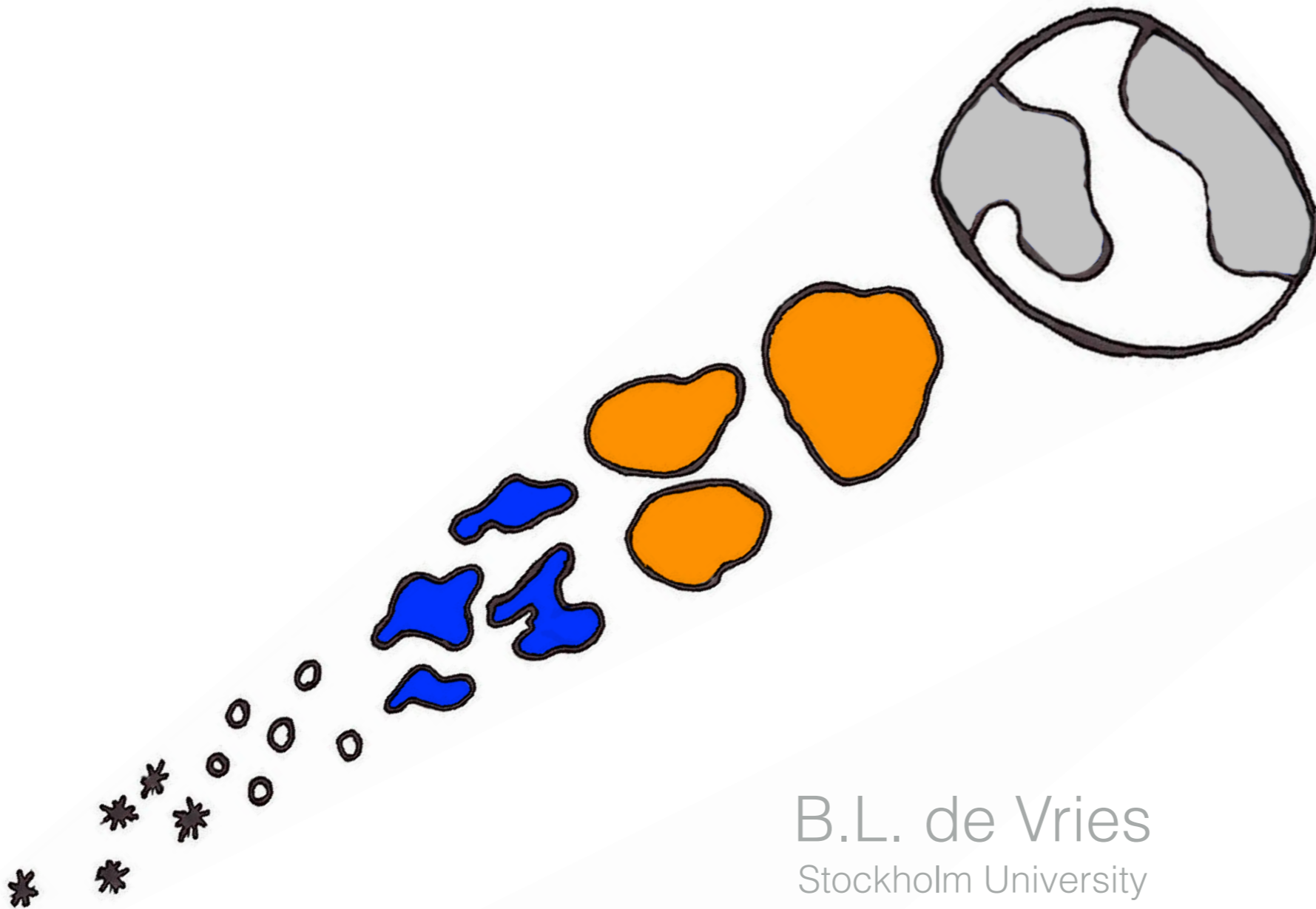
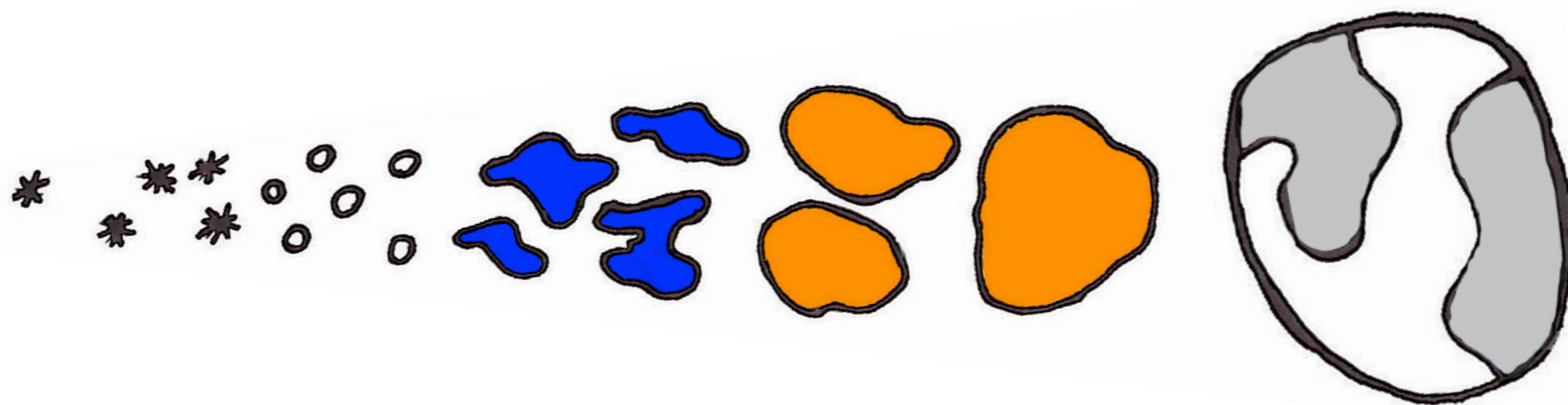


