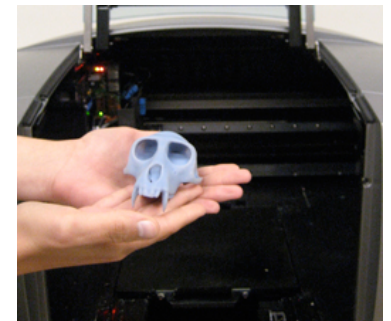
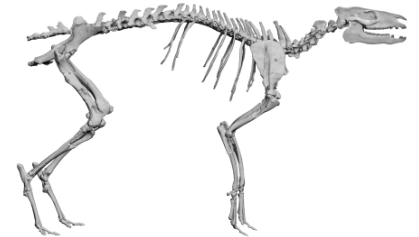
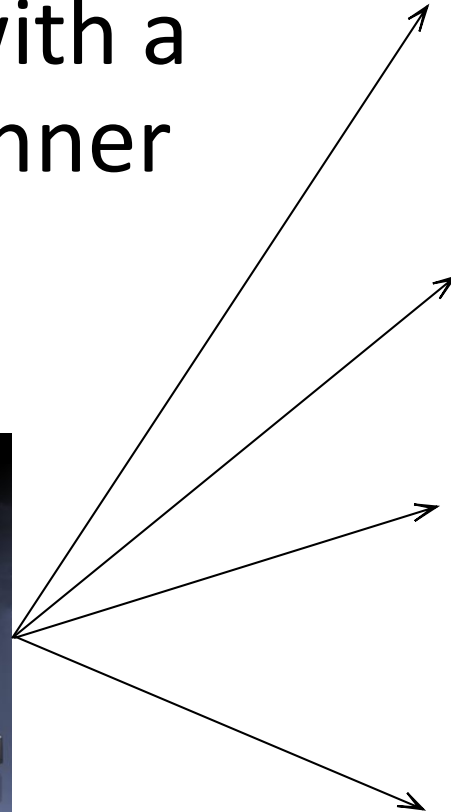


FAQ: 3D surface scanning of paleo collections with a NextEngine laser scanner



Aaron R. Wood

How does the scanner work?

What is the smallest size that can be scanned?

What is the largest size that can be scanned?

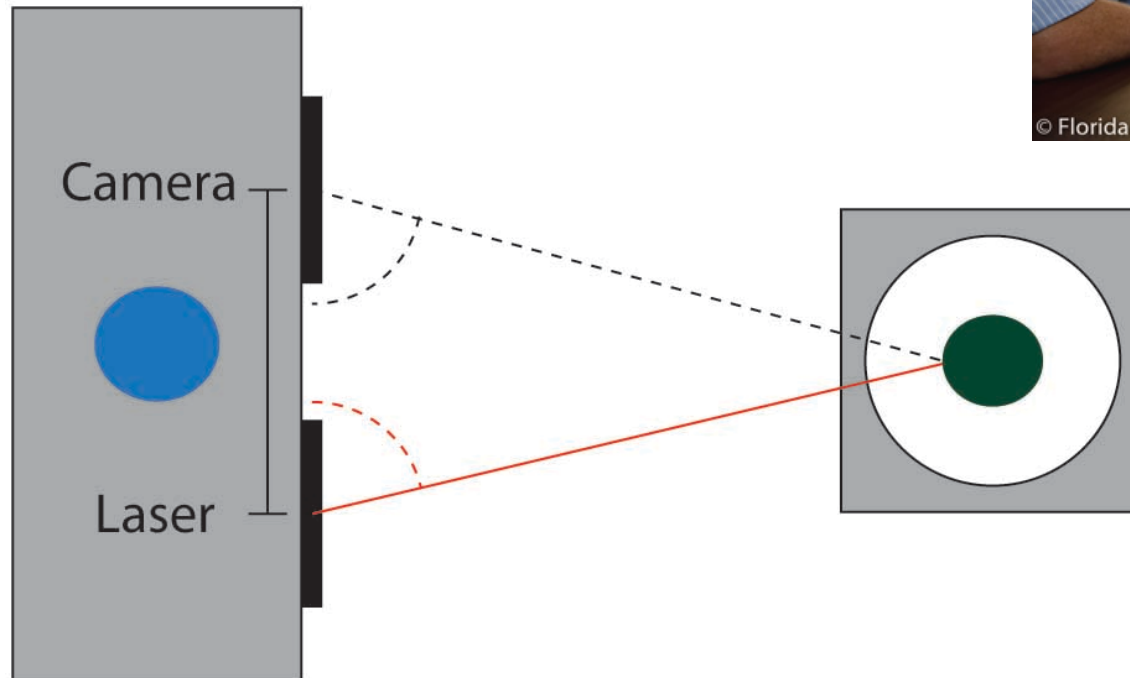
How much time does it take to scan a fossil?

