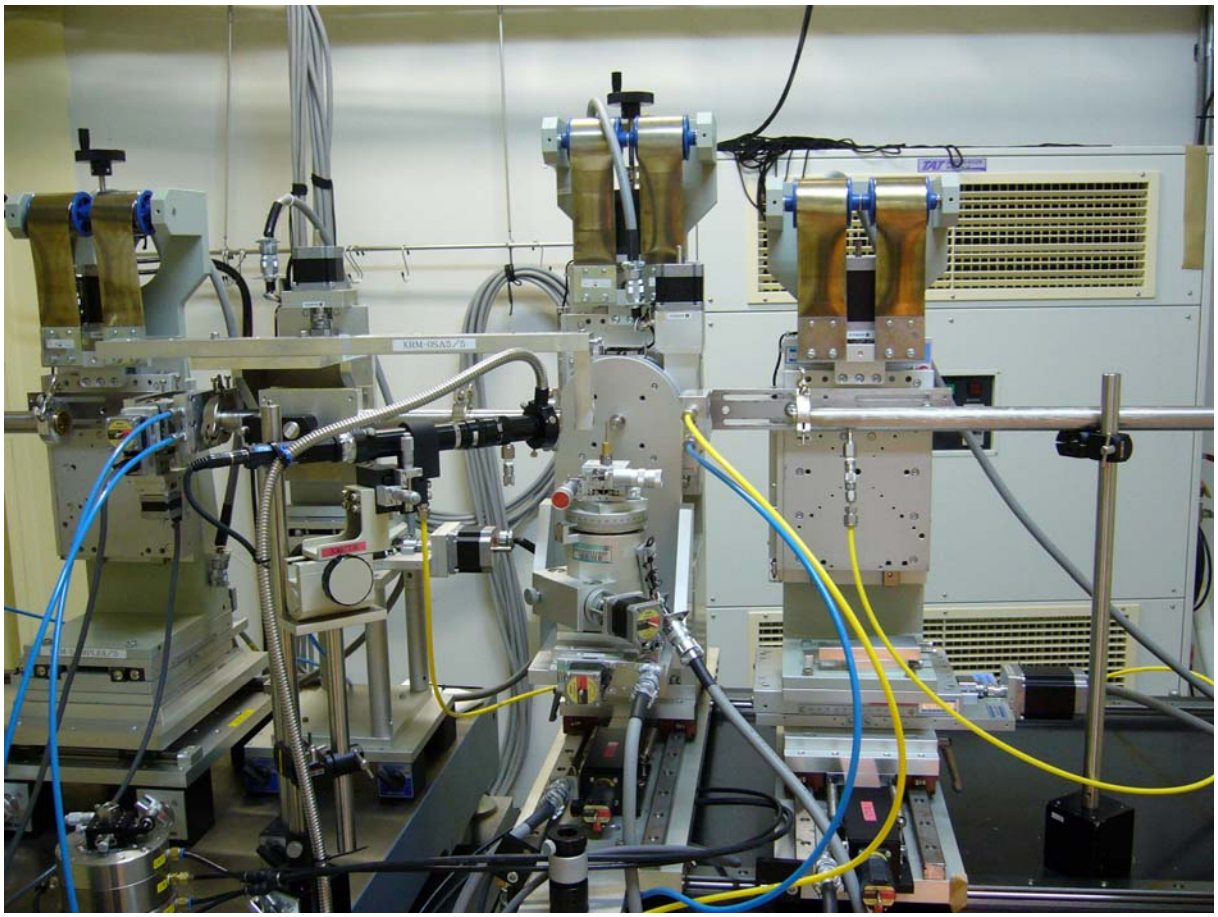
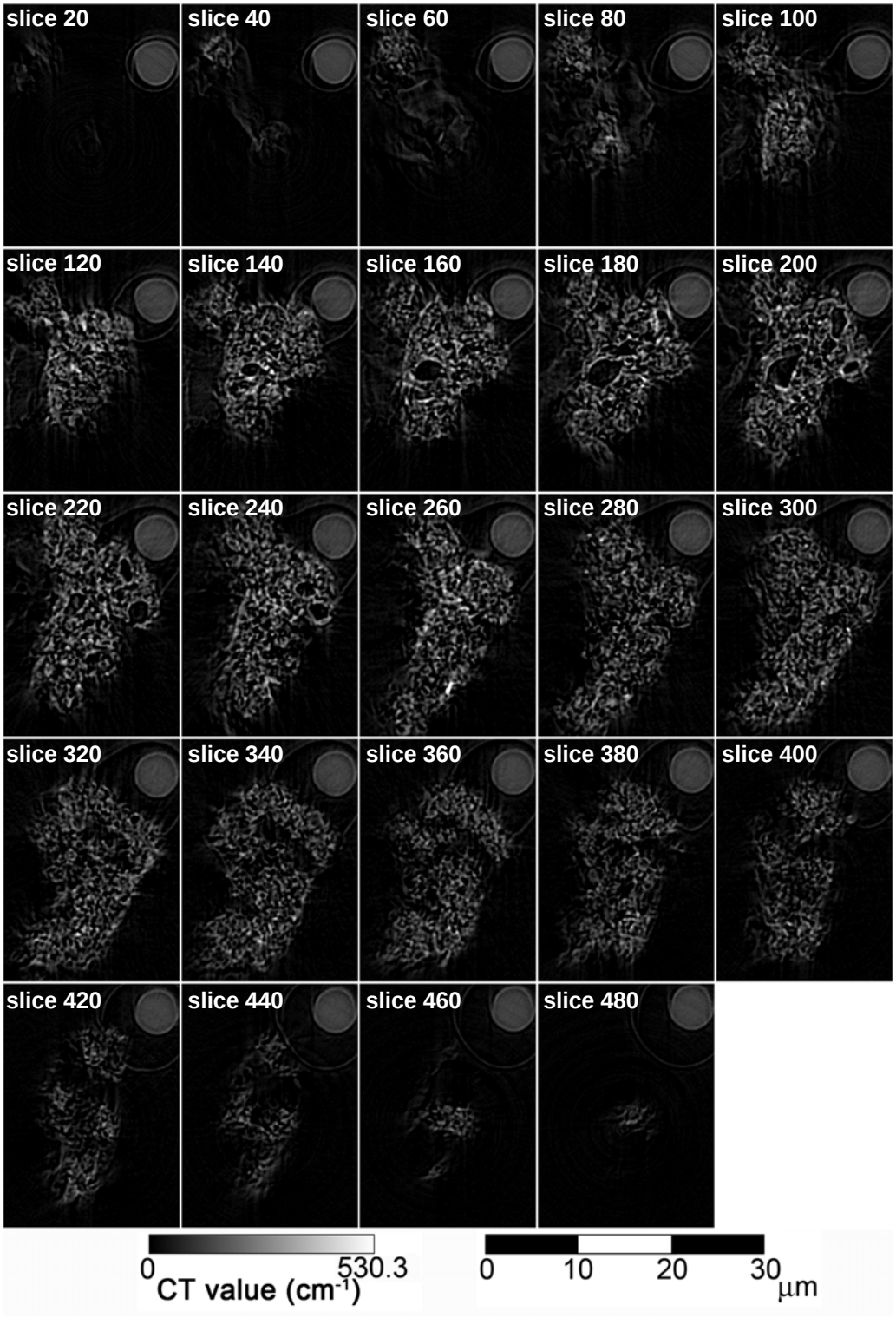
Stardust sample analysis: Imaging microtomography for particles removed from aerogel

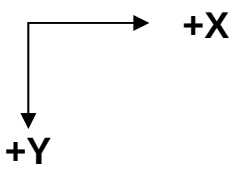
sample	beam line	no.	energy keV	exposure sec	projection	pixel μm
C2004.1.44.3	BL47XU	060410 l	8	0.3	3600	0.0425
C2054.0.35.6	BL47XU	060410n	8	0.3	3600	0.0425
C2054.0.35.5	BL47XU	060410j	8	0.3	3600	0.0425
C2054.0.35.4	BL47XU	060410g	8	0.3	3600	0.0425



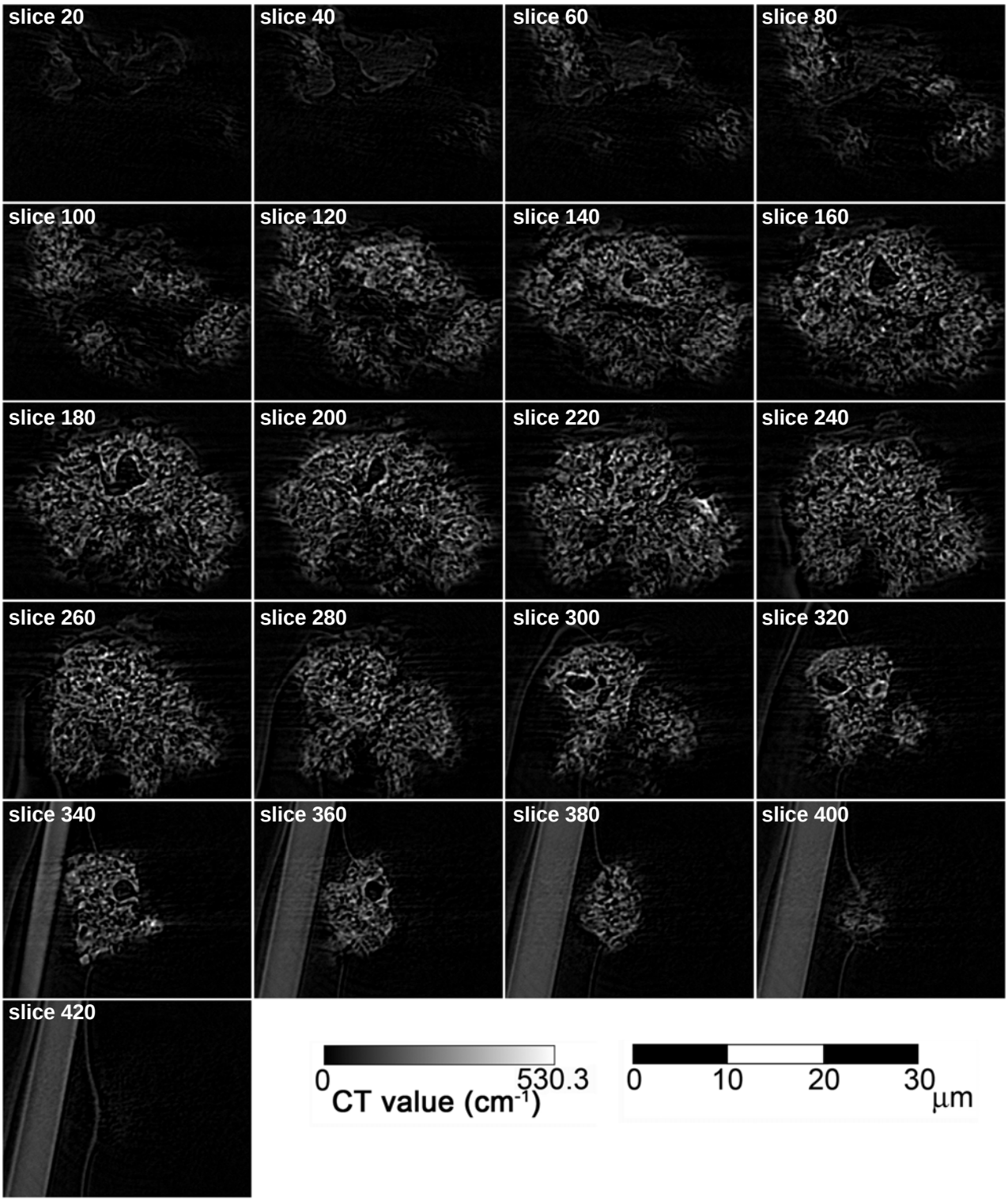
C2004.1.44.3 (Stardust #3)



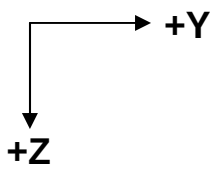
Z-plane (0.85 μm interval)



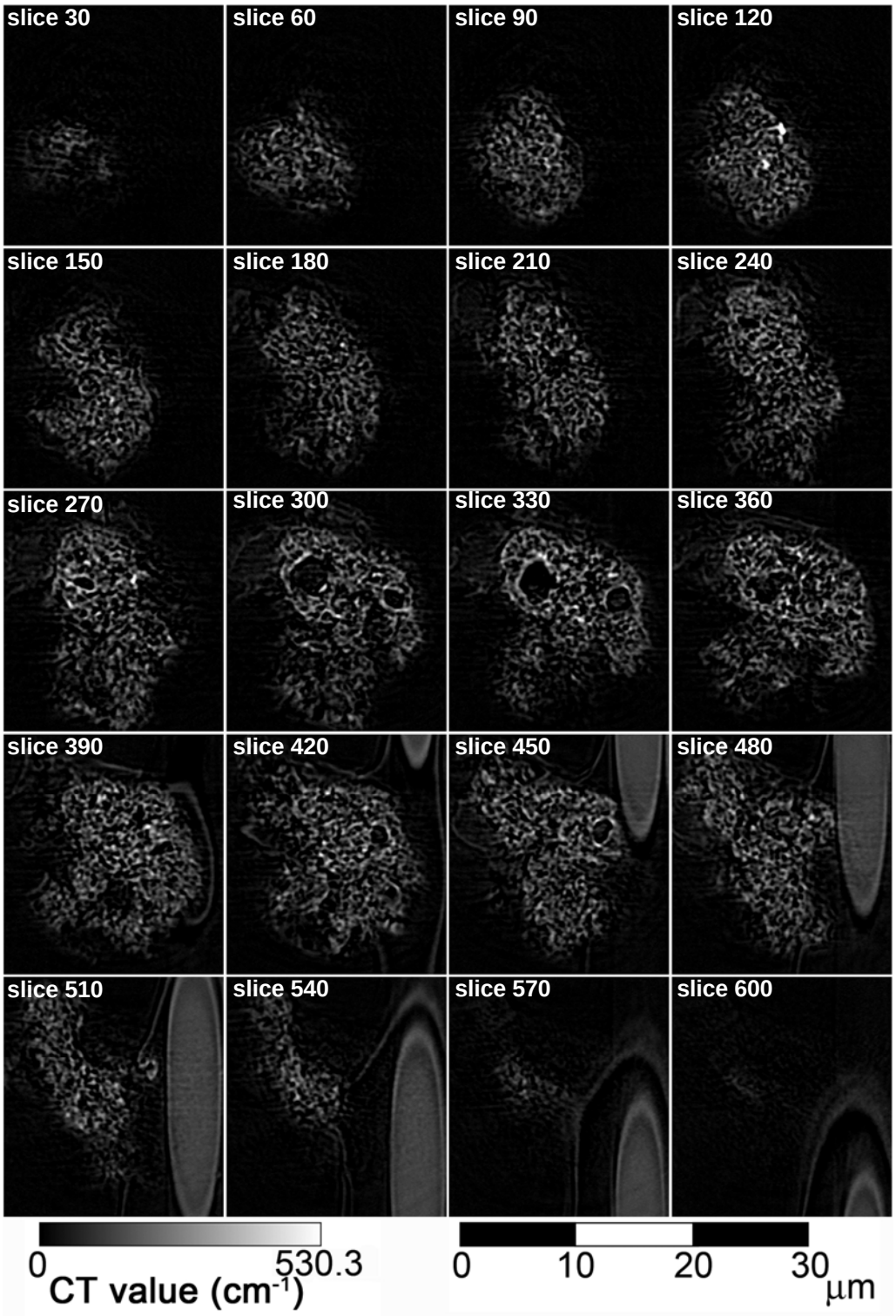
C2004.1.44.3 (Stardust #3)