# Observables of planetary evolution with JWST

Mid-IR laboratory spectra of meteorites



B.L. de Vries  
Stockholm University

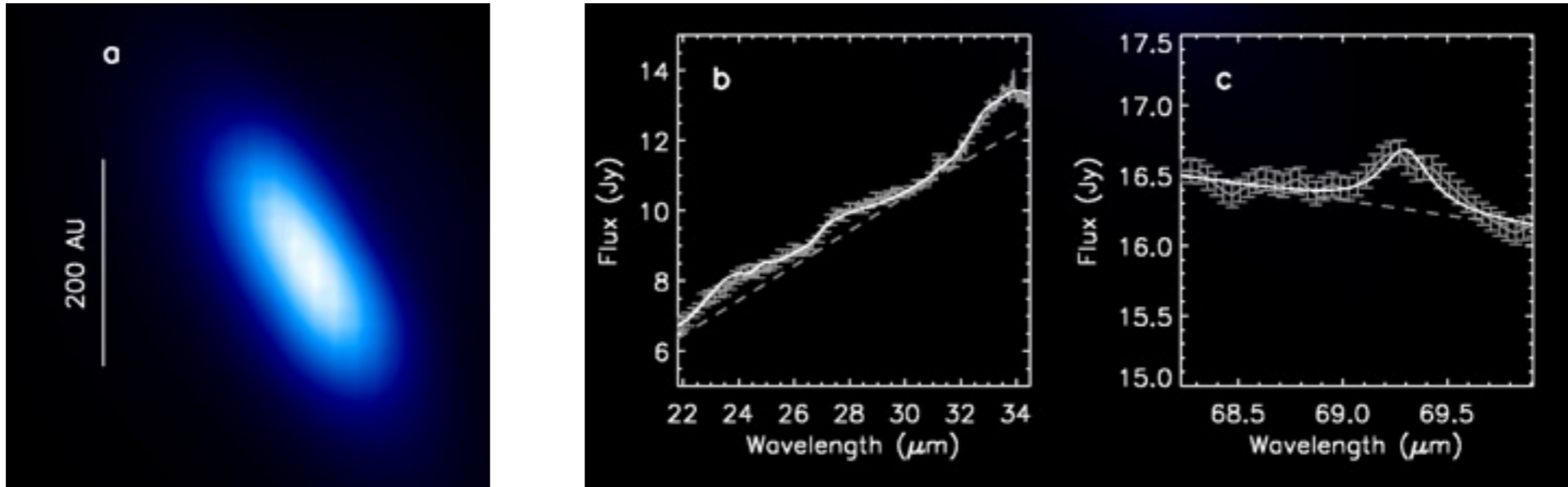


(sub) micron  
grains

?