How big are the scan files?

Can accurate measurements be taken from the scans?

How does the scanner work?

Triangulation



2 known variables: distance between camera and laser emitter
angle between laser and scanner body

1 measured variable: position of laser within camera's field of view

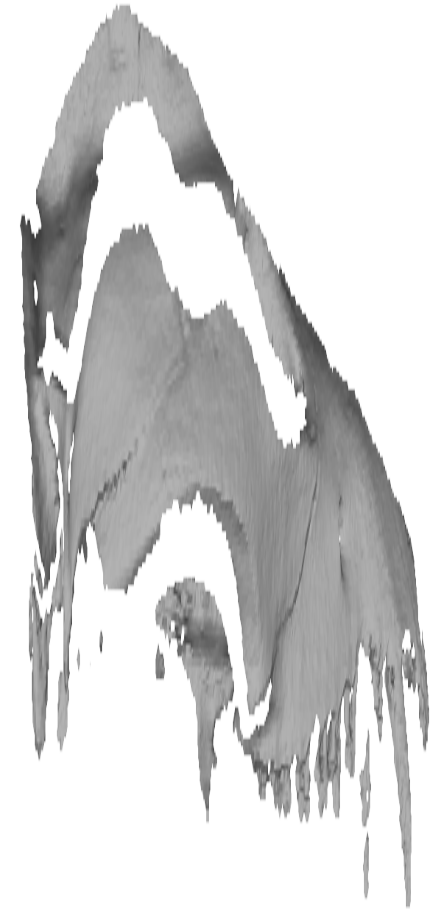
How does the scanner work?

3D data can be captured if:

the laser can reach it

the specimen is in the
camera's field of view

3) the specimen is in the
camera's depth of field



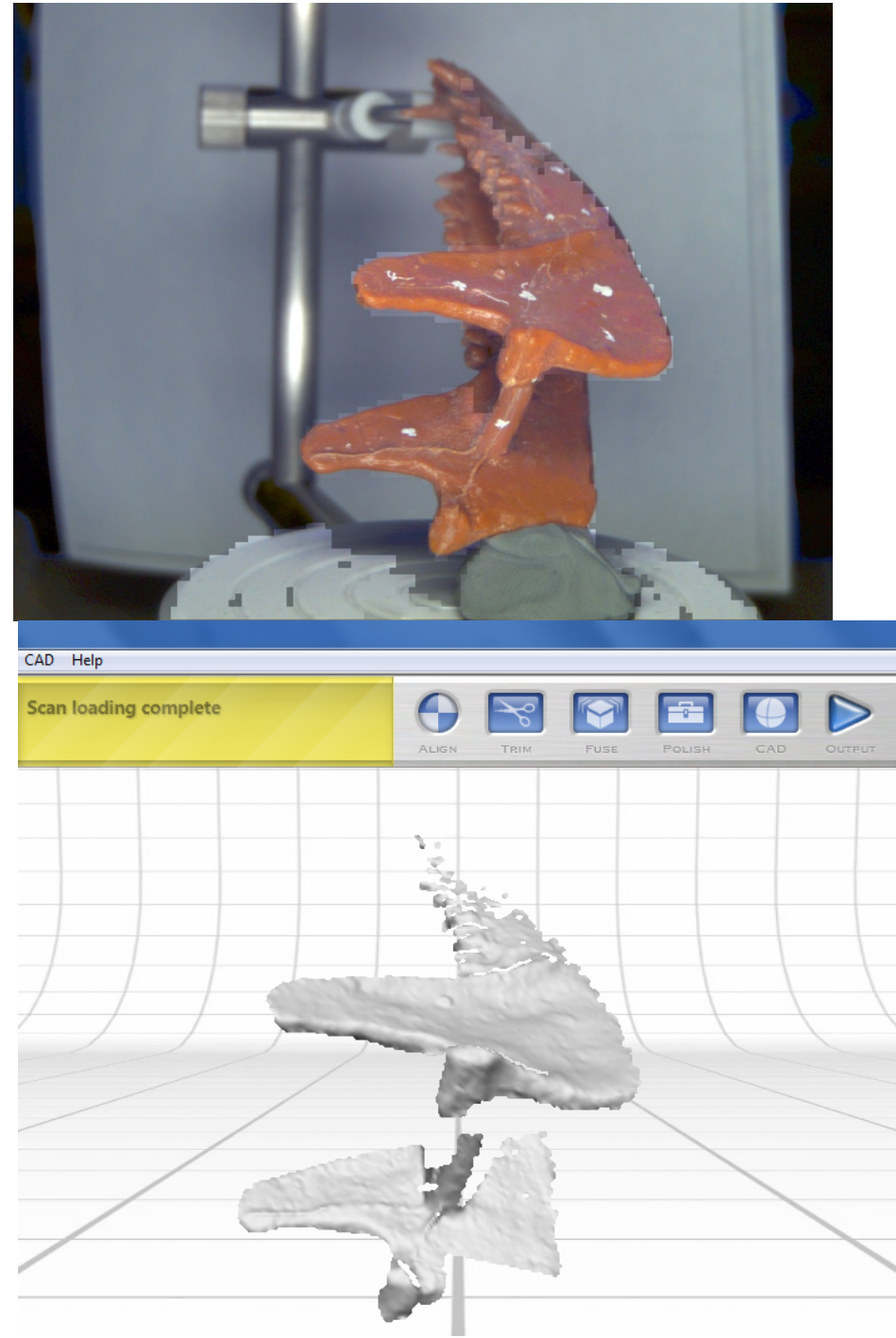
How does the scanner work?

