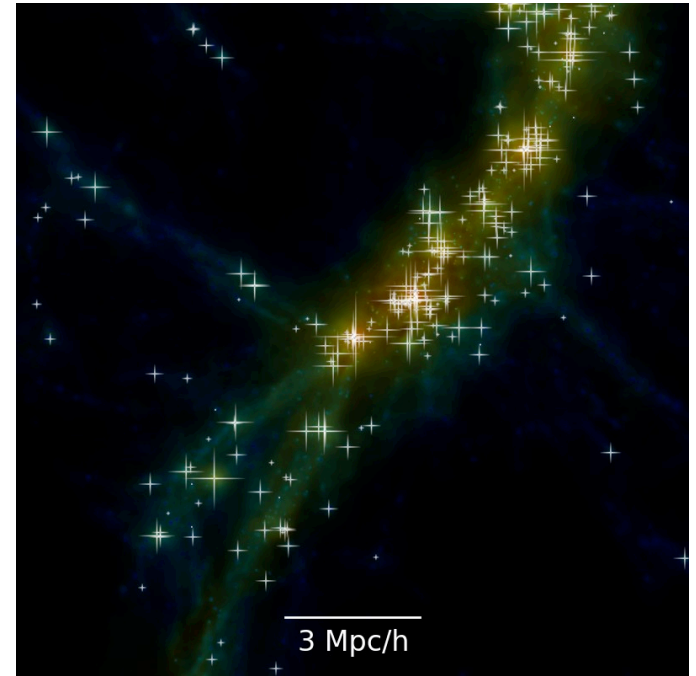
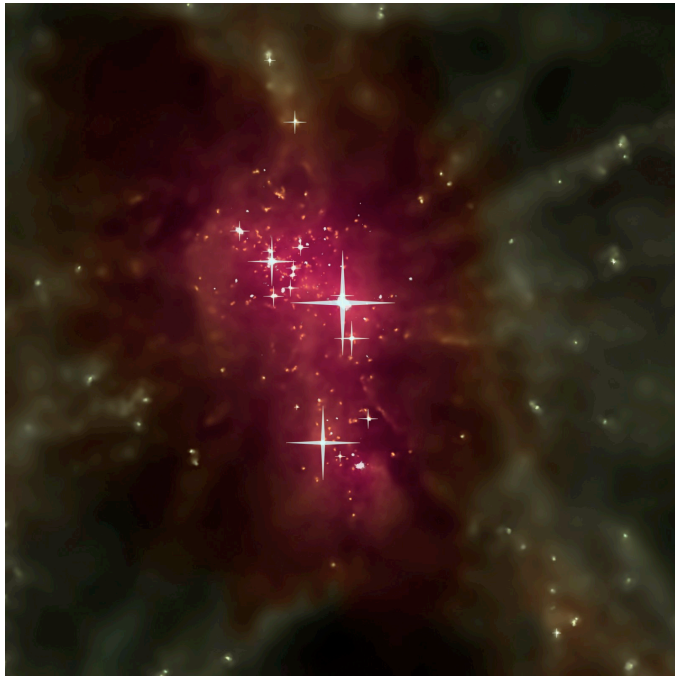


High- z black hole growth and the M - σ relation

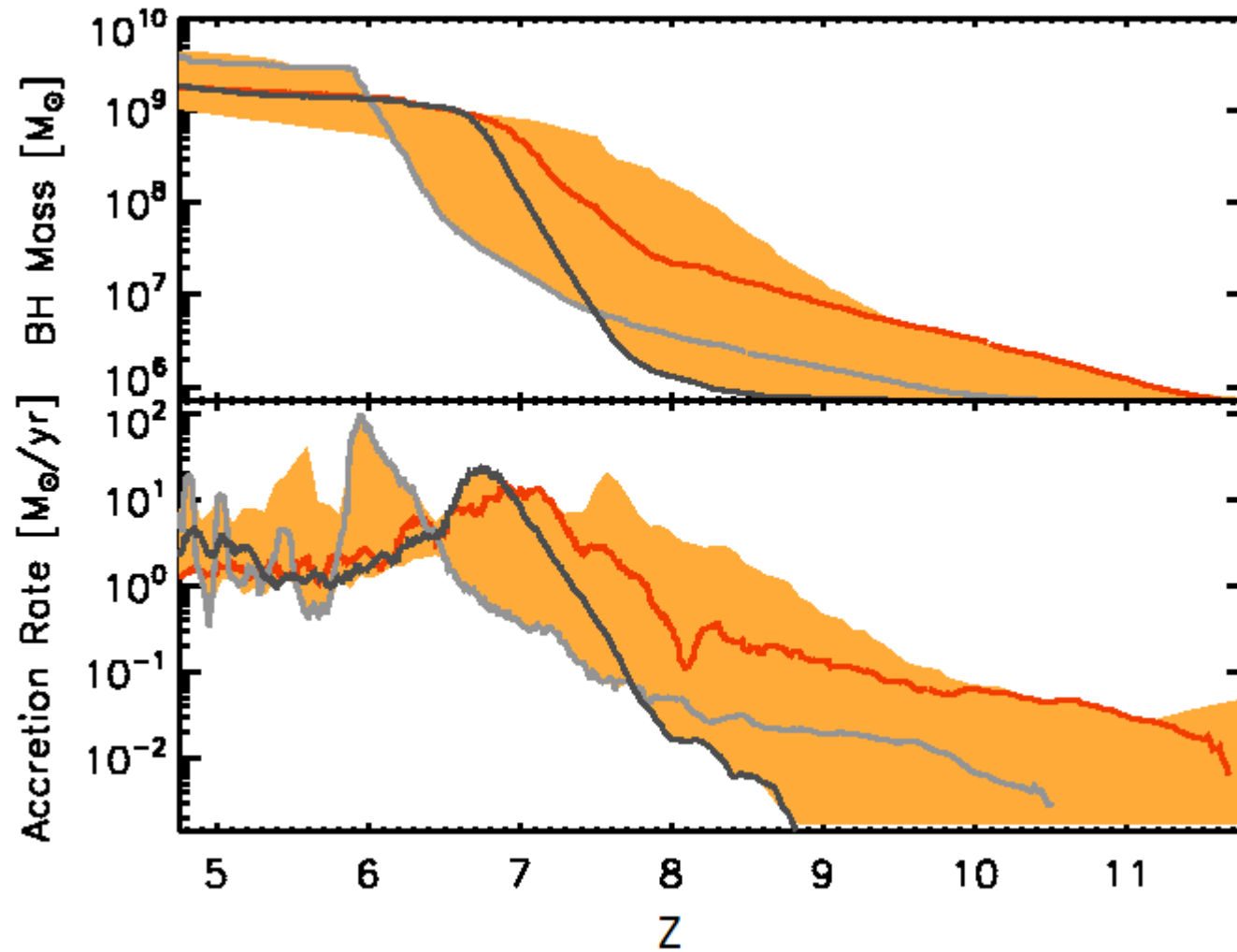


Colin DeGraf
UCSC Galaxy Workshop
August 16, 2012

Outline

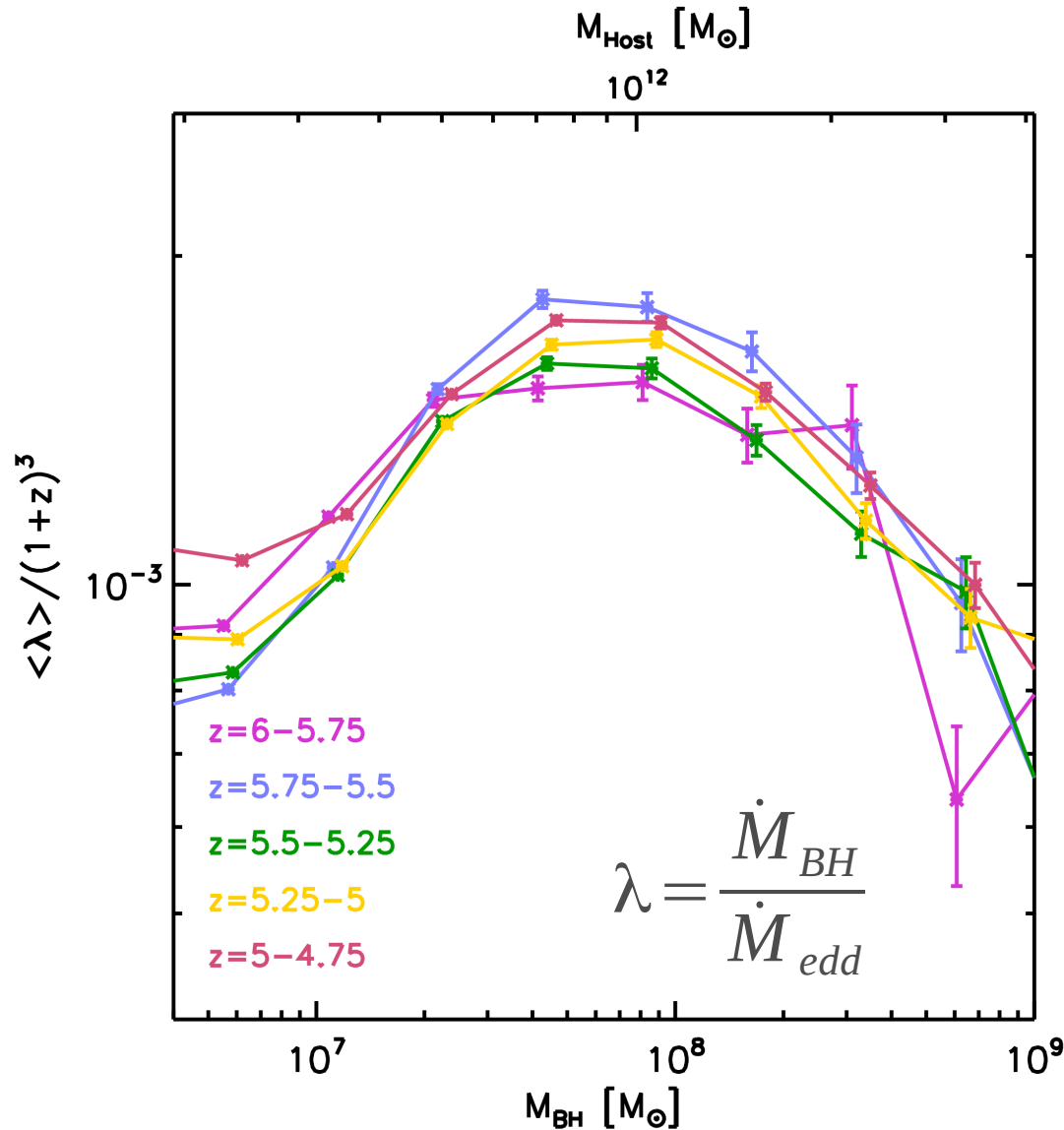
- High-redshift BH growth
 - Redshift dependence
 - Mass dependence
- M - σ at high- z
 - Luminosity dependence
 - Impact of mergers