Full sized planets

# How to observe content of planetesimals: **debris**



**Olivine:**  $(\text{Mg,Fe})_2\text{SiO}_4$   
(Forsterite:  $\text{Mg}_2\text{SiO}_4$ )

**Pyroxene:**  $(\text{Mg,Fe})\text{SiO}_3$   
(Enstatite:  $\text{MgSiO}_3$ )

What indicates planetesimal properties (size, etc): **minerals**



*Igneous processes / magma*

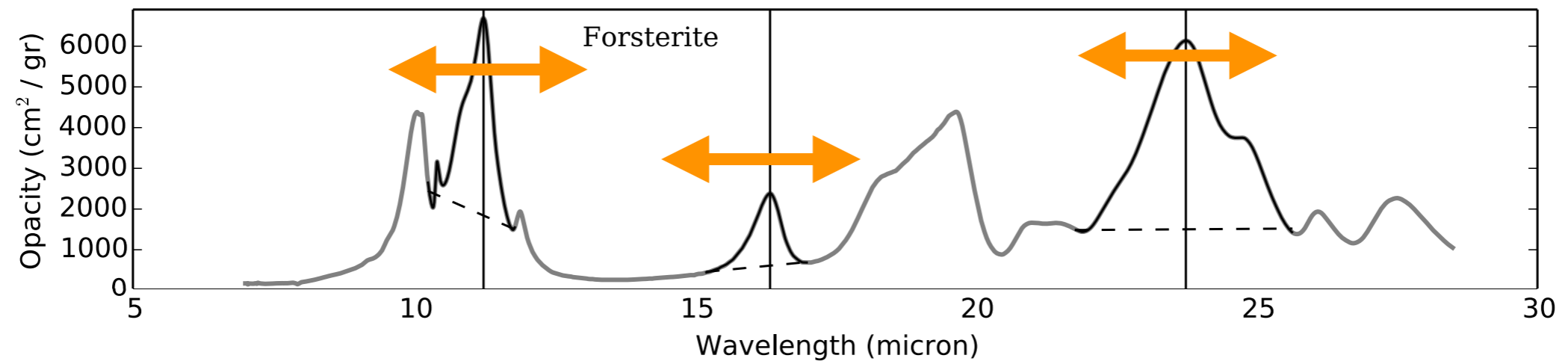
*Thermal and aqueous processes*

*Condensation and annealing*



Fe/Mg olivine  
increases

# How to observe mineral properties: **mid-IR spectra**



How to observe content of planetesimals: **debris**

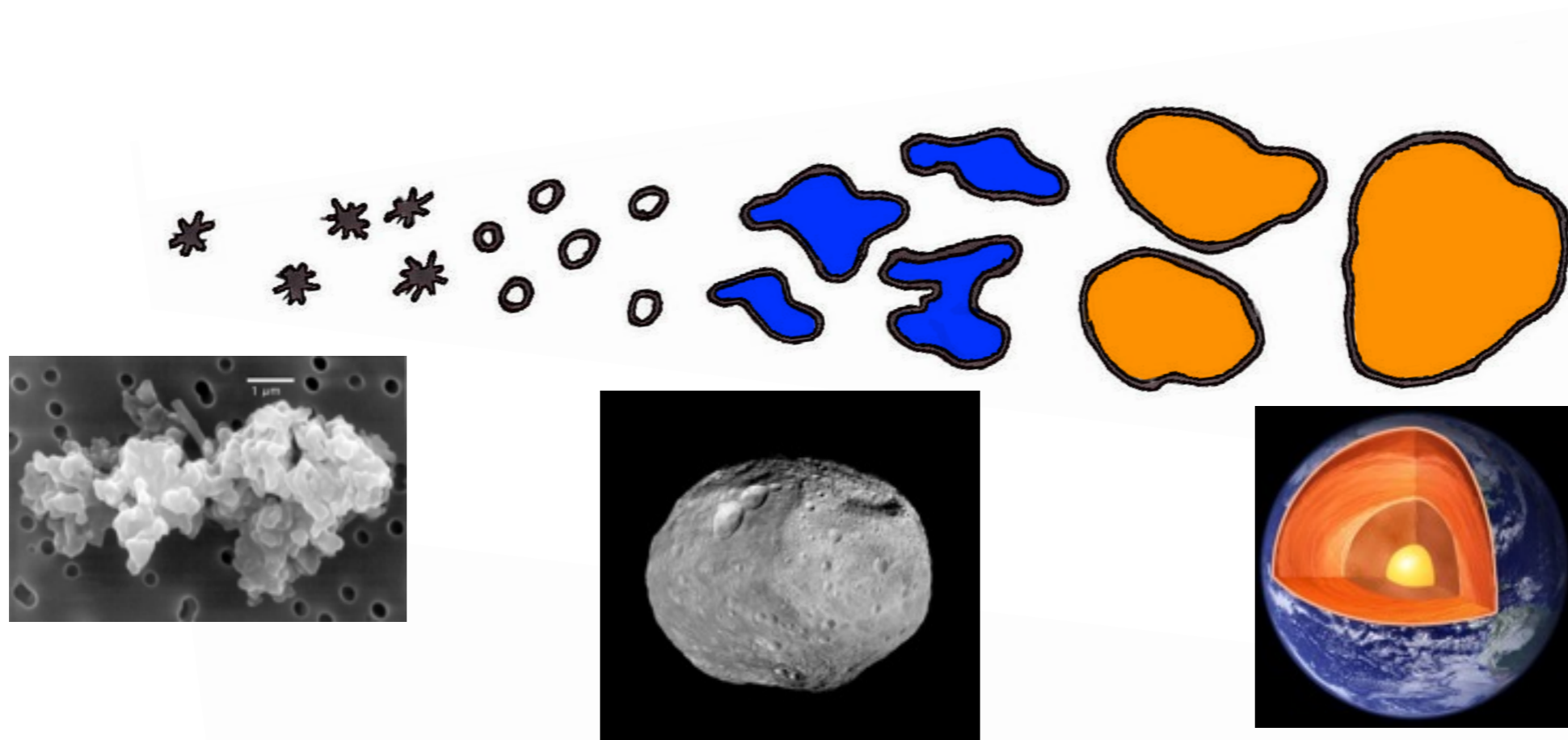
What indicates planetesimal properties (size, etc): **minerals**

How to observe mineral: **mid-IR spectra**

But how do minerals exactly change?

**Meteorites!!**

# Meteorites



Pristine

Equilibrated

Differentiated

*IDPs*

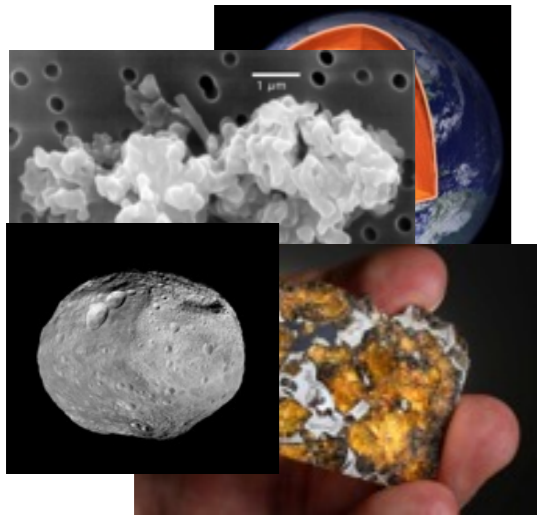
*Chondrites*

*Achondrites*

*Ordinary  
(dry)*

*Carbonaceous  
(wet)*

# The goal



- Molster et al 2003
- Morlok et al
- 2010, 2012, 2014
- Beck et al 2014
- de Vries & Skogby in prep

1. Completed the set of meteorite lab measurements



- Maaskant et al 2014
- Olofsson et al 2012
- Lisse et al. deep impact
- Chen et al 2010
- many more