3D data can be captured if:

the laser can reach it

the specimen is in the
camera's field of view

3) the specimen is in the
camera's depth of field



What is the smallest size that can be scanned?

Arenahippus grangeri
(Eocene)

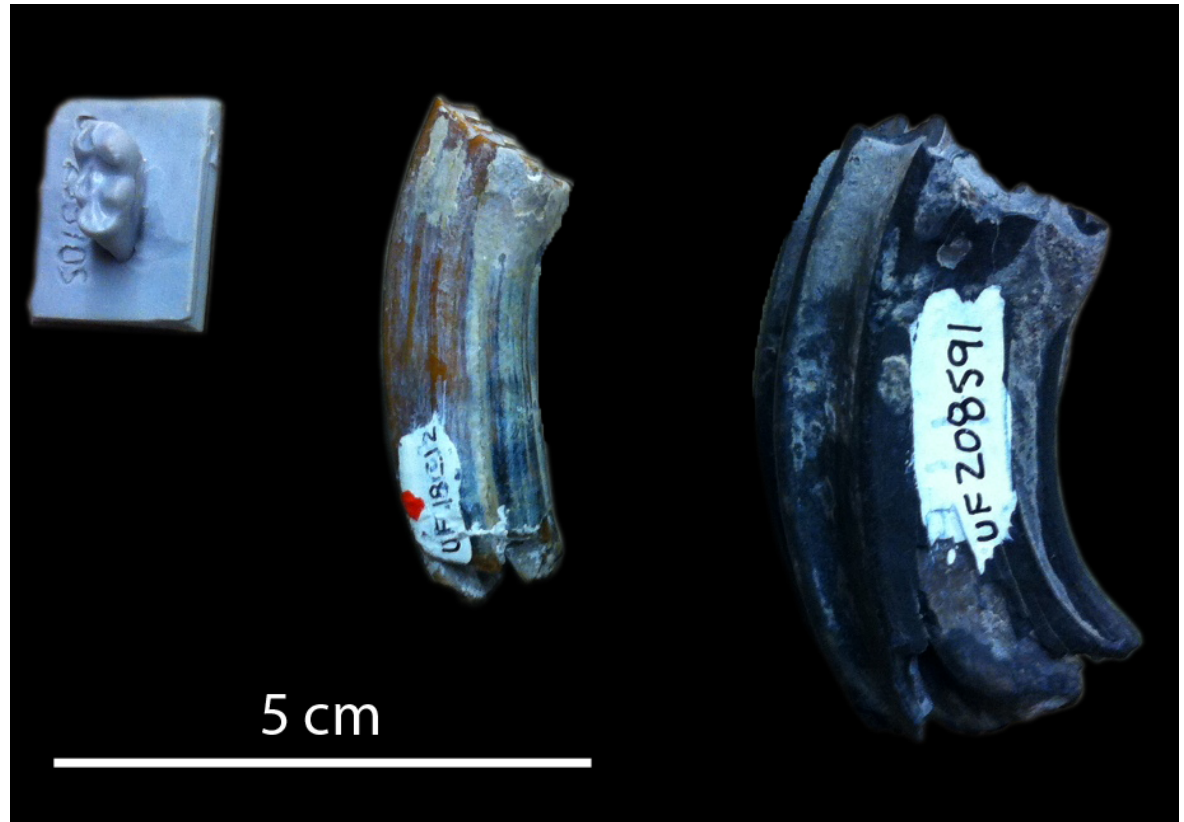
Crown area = 54 mm²

Pseudhipparion simpsoni
(l. Miocene – e. Pliocene)

Crown area = 163 mm²