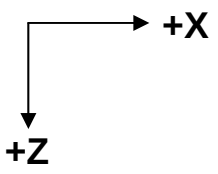
X-plane (0.85 μm interval)



C2004.1.44.3 (Stardust #3)

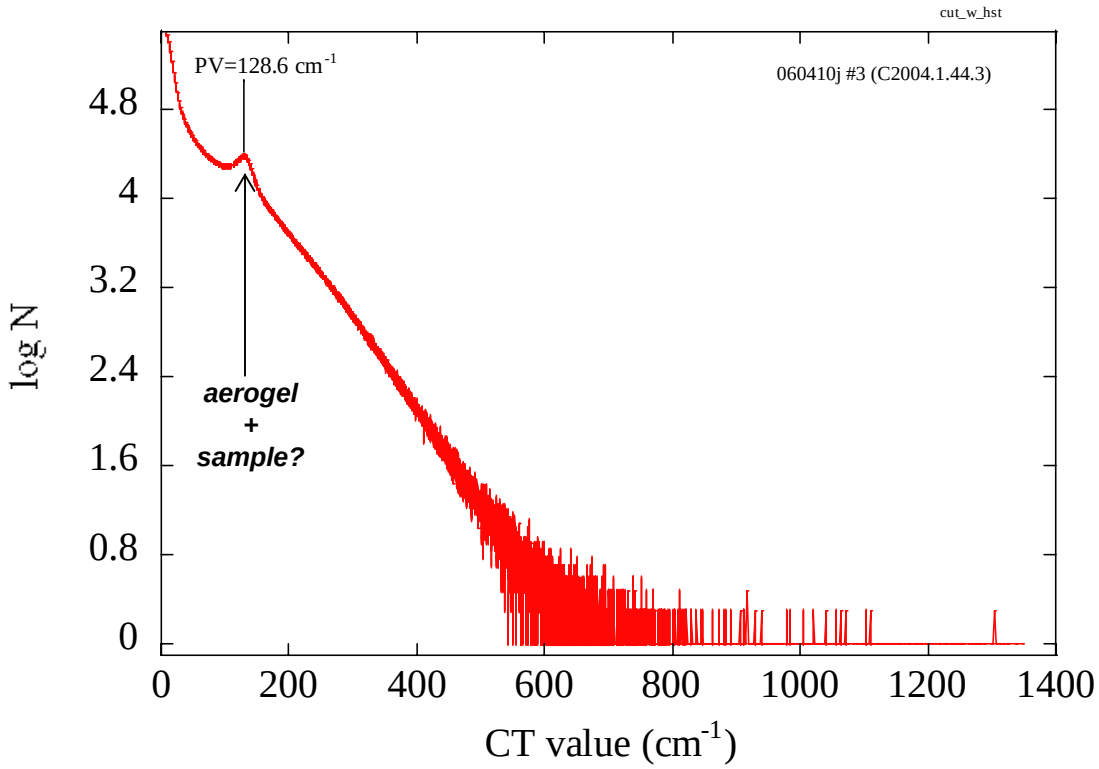


Y-plane (1.275 μm interval)



C2004.1.44.3 (Stardust #3)

Histogram of CT value (cm^{-1})



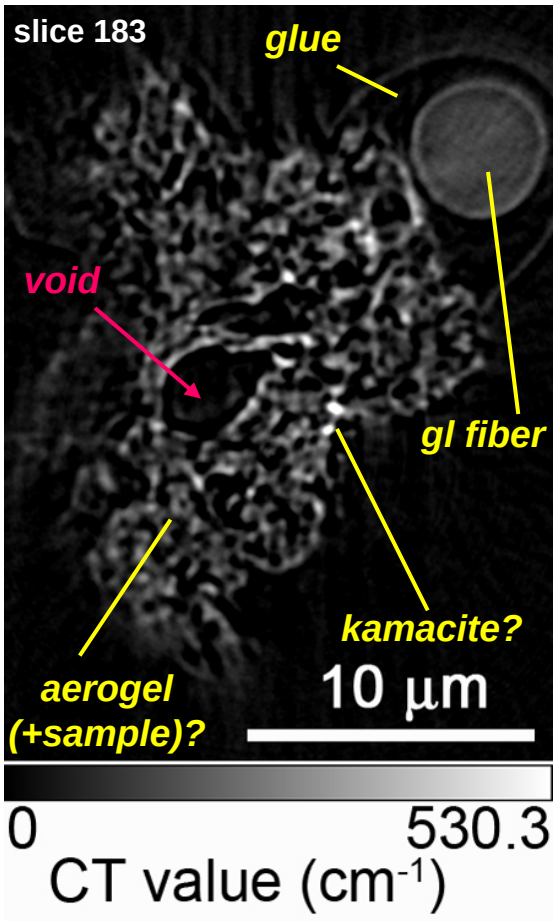
CT values (cm^{-1}) of related minerals at 8 keV

olivine	CT value	opx	CT value	cpx	CT value	pl	CT value		CT value
Fo100	90.5	En100	93.6	Di100	167.0	An100	127.6	quartz	84.0
Fo90	153.8	En90	137.1	Di90	187.5	An50	103.0	troilite	962.9
Fo80	216.3	En80	179.8			An0	78.2	magnetite	857.0

XRD by T. Nakamura

amorphous, kamacite, phase unidentified

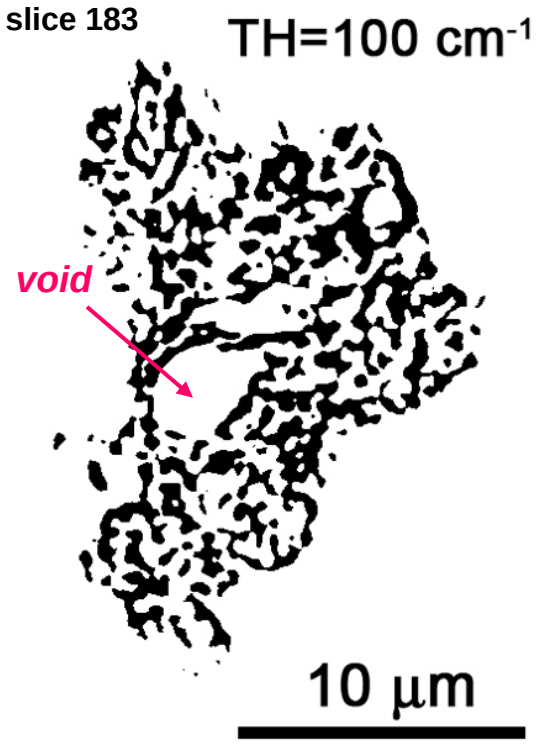
C2004.1.44.3 (Stardust #3)



Small grains of heavy minerals:
kamacite?
dispersed in
aerogel (+ samples?)

Large void (red arrow)

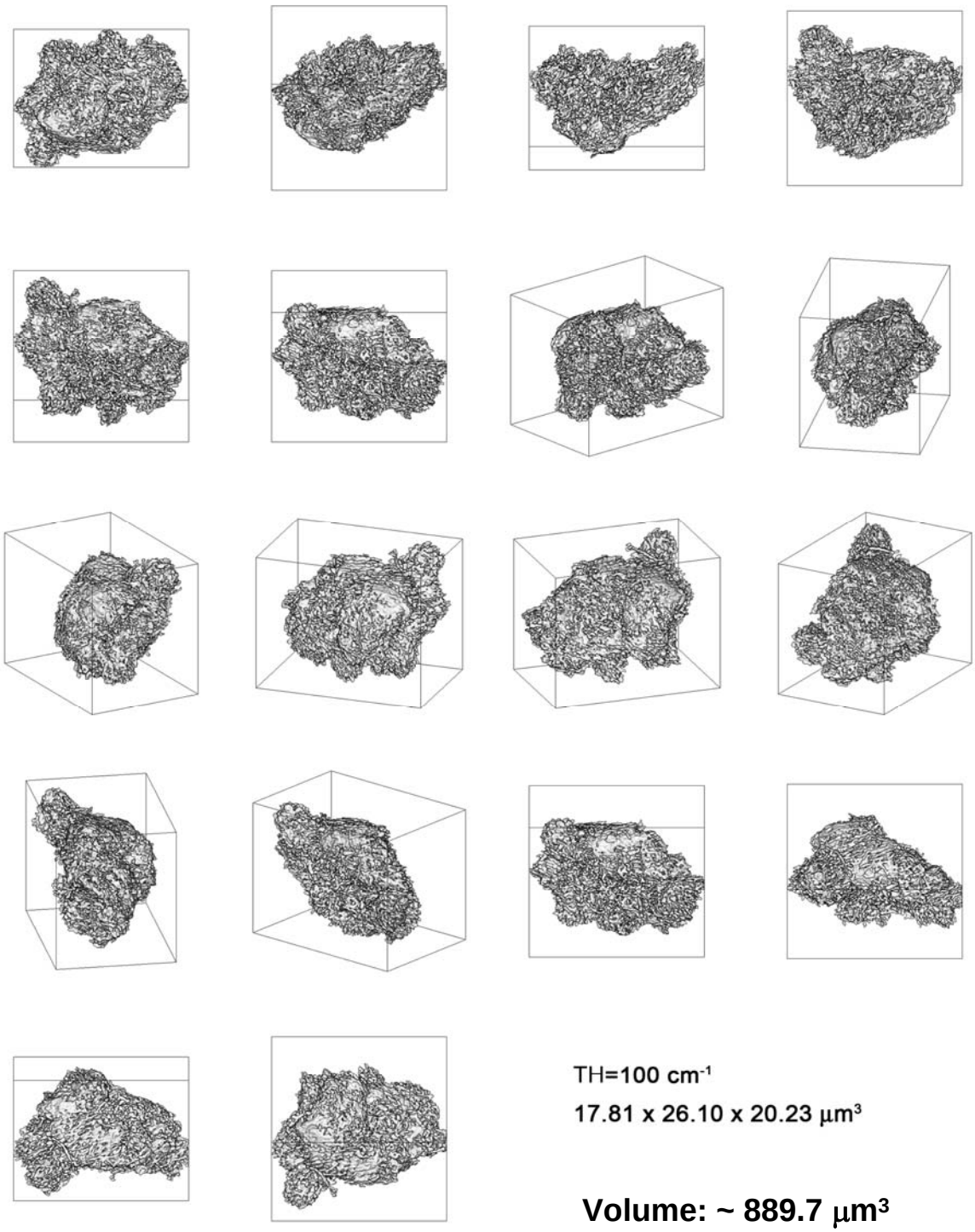
Glass fiber is used
for holding the sample



Binery image

Large void (red arrow)

C2004.1.44.3 (Stardust #3)
Bird's eye view images (particle)