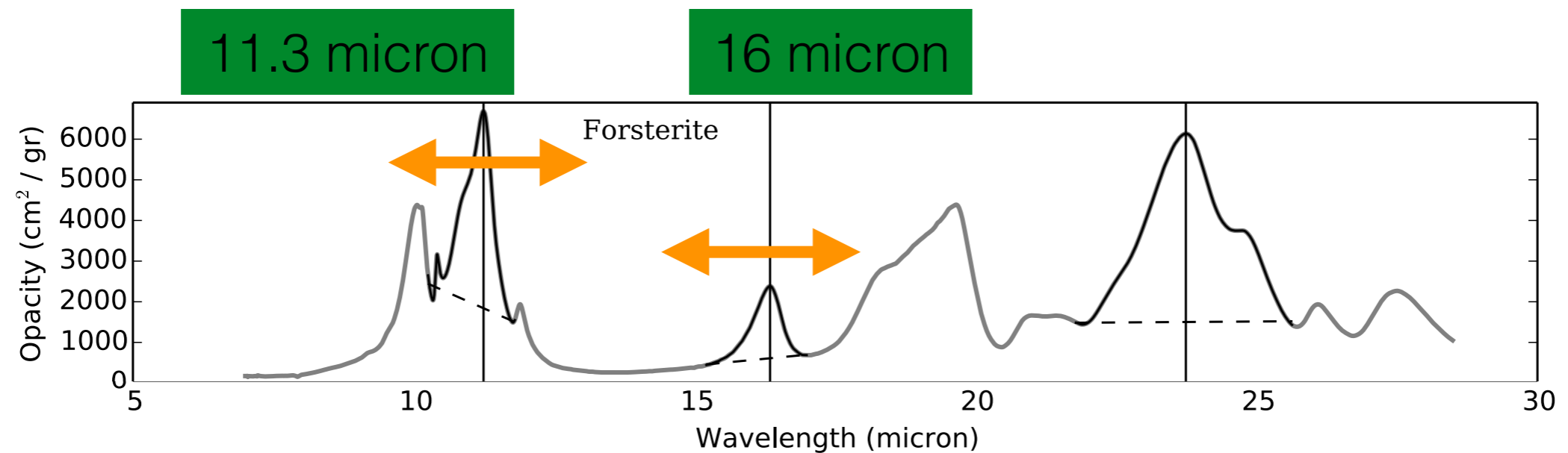
2. define observables

3. Compare meteorites and observations

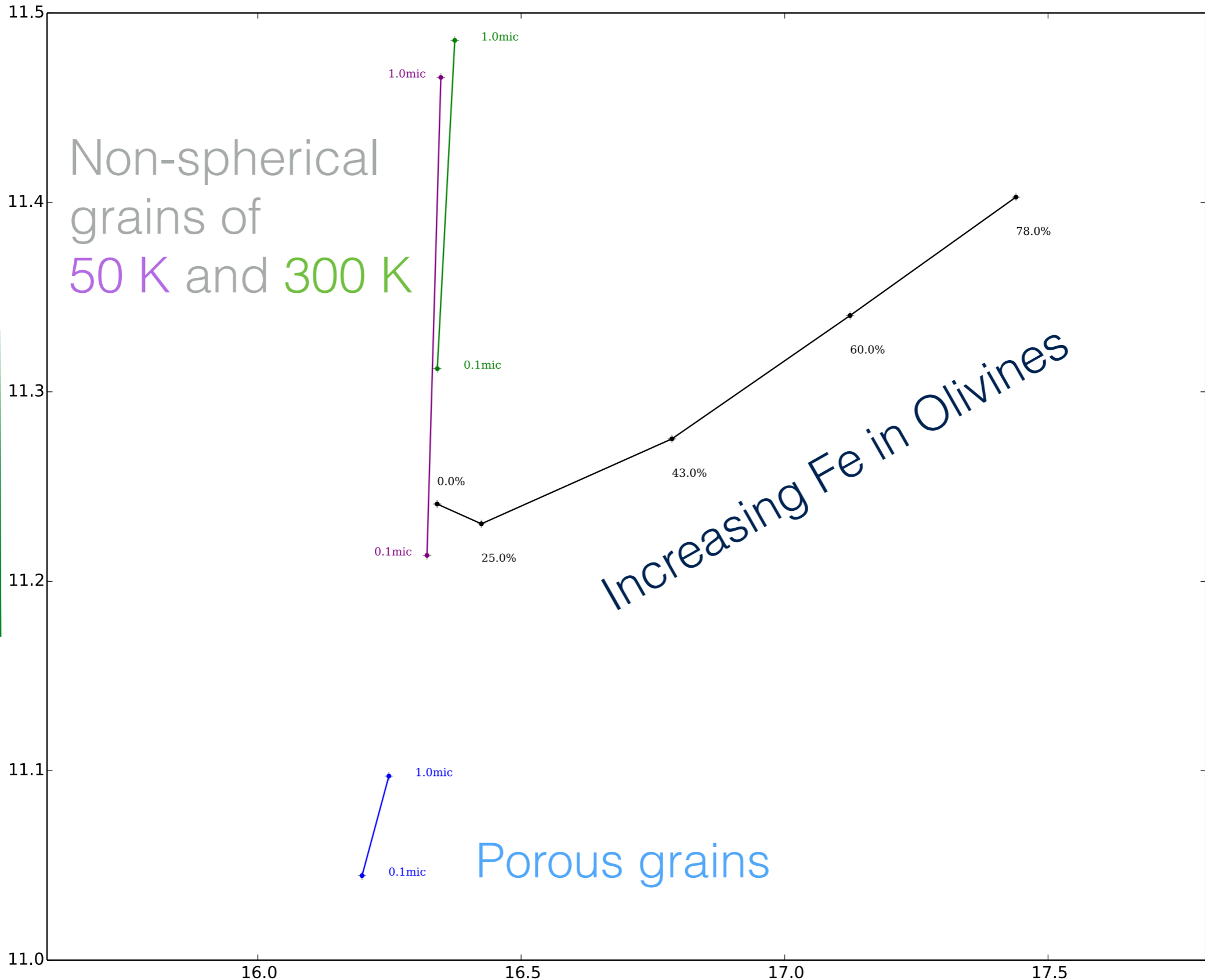


