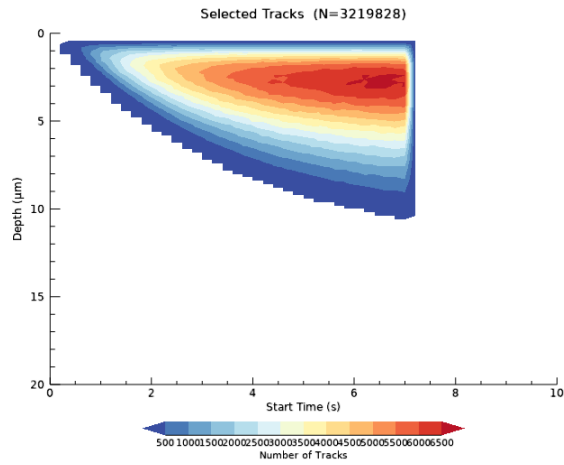
GenerateTrackSet, 0.022, 3.109, 0.78, 5.810, STEPS=[10], DEPTH_INC=0.2, TIME_INC=0.2, EX_TIP=2., NUM_TRACKS=10000000,MAX_DIP=25., MAX_TIP_VTVB=12., SD_LEN=0.8, UNDERETCH_BIAS=3.
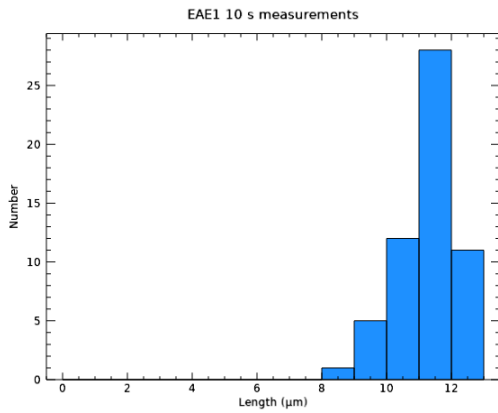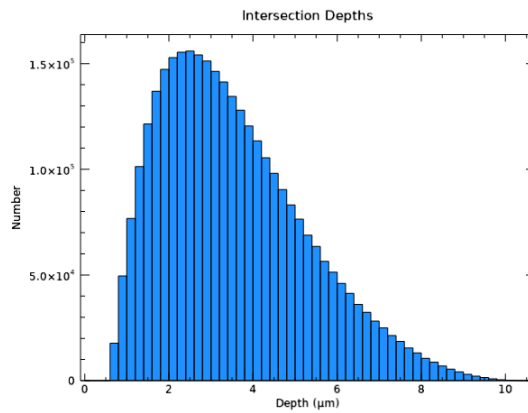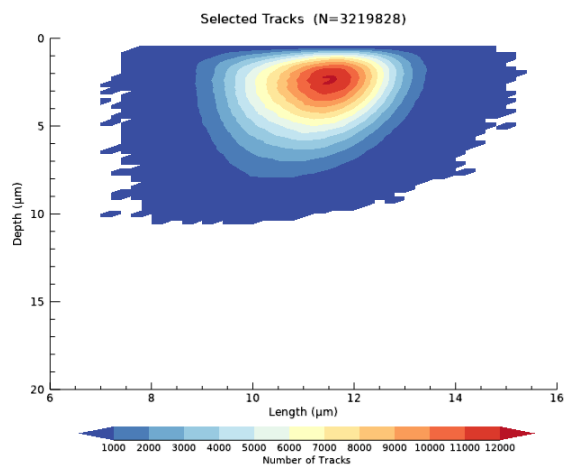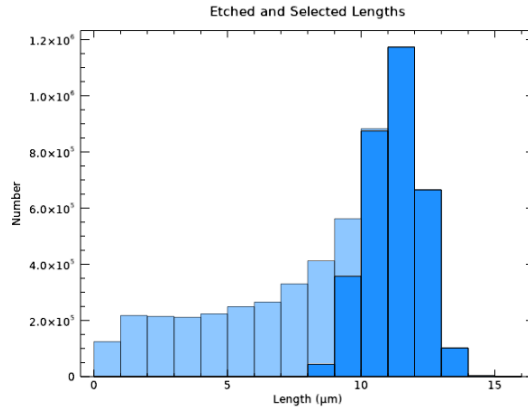Etch step   1   11.2377   1.01552   3219828   12.3797   4.79518
3.44276

IA280-20 model

All Tracks (N=10000000)

Confined Tracks (N=6241026)

Etched Lengths

Tip Etching Ratios

Selected Tracks (N=4029430)