Black Hole Growth

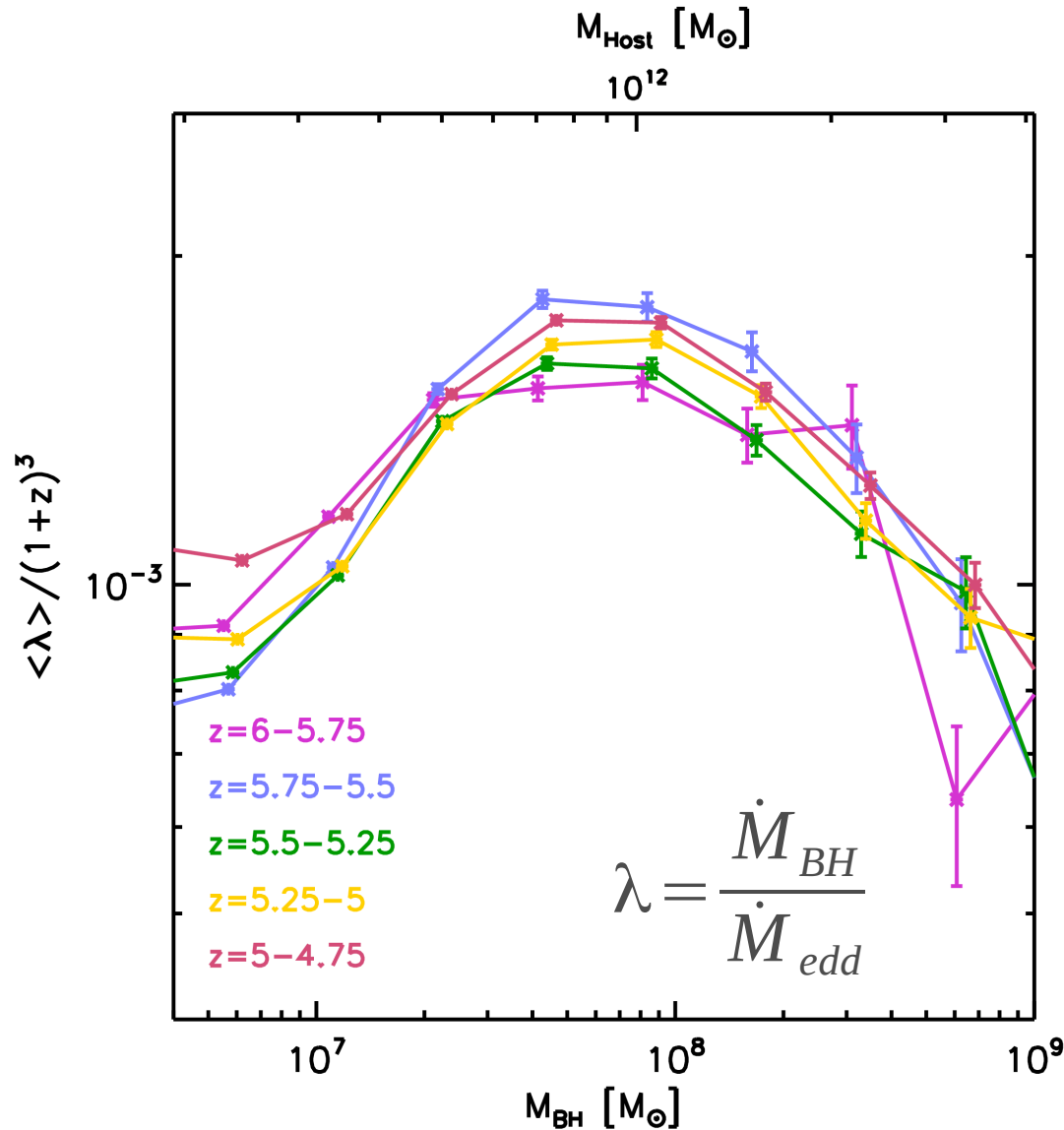


Black Hole Growth

- Clear peak in growth rate

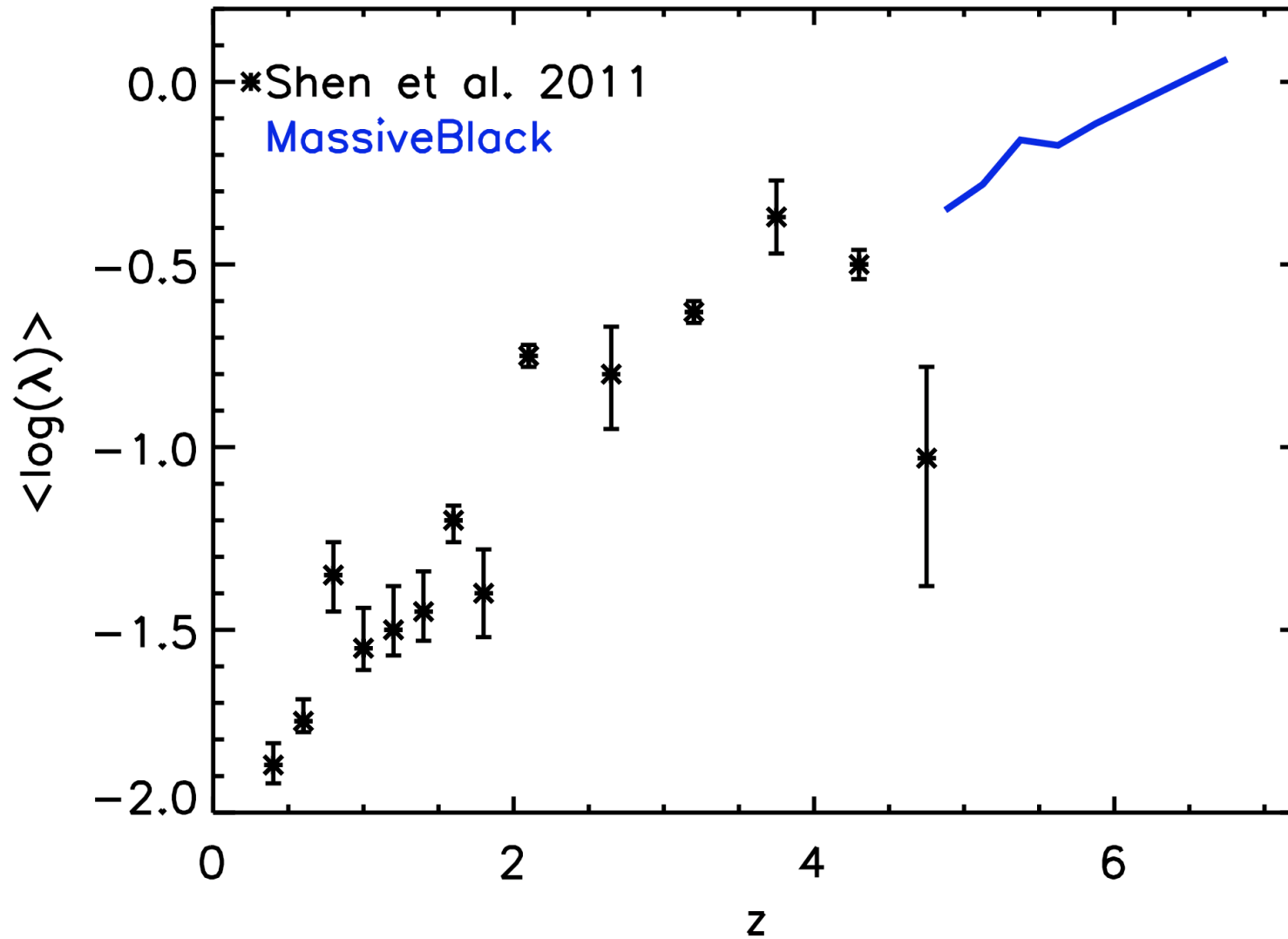


Black Hole Growth

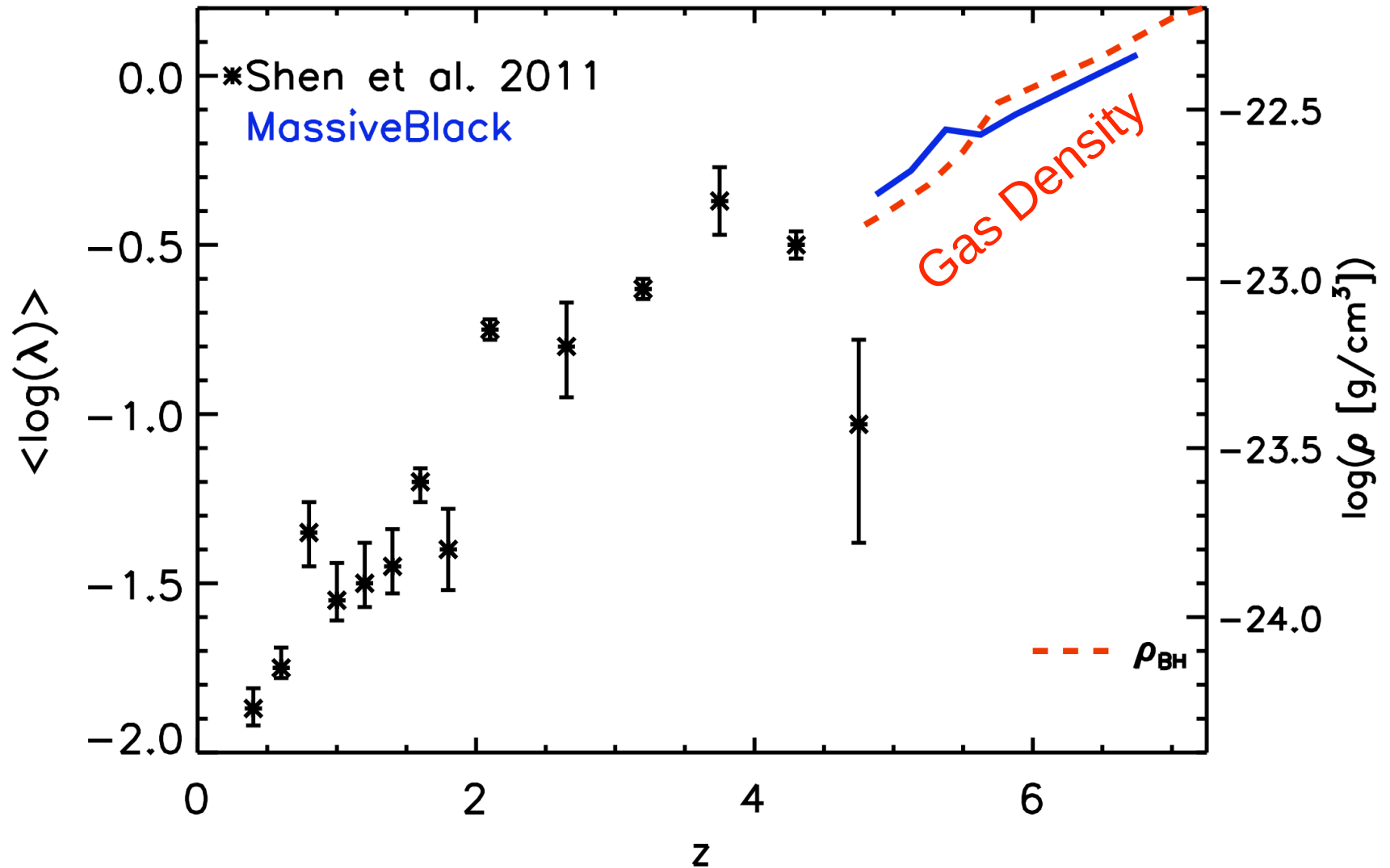


- Clear peak in growth rate
- Peak occurs at characteristic scale
 - Redshift-independent
- Accretion scales as $(1+z)^{-3}$