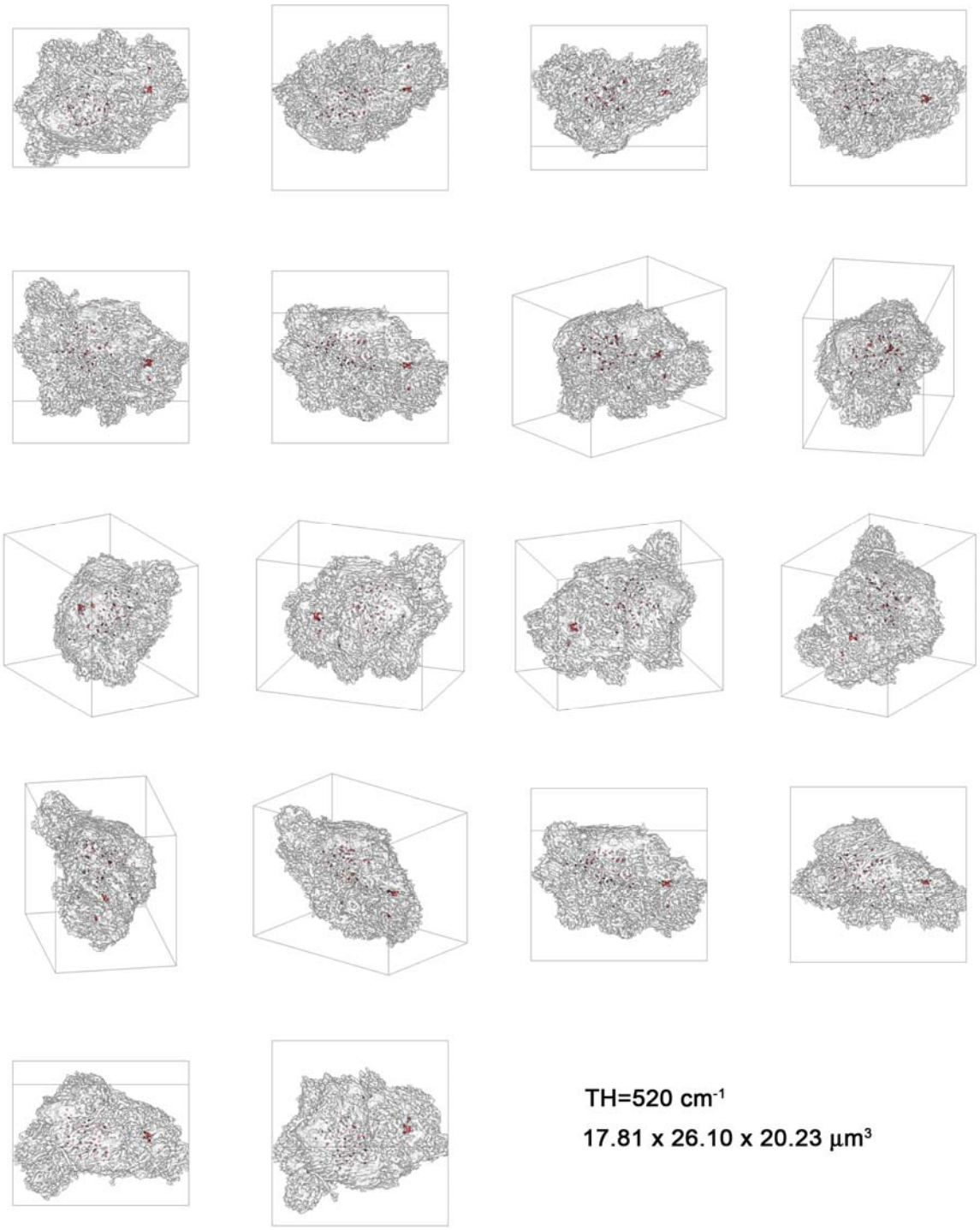
TH=100 cm^{-1}

17.81 x 26.10 x 20.23 μm^3

Volume: ~ 889.7 μm^3

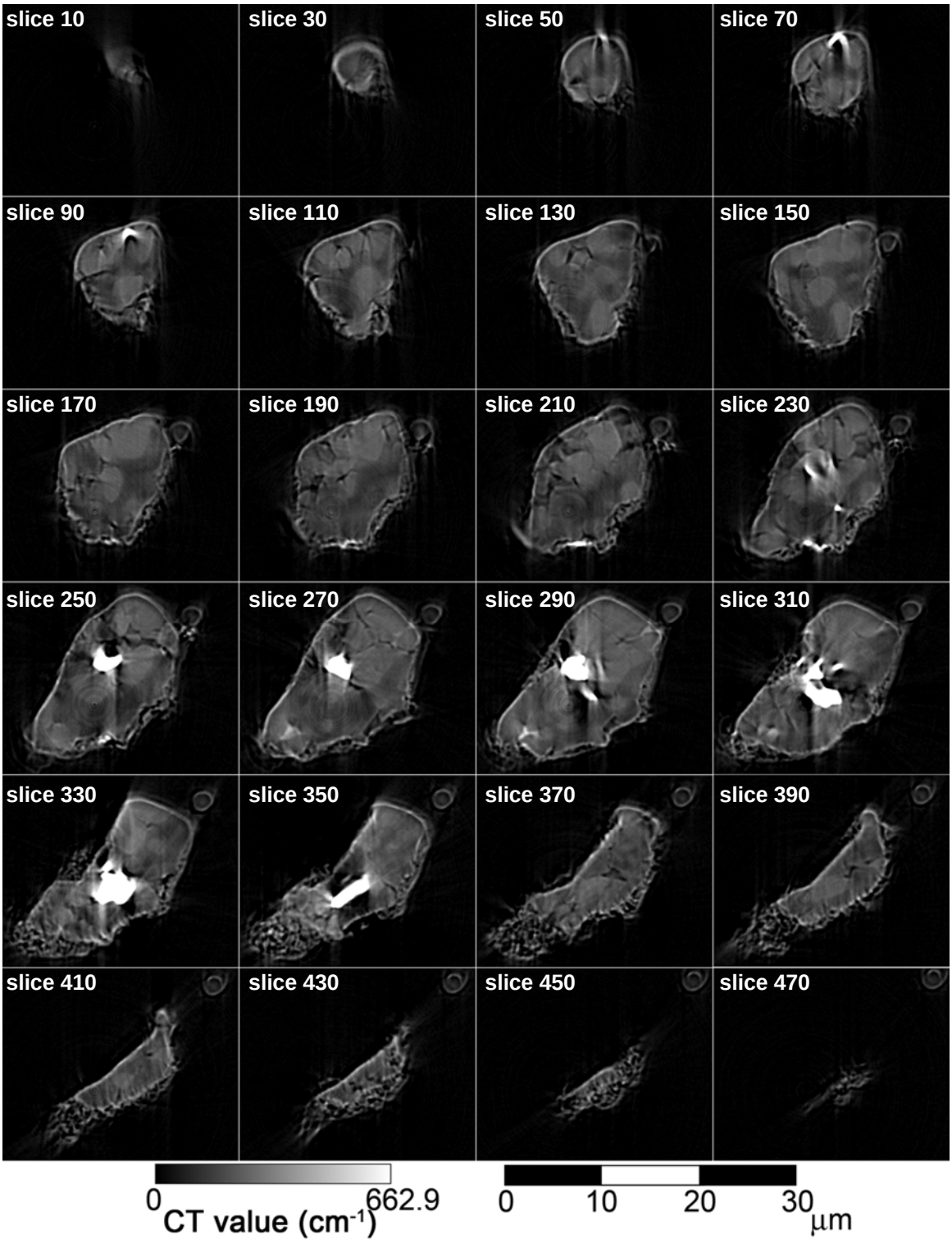
Mean diameter: ~ 11.9 μm

C2004.1.44.3 (Stardust #3)
Bird's eye view images
(heavy minerals in a porous material)

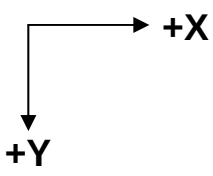


Volume of heavy mineral grains (red): 0.55 μm³
Mode: ~0.06 vol.%

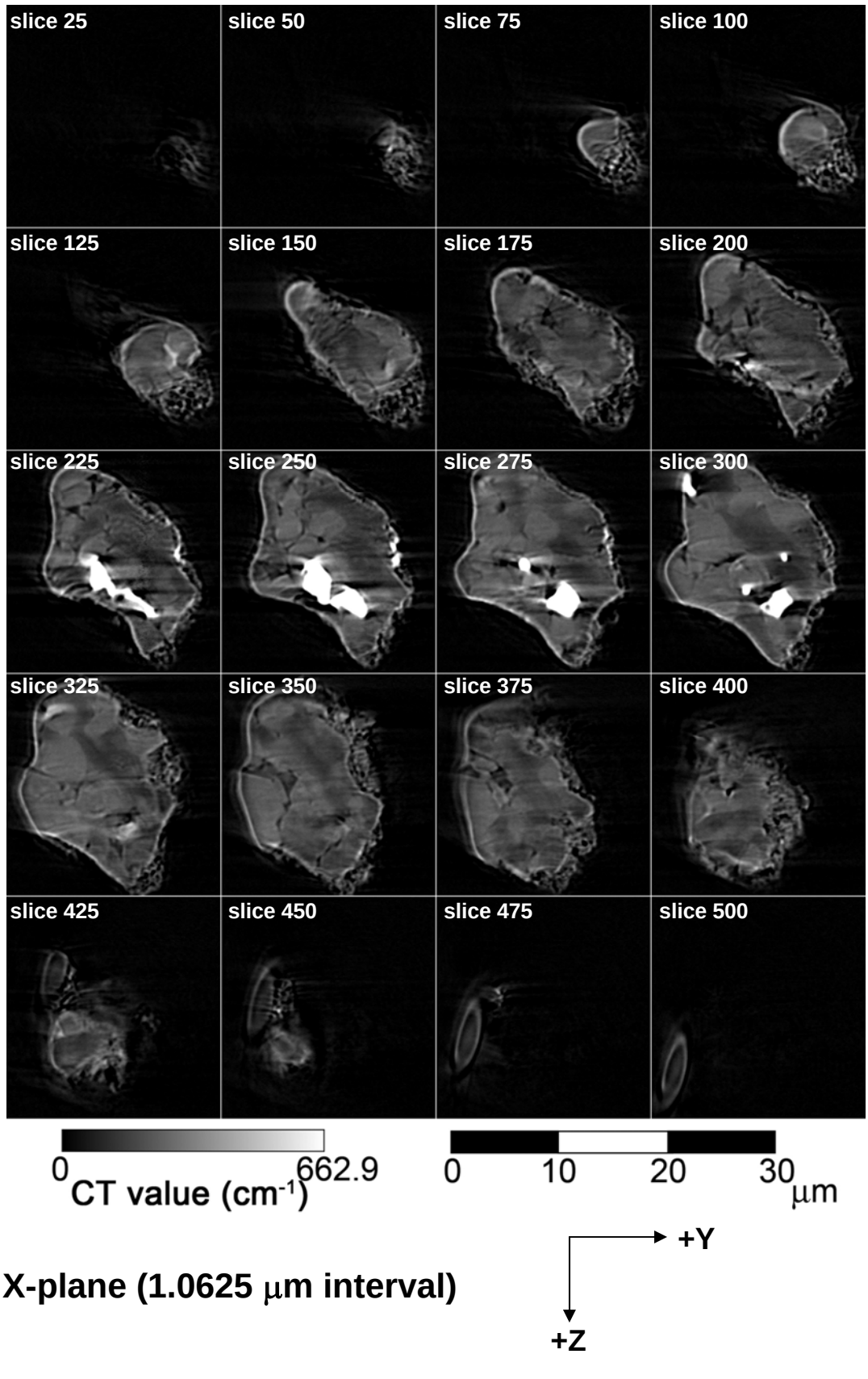
C2054.0.35.6 (Stardust #6)



Z-plane (0.85 μm interval)

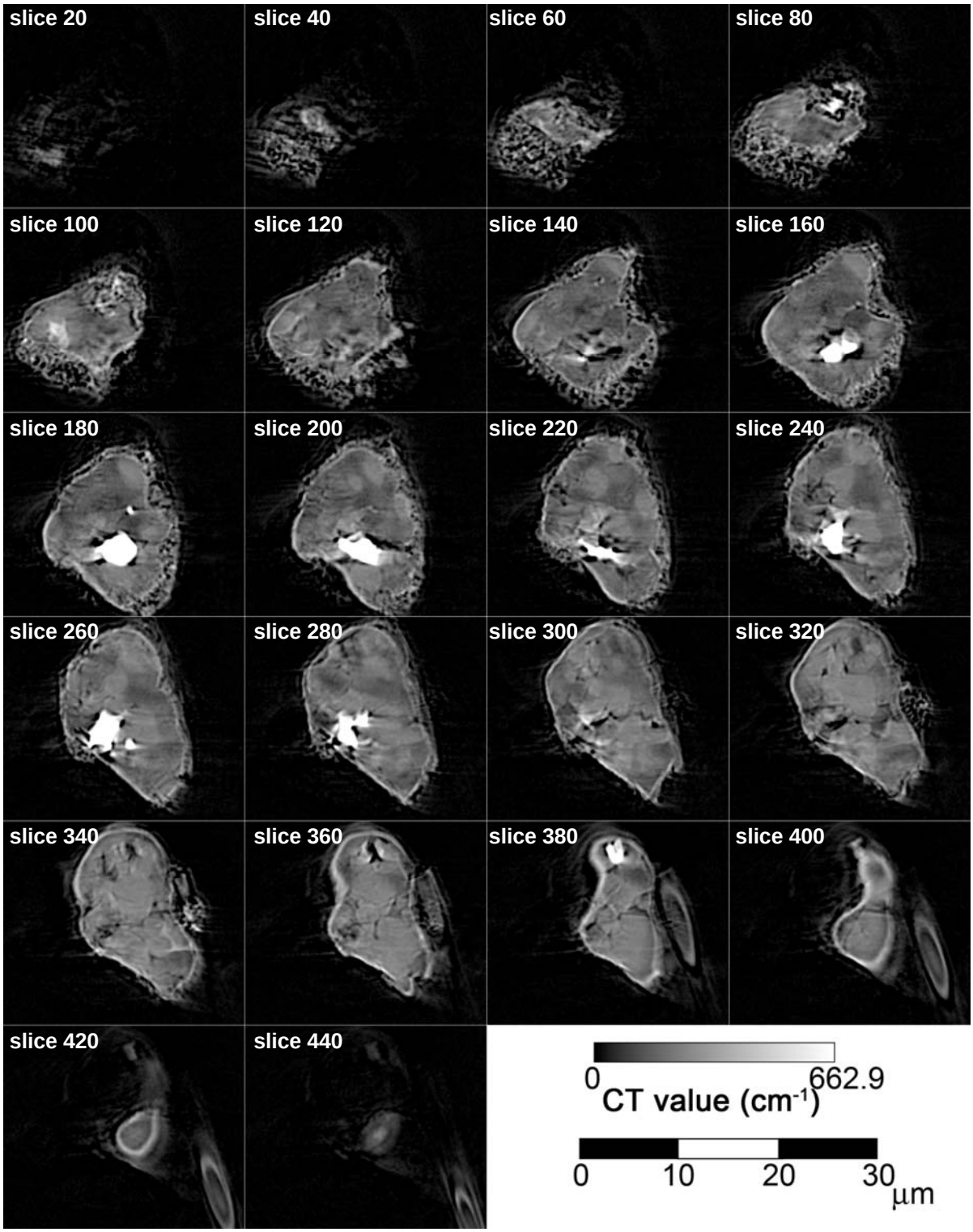


C2054.0.35.6 (Stardust #6)



X-plane (1.0625 μm interval)

C2054.0.35.6 (Stardust #6)



