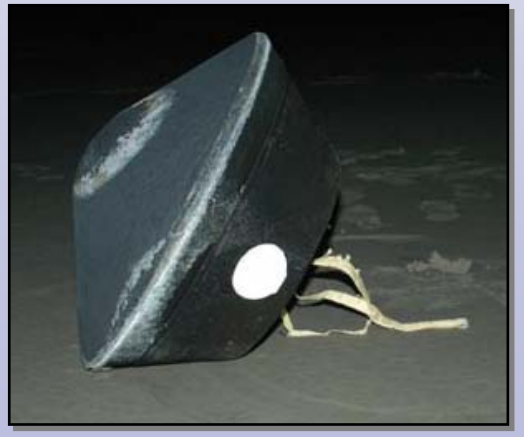
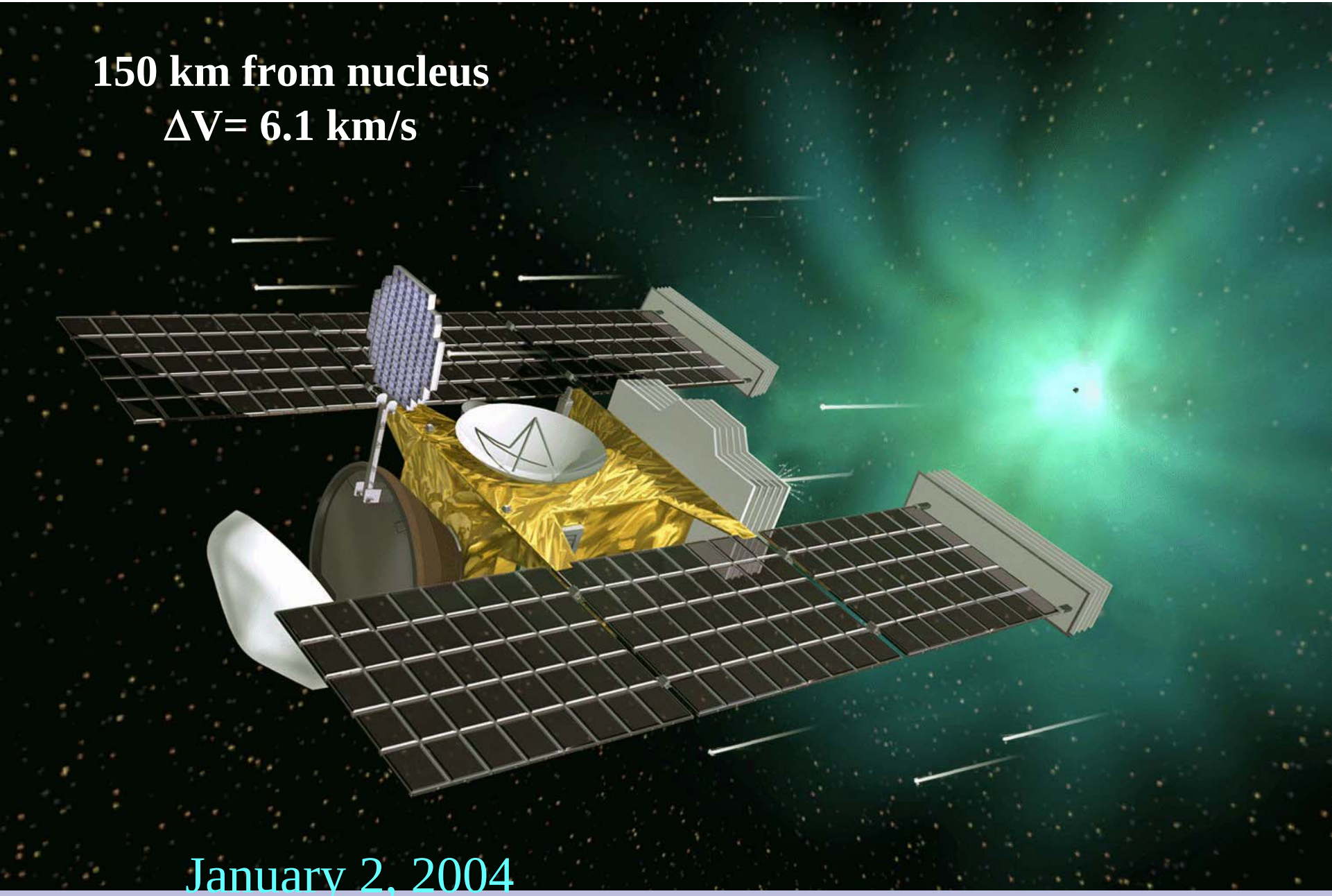
Stardust and Hayabusa Missions

Mike Zolensky

NASA JSC




150 km from nucleus
ΔV= 6.1 km/s
January 2, 2004

Wild 2 (81P)

A Jupiter family comet captured into present orbit in 1973 after a 0.006 AU Jupiter encounter

Track shape - unbiased insight into particle structure

<u>Type A</u> (Burchell et al 2008)

Cohesive - solid rocks

Only minor fragmentation

All short tracks & most made by

<5μ particles are type A

<u>Type B</u> (Burchell et al 2008)

Weakly bound

severe fragmentation

~50% of tracks made by >10μm particles are type B

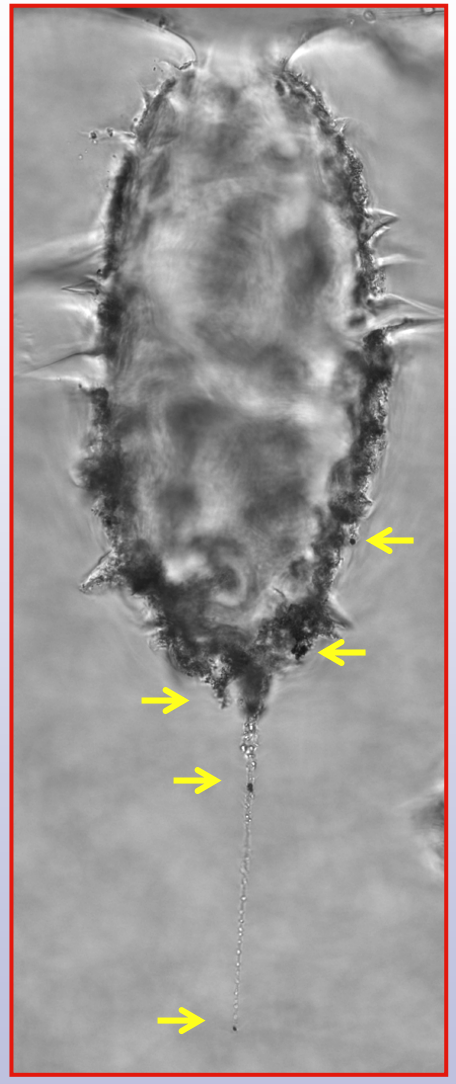
Implication

Much/Most Wild 2 dust is an aggregation

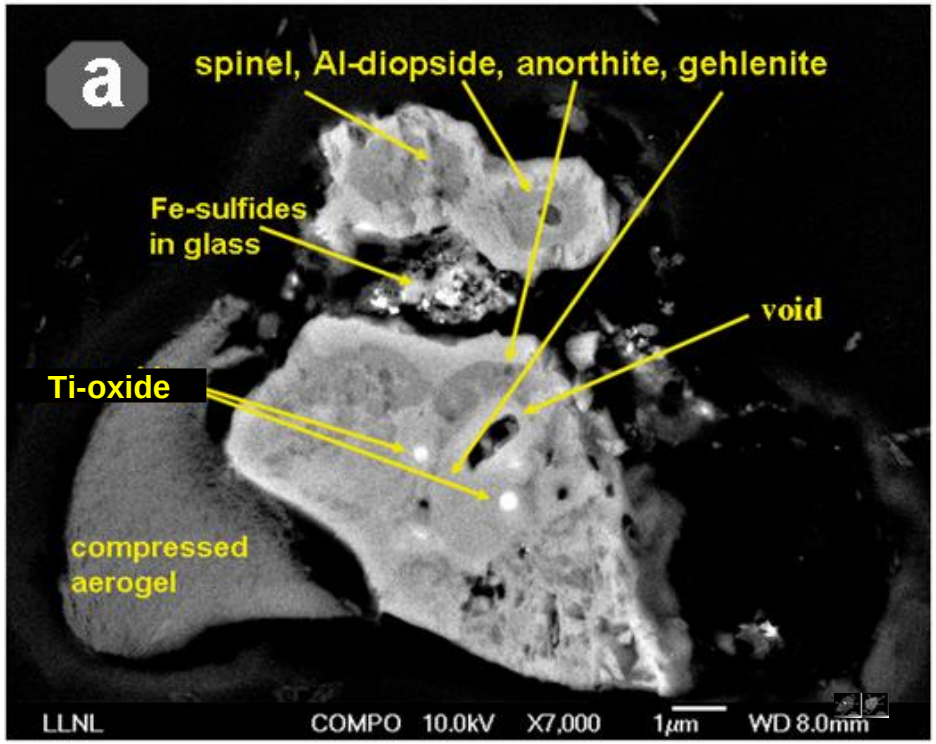
of solid > 1μm components!

