# Planetesimal Sizes and Mars Formation in the Magnetized Solar Nebula

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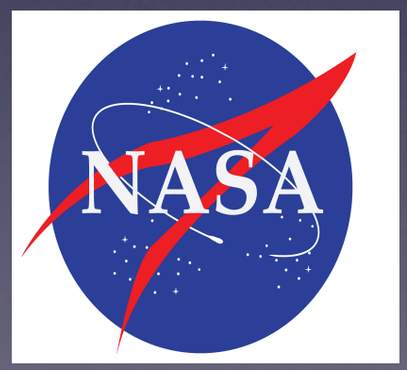
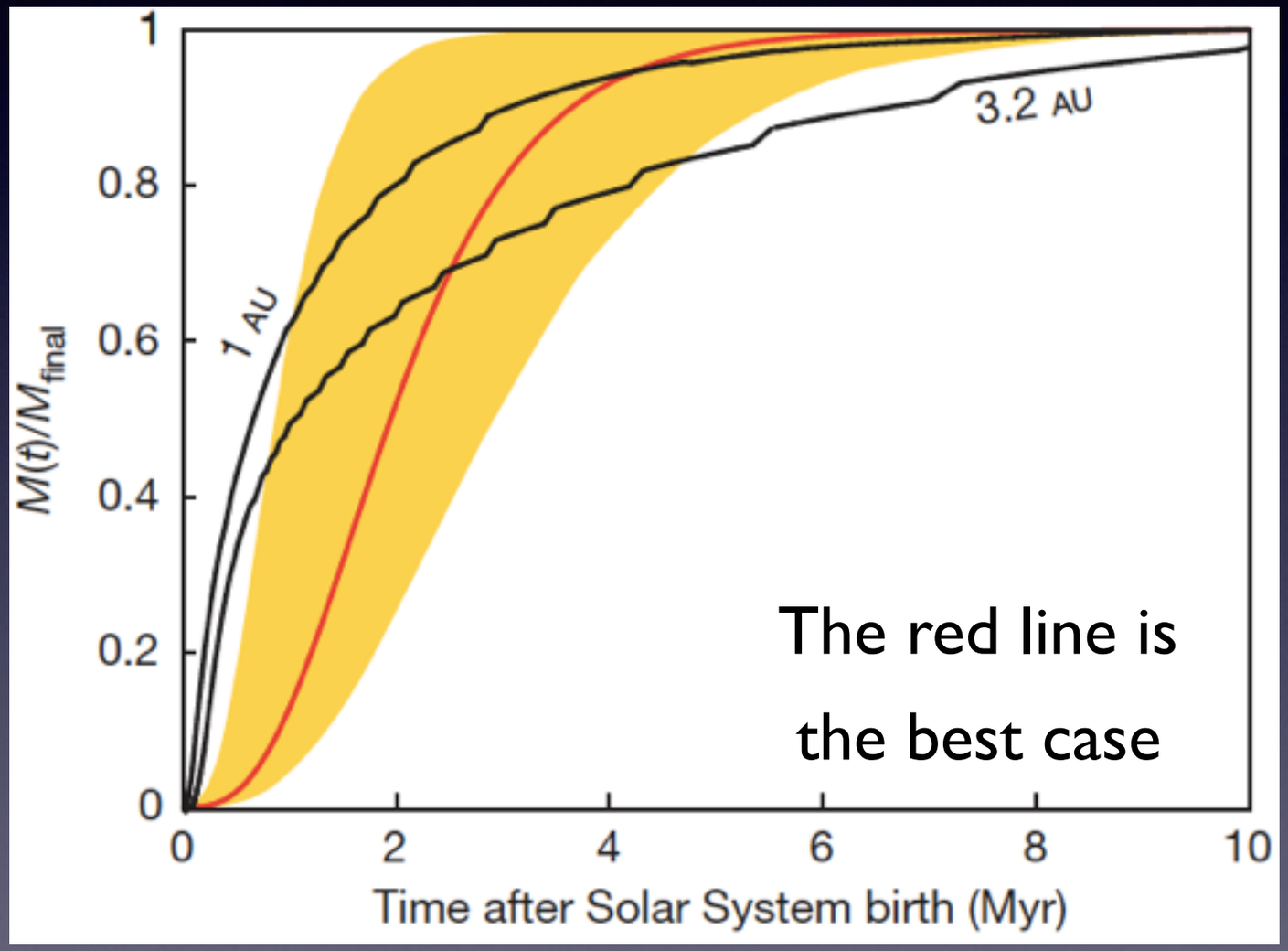