Dinohippus mexicanus
(l. Miocene – e. Pliocene)

Crown area = 615 mm²



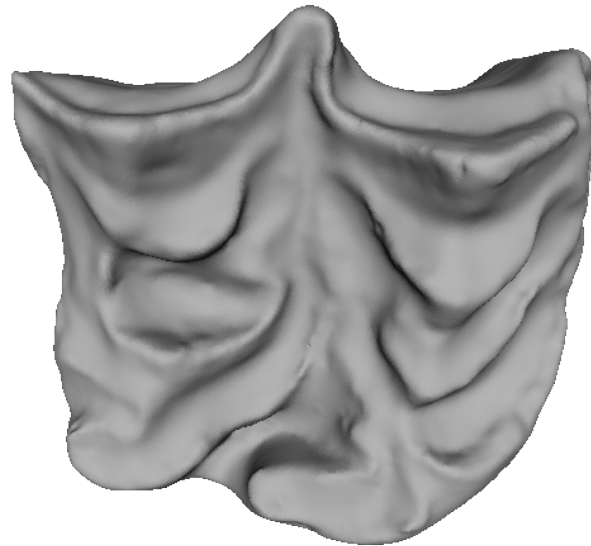
Morphology of interest:

Can we see topographical differences related to dental wear in all 3 scans?

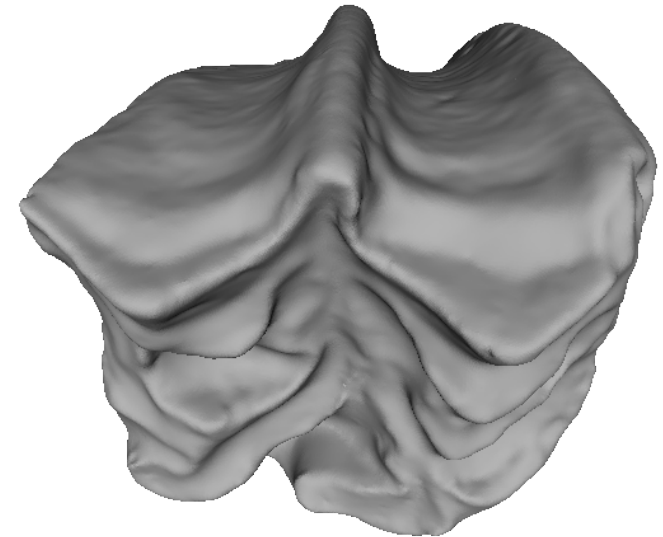
What is the smallest size that can be scanned?

Dinohippus mexicanus (l. Miocene – e. Pliocene)