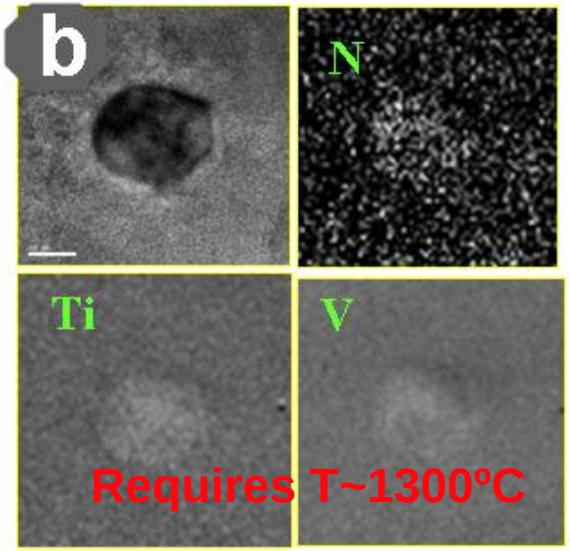
<u>Not submicron components!</u>

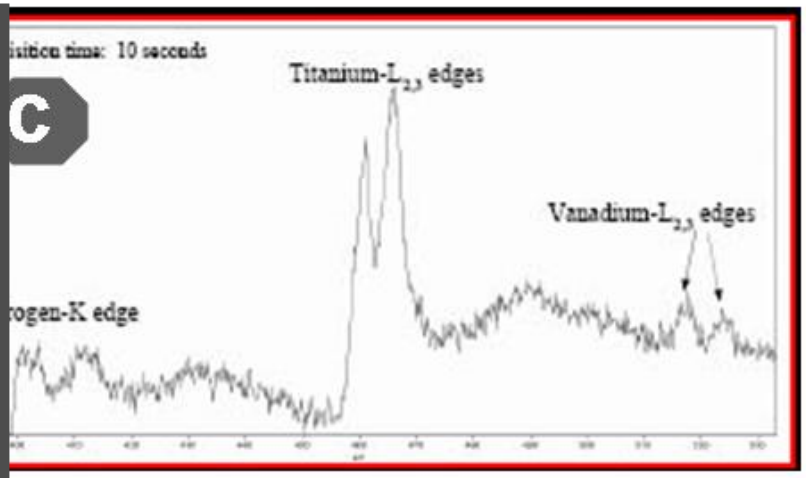
Type A
Carrot shaped

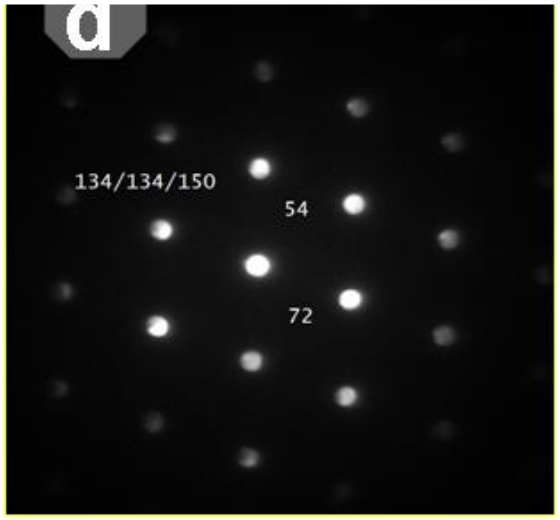


Type B
Bulbous


a
spinel, Al-diopside, anorthite, gehlenite
Fe-sulfides
in glass
void
Ti-oxide
compressed
aerogel
LLNL
COMPO 10.0kV X7,000 1μm WD 8.0mm