# Observables

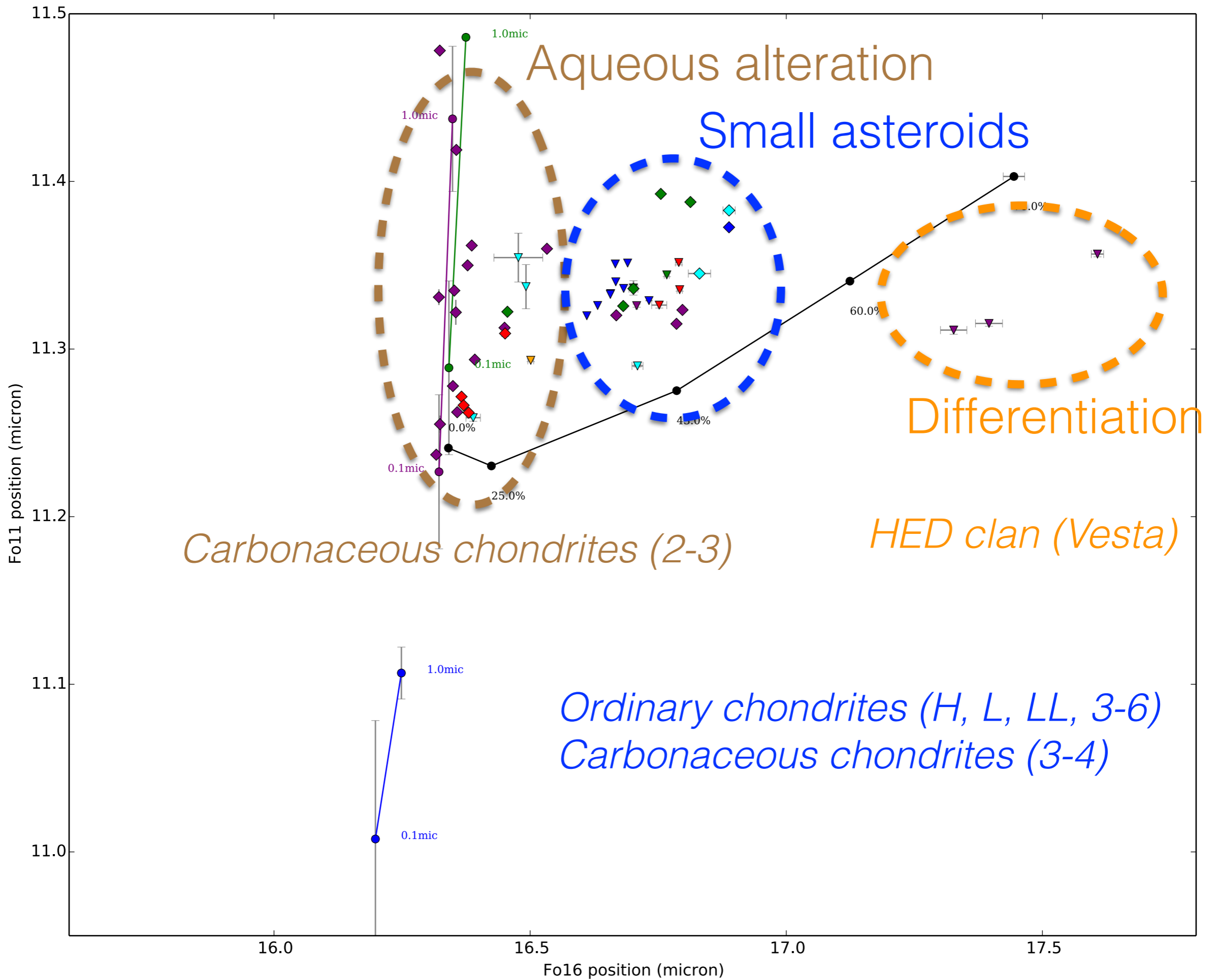
- Fe/Mg ratio olivine changes as function of thermal history of asteroid
- Fe/Mg ratio olivine can be determined from peak positions