Crown area = 615 mm²



occlusal view



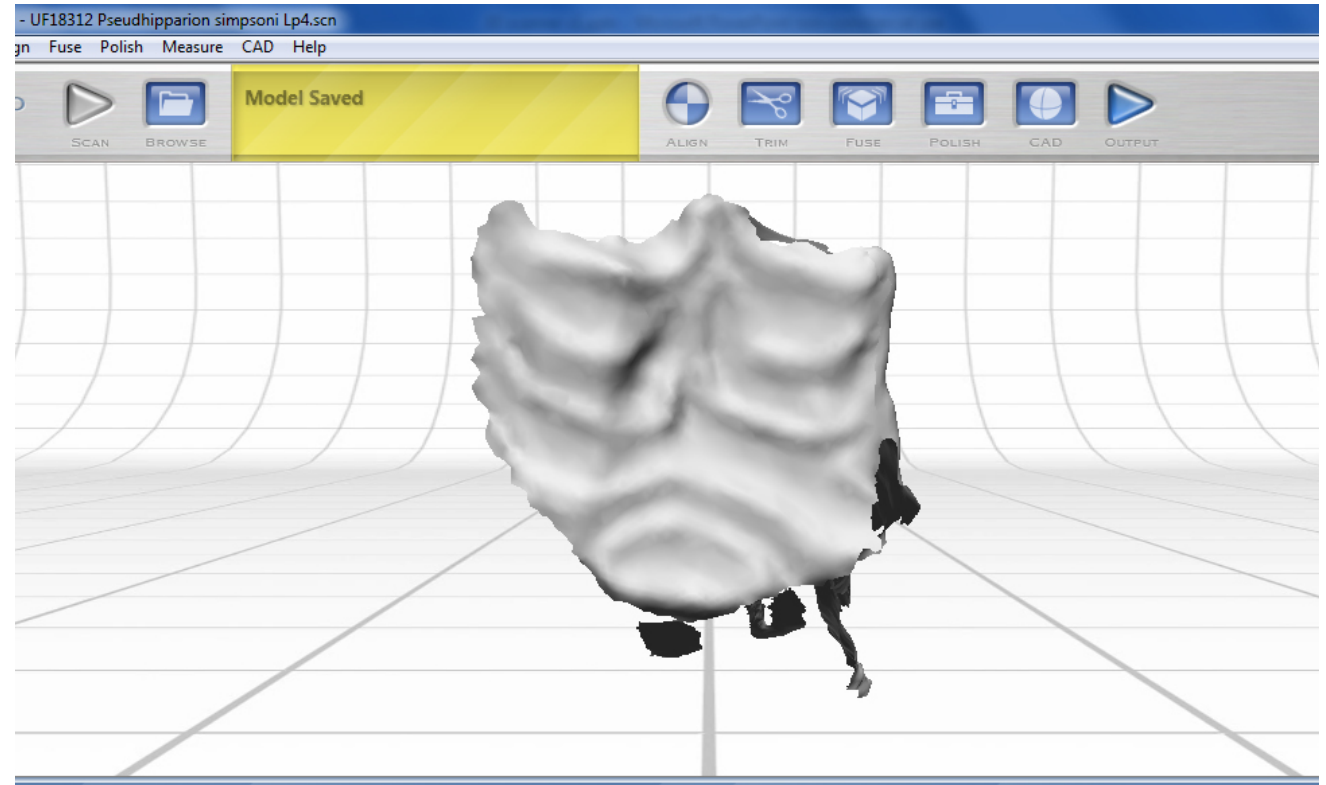
oblique buccal/occlusal view

- 1) Enamel (dark brown in photo) forms distinct ridges
- 2) Cementum and exposed dentin (light brown) clearly form basins

What is the smallest size that can be scanned?

Pseudhipparion simpsoni (l. Miocene – e. Pliocene)

Crown area = 163 mm²

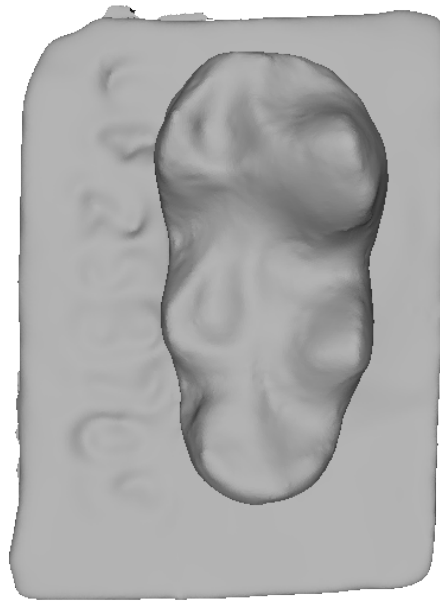


- 1) Enamel (dark brown in photo) forms ridges
- 2) Cementum and exposed dentin (light brown) form basins
- 3) Difference between ridges and basins not as distinct as in larger horse