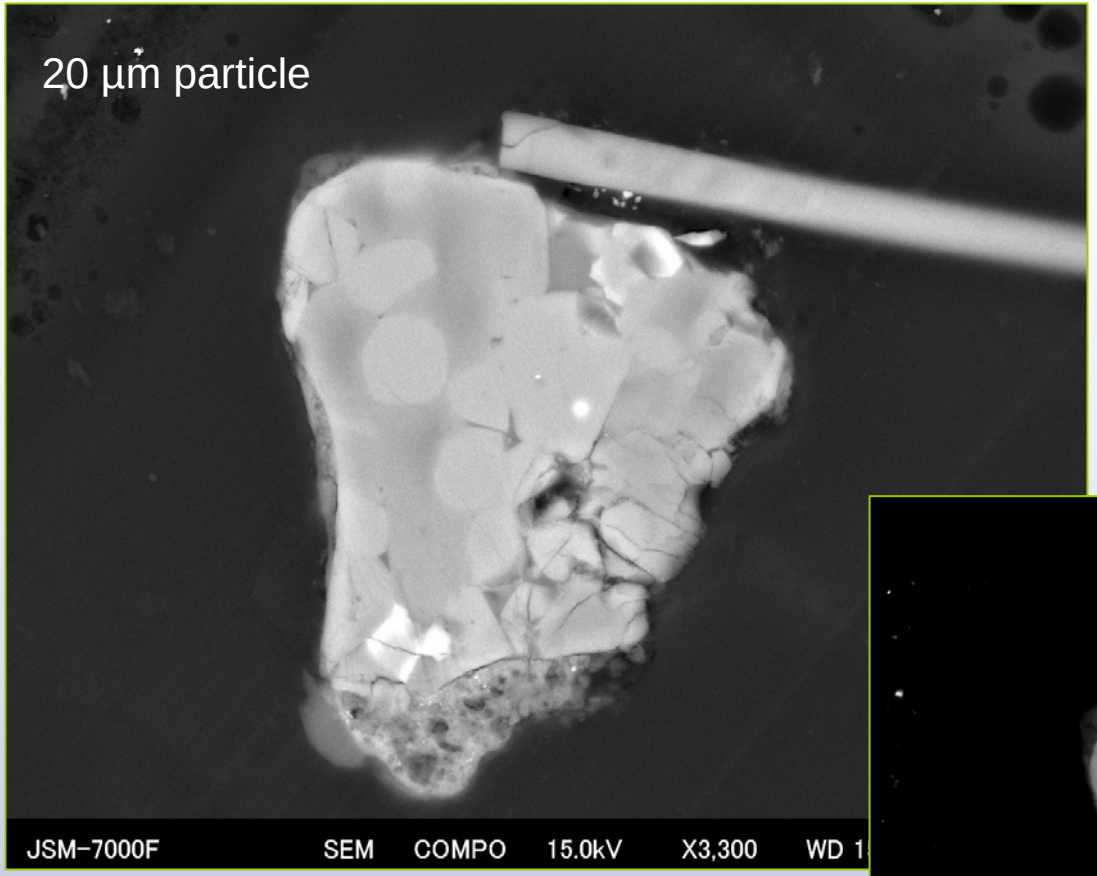

b
N
Ti
V
Requires T~1300°C


c
Titanium-L2,3 edges
Vanadium-L2,3 edges
rogen-K edge


d
134/134/150
54
72

LLNL Group

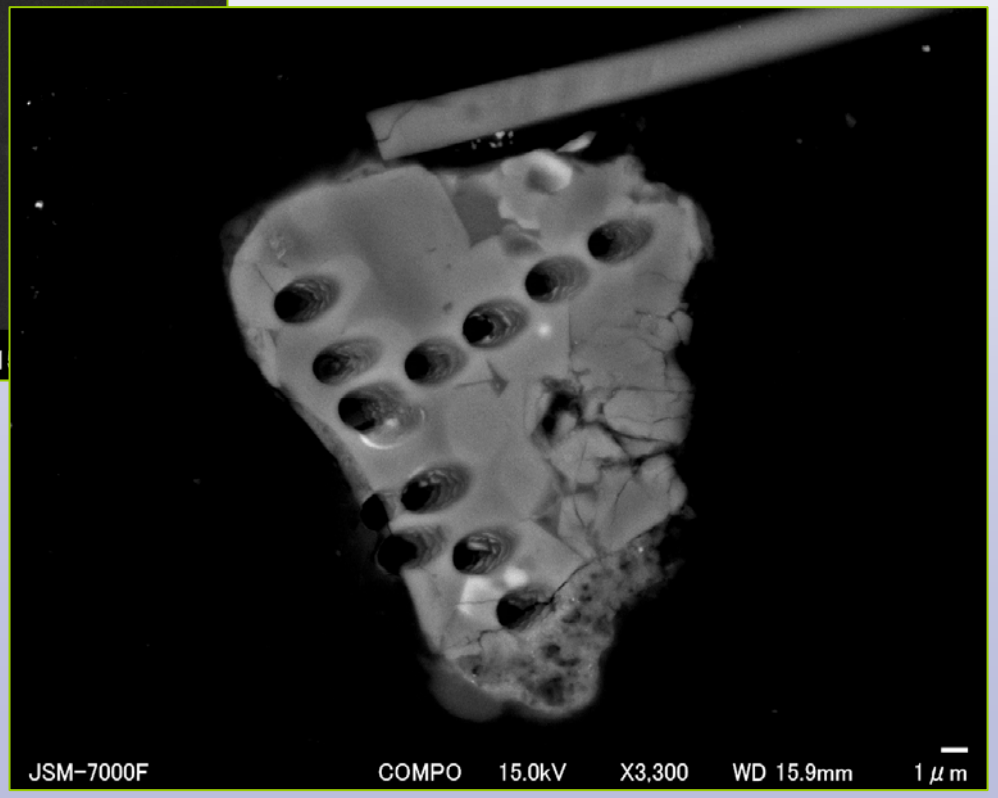
Torajiro



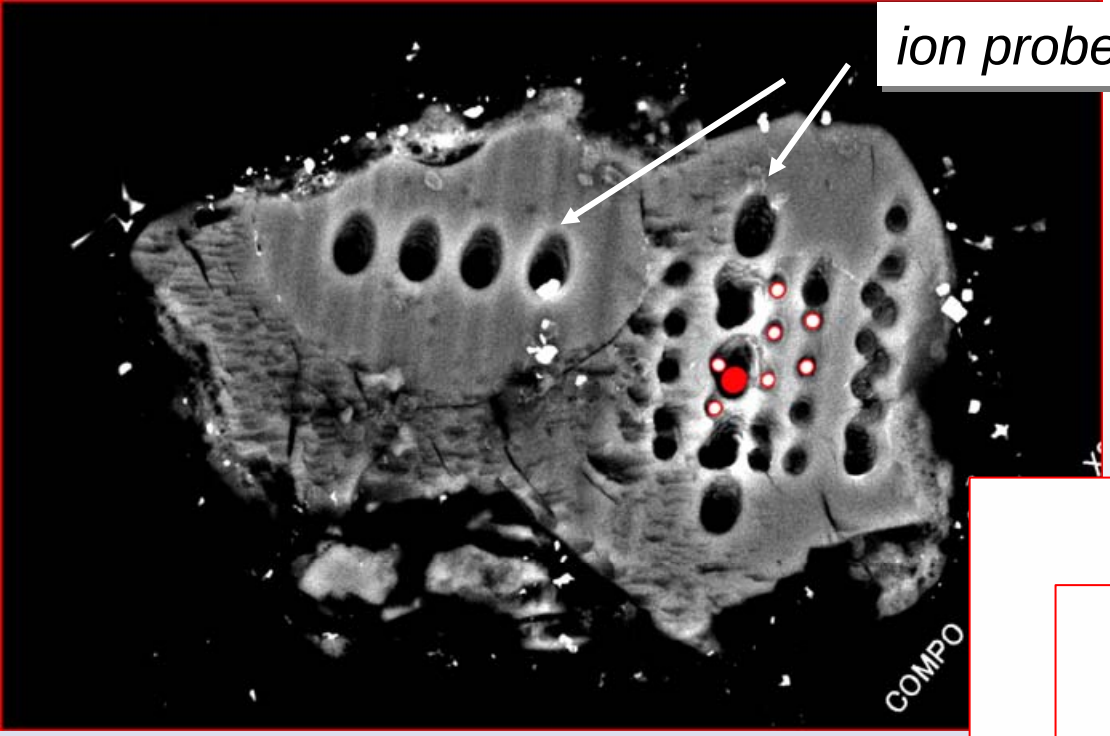
Nakamura et al LPSC 2008

$Fo_{79\sim80}$

$En_{83}Wo_5 \sim En_{88}Wo_3$

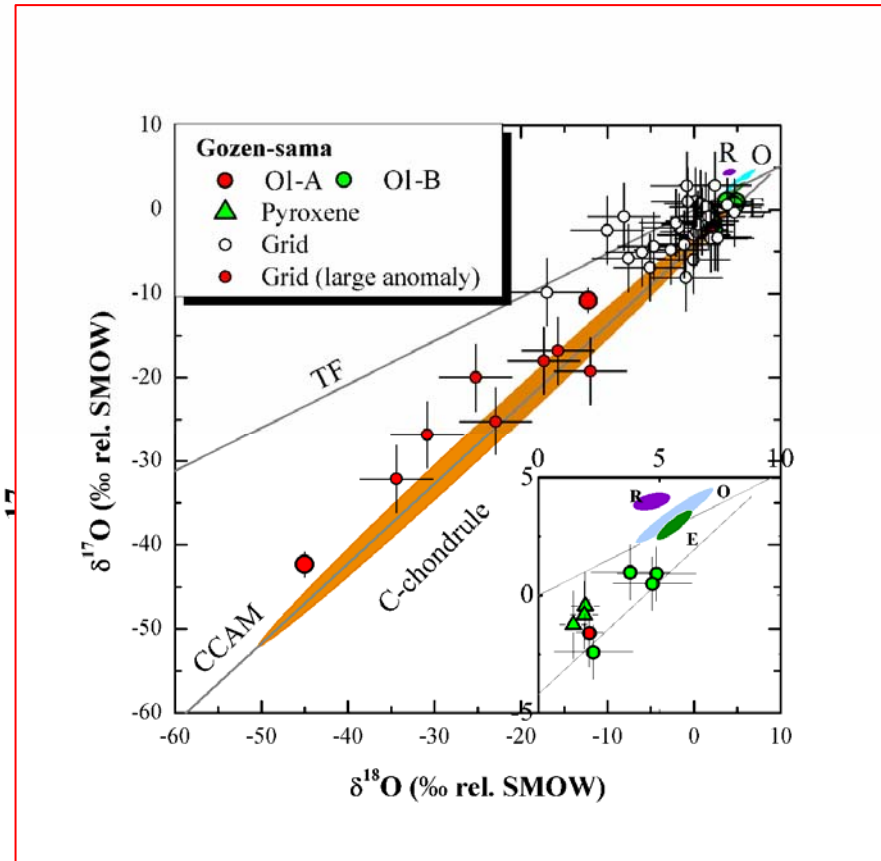


The particle experienced partial melting at temperature higher than 1800 ^{o}C, prior to the formation of the comet.



Gozen-sama oxygen isotopes

Nakamura et al LPSC 2008



Ol-A **^{16}O-rich**

Ol-B **^{16}O-poor**

LPx **intermediate**

A product of incomplete melting of ^{16}O-rich and ^{16}O-poor precursors

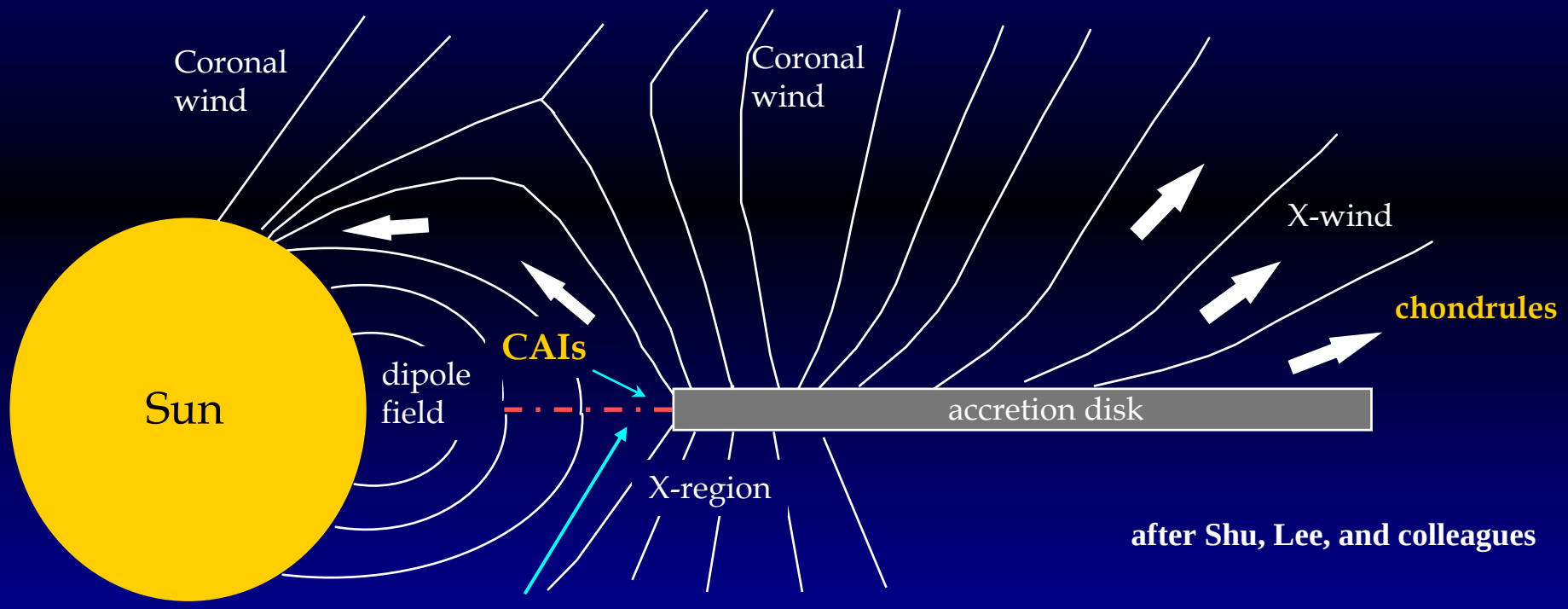
Large scale radial transport processes?

either
Above disk
or
In disk plane

Several authors had predicted large-scale radial transport

Shu et al X-Wind theory

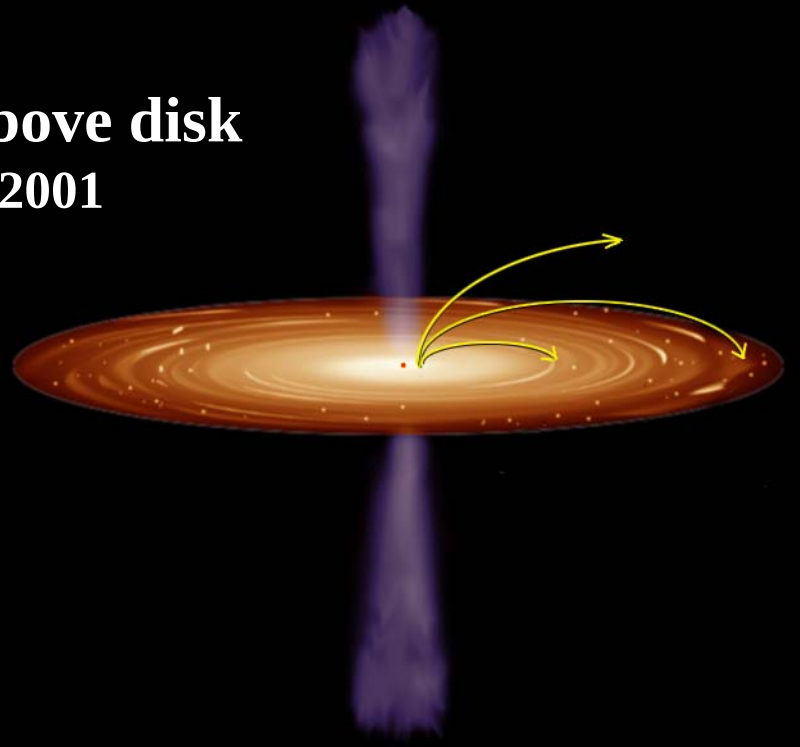
predicted that comets would contain CAIs
That formed a few radii from the T Tauri Sun