Evolution of Growth Rates

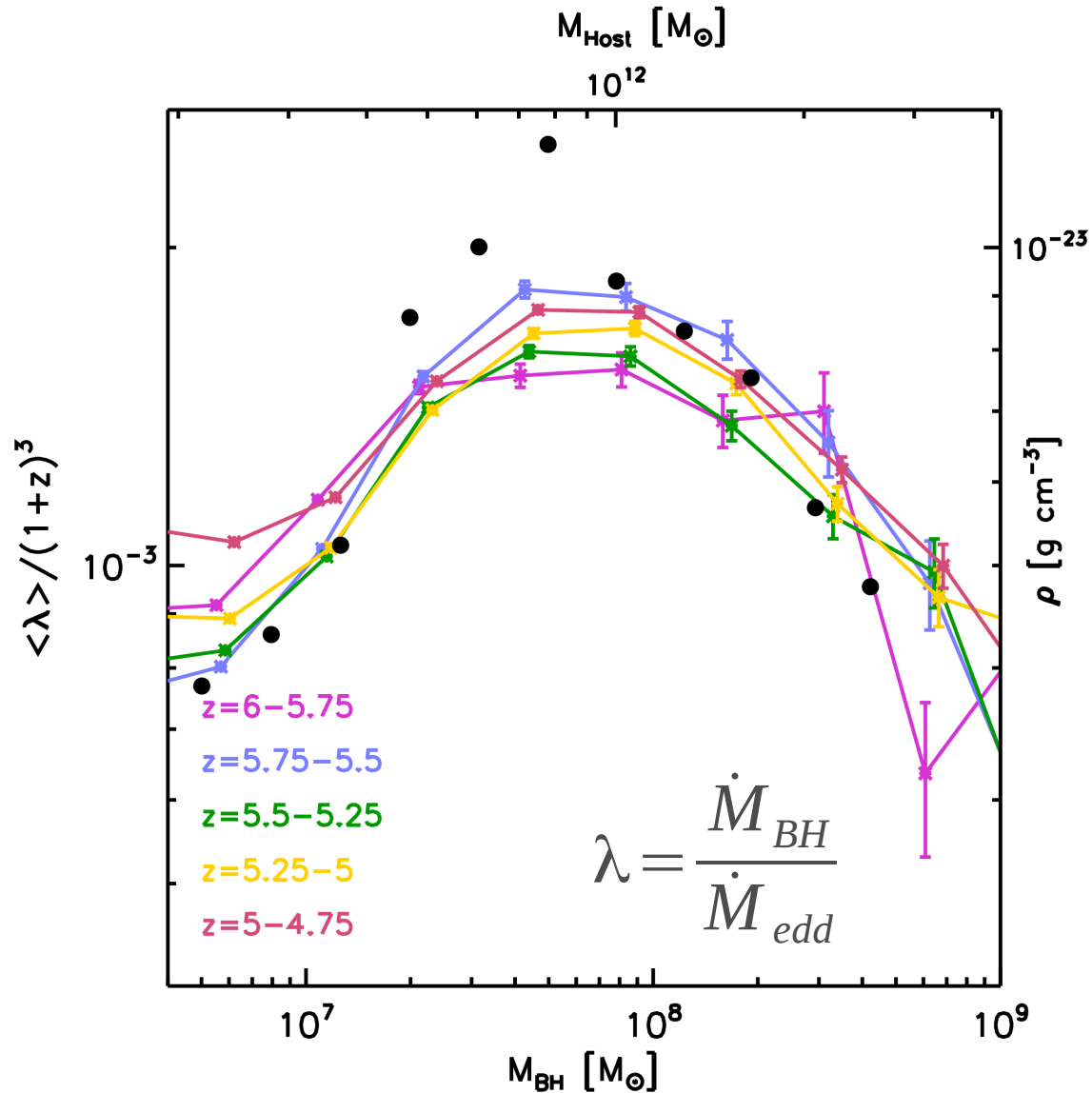


Evolution of Growth Rates



Redshift evolution caused by evolving gas density

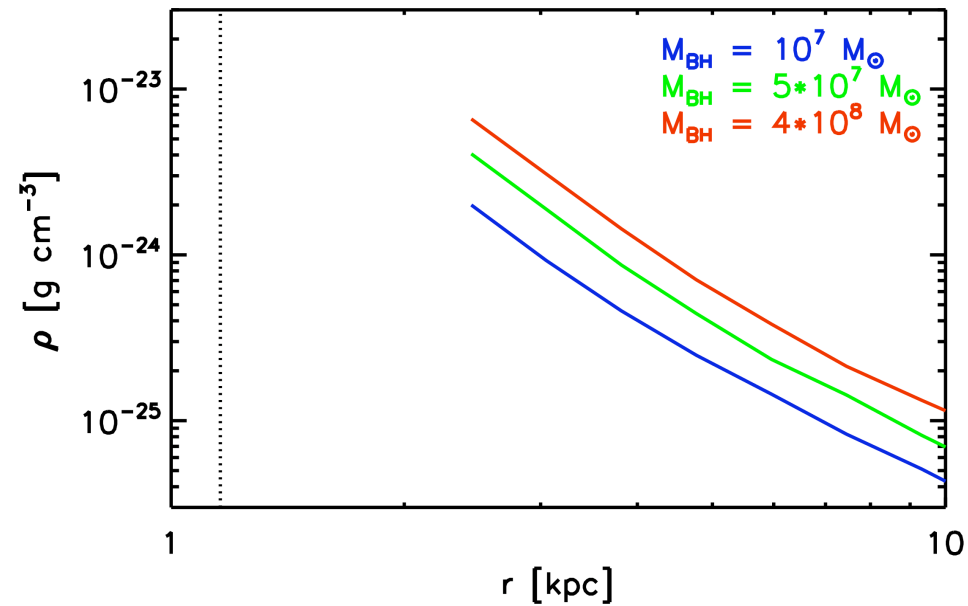
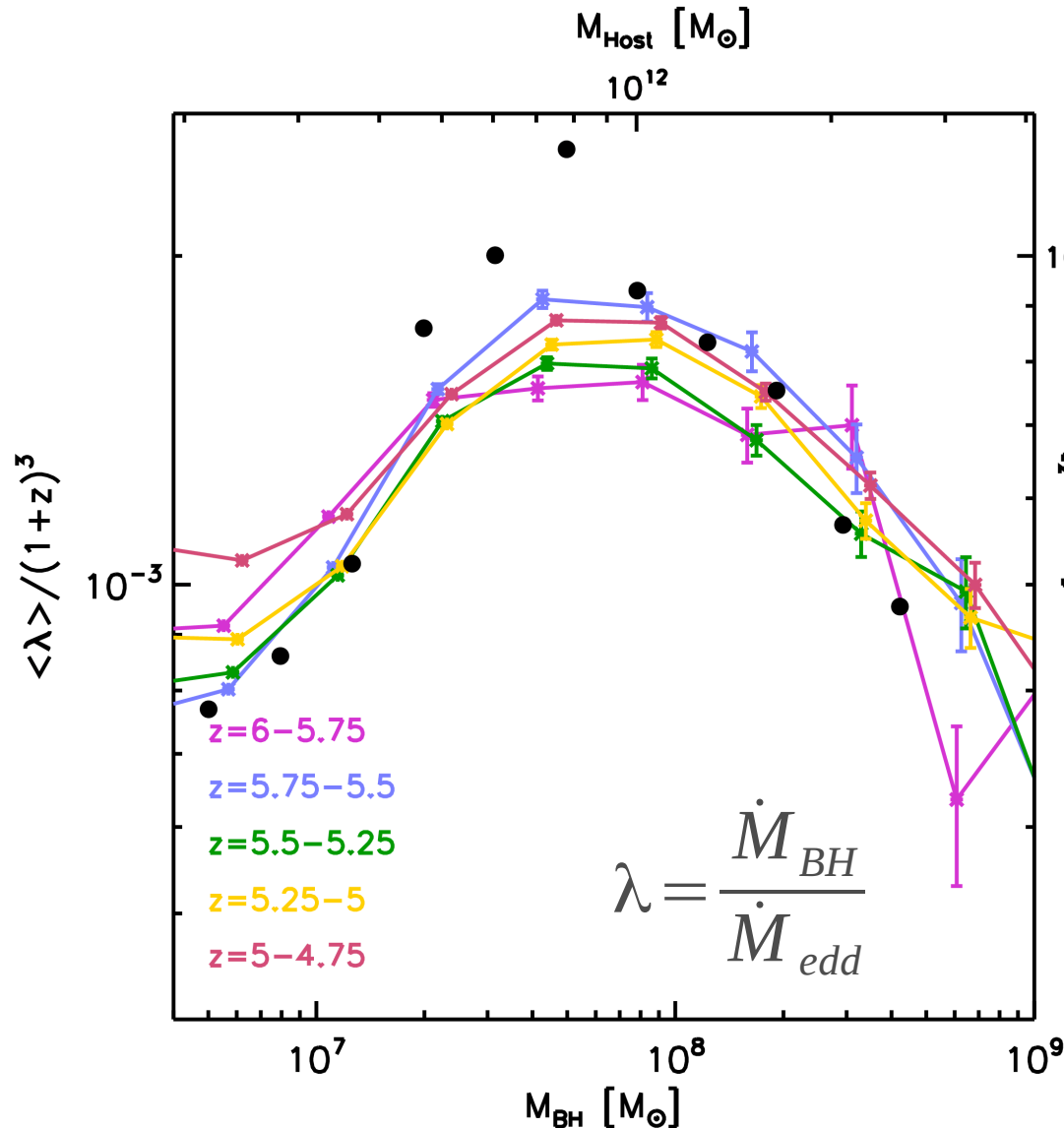
Black Hole Growth



- Clear peak in growth rate
- Peak correlates with local gas density

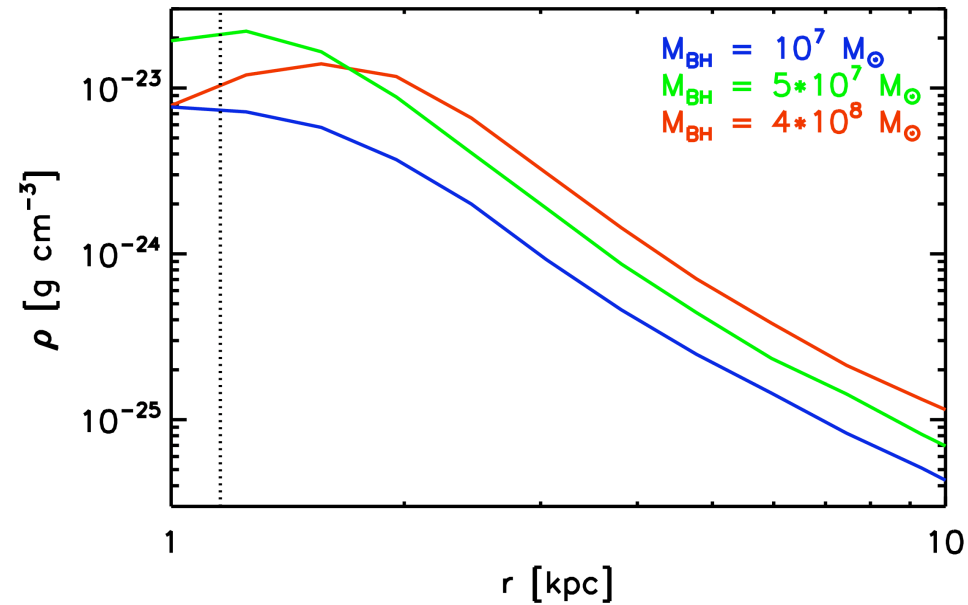
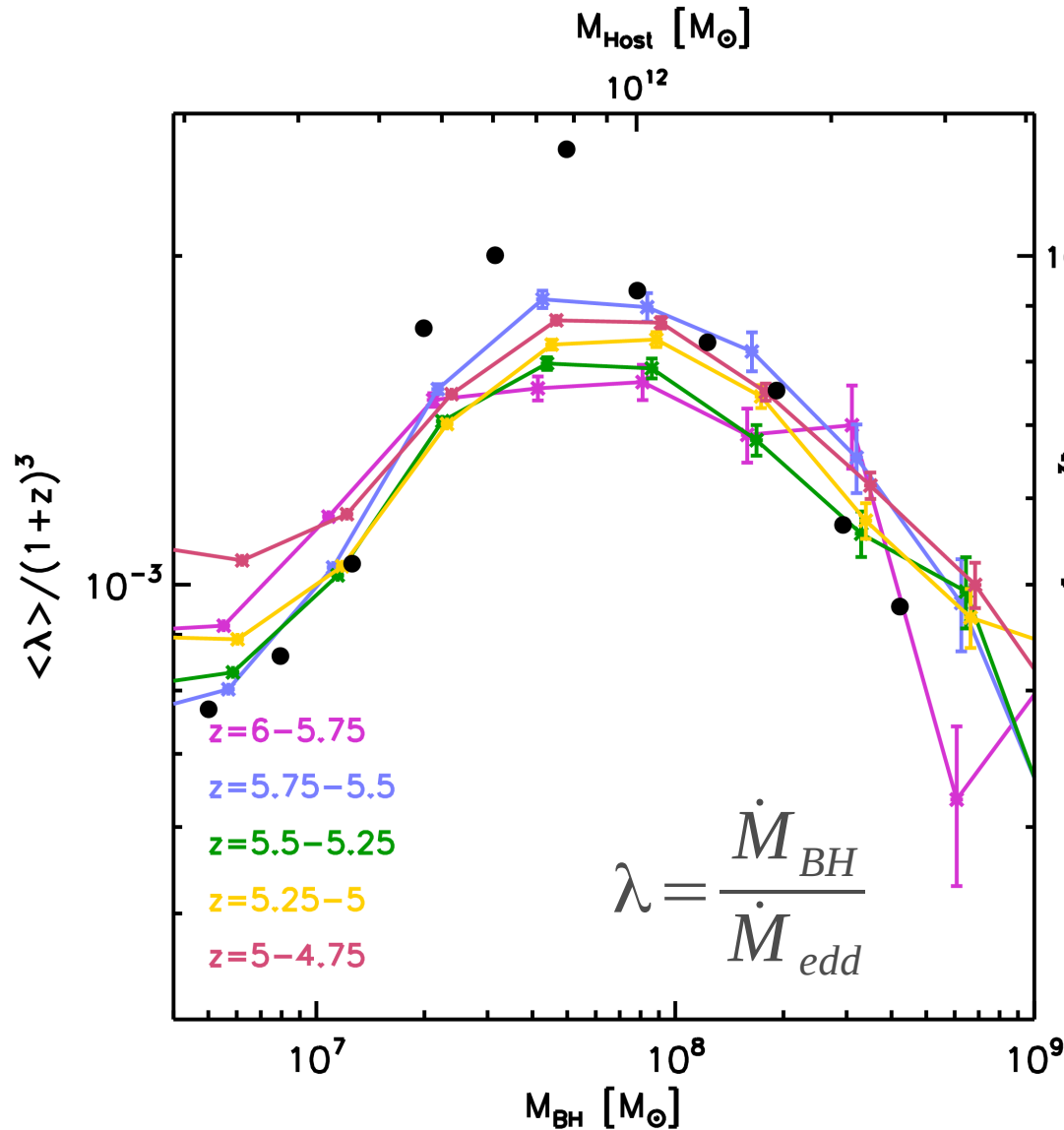
Black Hole Growth