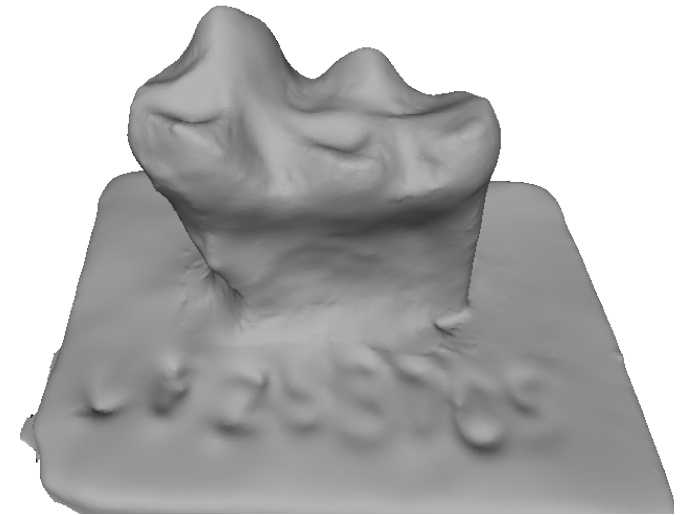
What is the smallest size that can be scanned?

Arenahippus grangeri (Eocene)

Crown area = 54 mm²



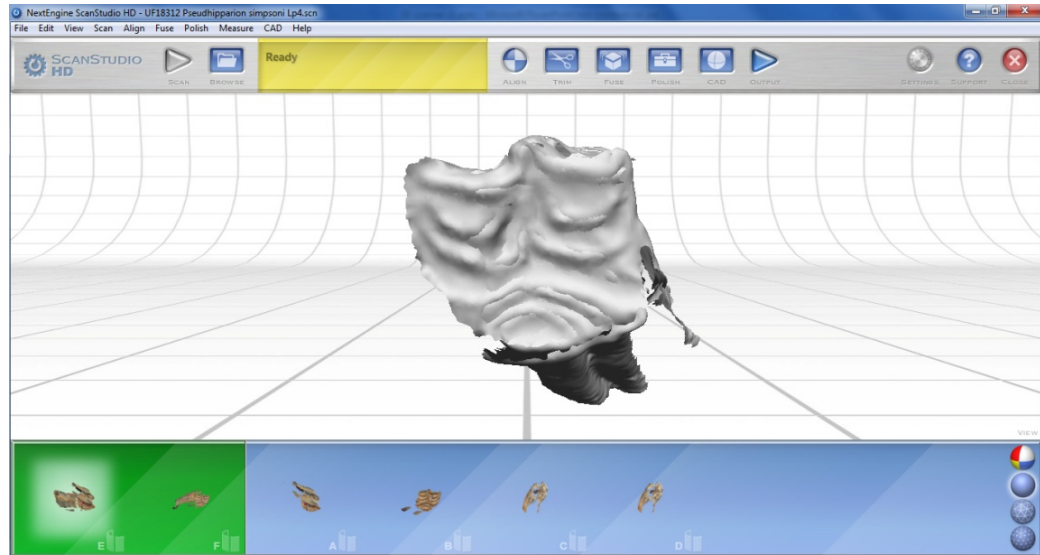
occlusal view



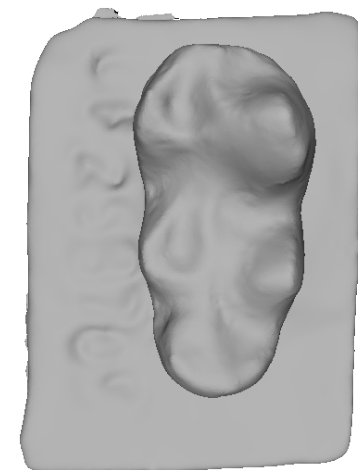
oblique buccal/occlusal view

- 1) Exposed dentin is shown as basins in scans
- 2) Margins of the dentin basins not always apparent

Problems associated with small objects



1) Auto-alignment function sometimes fails with small or narrow objects



2) Heterogeneity in color and reflectance creates artifacts as large as morphology

What is the largest size that can be scanned?



- No upper limit
- Major limitation is processor speed and memory



How much time does it take to scan a fossil?

Astragalus (~ 4
cm)

Metatarsal (~ 21
cm)

Femur (~25 cm)

Complexity: Metatarsal → Astragalus → Femur

How much time does it take to scan a fossil?