Etched and Selected Lengths

Selected Tracks (N=4029430)
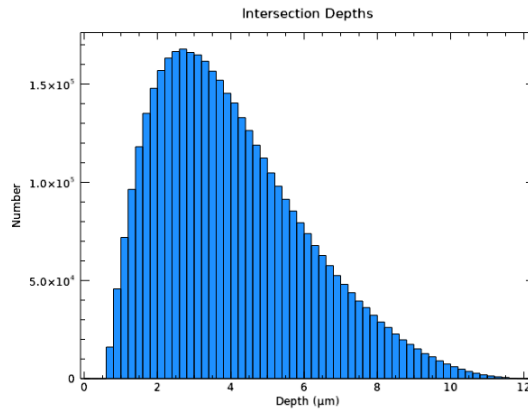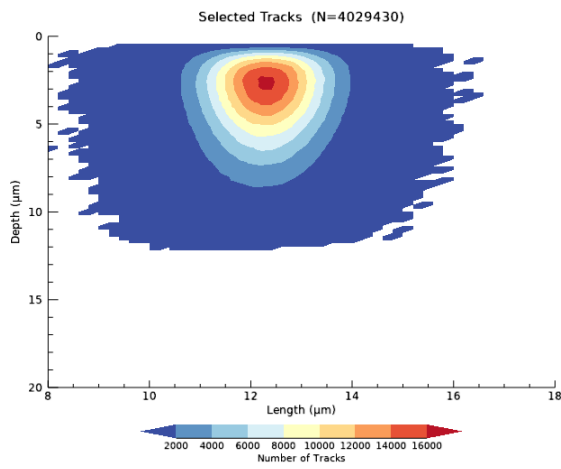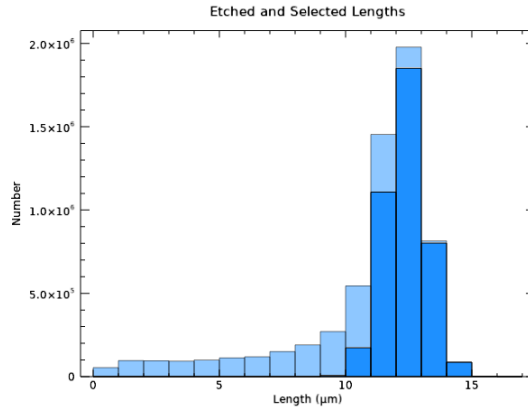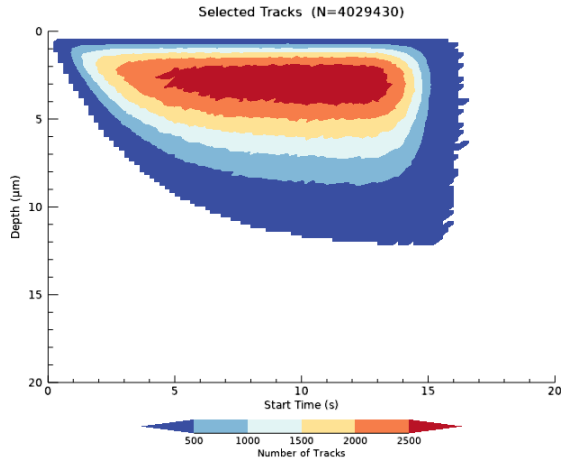
Intersection Depths