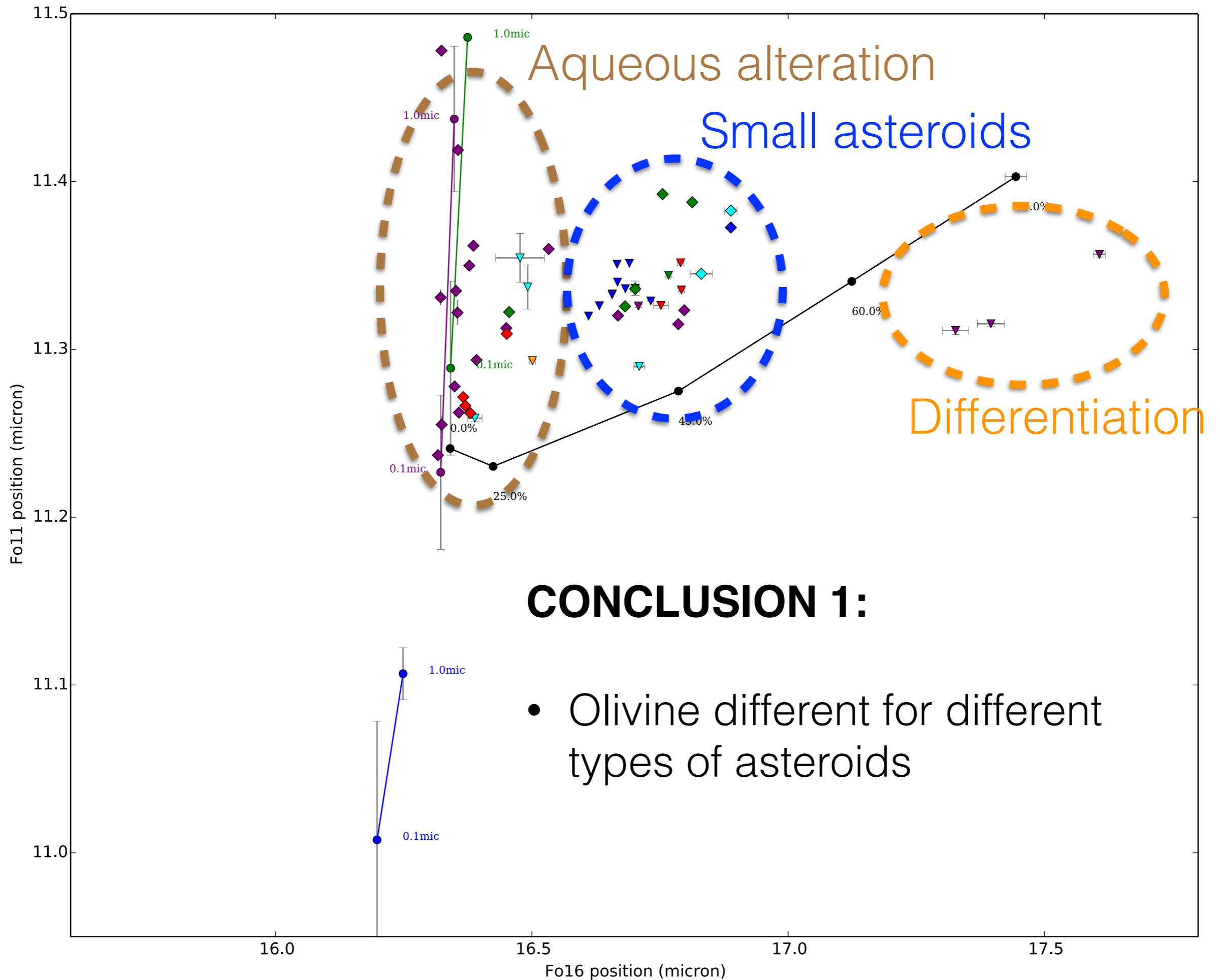


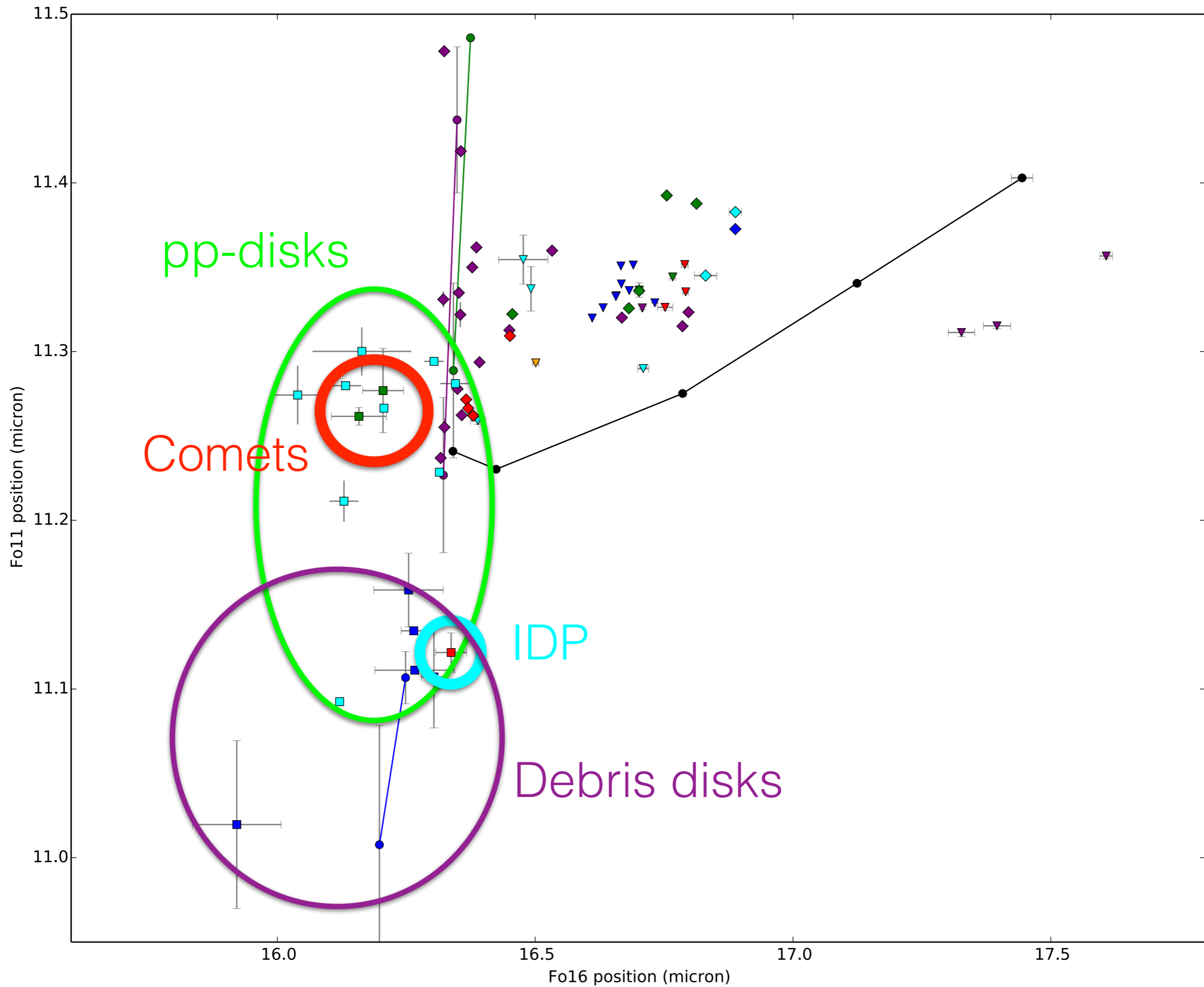
11.3 micron

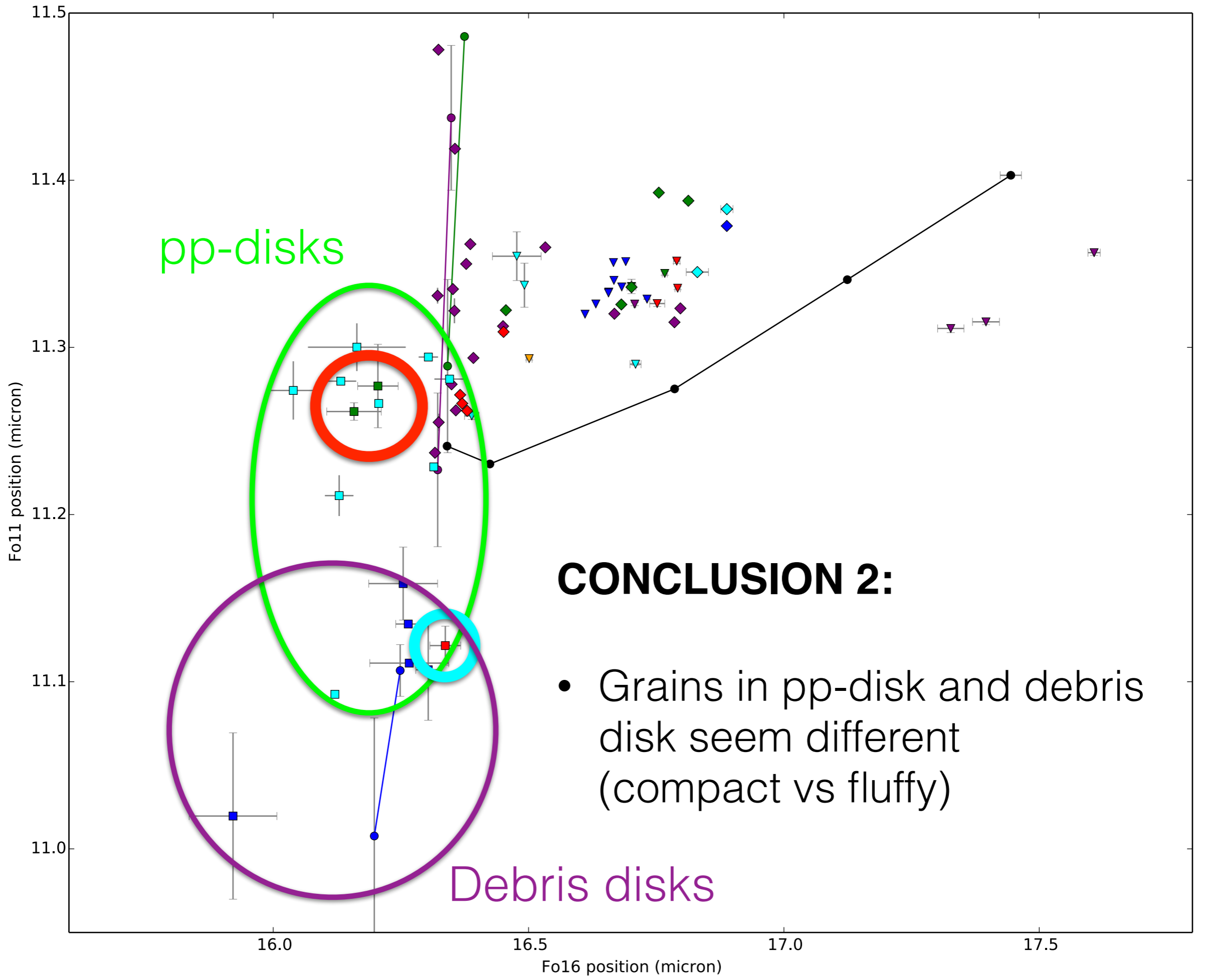


16 micron







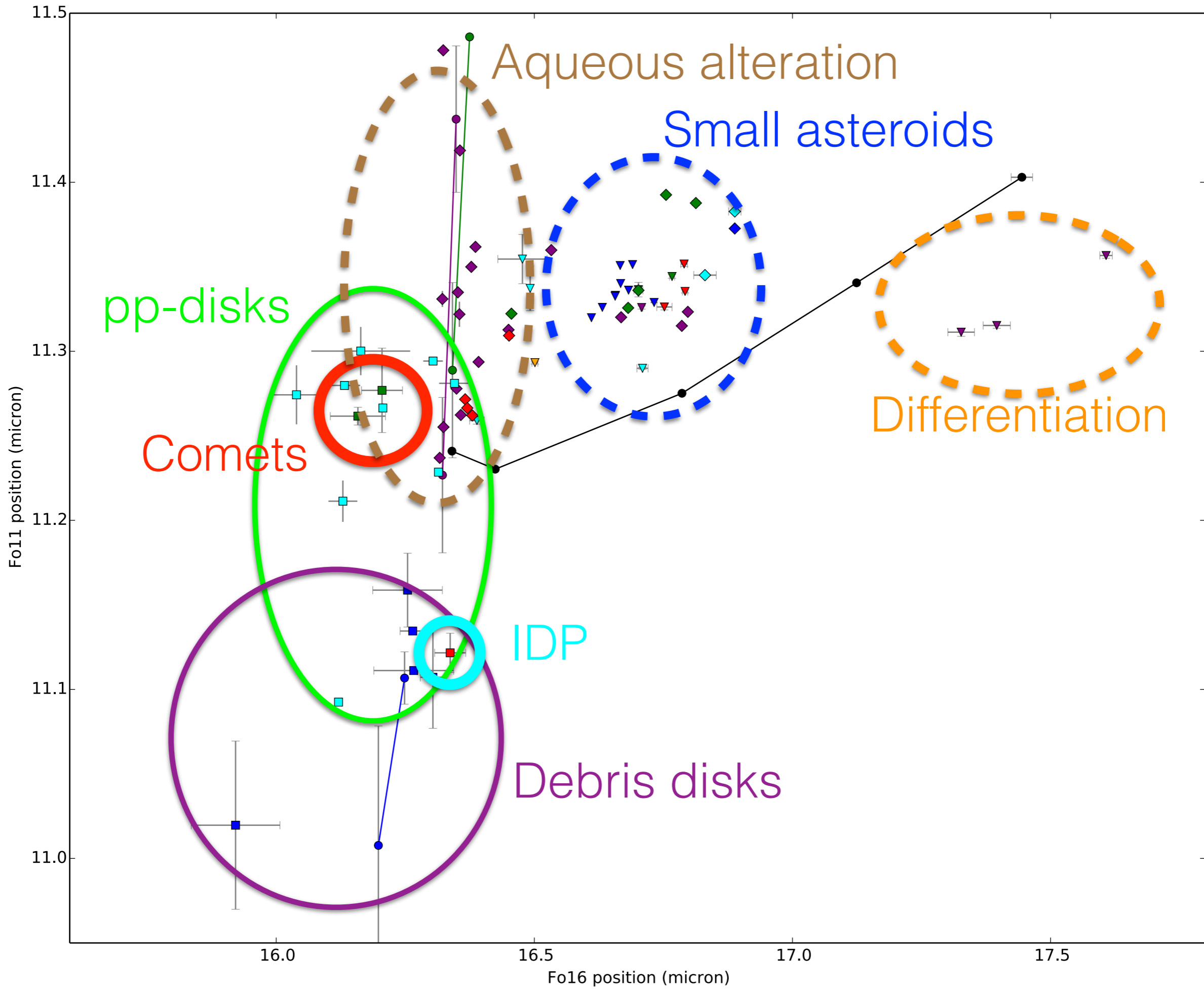


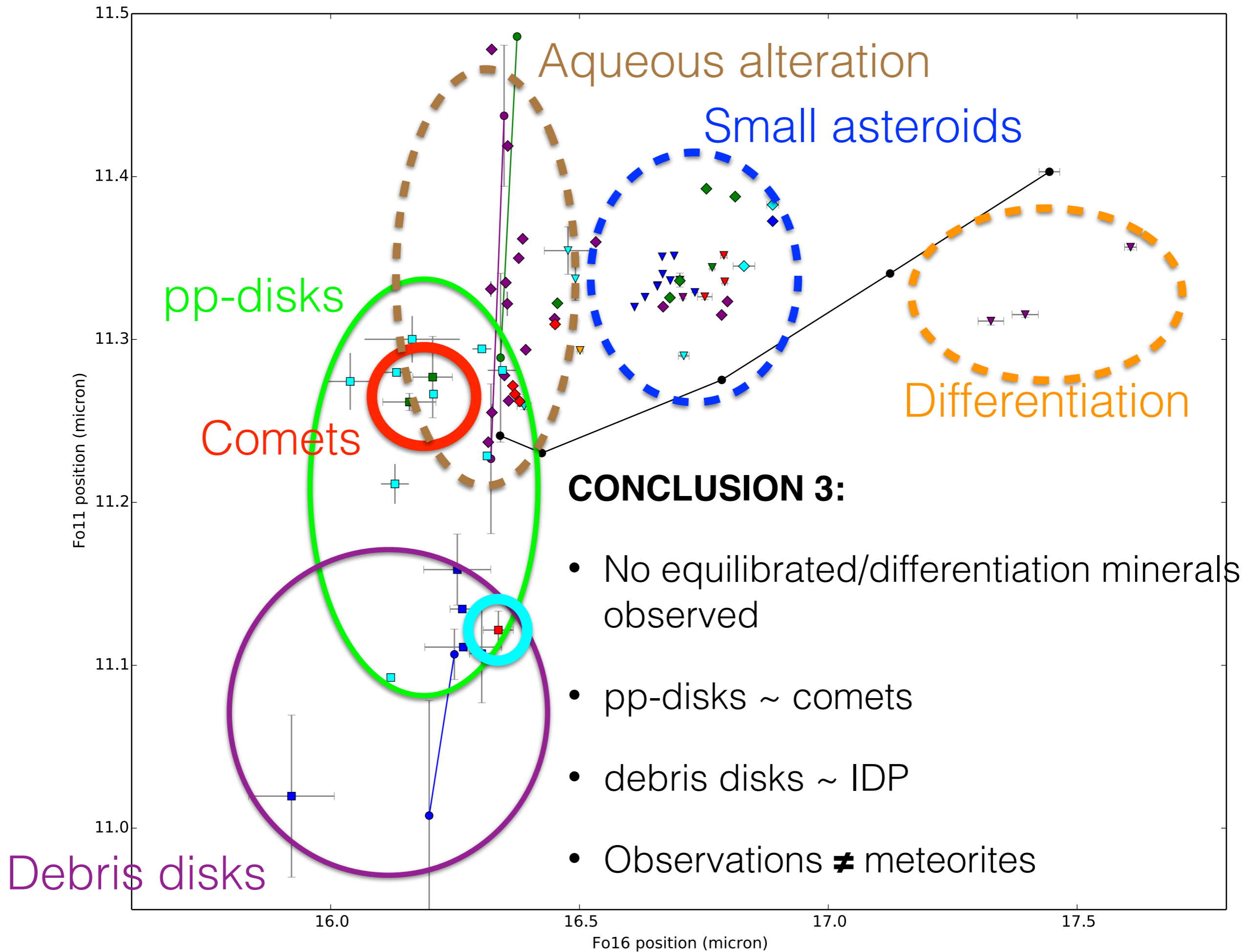
pp-disks

Debris disks

**CONCLUSION 2:**

- Grains in pp-disk and debris disk seem different (compact vs fluffy)







# JWST, opportunity!

- Will JWST be the first to observe debris from differentiated or equilibrated planetesimals?
- And finally probe the interior and properties of extra-solar asteroids?

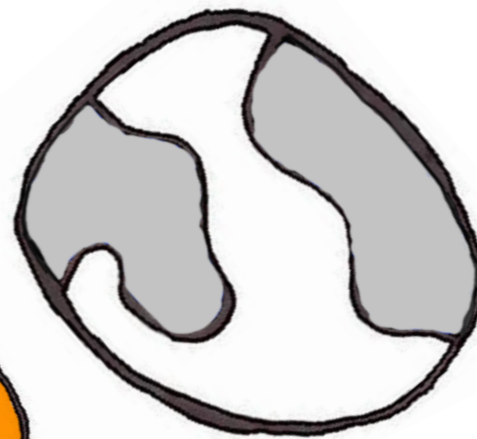
Remember!

minerals have interesting observables linked to planetesimal formation and evolution

# Observables of planetary evolution with JWST

Mid-IR laboratory spectra of meteorites

Download the spectra soon at:  
<http://www.stjerke.com>



There is much more to say:  
*de Vries & Skogby in prep.*

B.L. de Vries  
Stockholm University