Astragalus: 2 360° scans = 25.5 minutes



Metatarsal: 2 360° + 2 bracket scans = 50 minutes

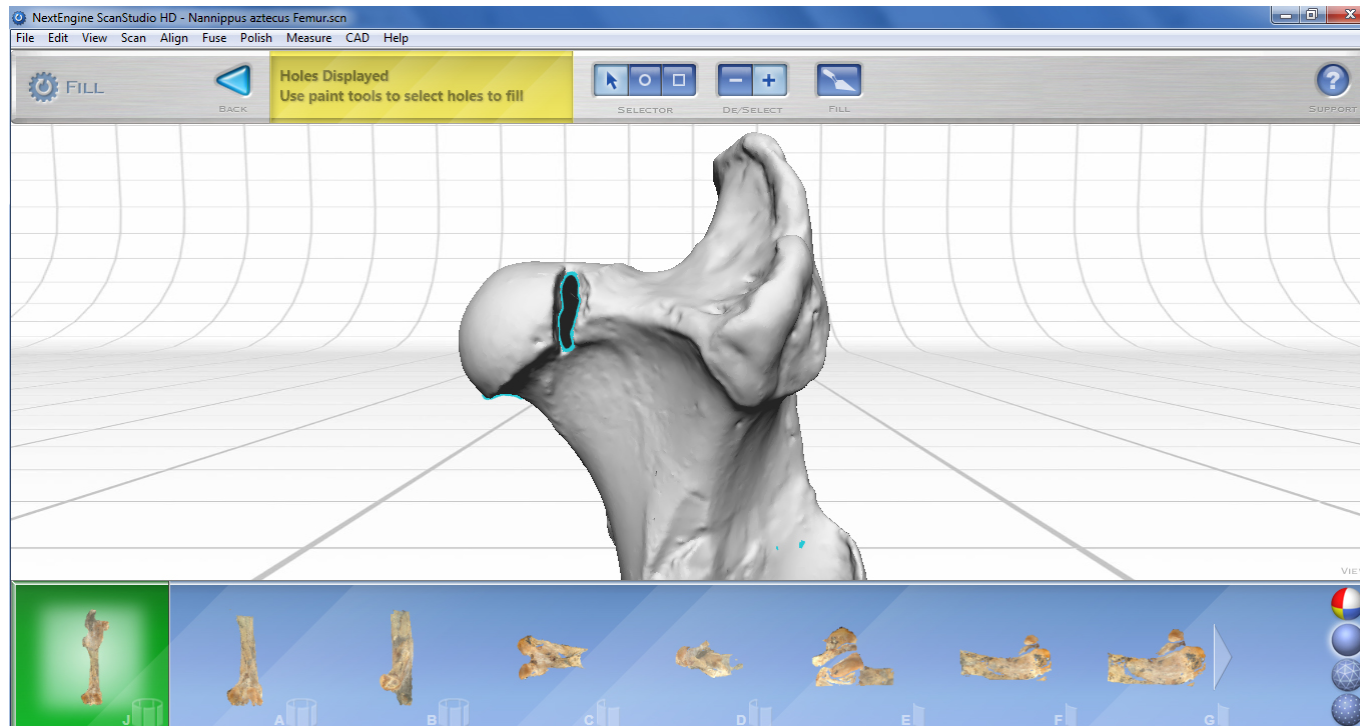


Femur: 2 360° + 2 bracket + 3 single scans
= 90 minutes



How much time does it take to scan a fossil?

Femur: 2 360° + 2 bracket + 3 single scans
= 90 minutes



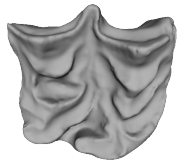
How big are the scan files?



Arenahippus grangeri Cast
Longest dimension = 1.2 cm



Nannippus aztecus astragalus
Longest dimension = 4.0 cm



Dinohippus mexicanus molar
Longest dimension = 5.8 cm



Turritella abrupta
Longest dimension = 7.1 cm



Nannippus aztecus metatarsal
Longest dimension = 21 cm



Nannippus aztecus femur
Longest dimension = 25 cm

ScanStudio Folder

Final Model

229 MB*

38 MB*

333 MB

7.0 MB

1.1 GB*

74.3 MB*

1.4 GB*

131 MB*

753 MB

15.9 MB

2.6 GB

29.0 MB

* = high resolution

How big are the scan files?