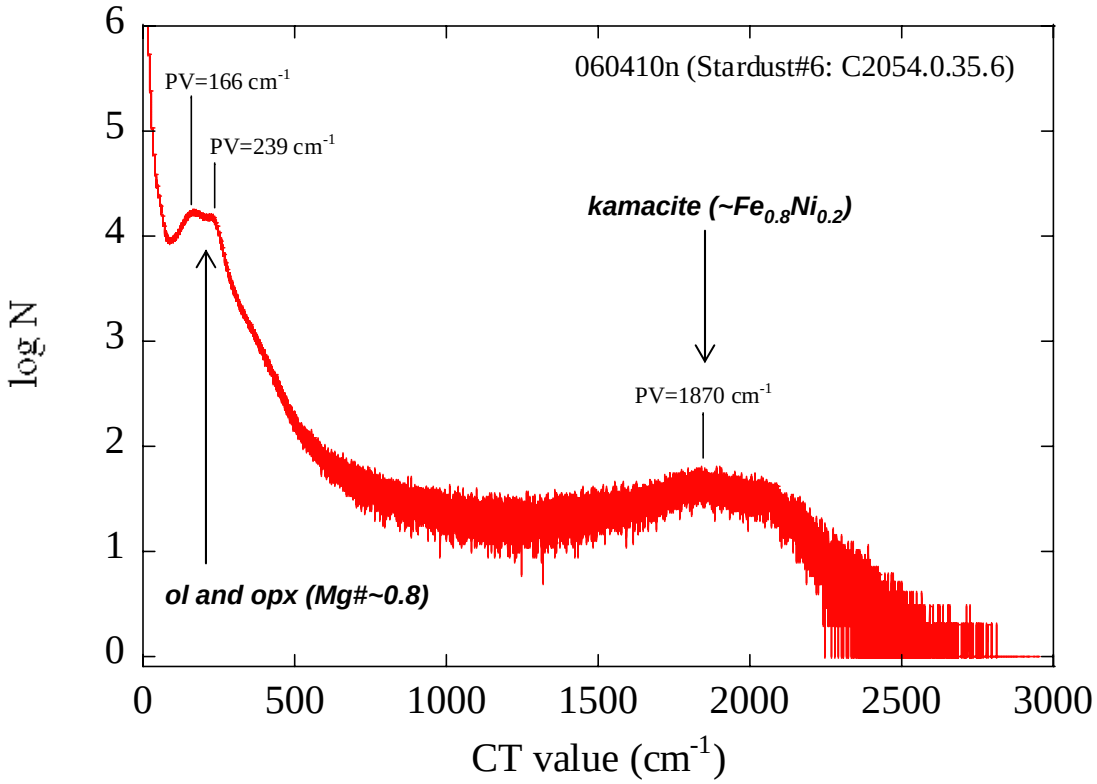
Y-plane (0.85 μm interval)

+X

+Z

C2054.0.35.6 (Stardust #6)

Histogram of CT value (cm^{-1})



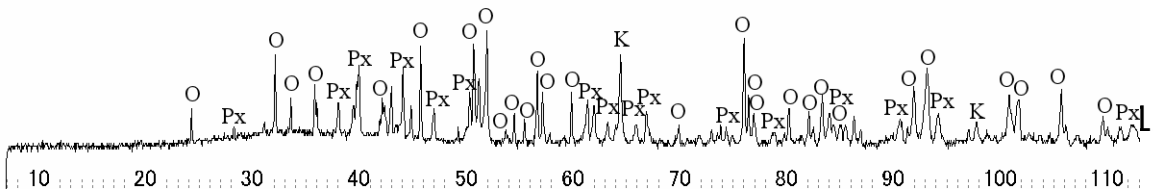
CT values (cm^{-1}) of related minerals at 8 keV

olivine	CT value	opx	CT value	Fe-Ni	CT value		CT value
Fo90	153.8	En90	137.1	Fe90	1940.1	quartz	84.0
Fo80	216.3	En80	179.8	Fe80	1778.4		
Fo70	278.0	En70	221.9	Fe70	1613.7		

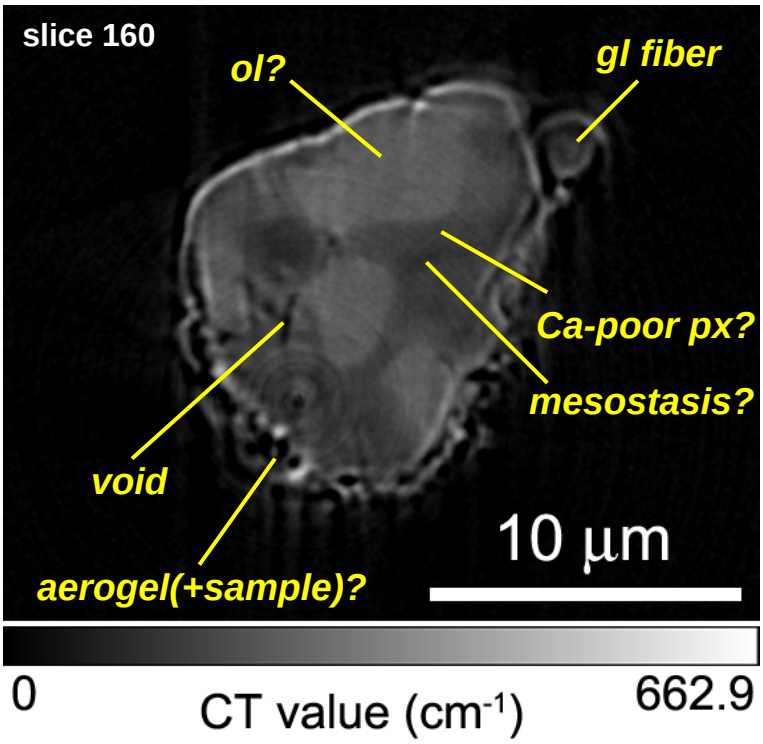
XRD by T. Nakamura

Wild II particle C2054, 0, 35, 6

O: Mg-rich olivine
Px: Ca-poor pyroxene
K: kamacite



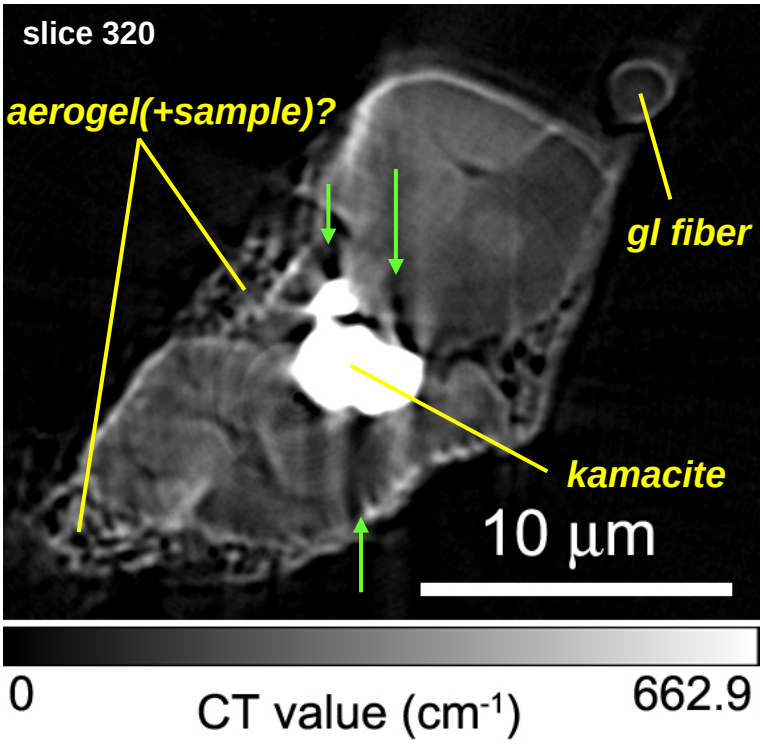
C2054.0.35.6 (Stardust #6)



Micro-porhiritic texture
- ol phenocrysts? (bright)
- dark Ca-poor px?
- mesostasis? (darker)
- voids in mesostasis

Bright surface
- artifact due to refraction of X-ray beams

Particle partially covered with
- aerogel (+samples)?



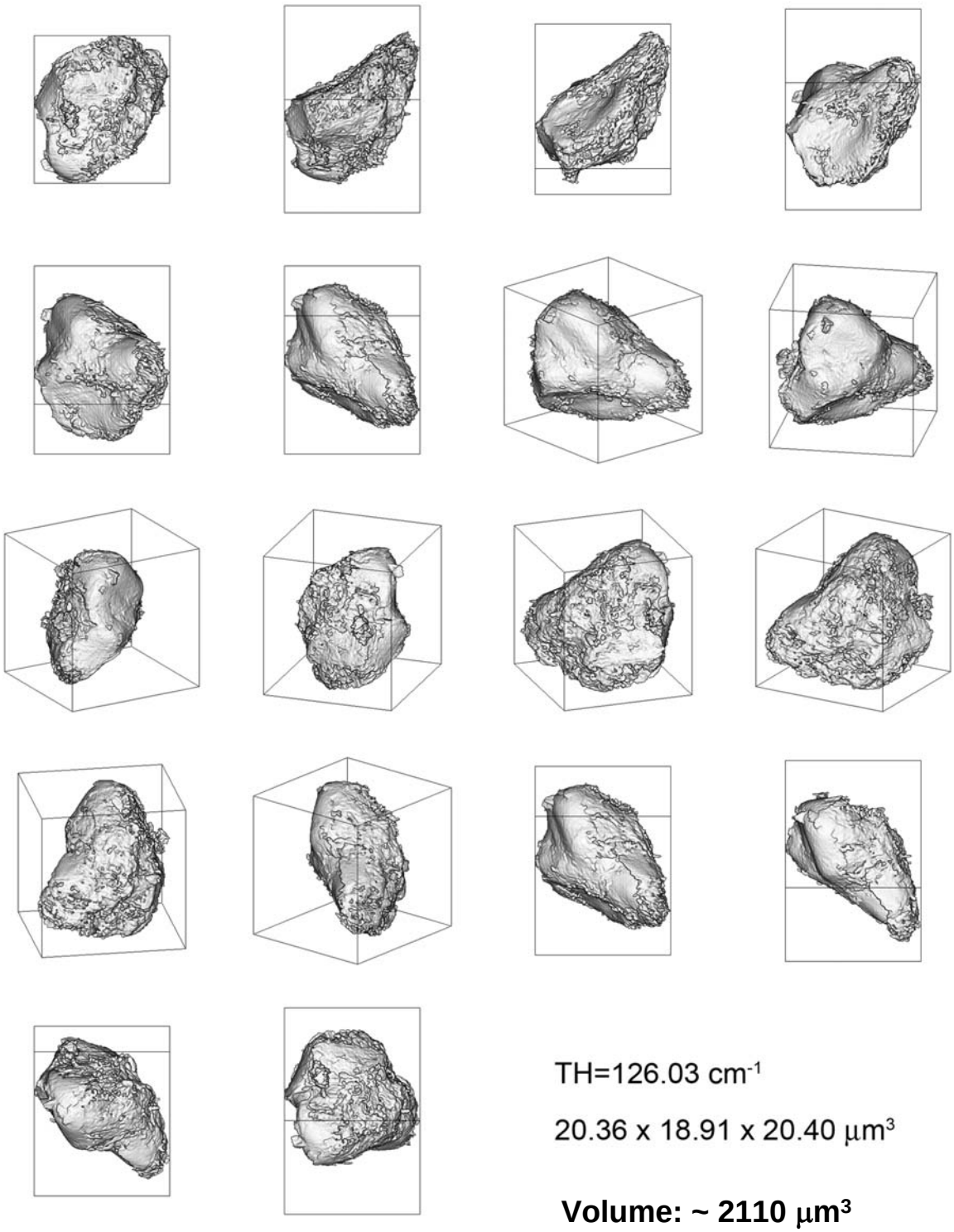
Kamacite crystals

Dark shadows (green arrows)
- artifacts due to insufficient X-ray transimission by kamacite

Bright surface
- artifact due to refraction of X-ray beams

Particle partially covered with
- aerogel (+samples)?

C2054.0.35.6 (Stardust #6)
Bird's eye view images (particle)