- Clear peak in growth rate
- Peak correlates with local gas density



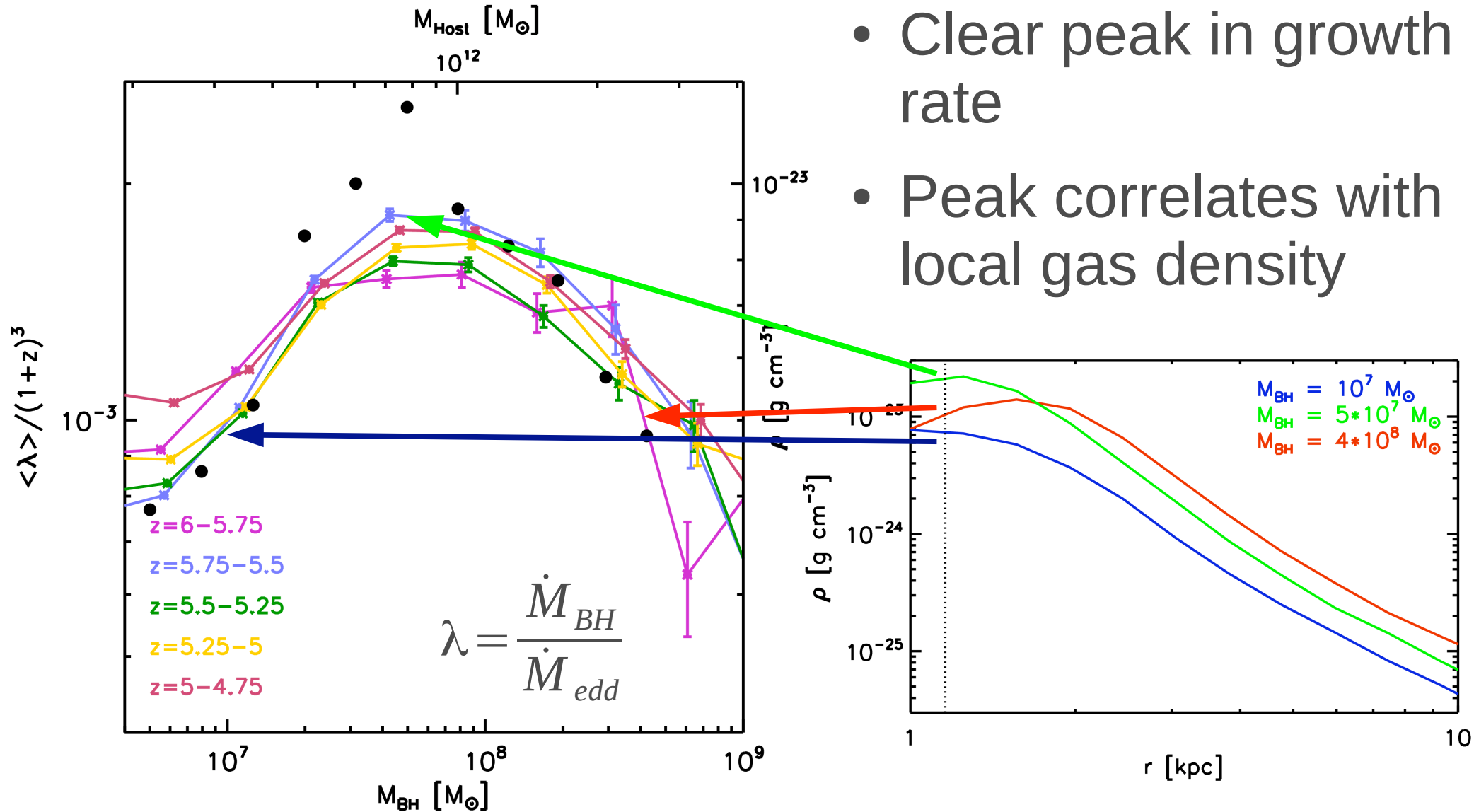
Black Hole Growth

- Clear peak in growth rate
- Peak correlates with local gas density

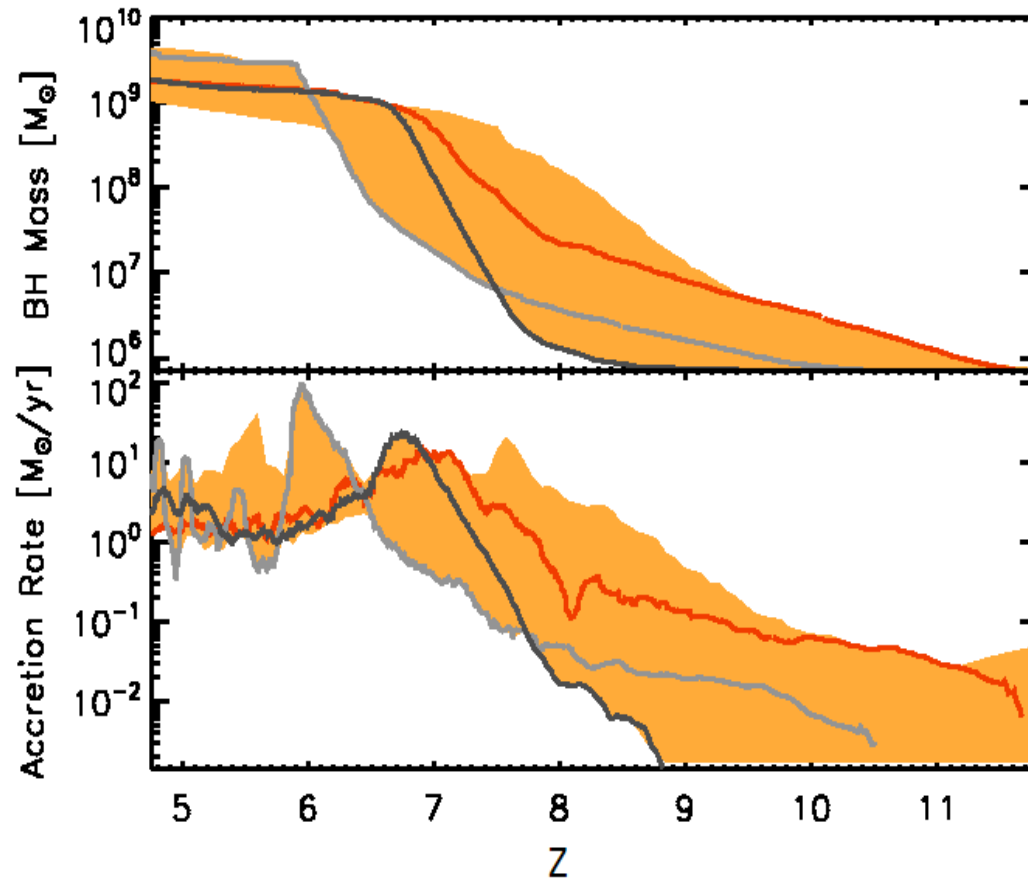


Black Hole Growth

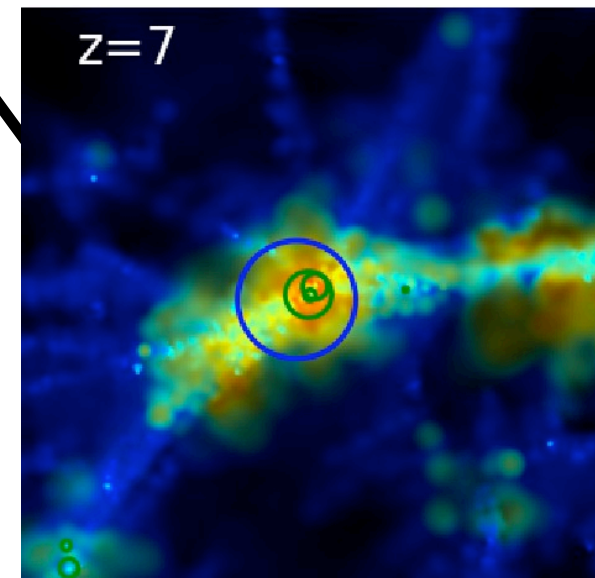
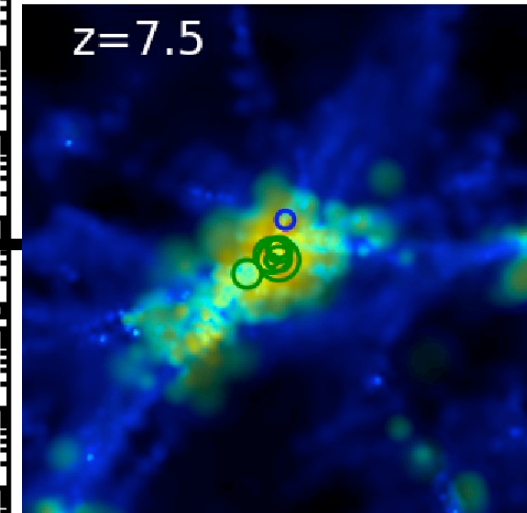
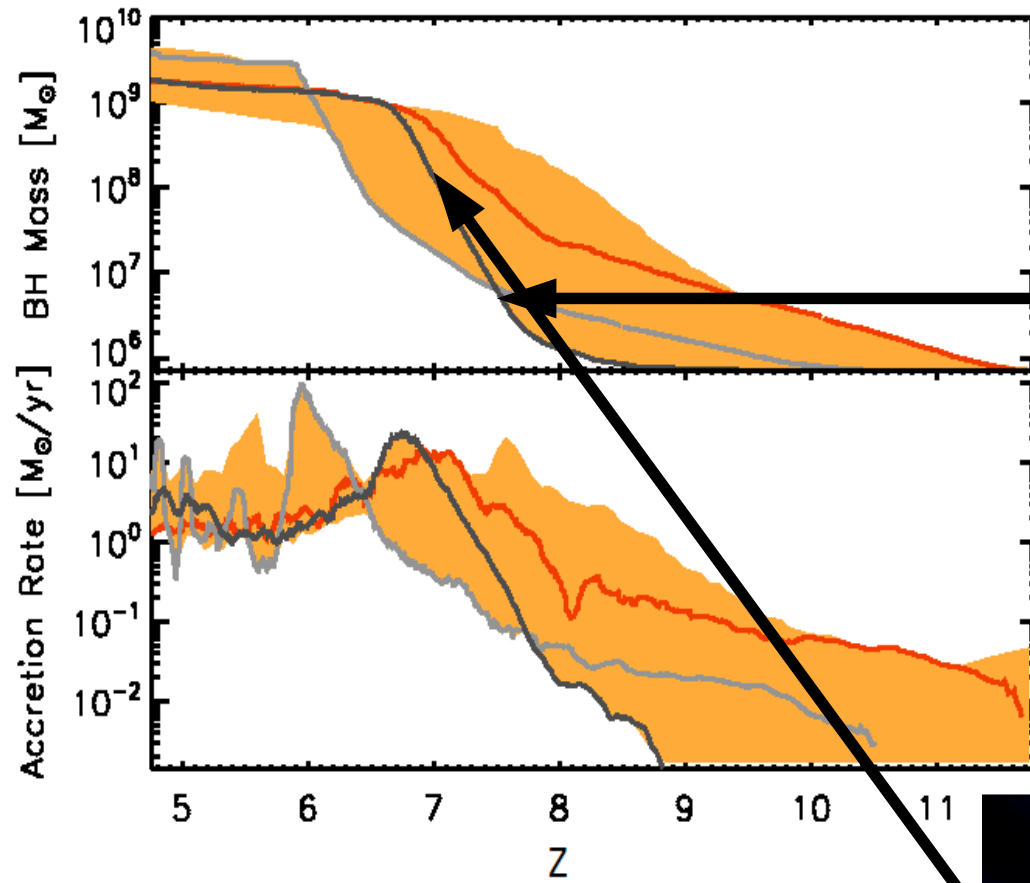
- Clear peak in growth rate
- Peak correlates with local gas density