SE4 20 s measurements
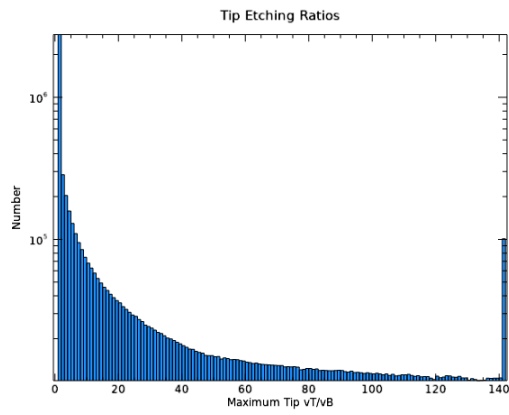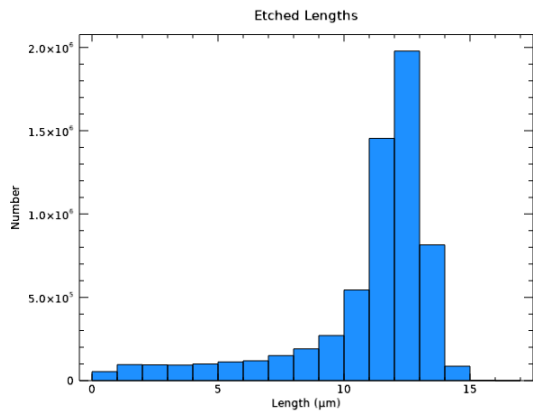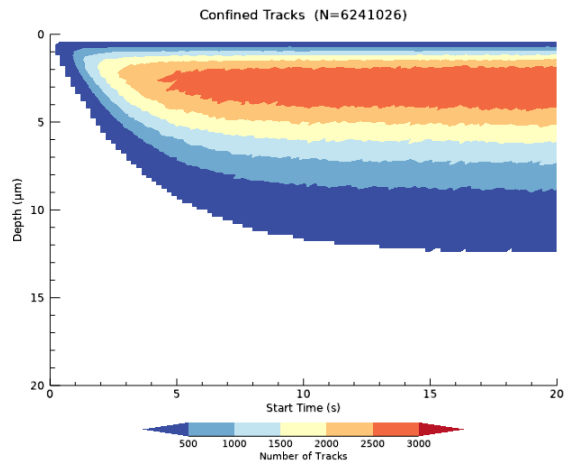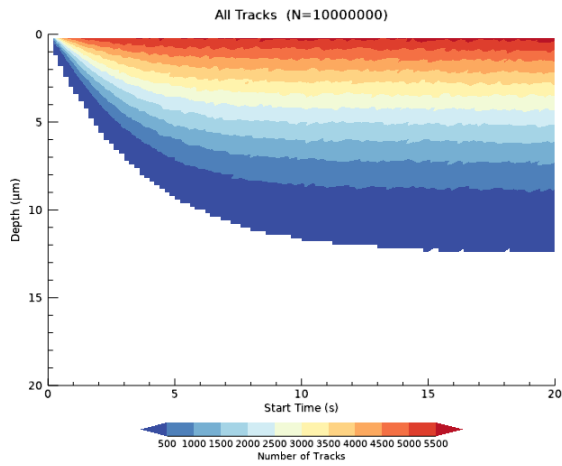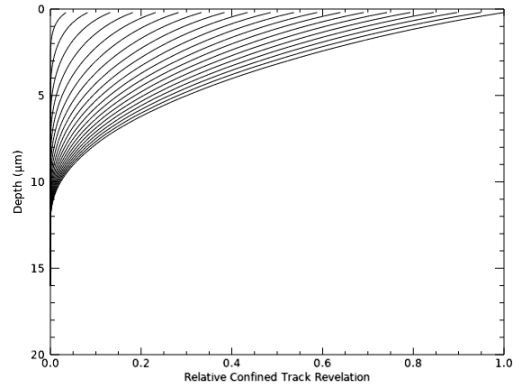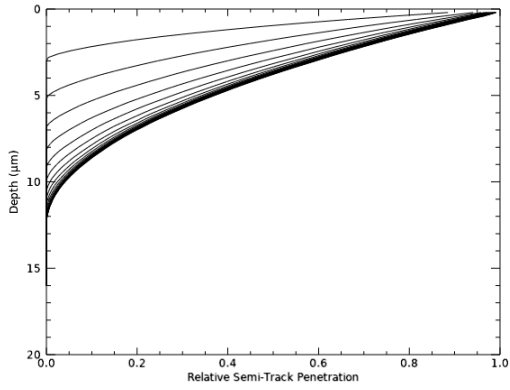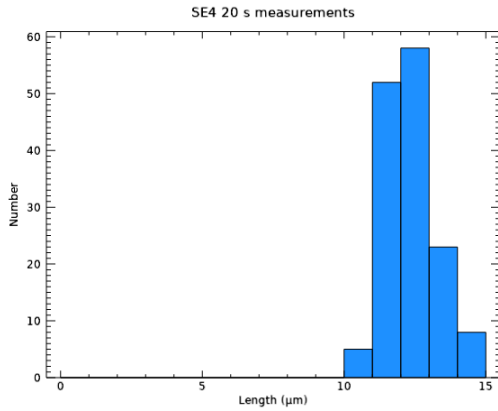
GenerateTrackSet, 0.022, 3.109, 0.78, 5.810, STEPS = [20,25,30], DEPTH_INC=0.2, TIME_INC=0.2, EX_TIP=2., NUM_TRACKS=10000000,MAX_DIP=25., MAX_TIP_VTVB=12., SD_LEN=0.8, UNDERETCH_BIAS=3.

| Etch step | 1 | 12.3775 | 0.808697 | 4029430 | 12.3519 | 8.82009 3.94890 |
| Etch step | 2 | 12.6498 | 0.795843 | 4029430 | 12.3519 | 8.82009 3.94890 |

Etch step   3   12.8698   0.795844   4029430   12.3519   8.82009
3.94890