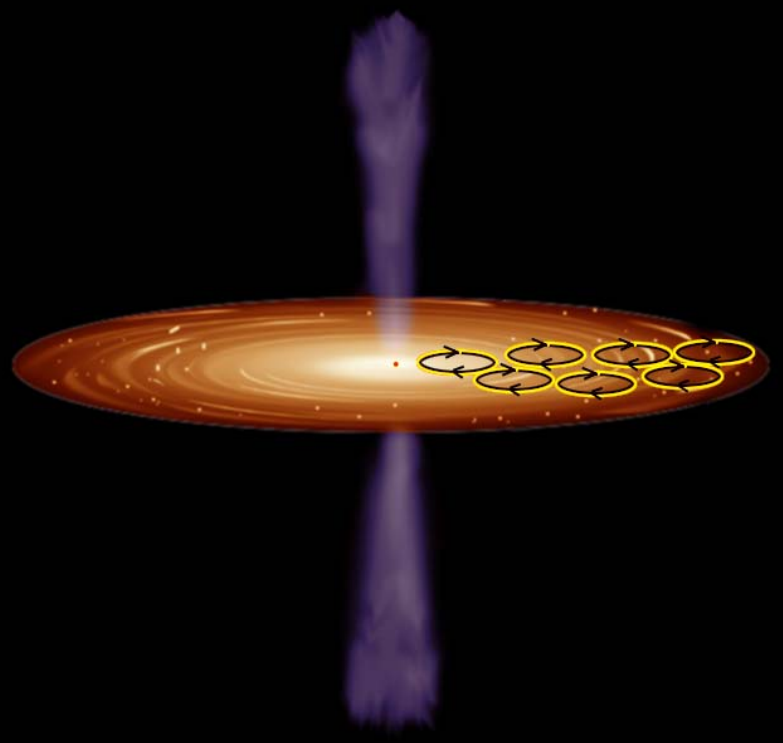


after Shu, Lee, and colleagues

Ballistic mechanisms above disk

X-Wind- Shu et al. 2001

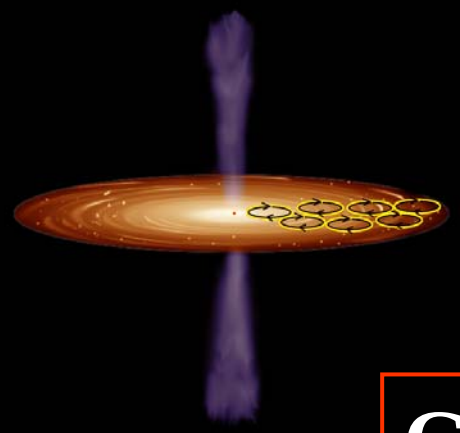


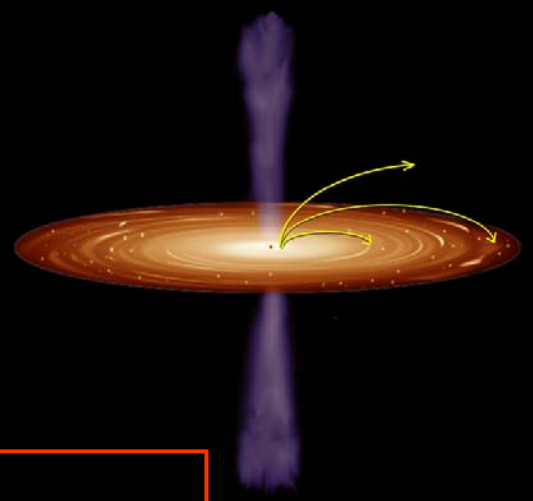


In-disk or near disk mechanisms

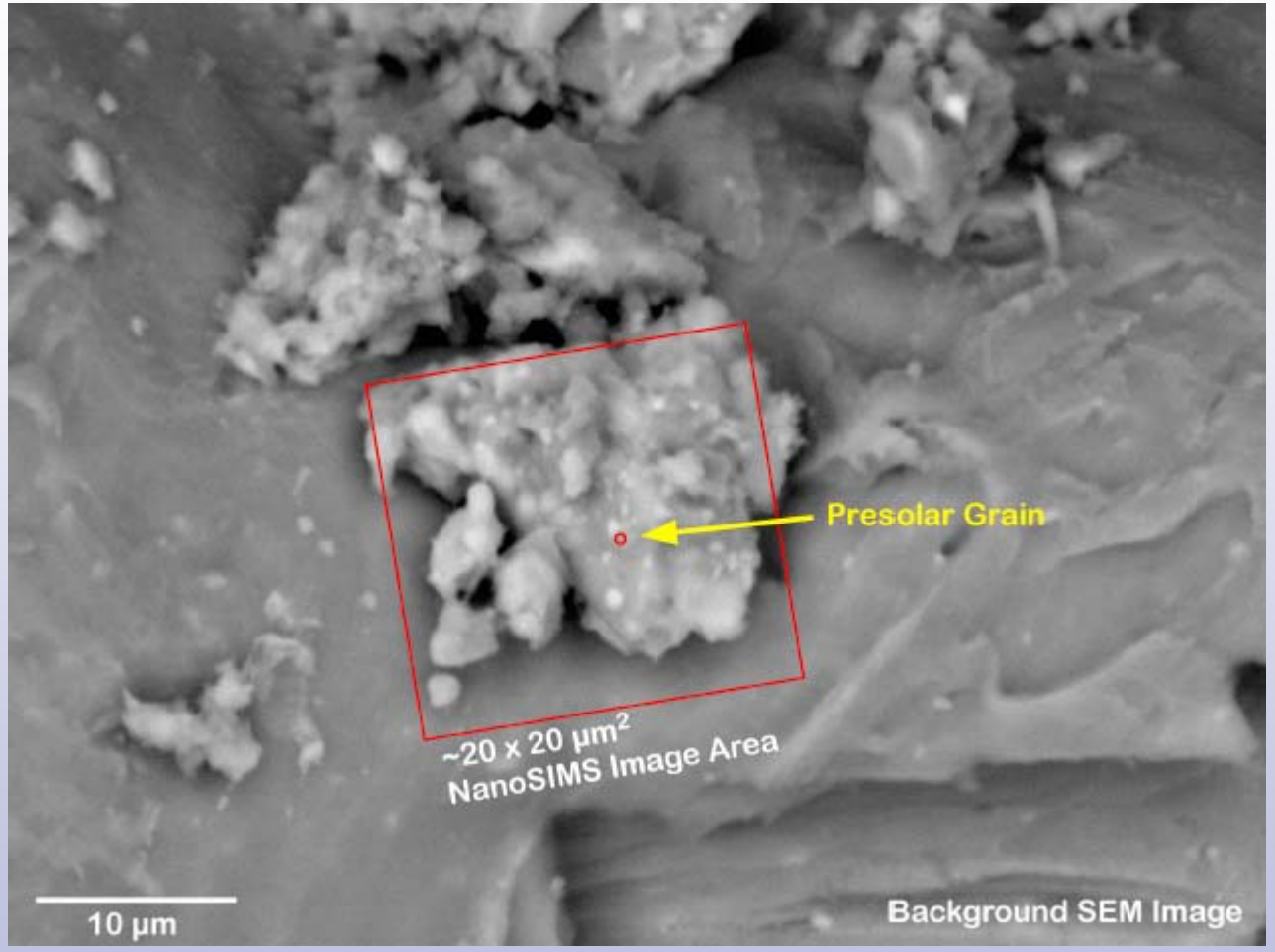
Bockelee-Morvan et al. 2002
Cuzzi et al. 2003
Ciesla 2007
Boss 2008
Mousis et al 2008

The large scale radial transport of particles to the Kuiper belt Can be considered to be the





Grand Radial Express (GRE)



Huge ^{17}O-enrichment:

$^{17}O/^{16}O$ = $(1.01 \pm 0.10) \times 10^{-3}$

$^{18}O/^{16}O$ = $(1.77 \pm 0.12) \times 10^{-3}$

origin in Red Giant or AGB star

Stadermann, Messenger, et al.

Presolar Grains

Concentration of presolar grains appears to be low

~17ppm

This could be low due to measurement bias

This is 5-10 times lower than primitive chondrites and IDPs

Speculation

There might be two types of comets

a) Those formed while the GRE was in operation
b) Those that formed before or afterwards

Are Wild 2 solids typical for Kuiper Belt Comets?
Probably when GRE operated - it sprinkled particles all bodies

The majority of Wild 2 solids formed at moderate to extreme temperatures

They appear to be products of the inner solar nebula
Most are similar to meteoritic components

The Wild components are highly unequilibrated
mineral compositions not modified during storage

The silicates are are at least as primitive as those in most primitive meteorites

<u>There is no evidence for modification inside Wild 2</u>

Conclusions

It is an extraordinary diverse mix of unequilibrated materials

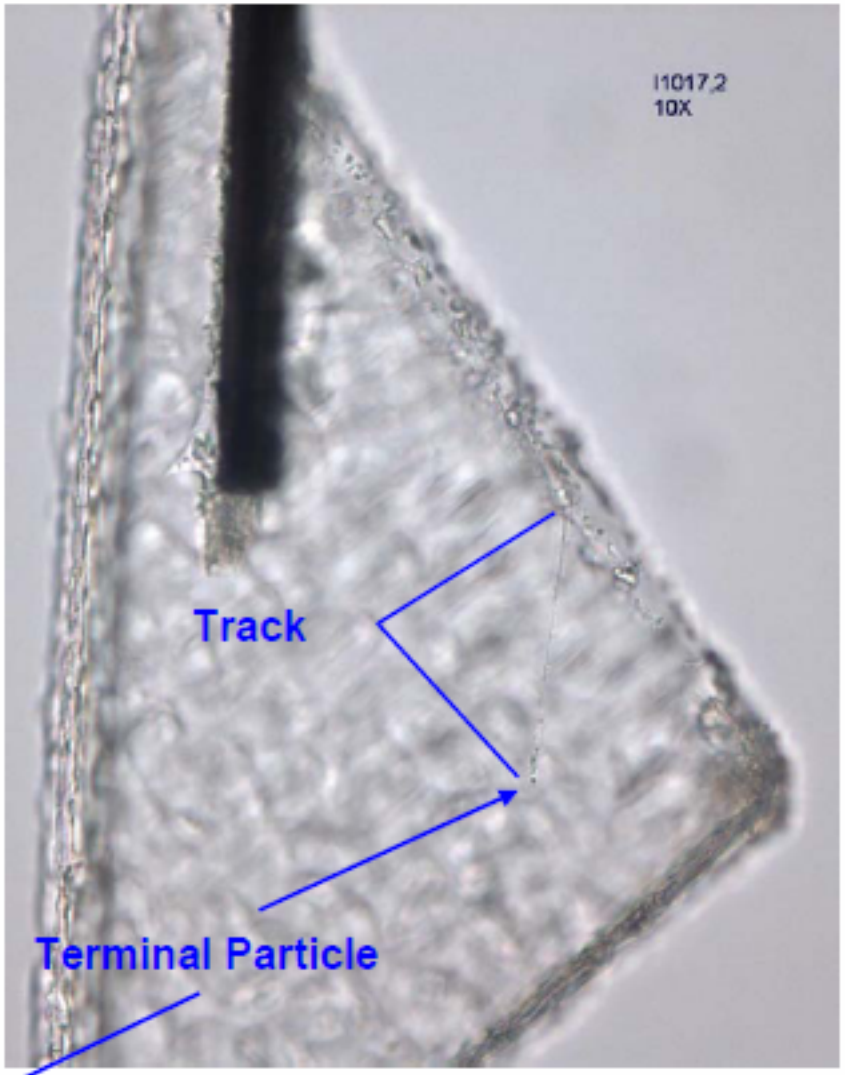
Its similarity to any meteorite or IDP group is unclear
It may be a sampling of the entire nebular disk