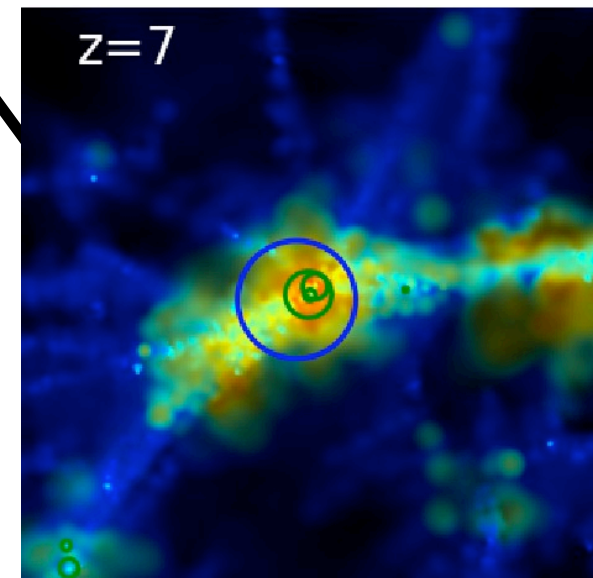
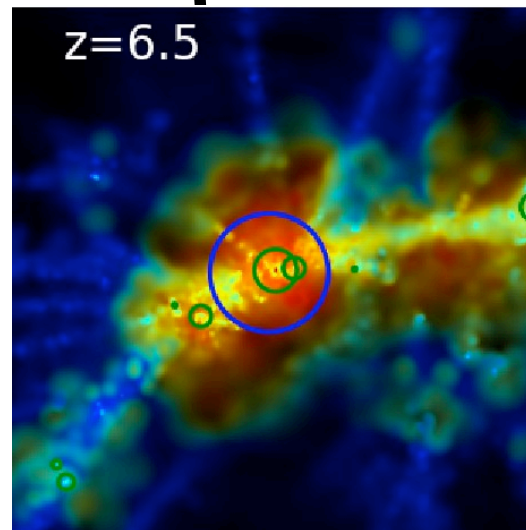
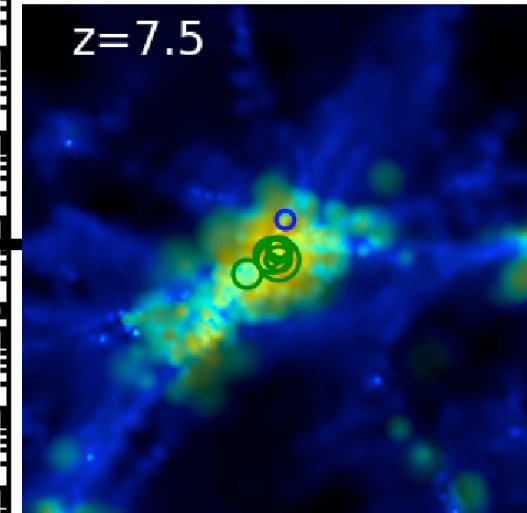
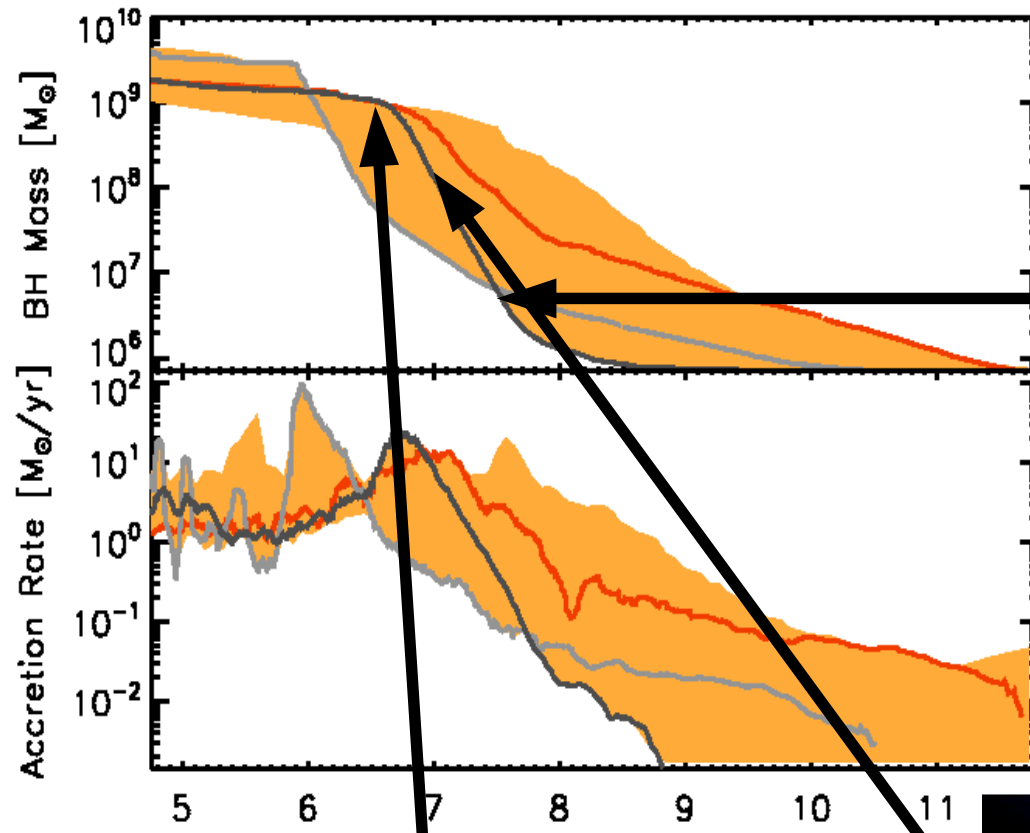
Black Hole Growth