# Hf-W Chronology for Mars Formation

Dauphas & Pourmand 2011

$^{182}Hf \longrightarrow ^{182}W$ with the half life of 9 Myr




The excess of $^{182}W$ at Mars mantle is estimated by Martian meteorites

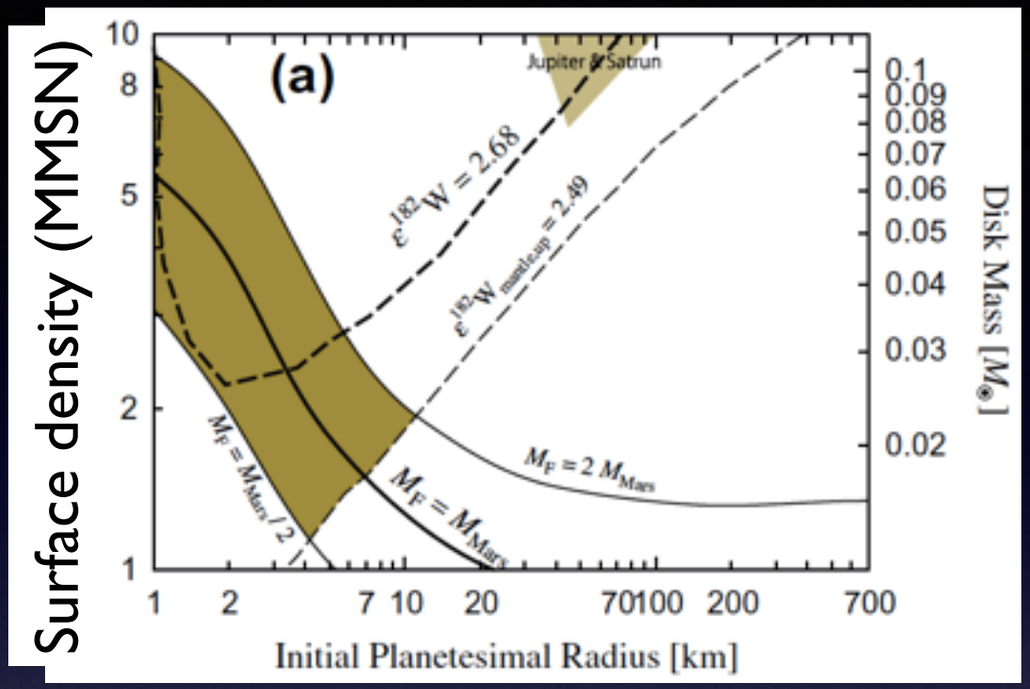
The optimal case is realized when Mars formation is completed at 2-4 Myrs after CAI formation

$^{60}Fe - ^{60}Ni$ Chronology also confirmed the short formation timescale

Tang & Dauphas 2014

# 1. Mars formed quickly after CAI formation

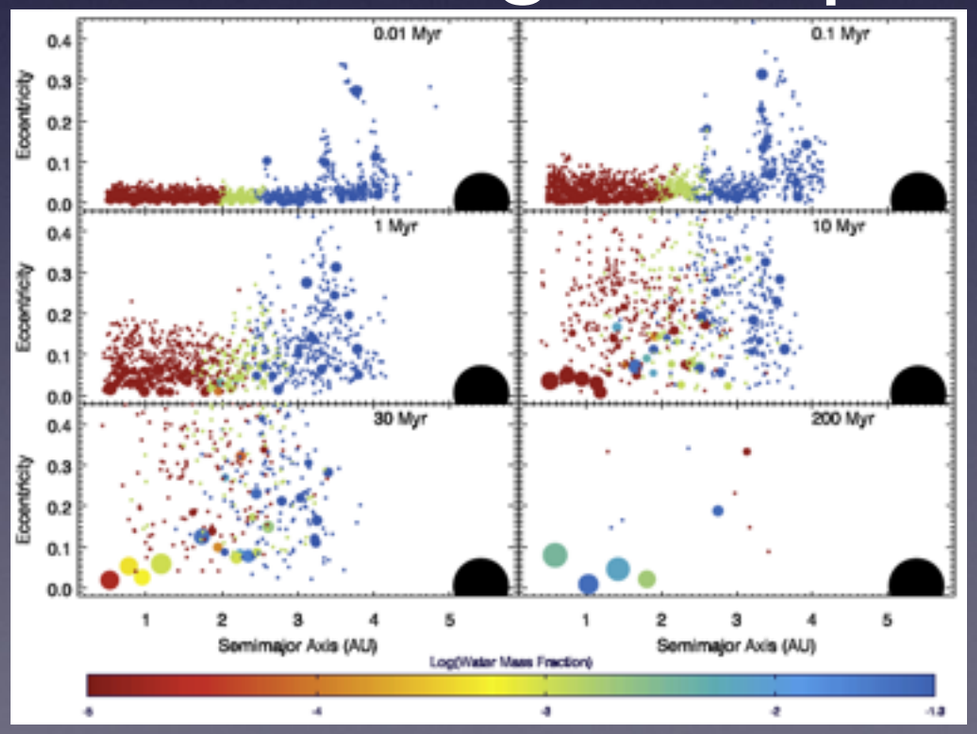
e.g., Kobayashi & Dauphas 2013, Morishima et al 2013, Levison et al 2015