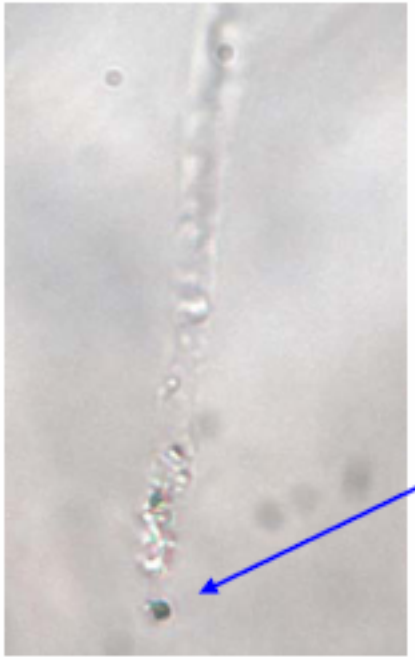
Cometary rocks, ices and perhaps organics formed in disparate local environments

Some comets accreted *after* CAI & chondrule formation

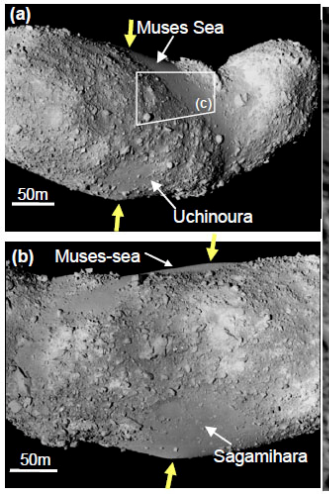
First Track / Keystone removed from the Interstellar Tray of Stardust

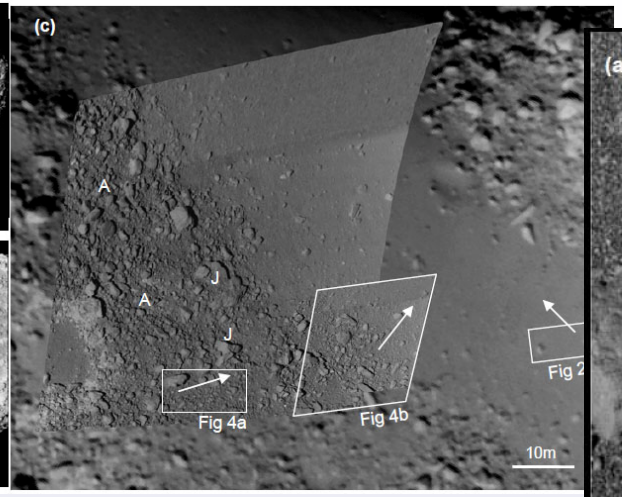
The first track / keystone was successfully removed from the Stardust Interstellar Tray on Wednesday, February 13, 2008. This the first track-containing keystone removed and is named I1017,2. The track is a high-angle track, with a rather large terminal grain (arrowed) that is either an IDP or a secondary grain from an impact onto a solar panel (that then splashed onto the tray). In the next few days we will be harvesting several of these high-angle tracks. After a short pause in the action we plan to begin harvesting actual interstellar track candidates.