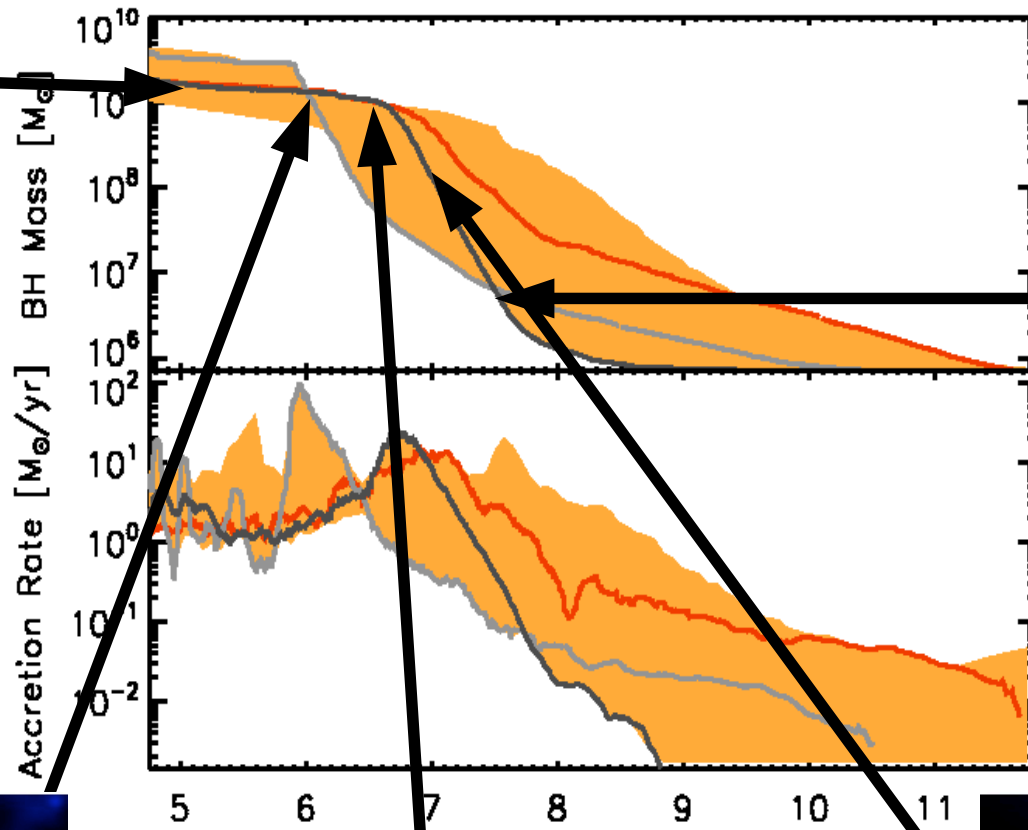
Black Hole Growth



Black Hole Growth



Black Hole Growth



$z=5$

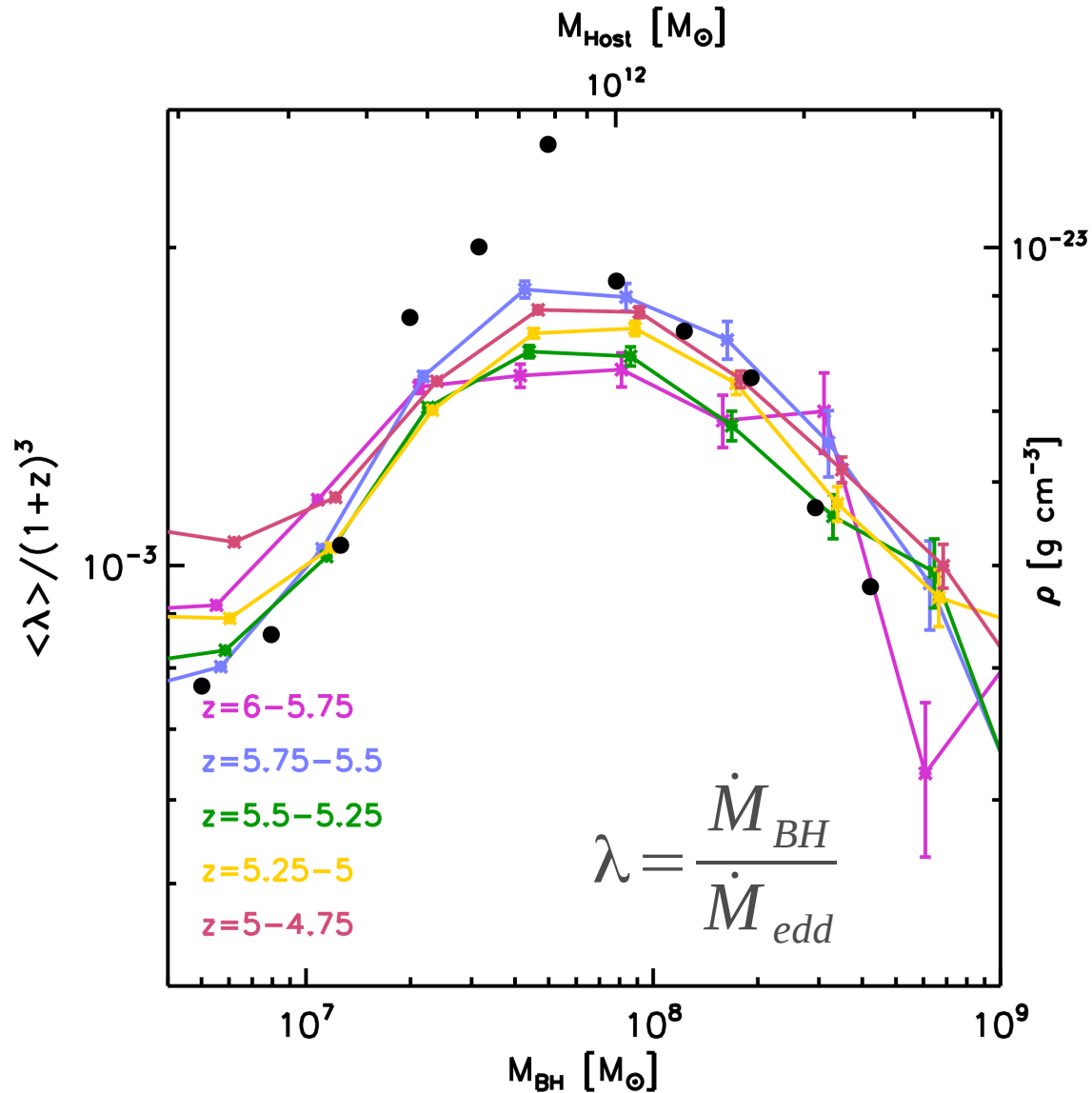
$z=7.5$

$z=6$

$z=6.5$

$z=7$

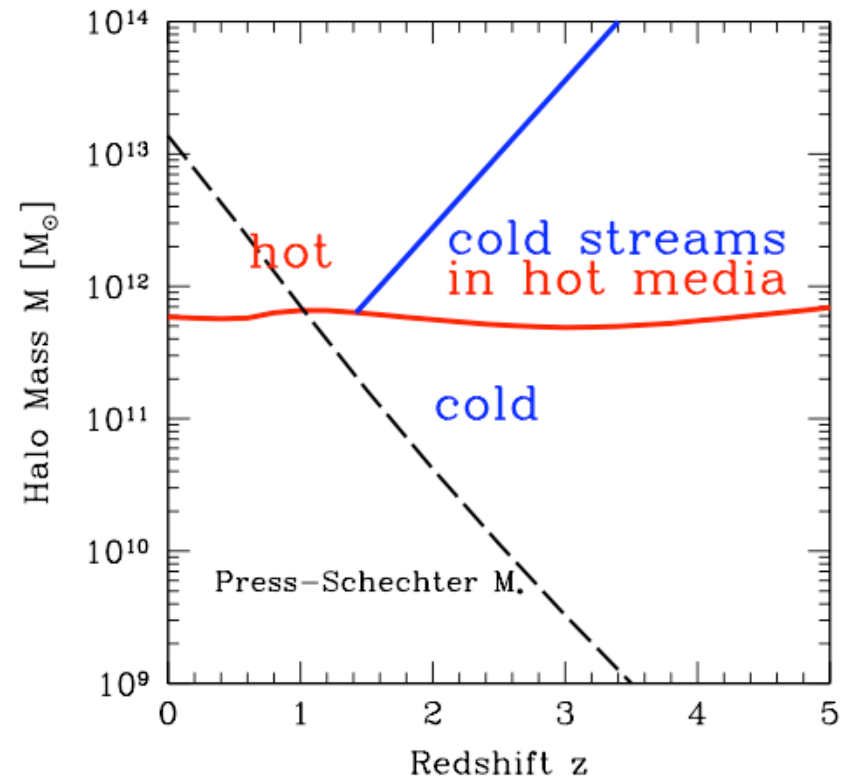
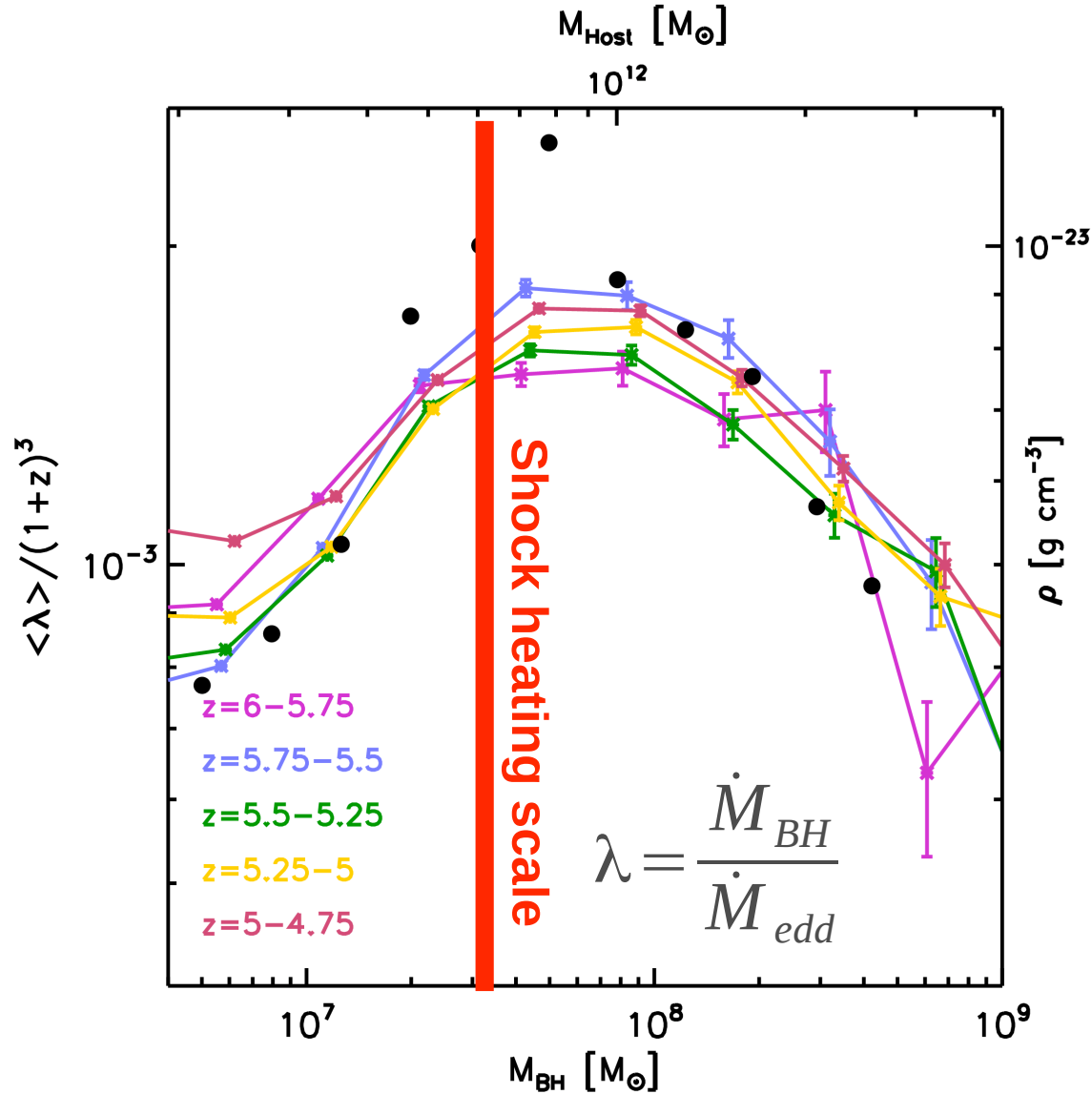
Black Hole Growth



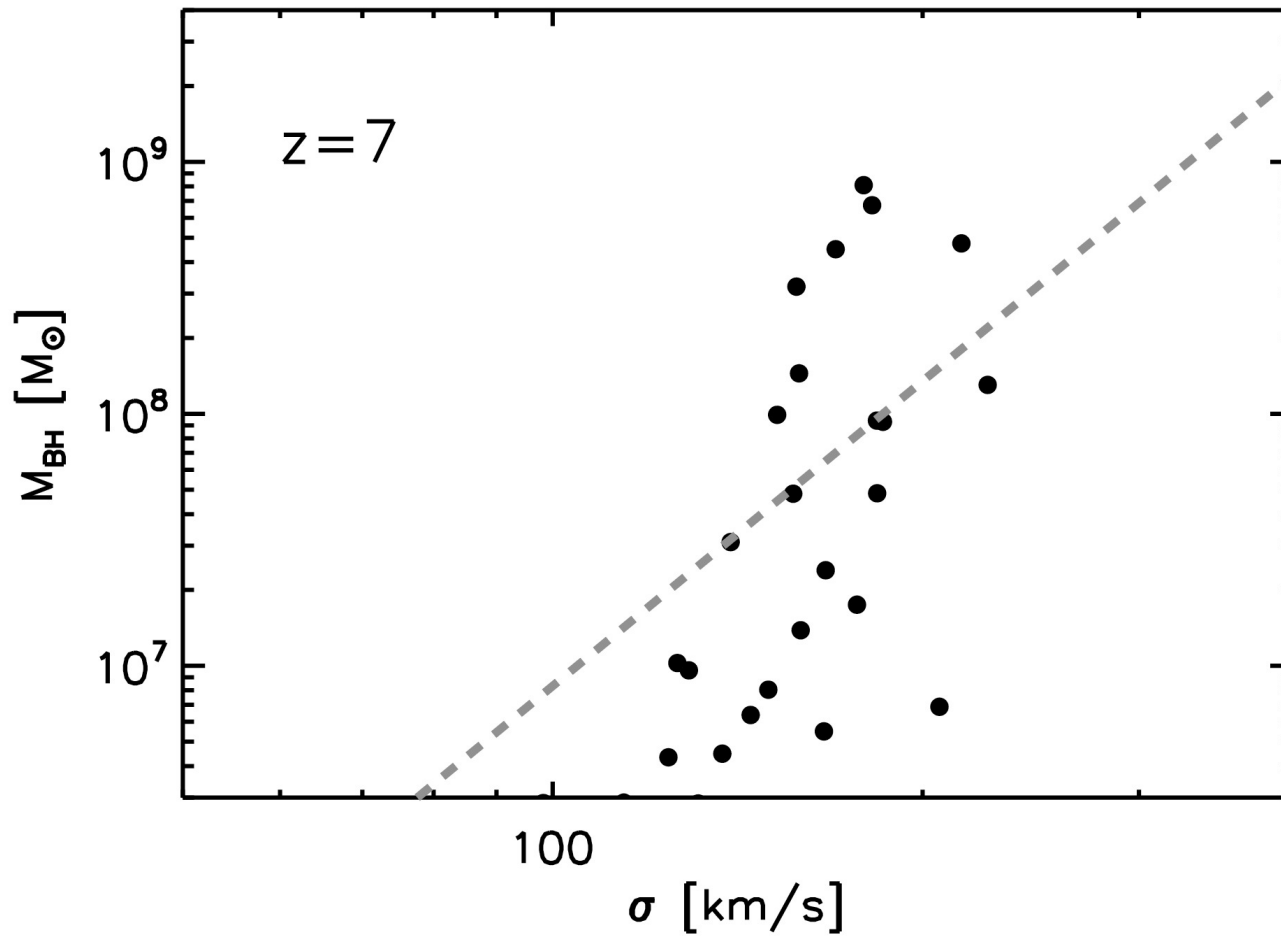
- Clear peak in growth rate
- Peak correlates with local gas density

Black Hole Growth

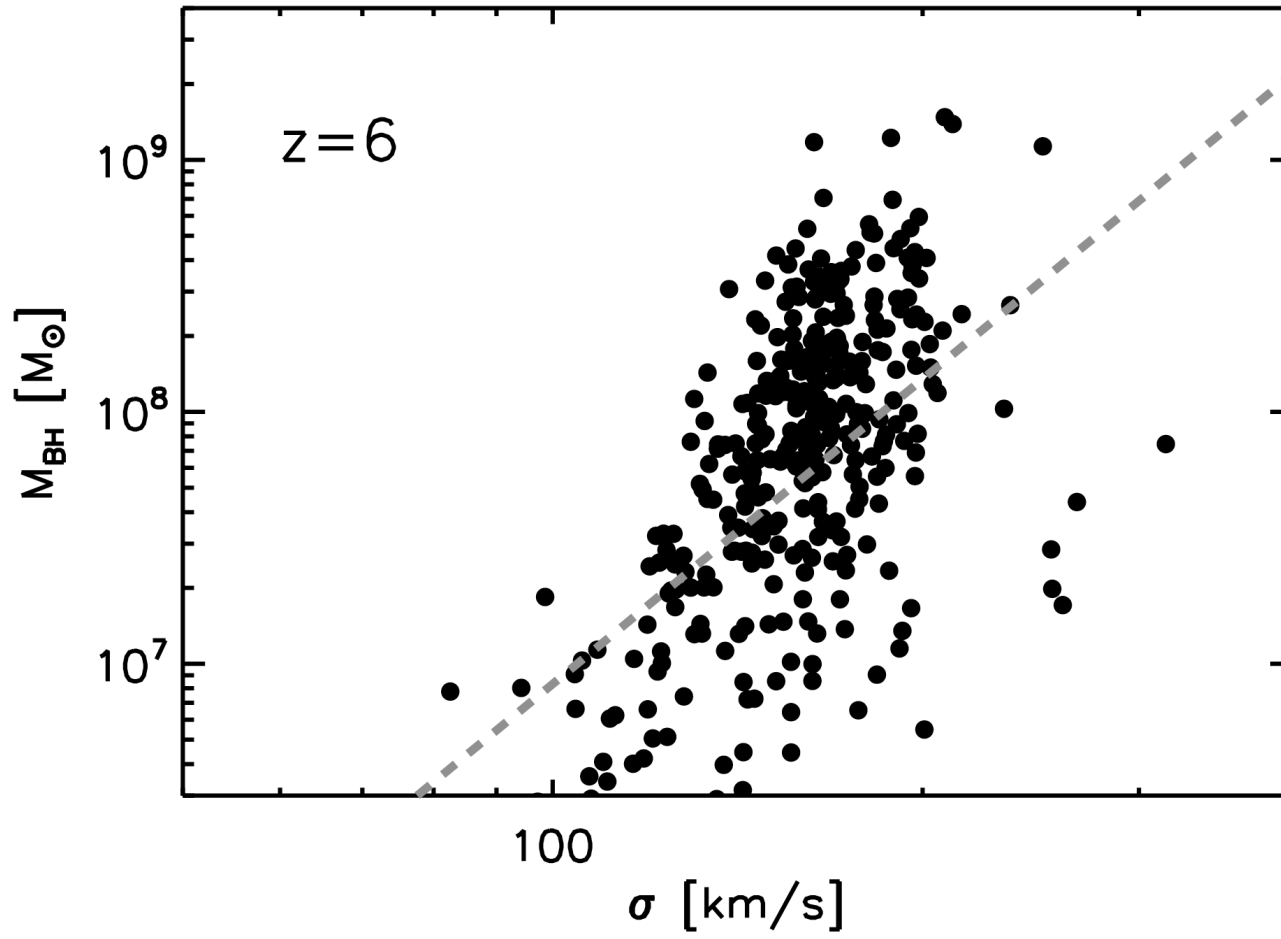
- Clear peak in growth rate
- Peak correlates with local gas density