Small planetesimals
(even pebbles)

High surface density
: destruction/radial drift of such planetesimals

# 2. Mars avoided giant impacts after the nebula was gone




e.g., Raymond et al 2009, Hansen 2009, Walsh 2011

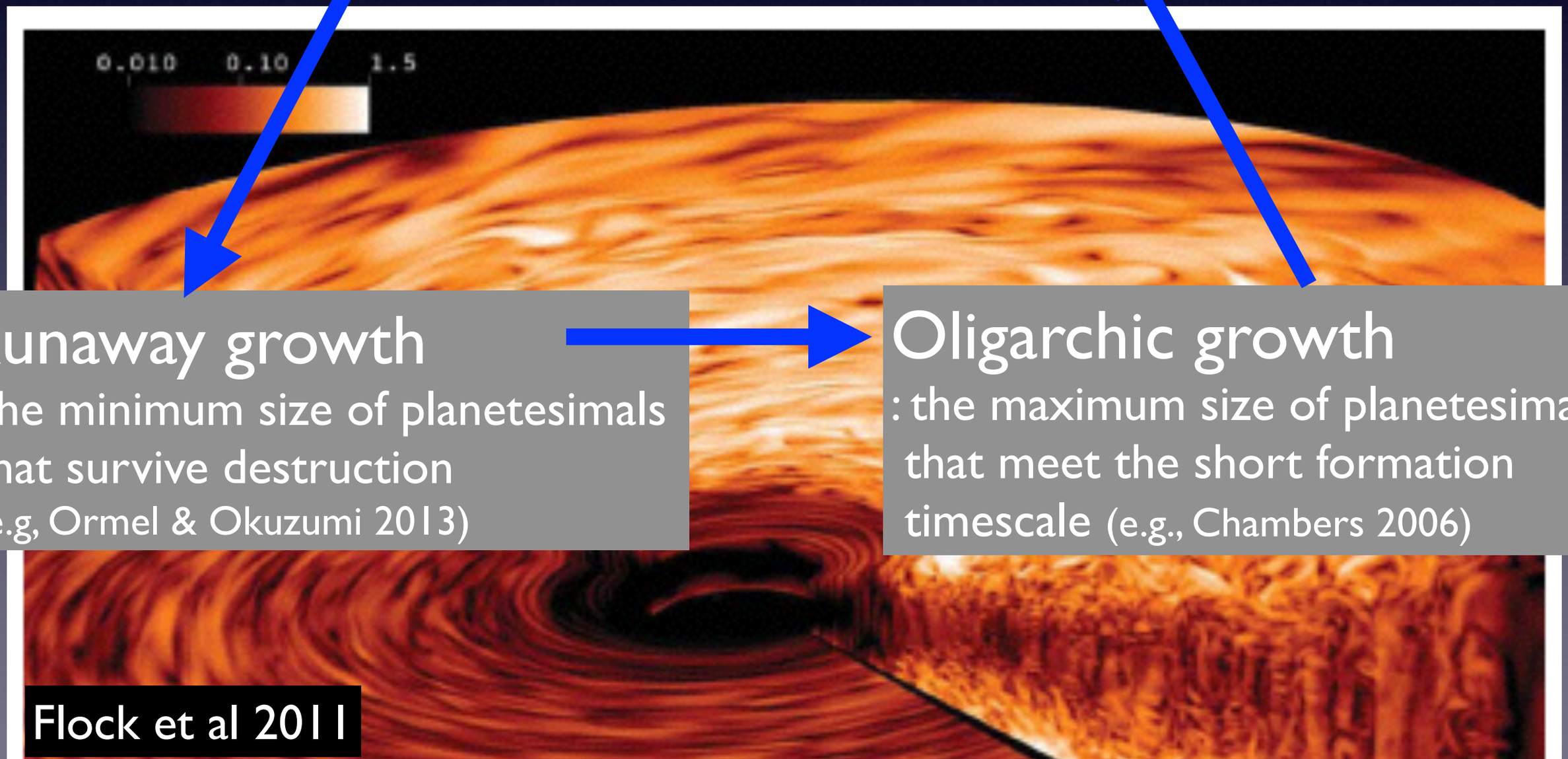
Jupiter and Saturn
: remove planet-forming materials