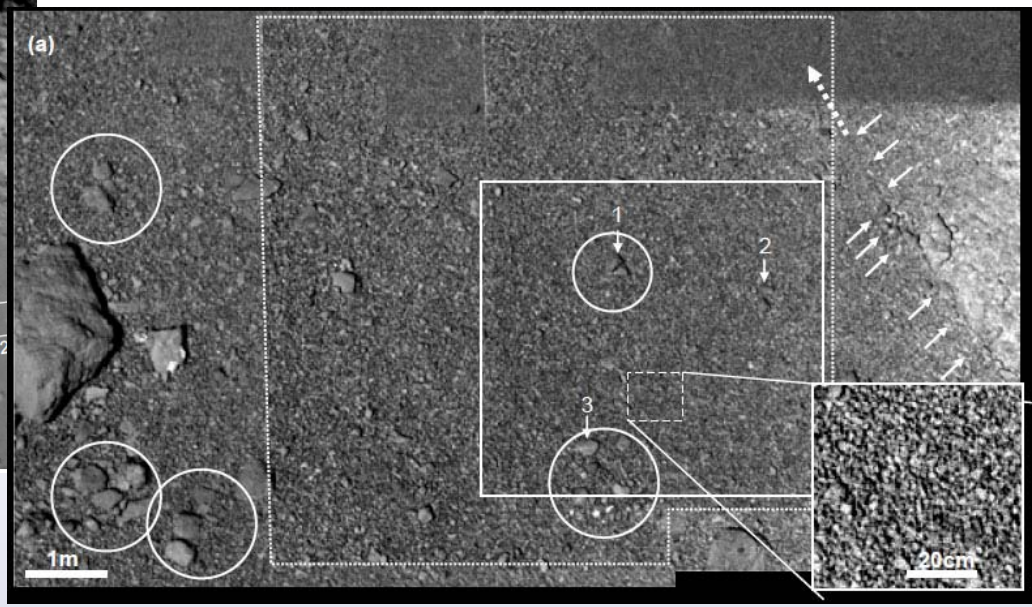




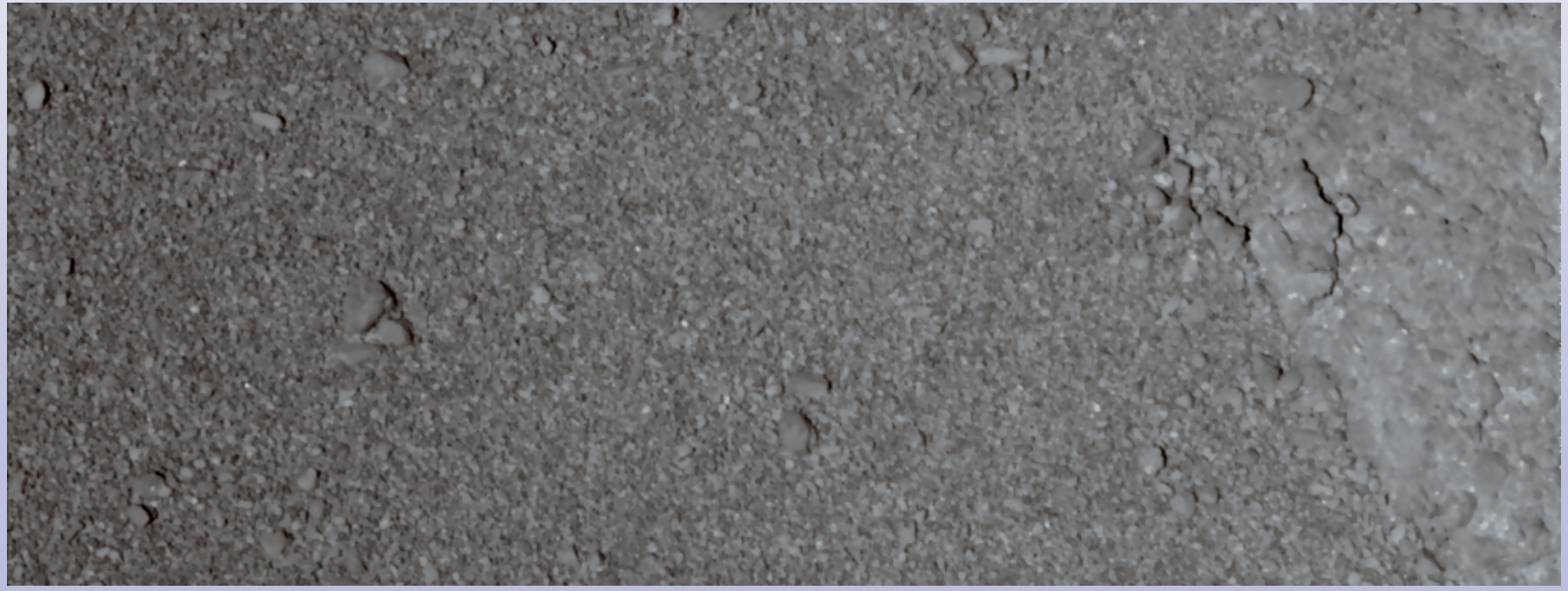

Asteroid
HAYAB
Launch in 2007


(a)
Muses Sea
(c)
50m
Uchinoura
(b)
Muses-sea
50m
Sagamihara


(c)
A
J
A
J
Fig 4a
Fig 4b
Fig 2
10m

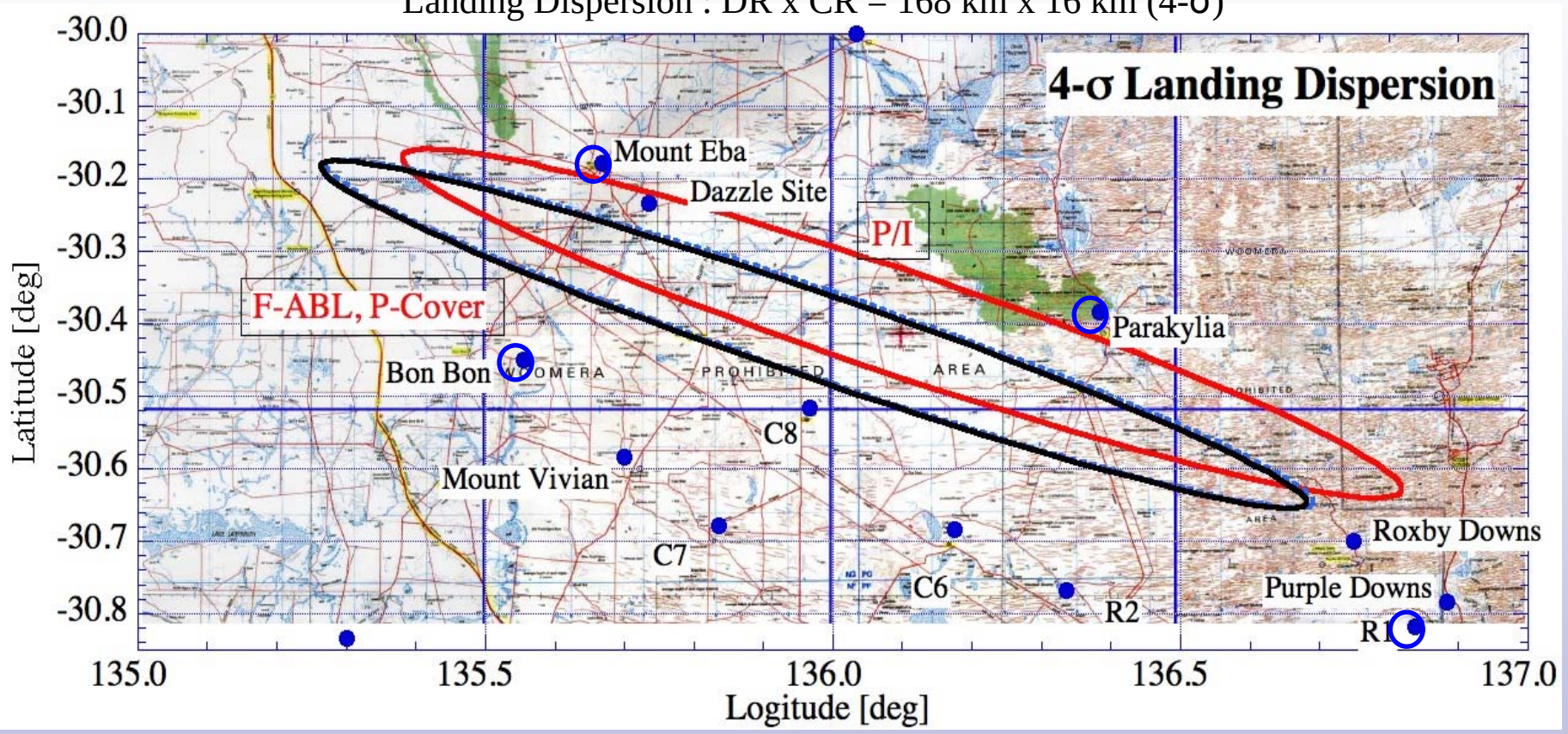

(a)
1
2
3
1m
20cm

Sept 2005

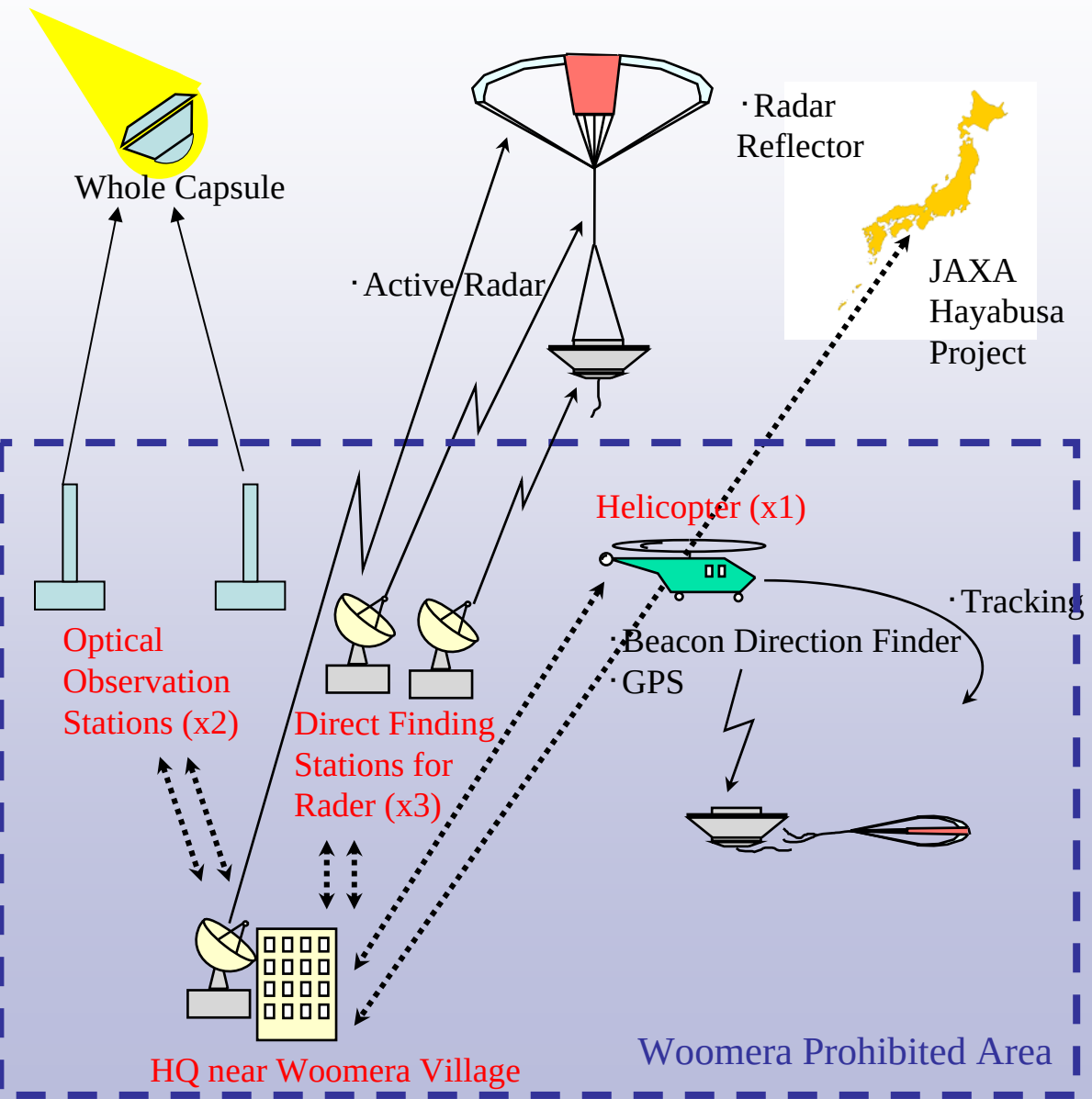


Preliminary Landing Ellipse (Courtesy: T. Yamada)

Landing Dispersion : DR x CR = 168 km x 16 km (4-σ)



Capsule Main Component Transportation: Segment-1 (1/3)