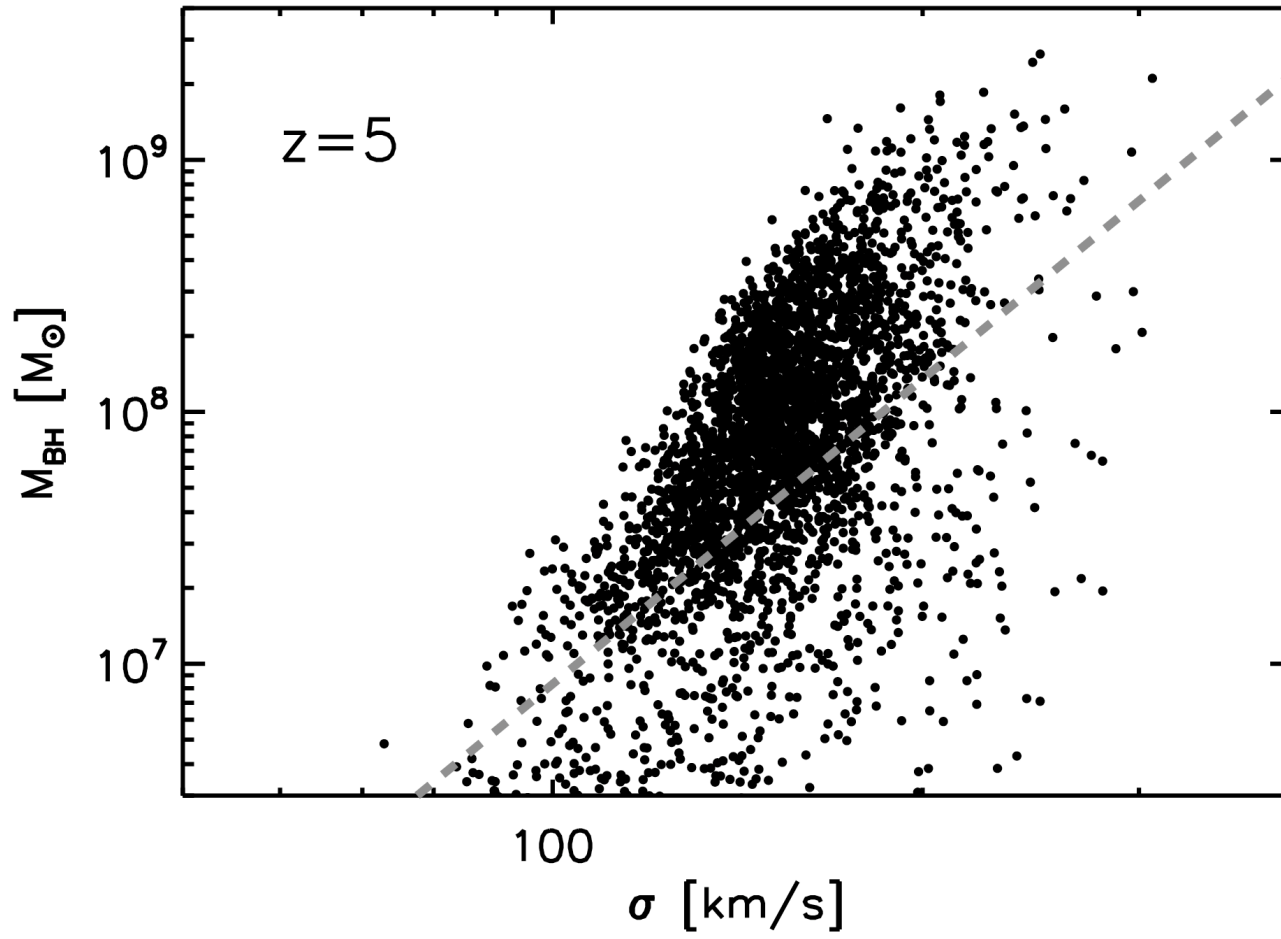
M- σ relation



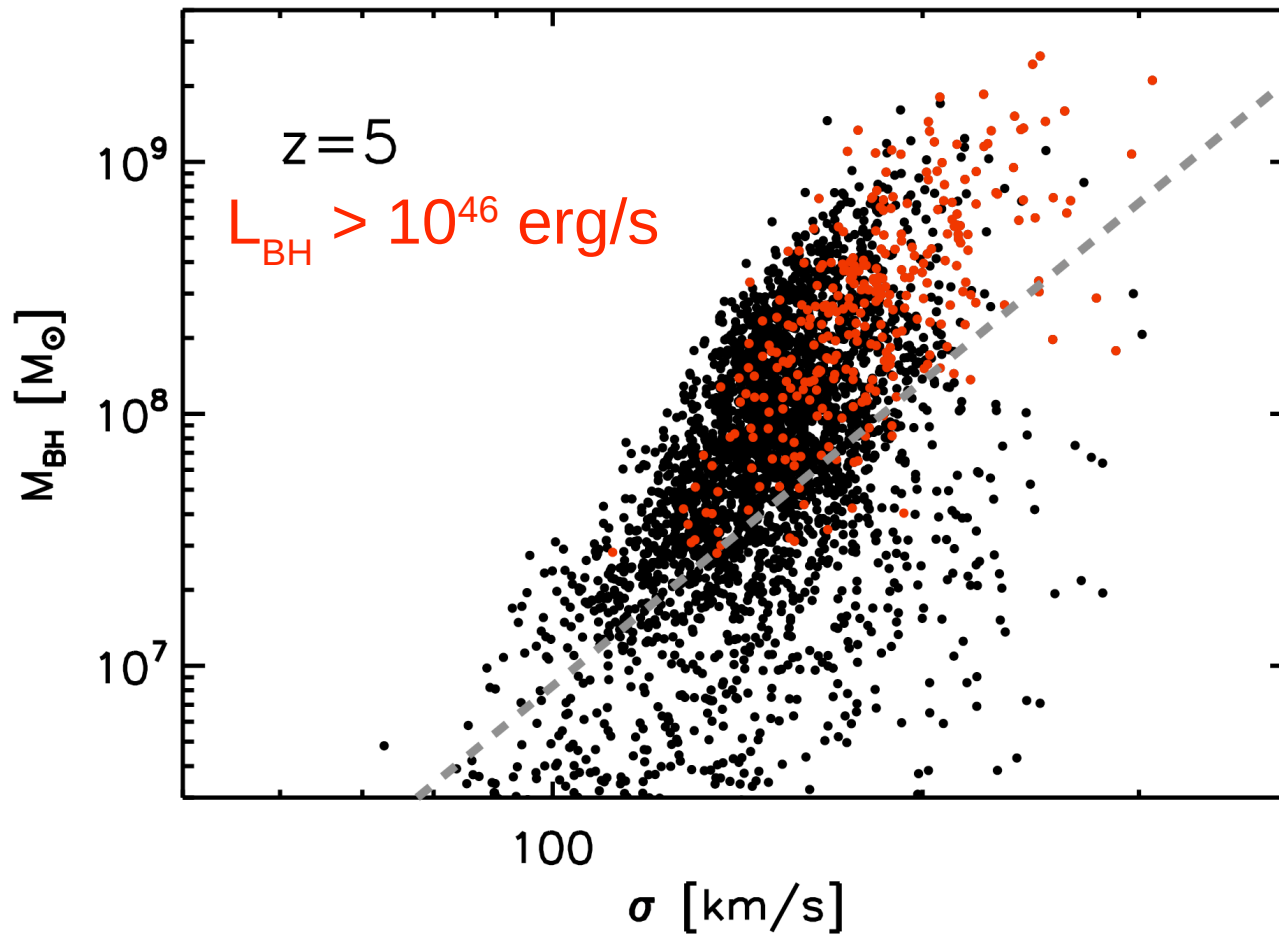
M- σ relation



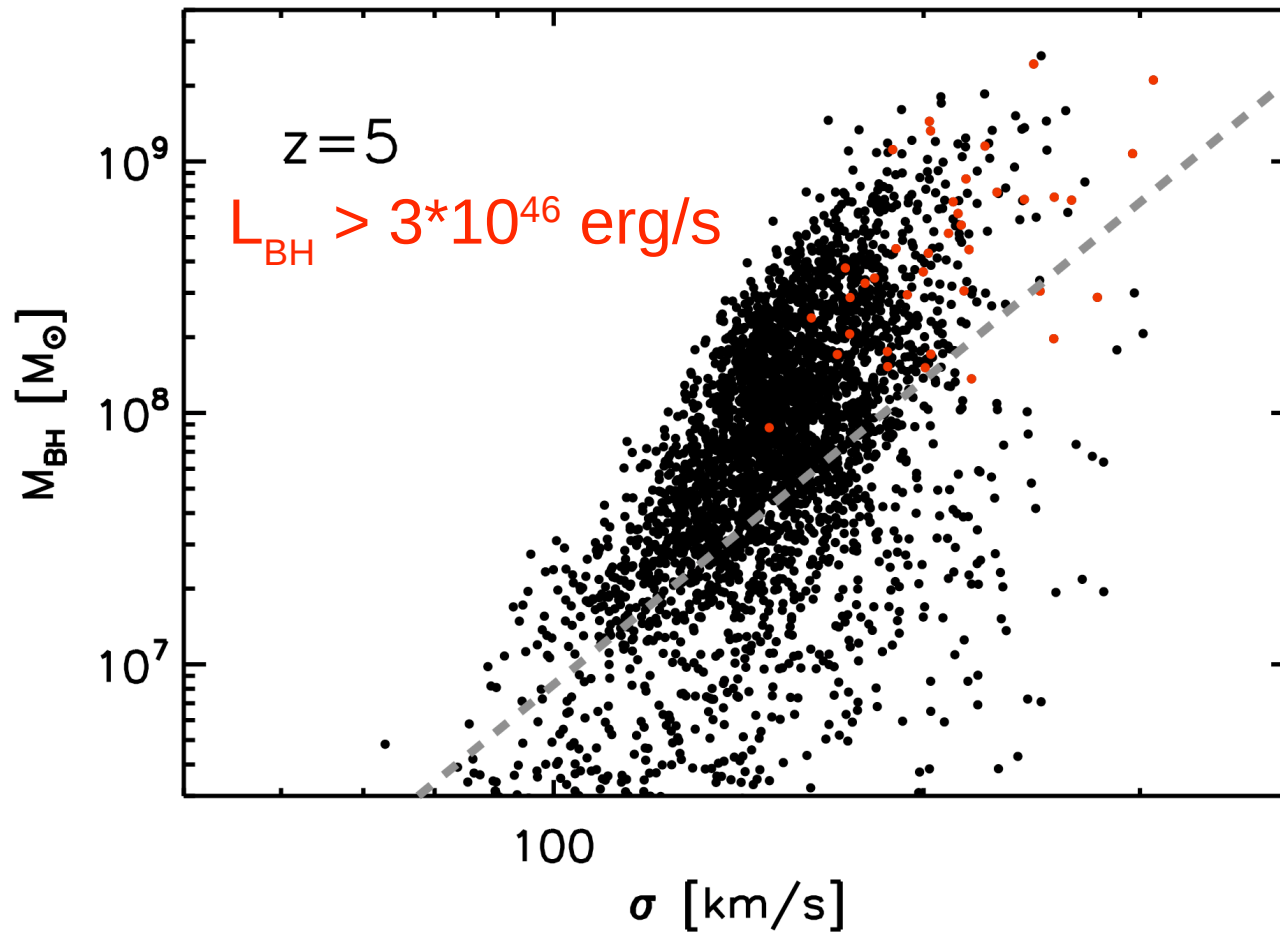
M- σ relation



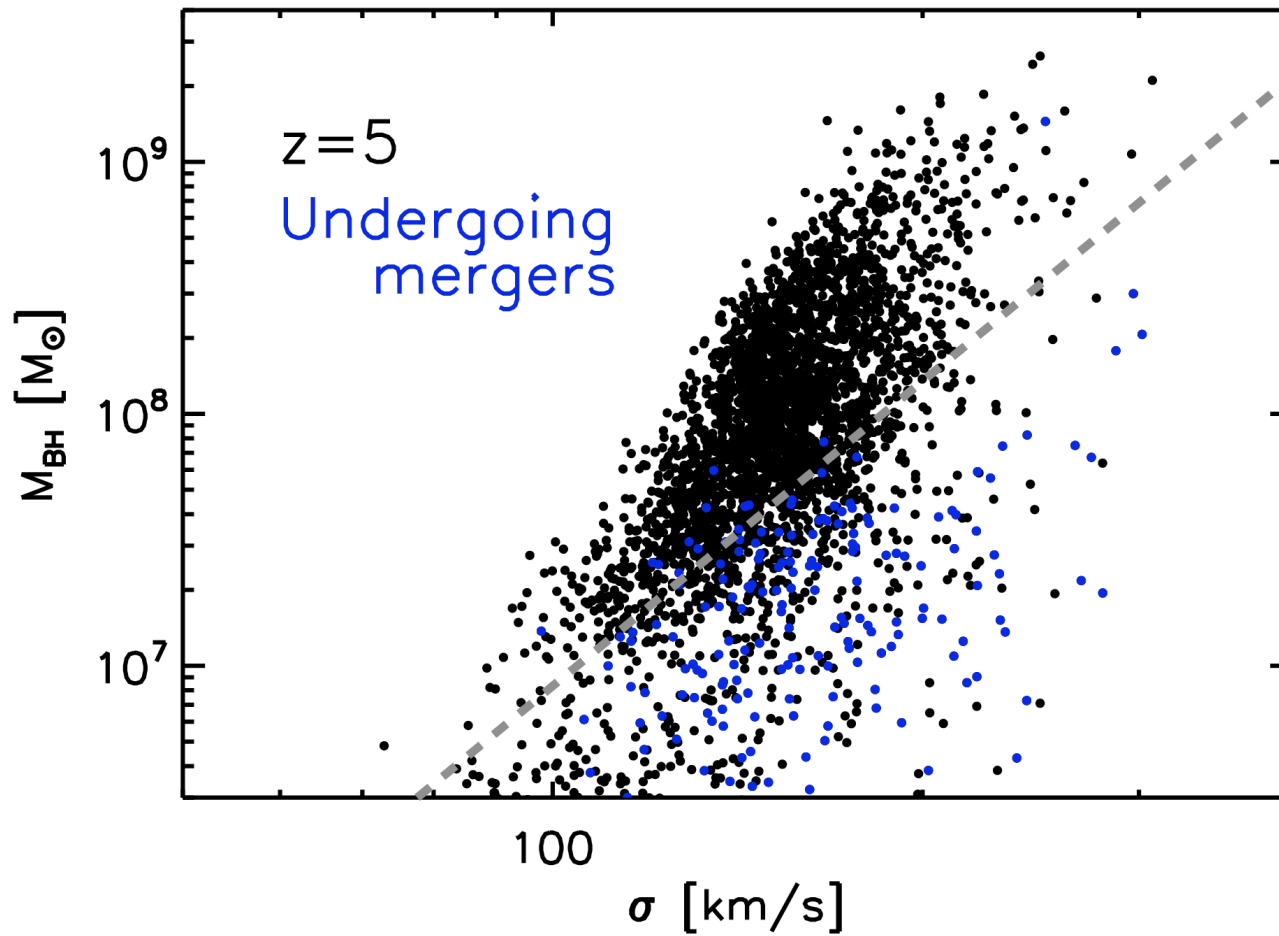
M- σ relation – Luminosity Dependence



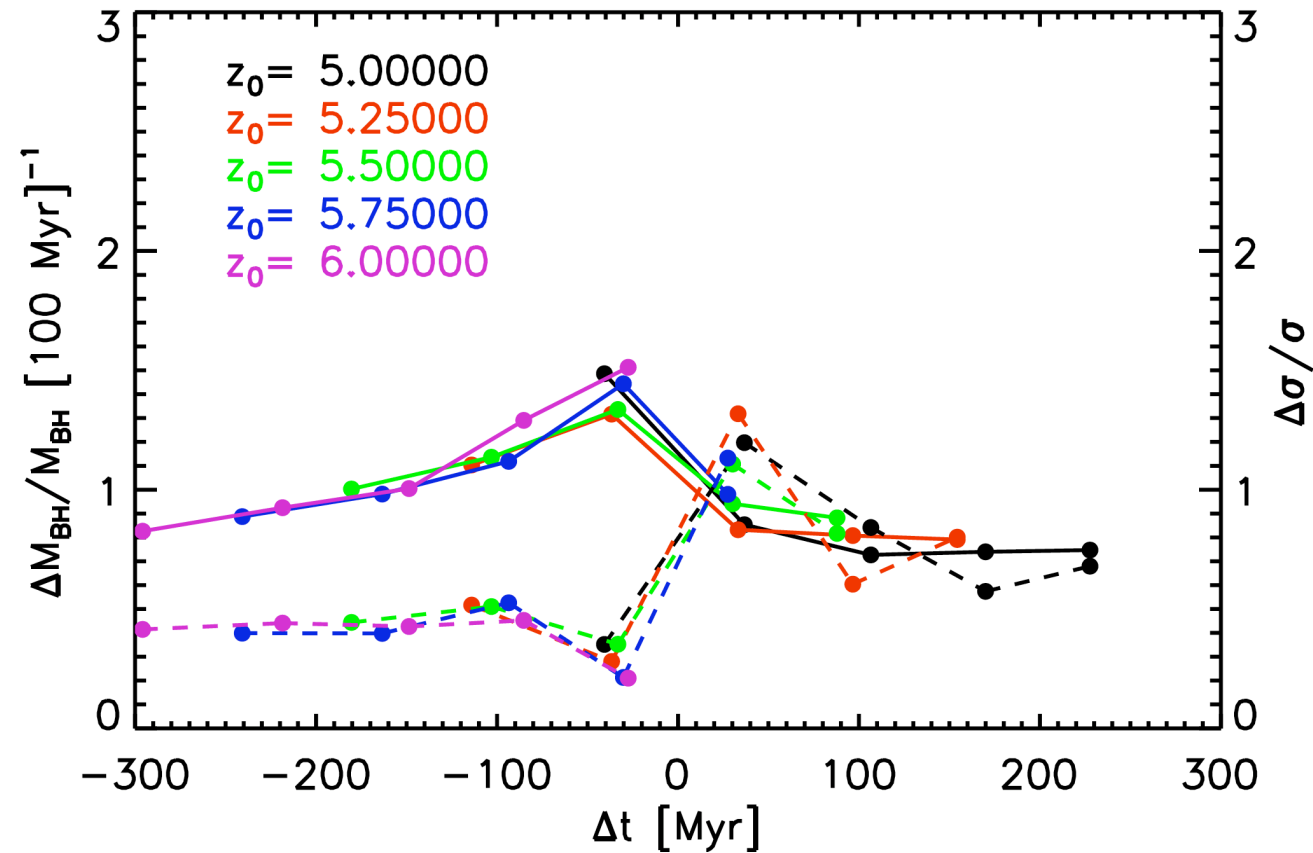
M- σ relation – Luminosity Dependence



M- σ relation – Galaxy Mergers

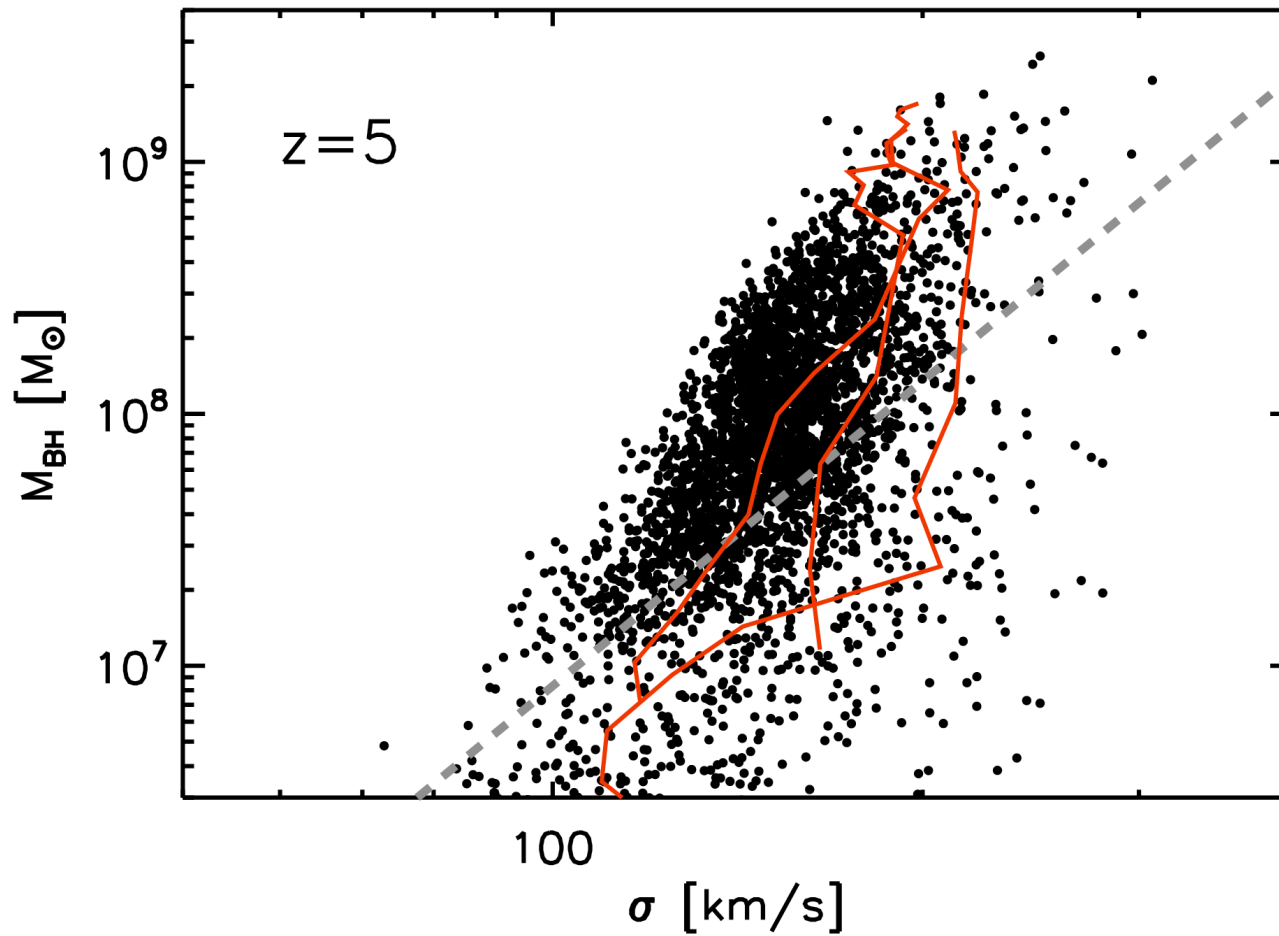


Merger evolution along M- σ