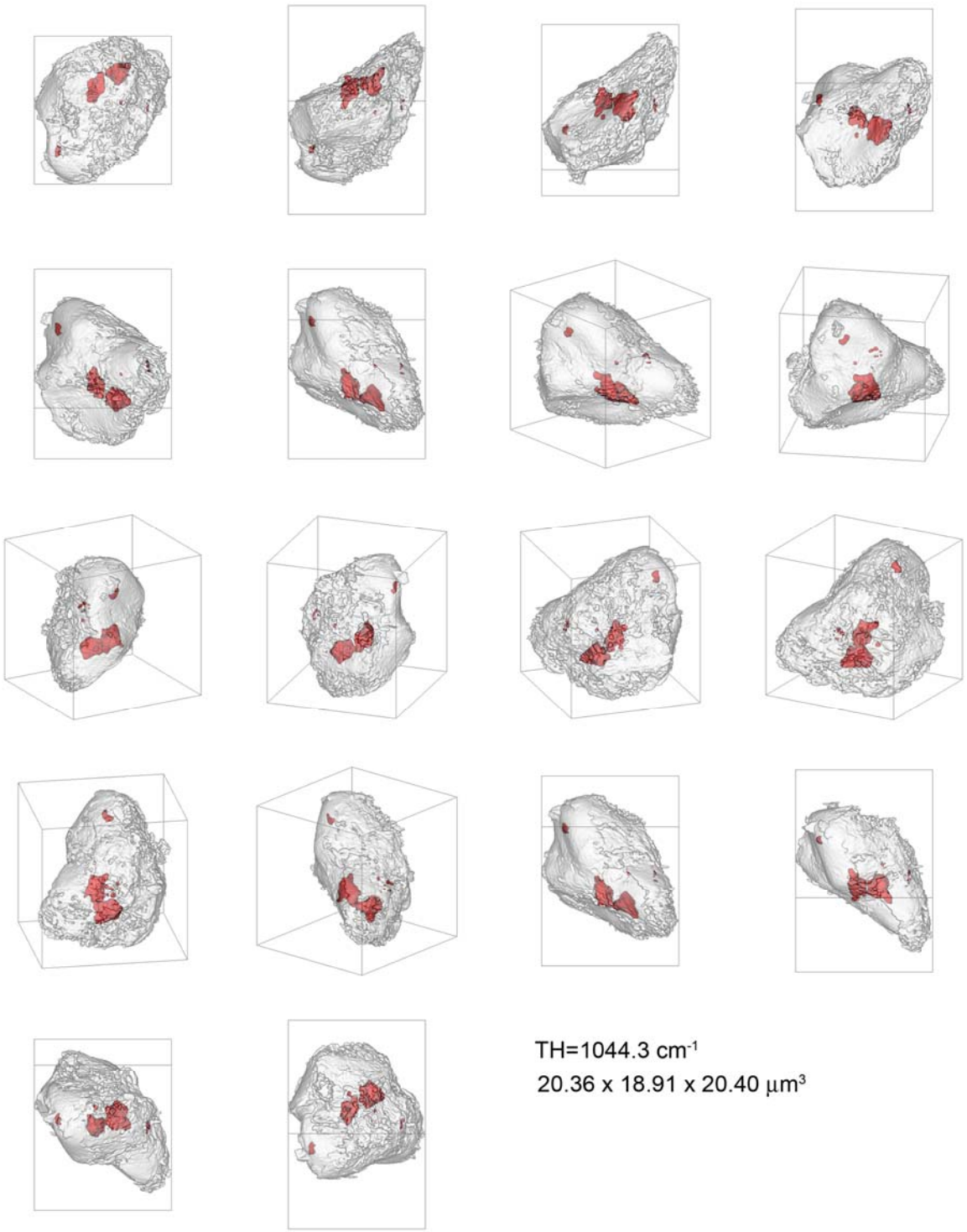
TH=126.03 cm^{-1}

20.36 x 18.91 x 20.40 μm^3

Volume: ~ 2110 μm^3
Mean diameter: ~ 15.9 μm

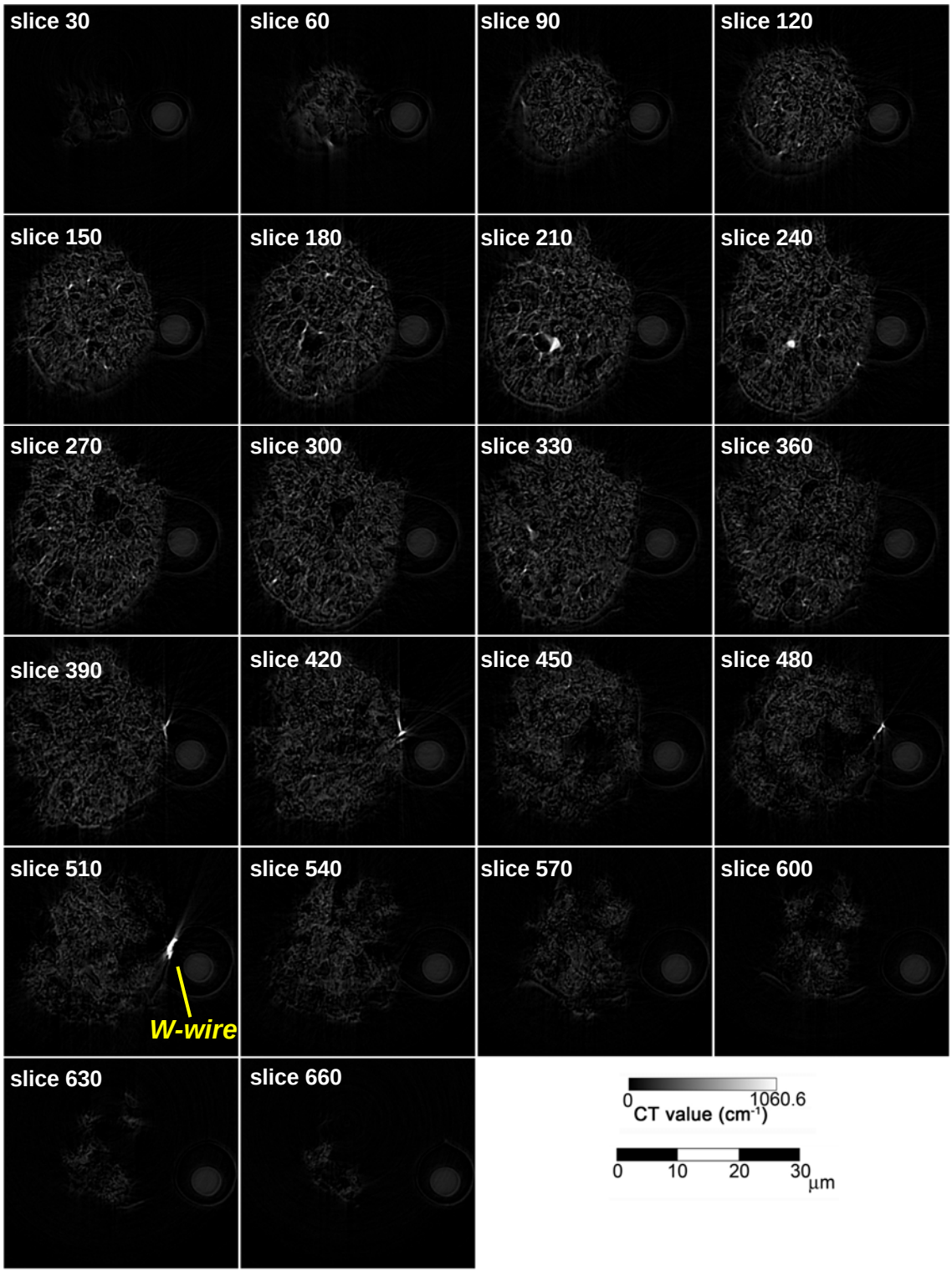
Sub-rounded grain partially covered with aerogel (+sample)?

C2054.0.35.6 (Stardust #6)
Bird's eye view images
(kamacite and Fe-S in particle)



Volume of heavy minerals (red): 24.7 μm³
Mode: ~1.2 vol.%

C2054.0.35.5 (Stardust #9)

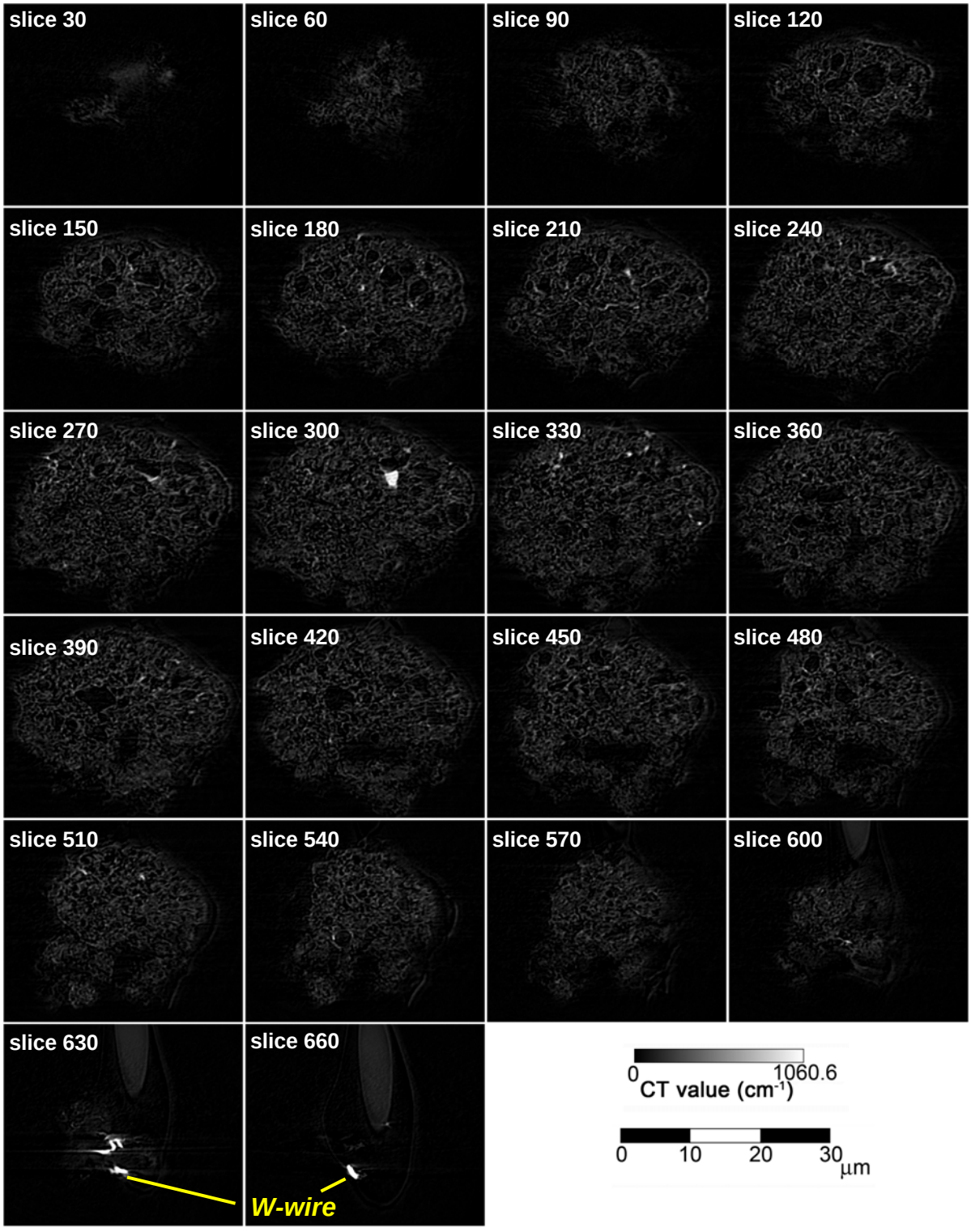


Z-plane (1.275 μm interval)

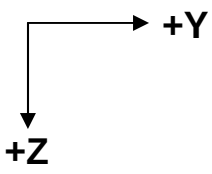
+X

+Y

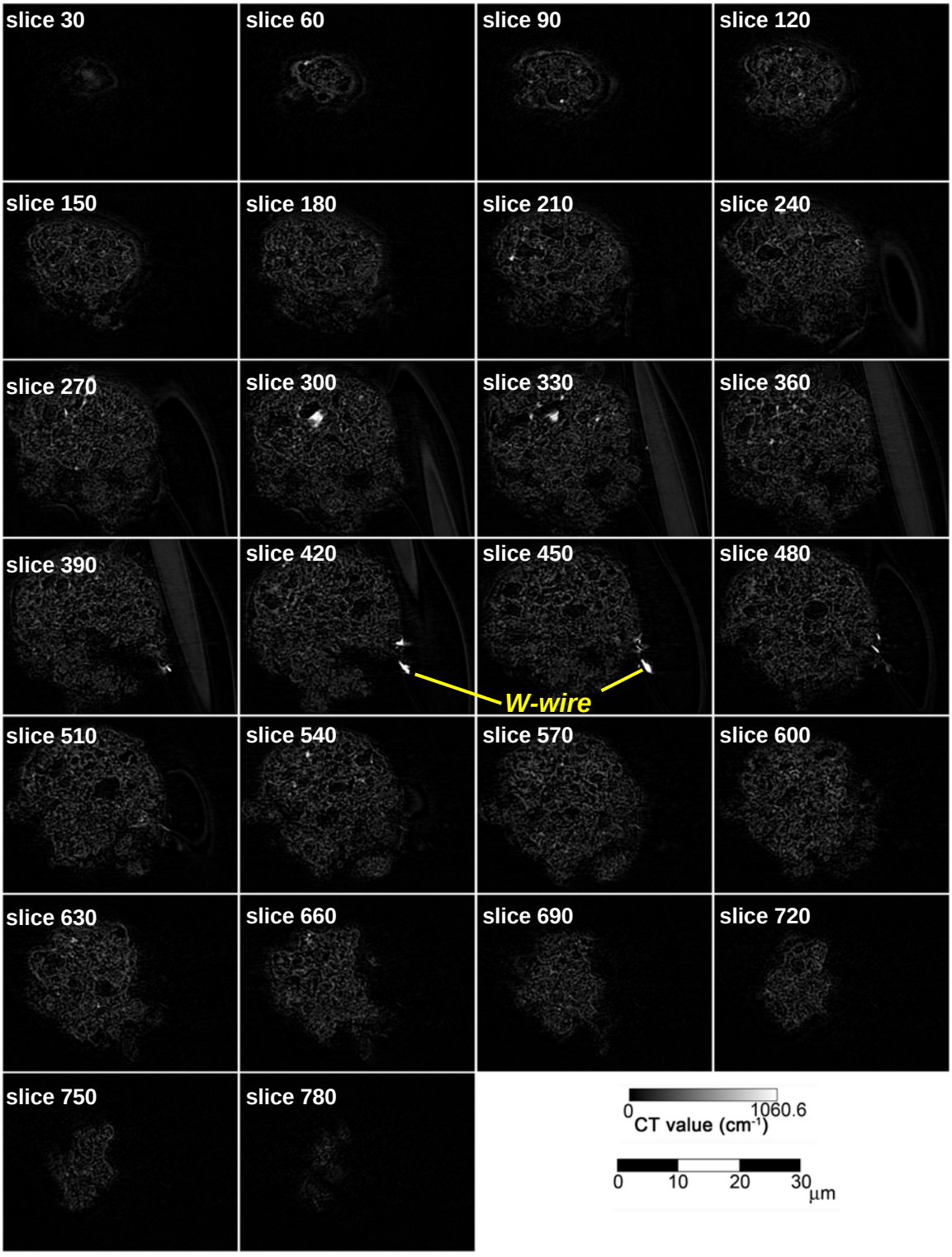
C2054.0.35.5 (Stardust #9)



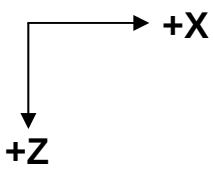
X-plane (1.275 μm interval)



C2054.0.35.5 (Stardust #9)

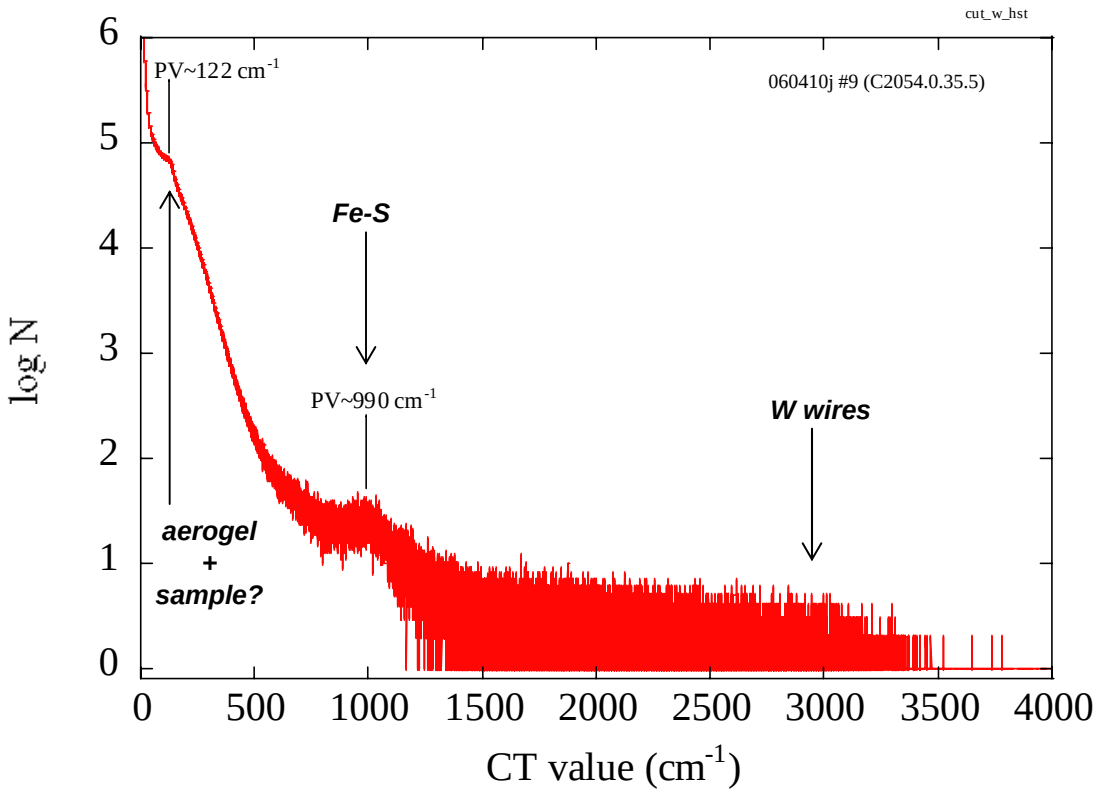


Y-plane (1.275 μm interval)