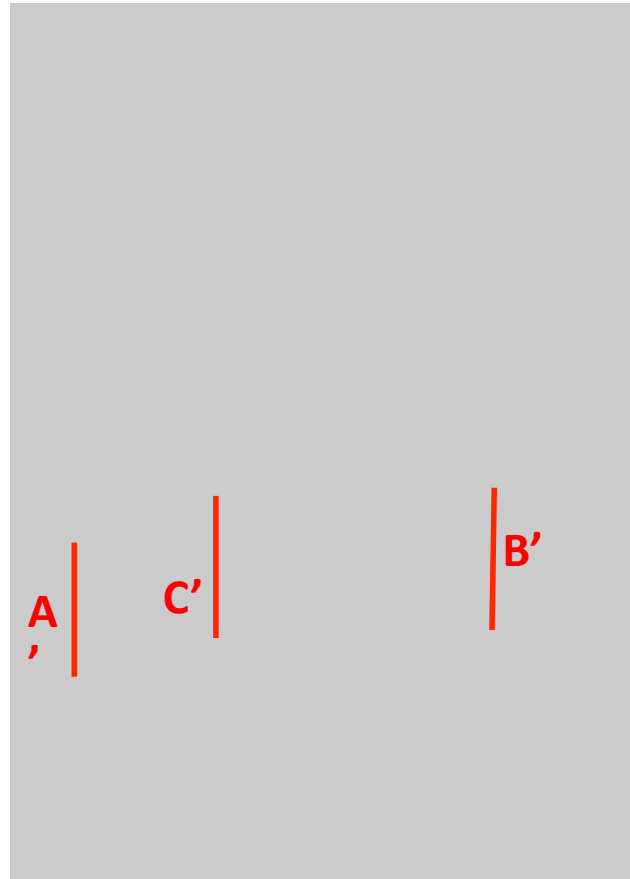
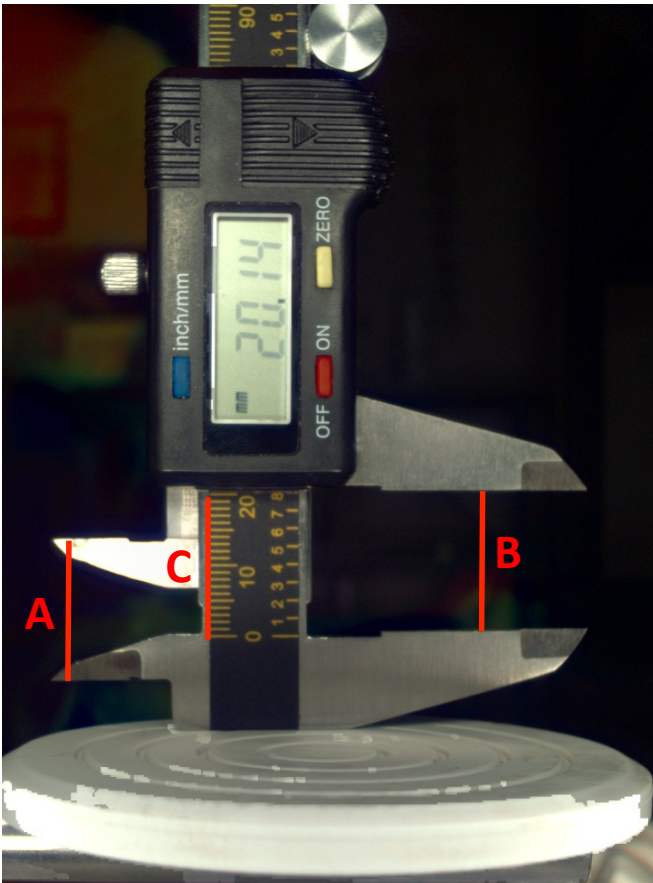
Exponential relationship between longest dimension and file size of final model:

Standard definition: $\ln(\text{file size MB}) = 0.67 * \ln(\text{longest dimension cm}) + 1$

High definition: $\ln(\text{file size MB}) = 0.67 * \ln(\text{longest dimension cm}) + 3.5$

Longest Dimension (cm)	Standard 180-500 pts/in.2 (MB)	High 1100-4400 pts/in.2 (MB)
1		
2	3	33
3	4	53
4	6	69
5	7	84
10	8	97
15	13	155
20	17	203
25	20	246
30	23	286
35	27	323
40	29	359
	32	392

Can accurate measurements be taken from the scans?



Actual

A 20.14 mm
 B 20.14 mm
 C 20 mm

Model

A' 19.77 mm
 B' 20.42 mm
 C' 20 mm

Inside jaws (A) are underestimated while outside jaws (B) are overestimated
 → errors due to incomplete models

Bottom line: Surface models are appropriate for mm-scale measurements

Other questions?