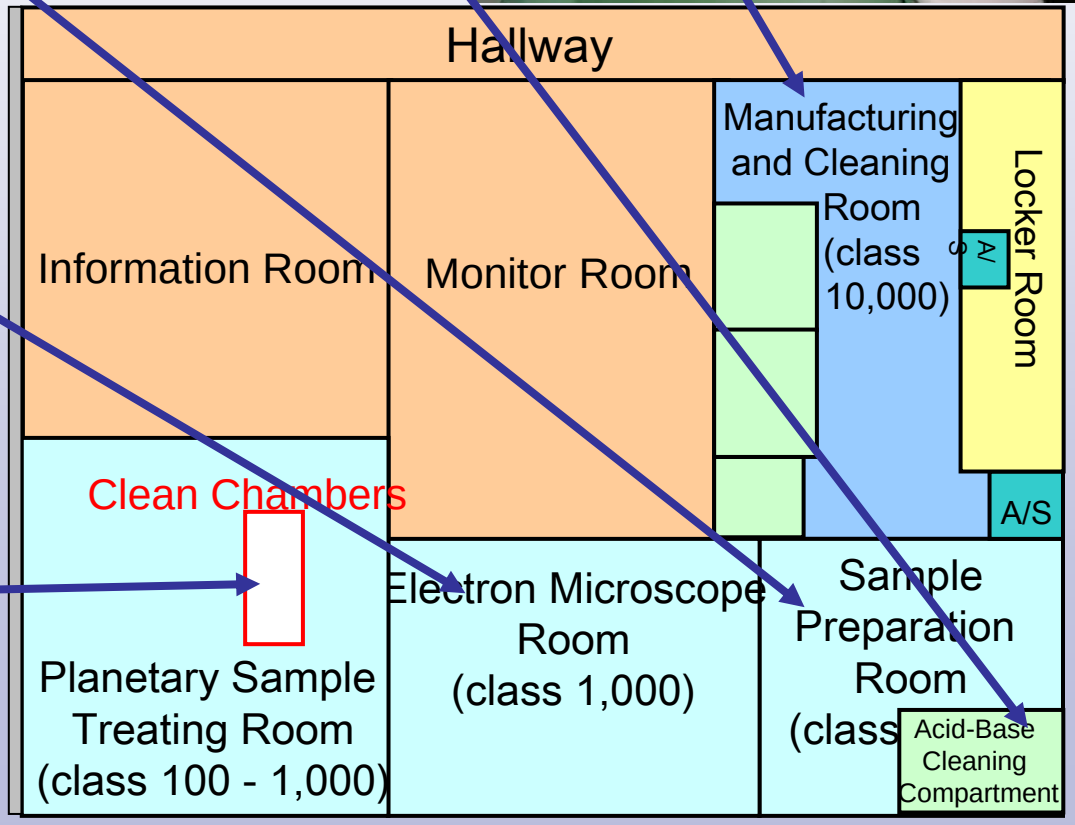


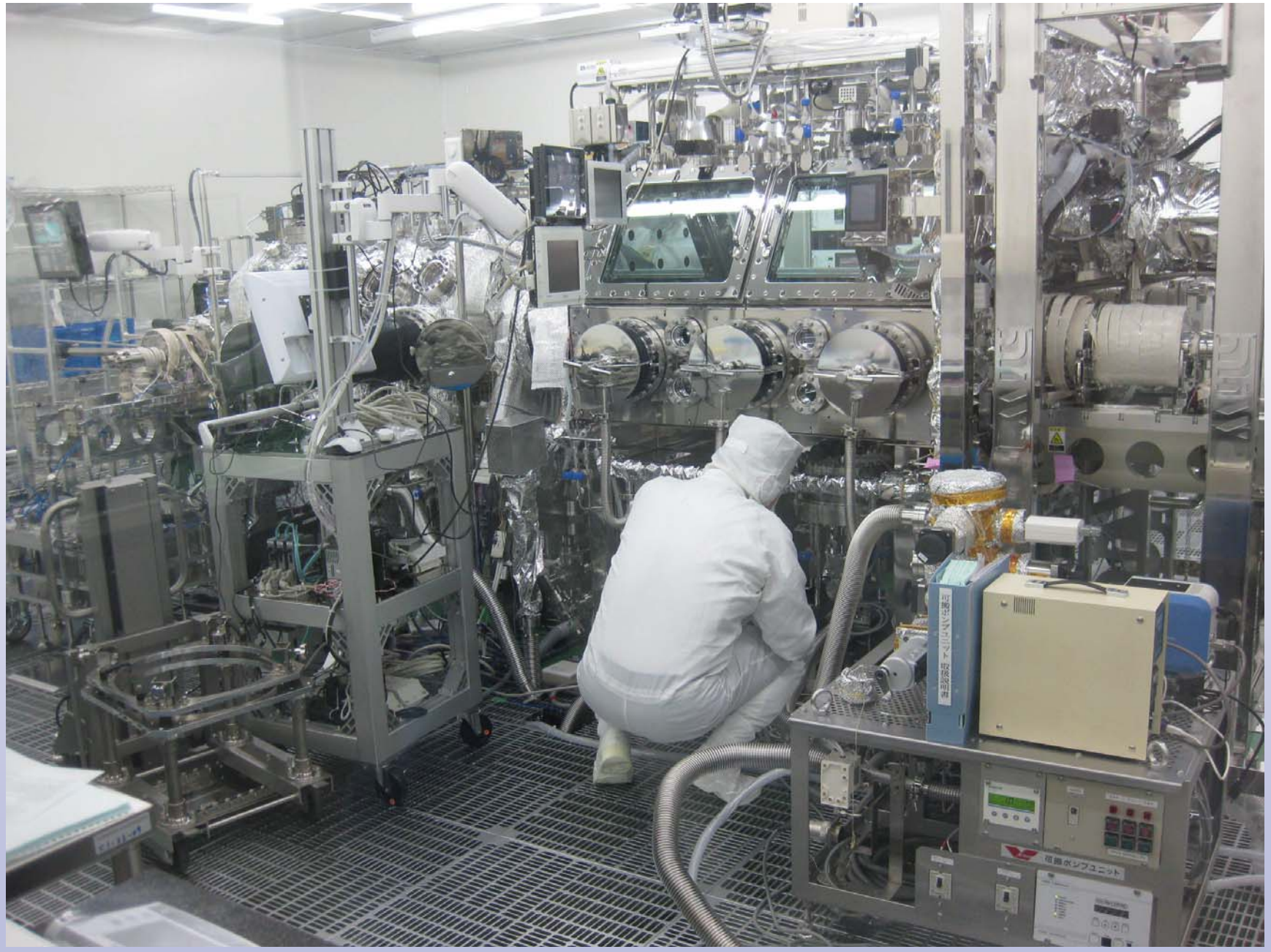
- 23:20LT> The capsule enters the atmosphere at 200 km altitude
- 23:26> The capsule beacon signal (T4) starts at 10 km altitude
- 23:40> Resumed landing of the capsule
- Direct Finding Stations (DFS) narrow down lat./long. (down to 2~5 km or so across) at the landing point
- Initial estimate of the landing coordinates by HQ
- 24:00~02:00> The helicopter seeks beacons and visuals to bookmark the GPS position.