C2054.0.35.5 (Stardust #9)

Histogram of CT value (cm^{-1})



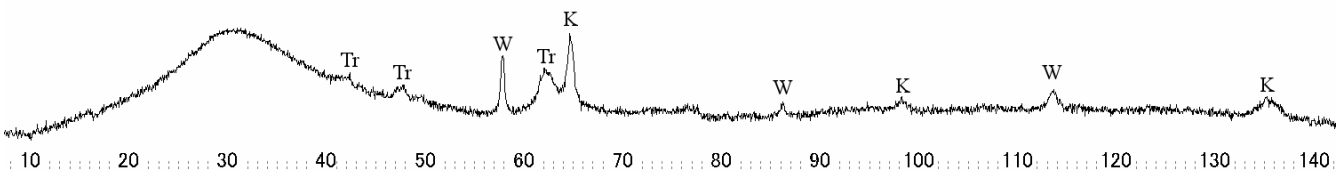
CT values (cm^{-1}) of related minerals at 8 keV

olivine	CT value	opx	CT value	cpx	CT value	pl	CT value		CT value
Fo100	90.5	En100	93.6	Di100	167.0	An100	127.6	quartz	84.0
Fo90	153.8	En90	137.1	Di90	187.5	An50	103.0	troilite	962.9
Fo80	216.3	En80	179.8			An0	78.2	magnetite	857.0

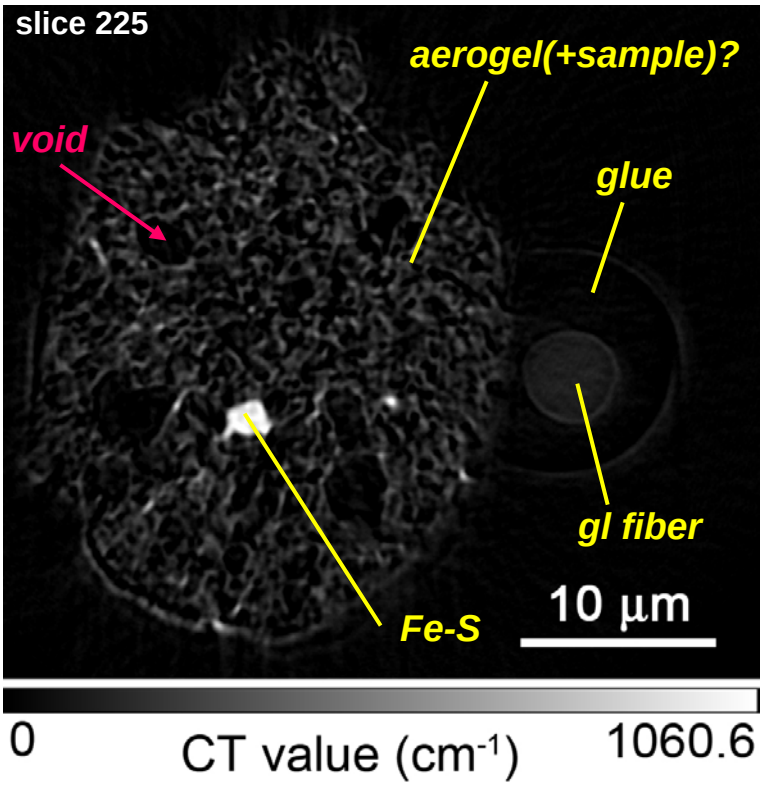
XRD by T. Nakamura

Wild II particle C2054, 0, 35, 5

Tr: troilite or pyrrhotite
K: kamacite
W: tangsten

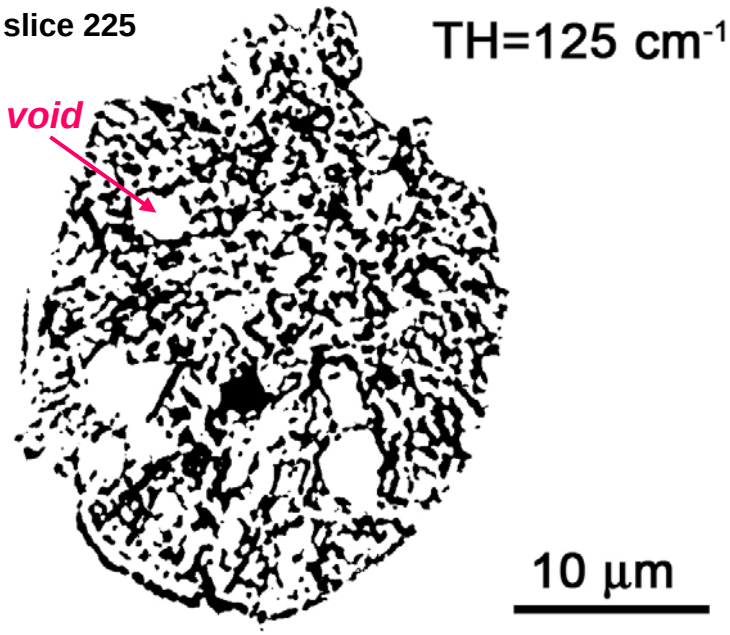


C2054.0.35.5 (Stardust #9)



Small grains of heavy minerals
FeS (troilite or pyrrhotite)
and kamacite
dispersed in
aerogel (+ samples?)

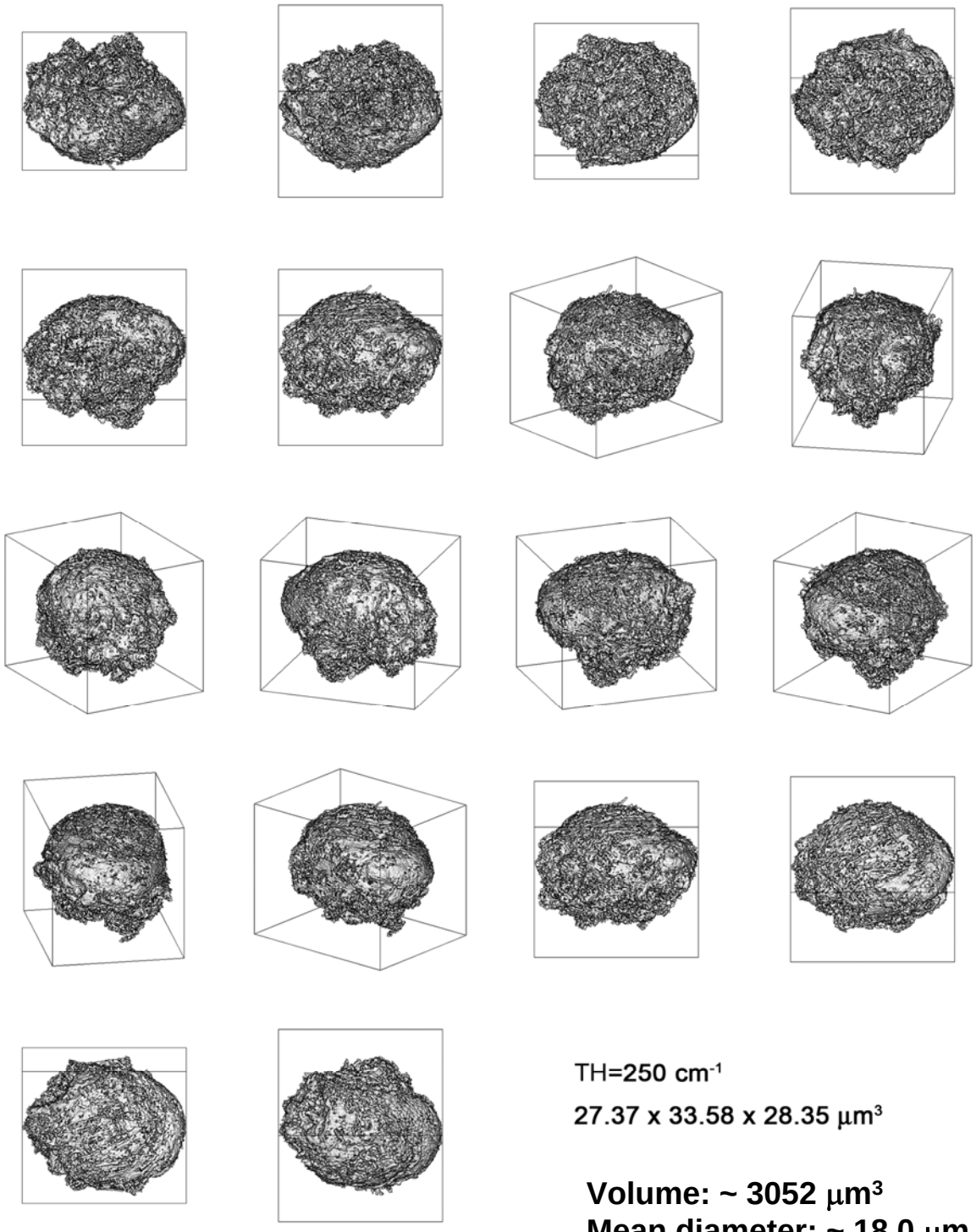
Large voids (red arrow)



Binery image

Large void (red arrow)

C2054.0.35.5 (Stardust #9)
Bird's eye view images (particle)