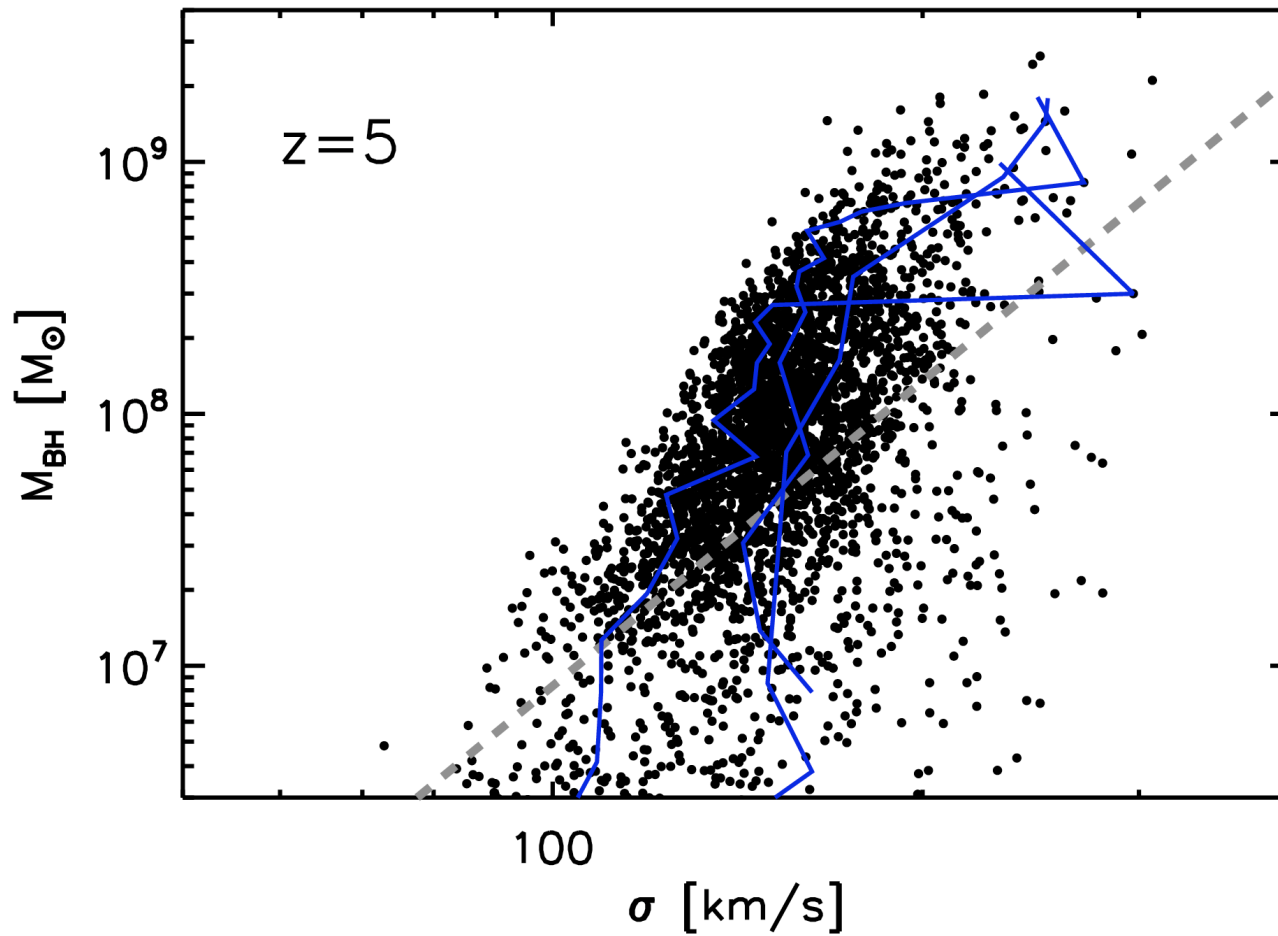


- Jump in σ , followed by increased BH growth

Evolution along M- σ



Evolution along M- σ



Conclusions

- BHs follow a characteristic growth pattern
- Growth dominated by gas density
- Self-regulation starts at characteristic mass scale
 - Independent of redshift
- High-redshift M - σ steeper than local
 - Independent of L_{BH}
 - Galaxy merger boosts σ , followed by rapid BH growth