# 3. The turbulent solar nebula was present at Mars formation

# Our Model

## Initial Conditions
: surface density
: magnetic fields
: planetesimal size

## Comparison with Hf-W chronology
: Formation history
: excess of W



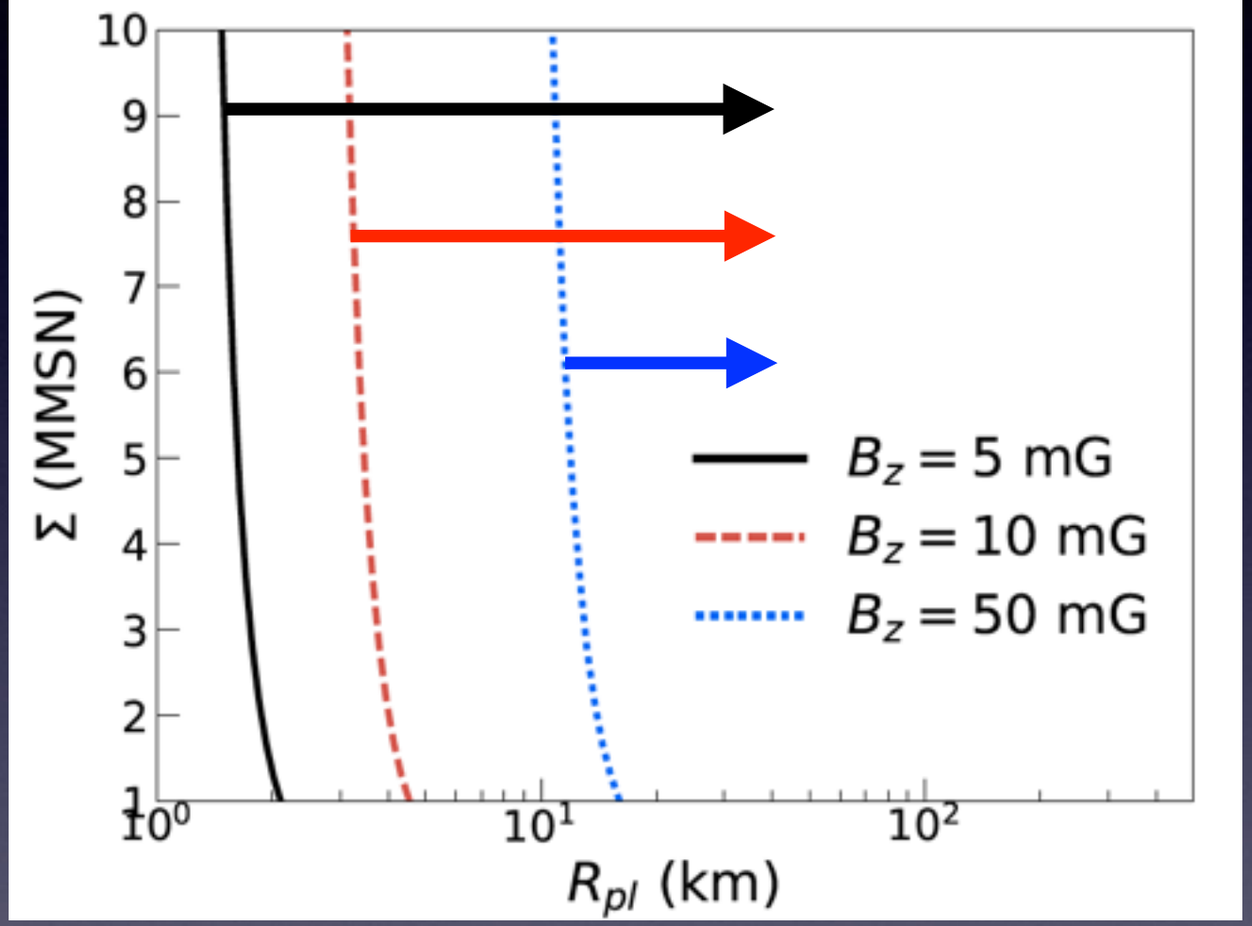

Flock et al 2011

## Runaway growth
: the minimum size of planetesimals that survive destruction (e.g, Ormel & Okuzumi 2013)

## Oligarchic growth
: the maximum size of planetesimals that meet the short formation timescale (e.g., Chambers 2006)

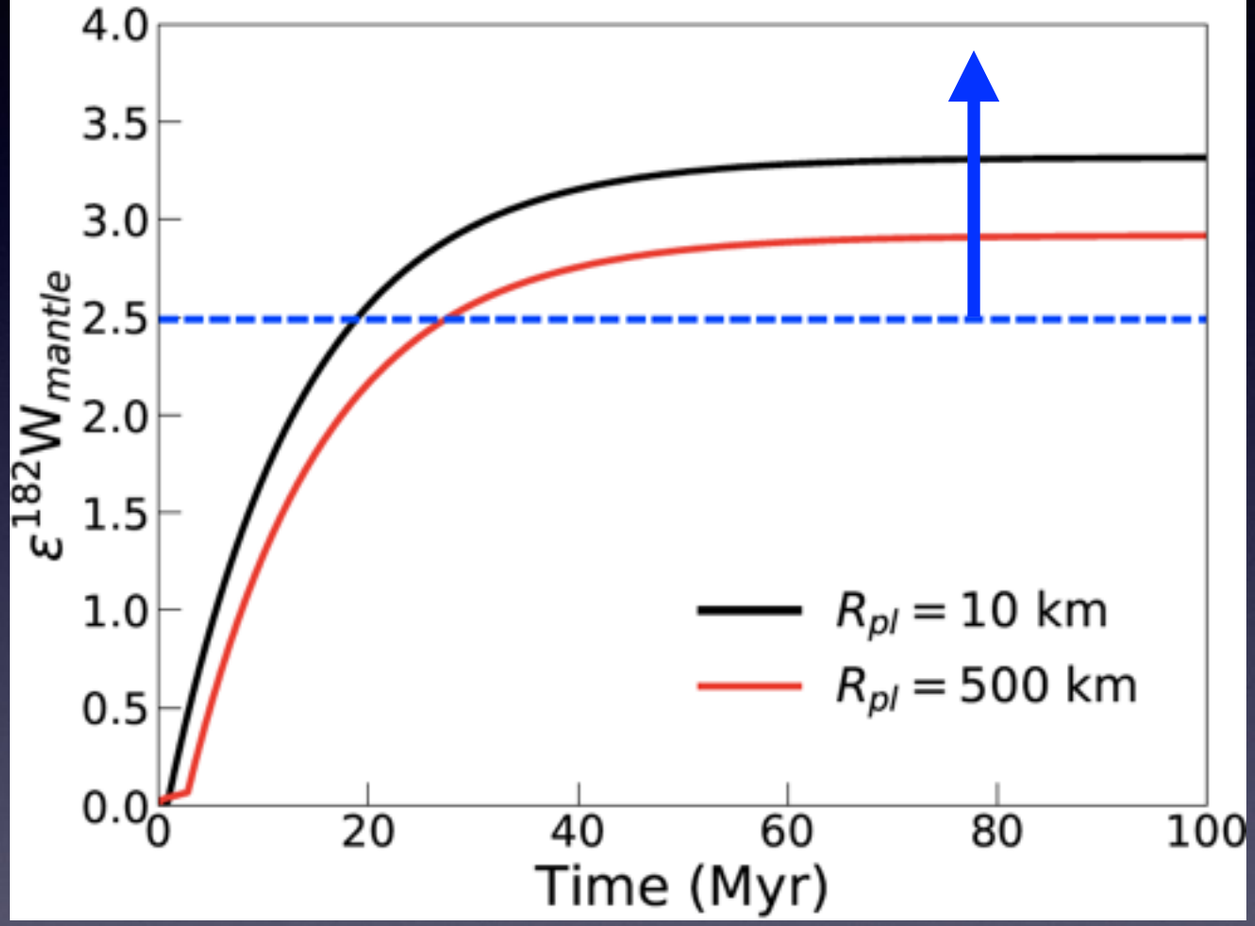
# Preliminary results

## Minimum size of planetesimals




Larger planetesimals for higher B-fields

## Maximum size of planetesimals




A wide range of planetesimals for a given surface density

cf) Kobayashi et al 2016

# Next steps & Summary

- Hf-W Chronology suggests that Mars formed quickly after CAI formation
- Take into account the effect of the nebular turbulence
- develop a semi-analytical model in which the optimal values of planetesimal size and the nebular mass are specified
- will cover the larger parameter space to find out the nebular mass
- will compare other scenarios such as the narrow ring and pebble accretion