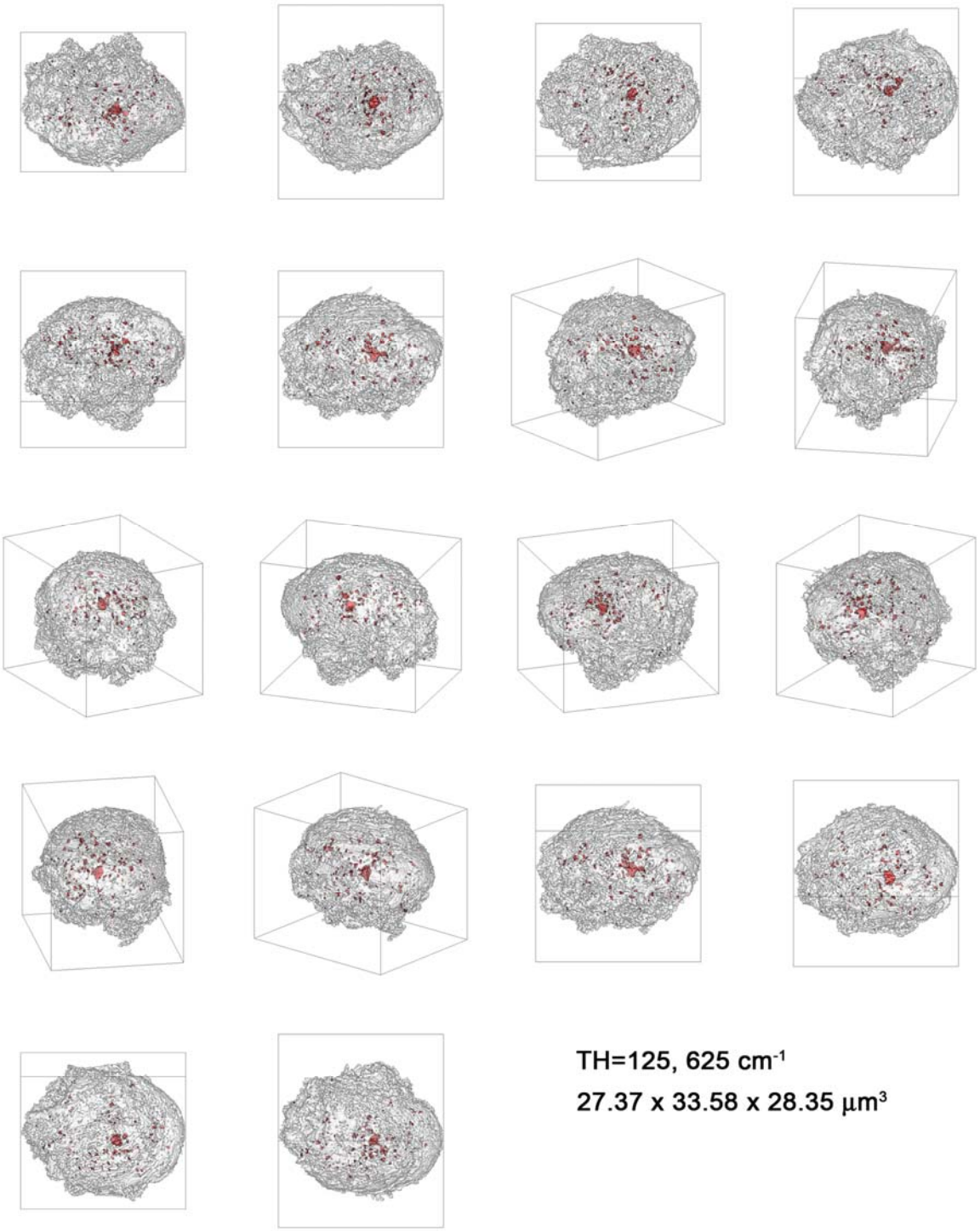
TH=250 cm^{-1}

27.37 x 33.58 x 28.35 μm^3

Volume: ~ 3052 μm^3
Mean diameter: ~ 18.0 μm

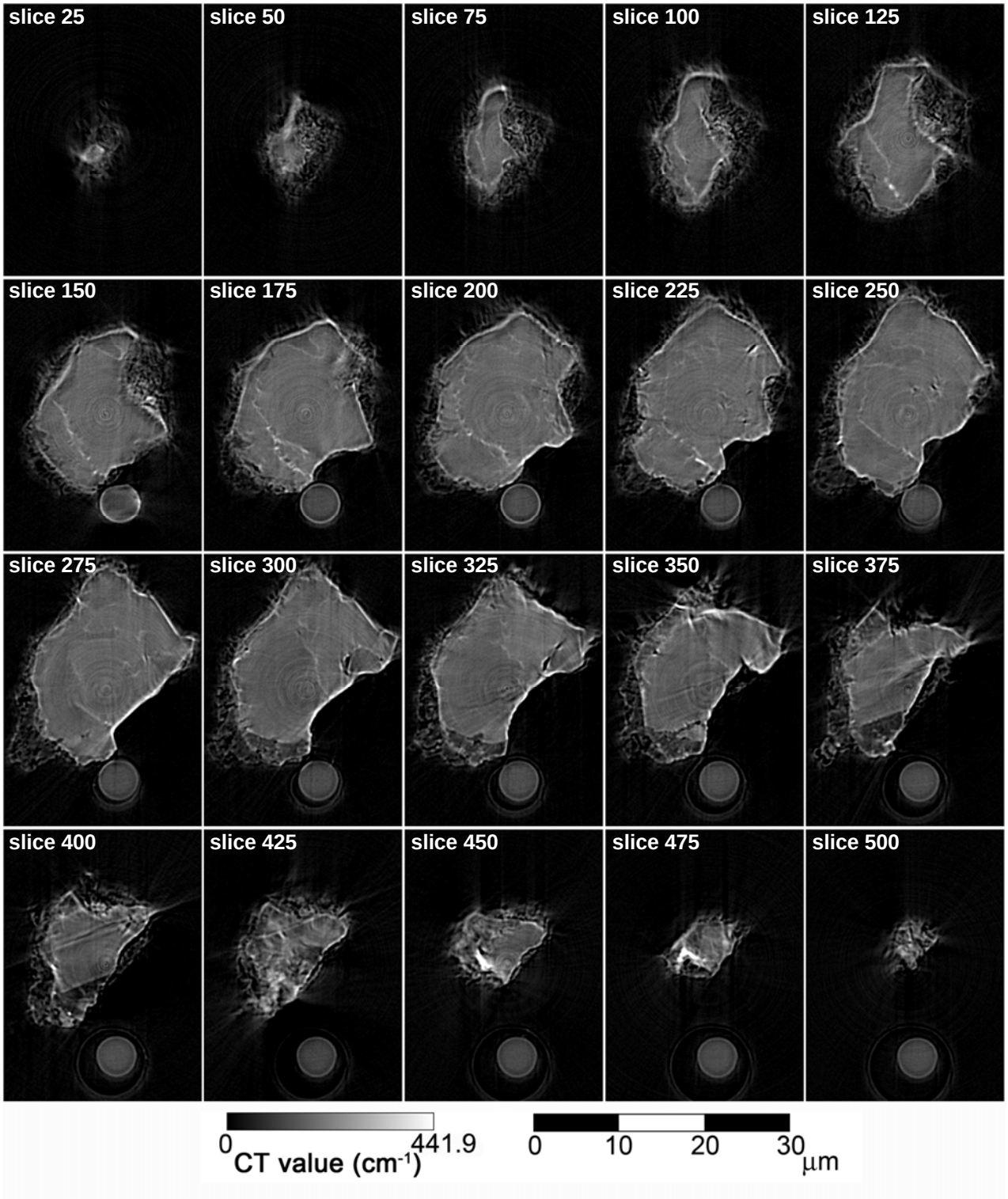
Smooth and rough surfaces

C2054.0.35.5 (Stardust #9)
Bird's eye view images
(FeS and metal grains in particle)

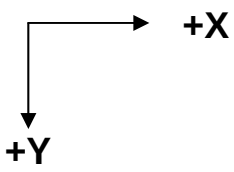


Volume of heavy minerals (red: kamacite and Fe-S?): 8.64 μm³
Mode: ~0.28 vol.%

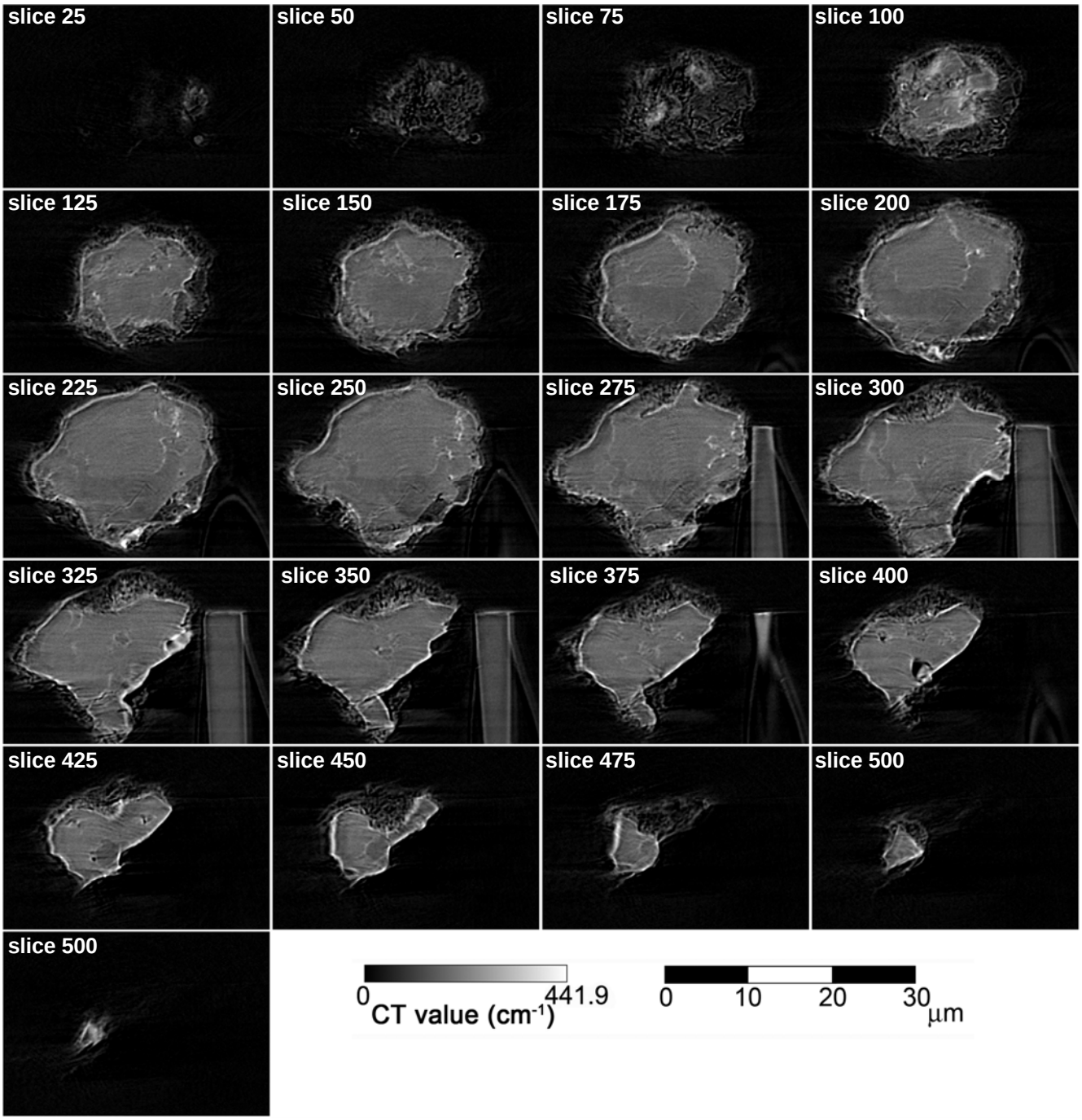
C2054.0.35.4 (Stardust #10)



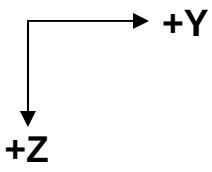
Z-plane (1.0625 μm interval)



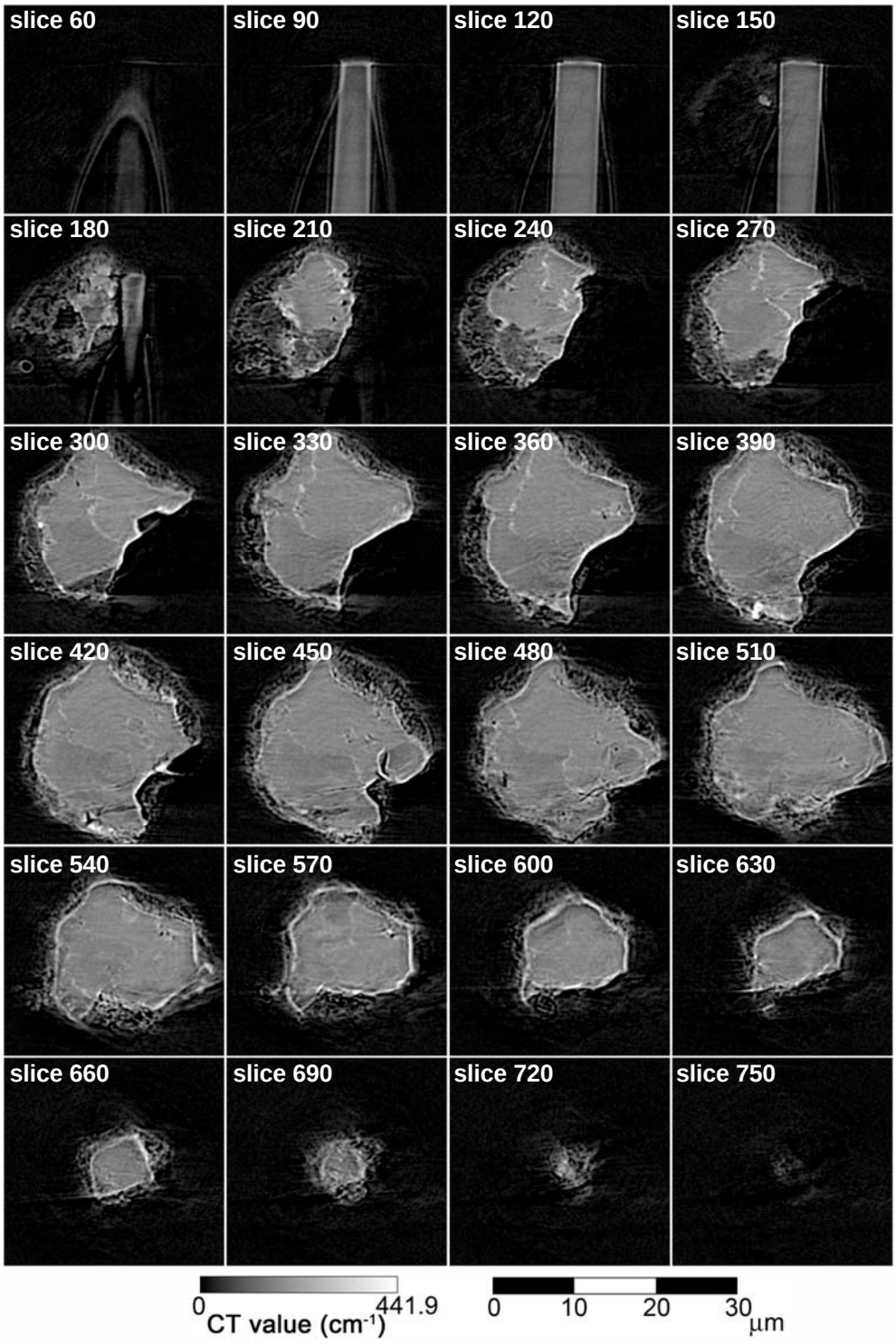
C2054.0.35.4 (Stardust #10)



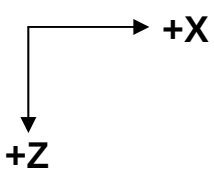
X-plane (1.0625 μm interval)



C2054.0.35.4 (Stardust #10)

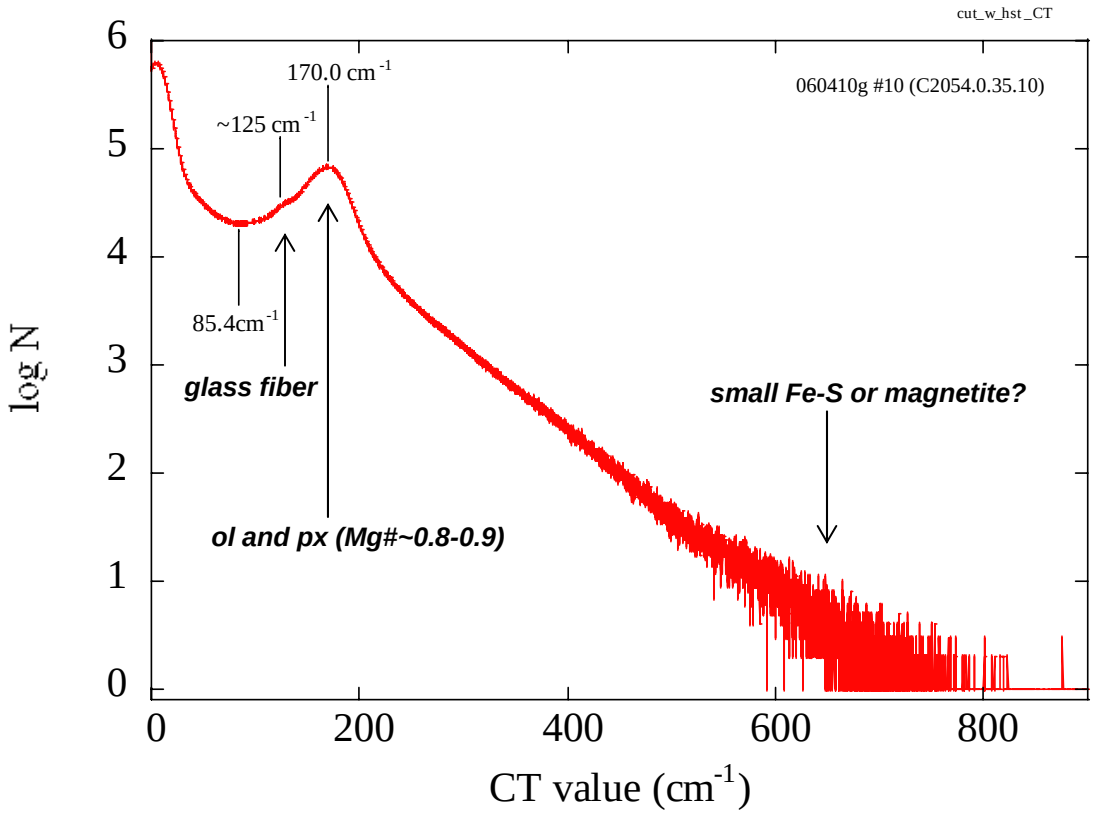


Y-plane (1.275 μm interval)