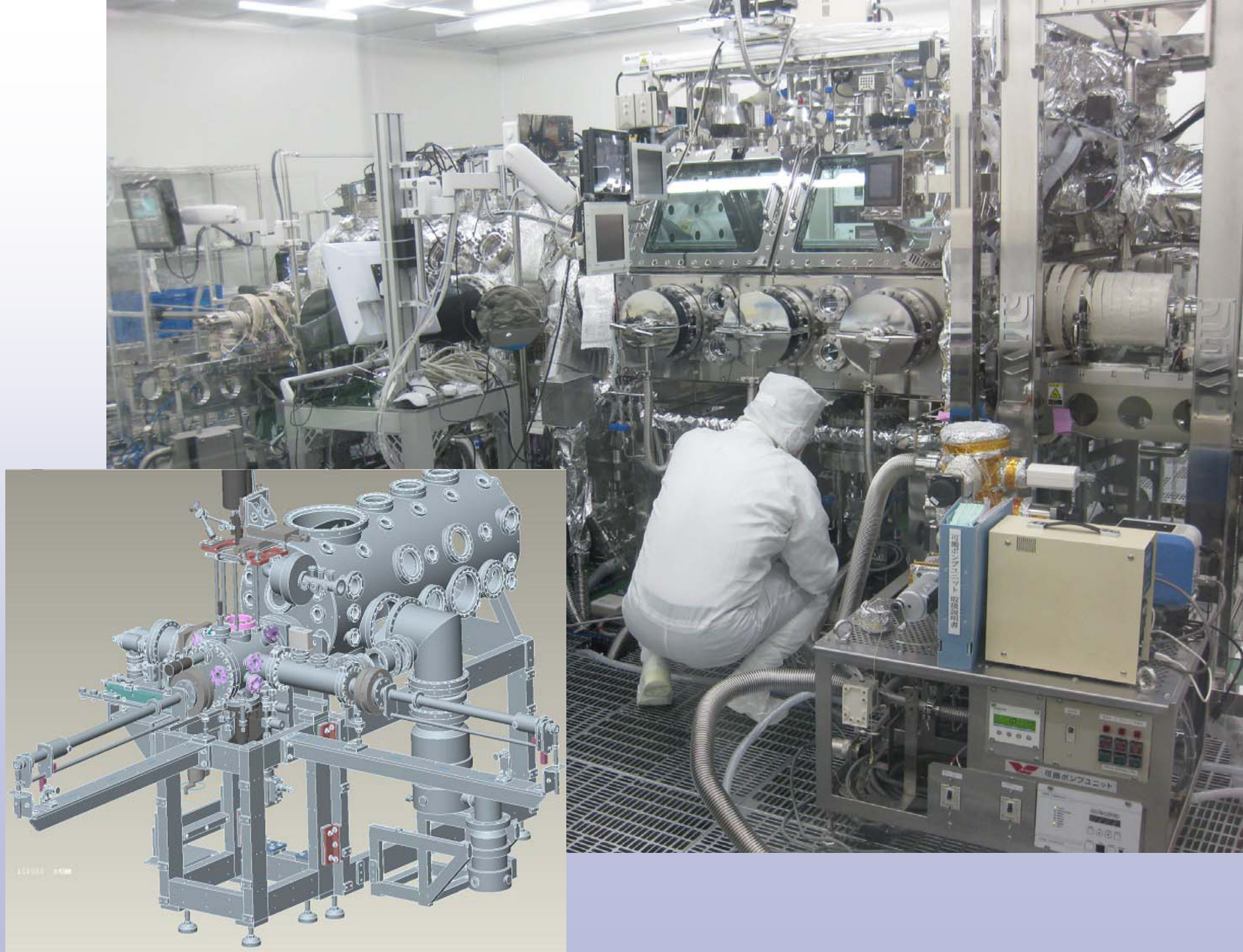

2F
3F

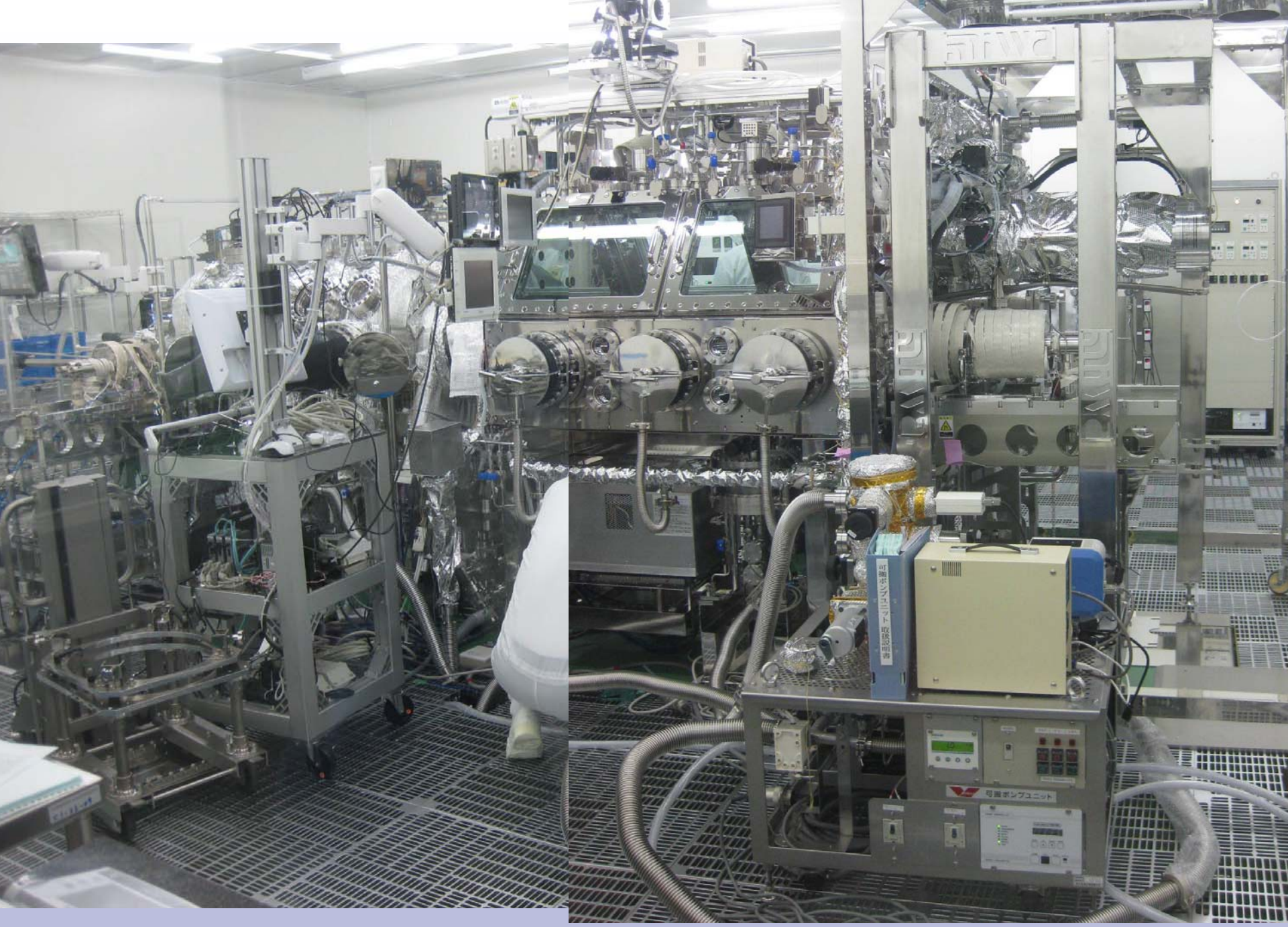

こちらより先へは、靴を脱いで、
靴箱（下段）に収め、上段に置い
てある上履き（スリッパ・サンダ
ル）に履き替えてください。
感染試料受け入れ設備責任者

Clean Rooms and Equipment in the Curation Facility








可搬ポンプユニット 取扱説明書
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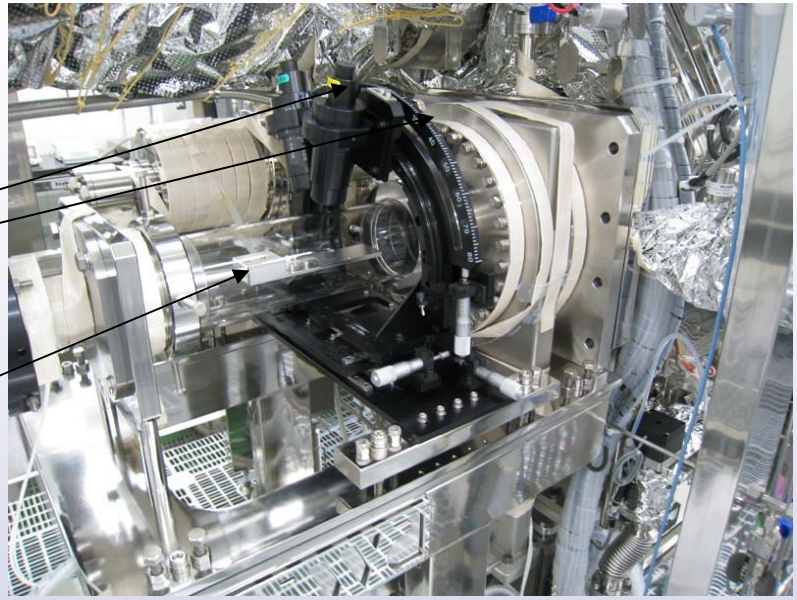
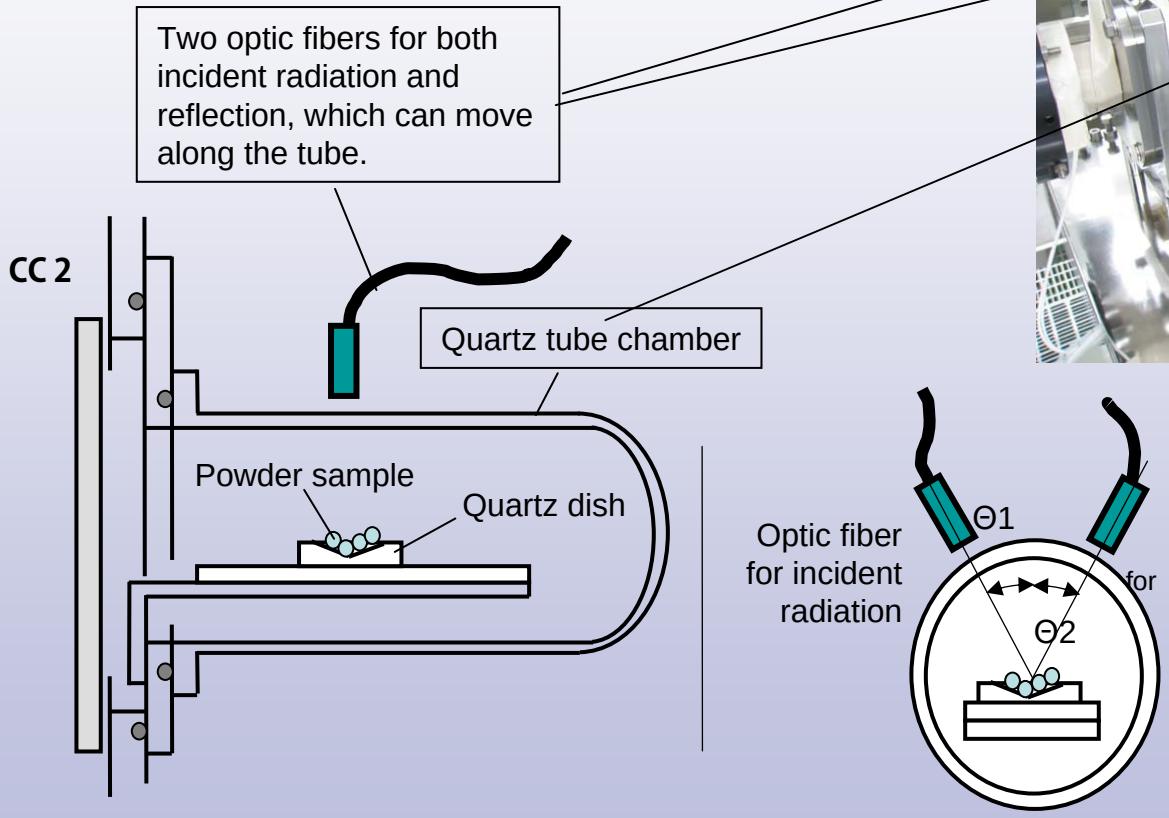
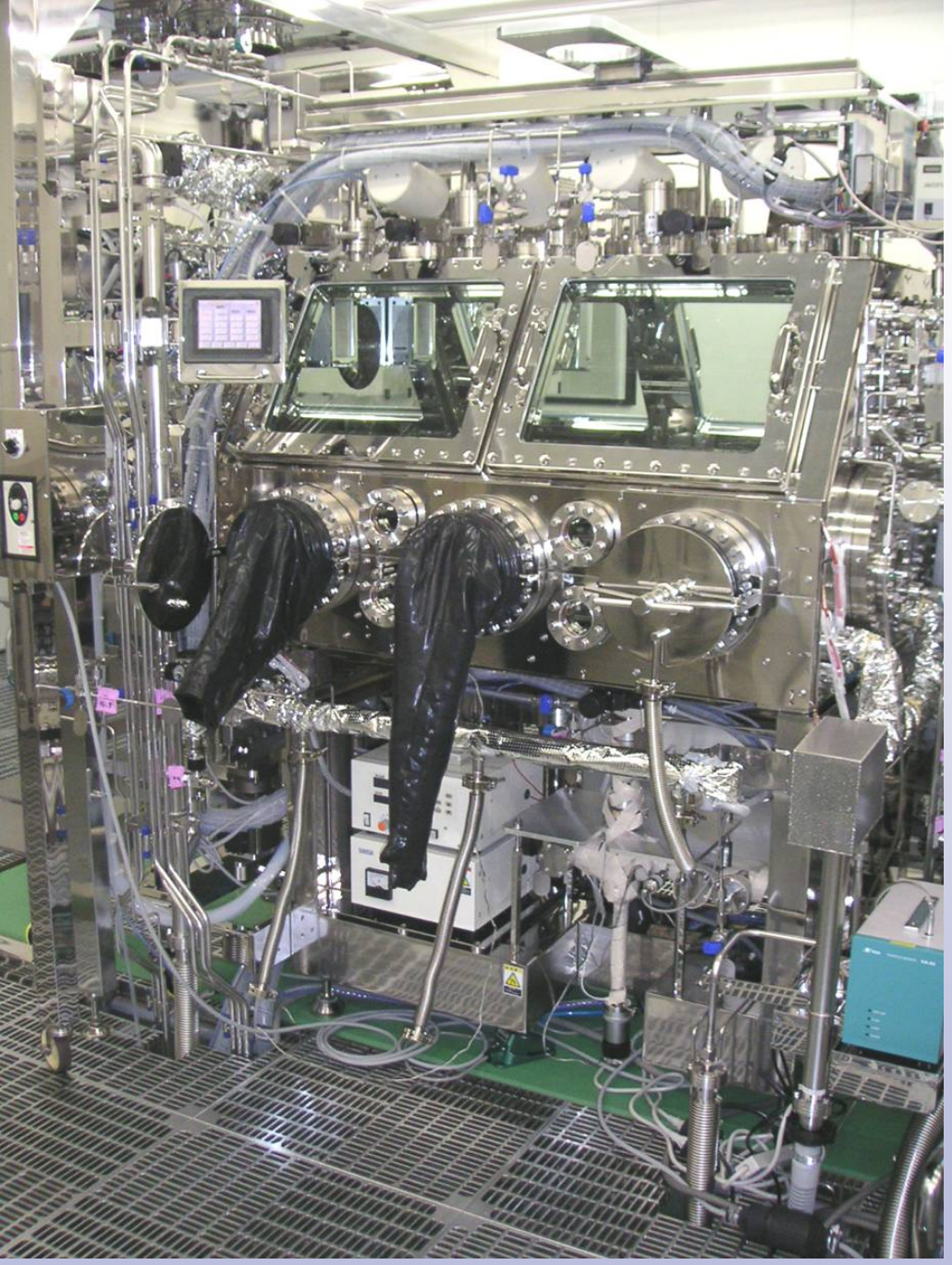
Visible and Near-infrared Spectroscopy

Analyze samples with visible and near-Infrared (from 300nm to 3200nm) spectroscopy for their initial descriptions.







Now we are practicing sample handling for sub-sub gram sized samples