C2054.0.35.4 (Stardust #10)

Histogram of CT value (cm^{-1})



CT values (cm^{-1}) of related minerals at 8 keV

olivine	CT value	opx	CT value	cpx	CT value	pl	CT value		CT value
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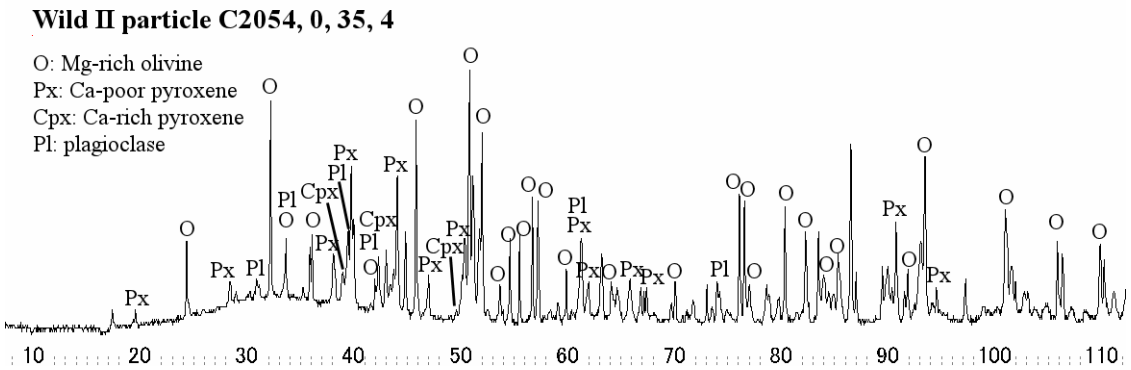
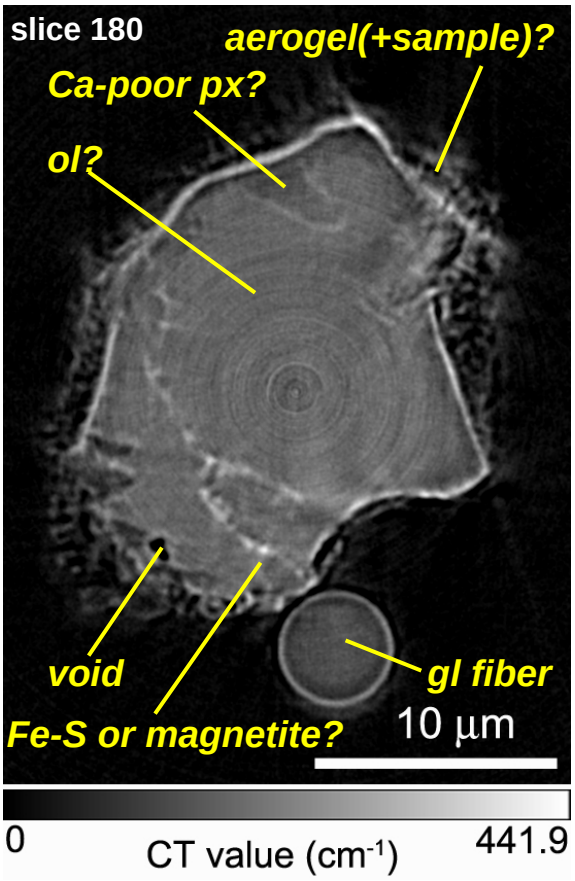
Fo90	153.8	En90	137.1	Di90	187.5	An50	103.0	troilite	962.9
Fo80	216.3	En80	179.8			An0	78.2	magnetite	857.0

XRD by T. Nakamura



C2054.0.35.4 (Stardust #10)

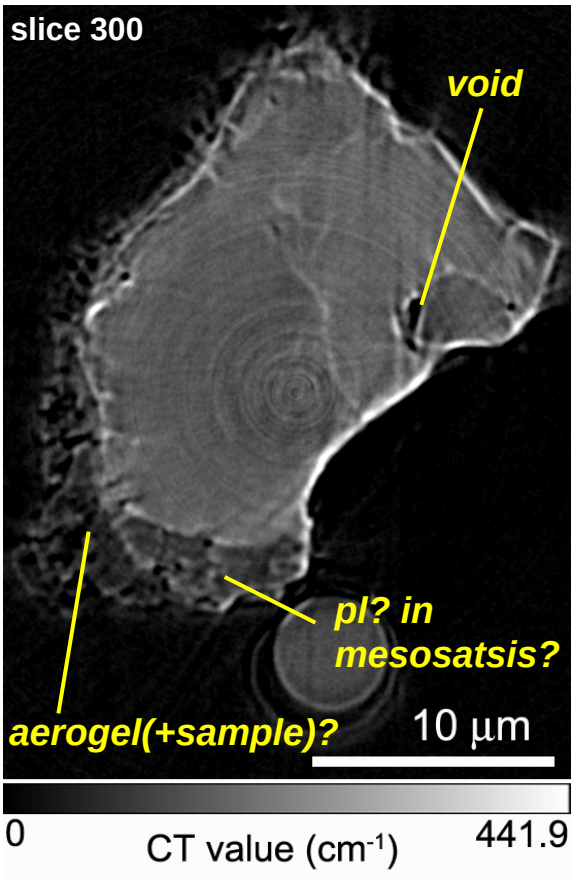


Crystalline
- ol? (bright)
- dark Ca-poor px?
- voids

Grain boundaries (bright)
- Fe-S or magnetite? along GB

Bright surface
- artifact due to refraction of X-ray beams

Particle partially covered with
- aerogel (+samples)?

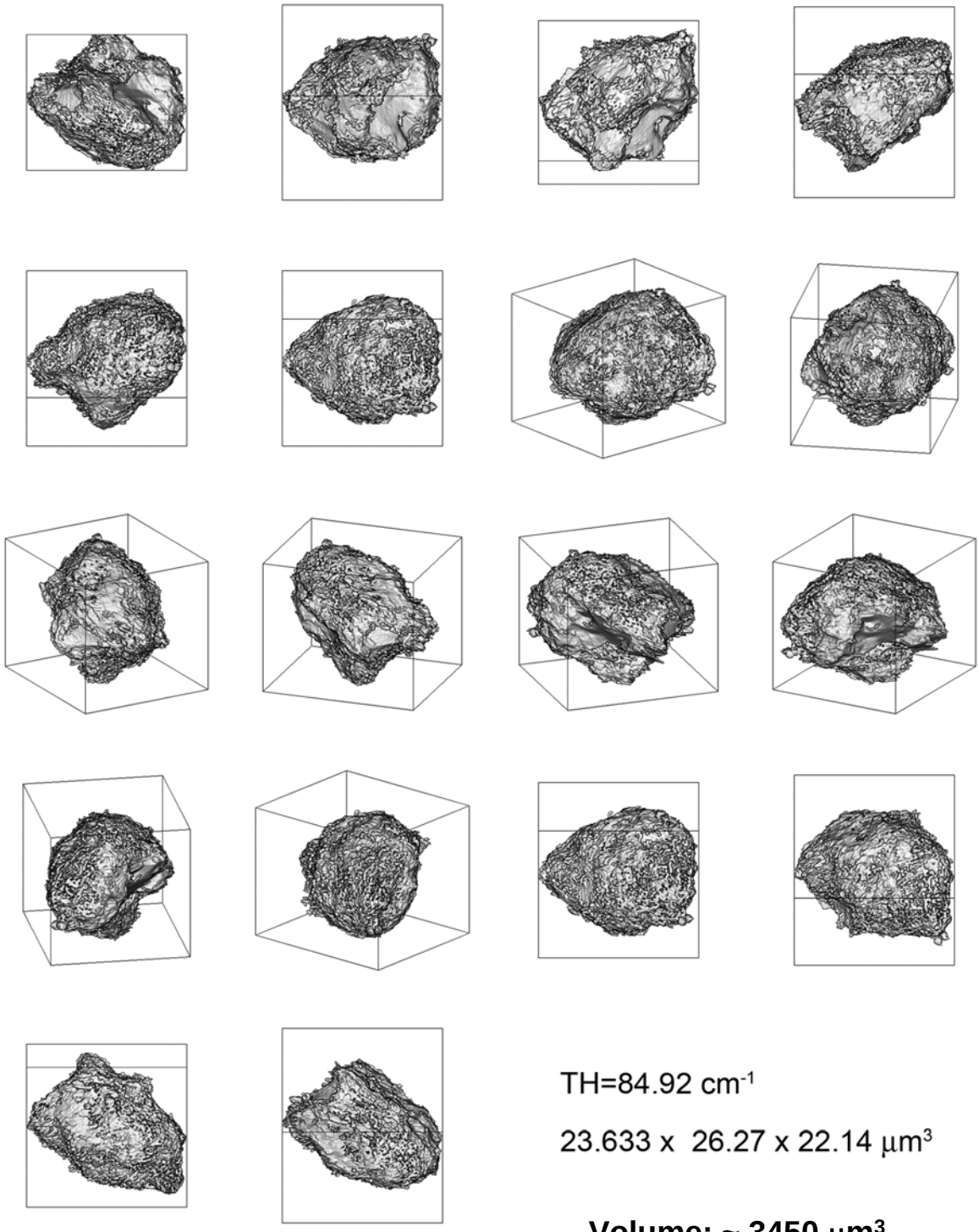


Mesostasis-like material
- pl?

Bright surface
- artifact due to refraction of X-ray beams

Particle partially covered with
- aerogel (+samples)?

C2054.0.35.4 (Stardust #10)
Bird's eye view images (particle)



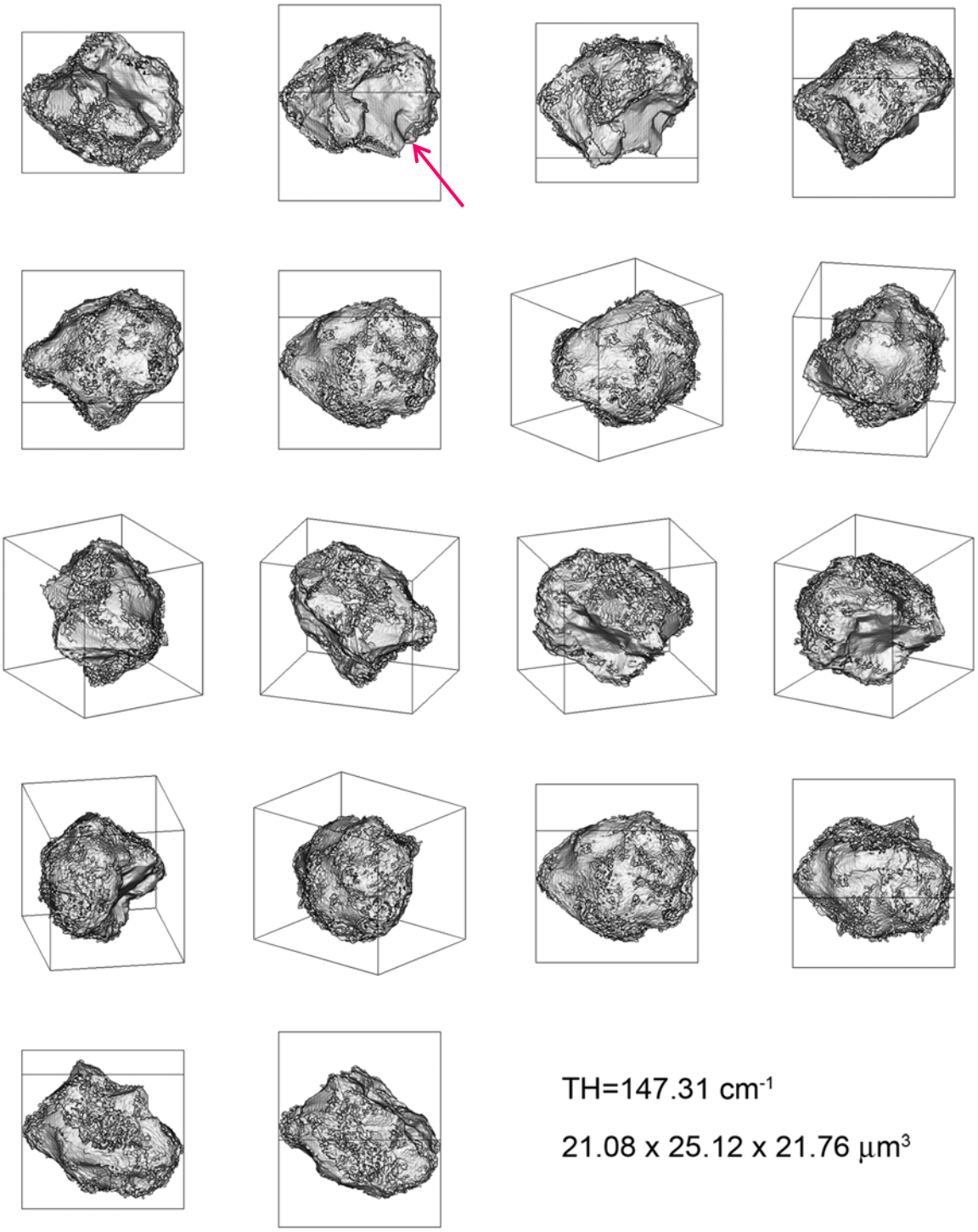
TH=84.92 cm^{-1}

23.633 x 26.27 x 22.14 μm^3

Volume: ~ 3450 μm^3
Mean diameter: ~ 18.7 μm

Grain mostly covered with aerogel (+sample)?
except for fractured surface

C2054.0.35.4 (Stardust #10)
Bird's eye view images
(aerogel is mostly removed)



Fractured surface is easily seen (red arrow).