

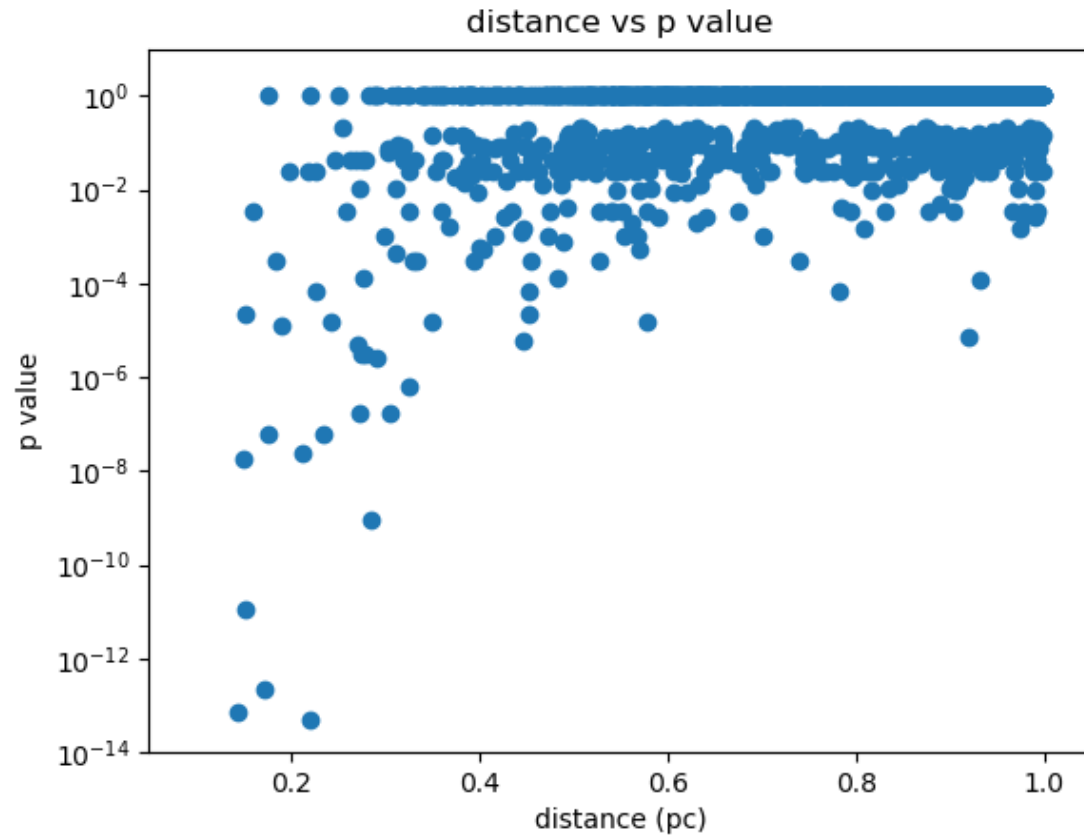
# PBH Update

MSU group meeting

3/28/19

[https://private.hawc-observatory.org/wiki/images/1/15/Pbh\\_032519.pdf](https://private.hawc-observatory.org/wiki/images/1/15/Pbh_032519.pdf)

# Why do we only generate out to 0.5 pc?



# Creating the model

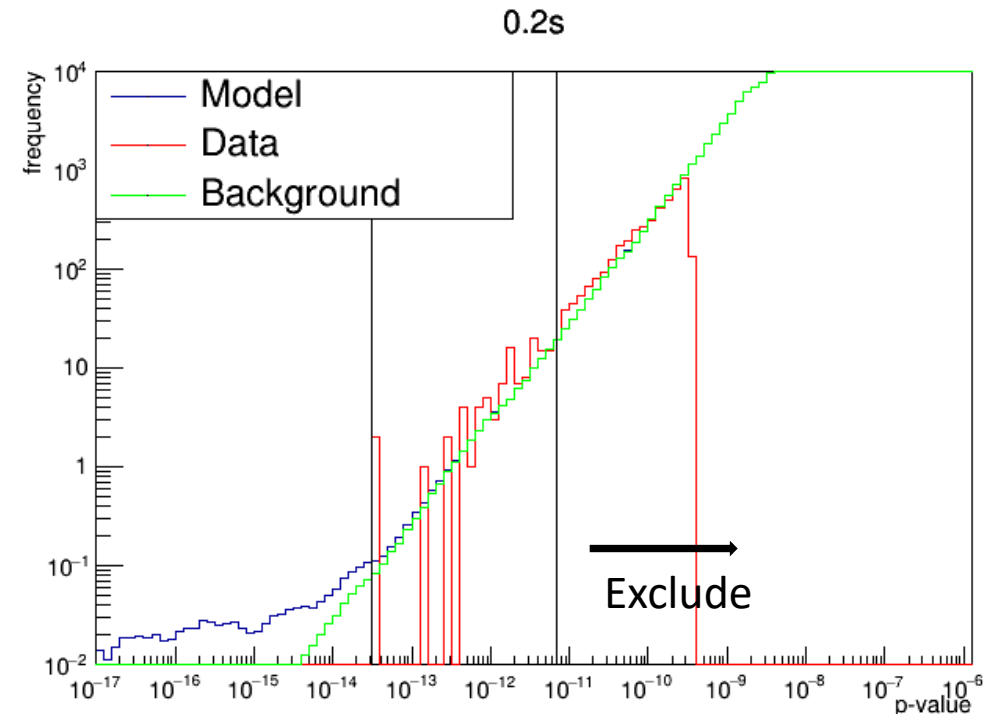
- Calculate the p-value of obtaining N counts (from ZEBRA) given the background B for each event:

$$prob(\geq N) = \sum_{i=N}^{\infty} \frac{B^i \exp(-B)}{i!} = 1 - \frac{\Gamma(N, B)}{\Gamma(N)}$$

- Define  $H_{\text{model}}$  as:

$$H_{\text{model}}(p) = H_{\text{pbh}}(p) + H_{\text{bkg}}(p)$$

- Where  $H_{\text{pbh}}(p)$  is the PBH distribution scaled to search time and burst rate
- And  $H_{\text{bkg}}(p)$  is the background distribution scaled to search time



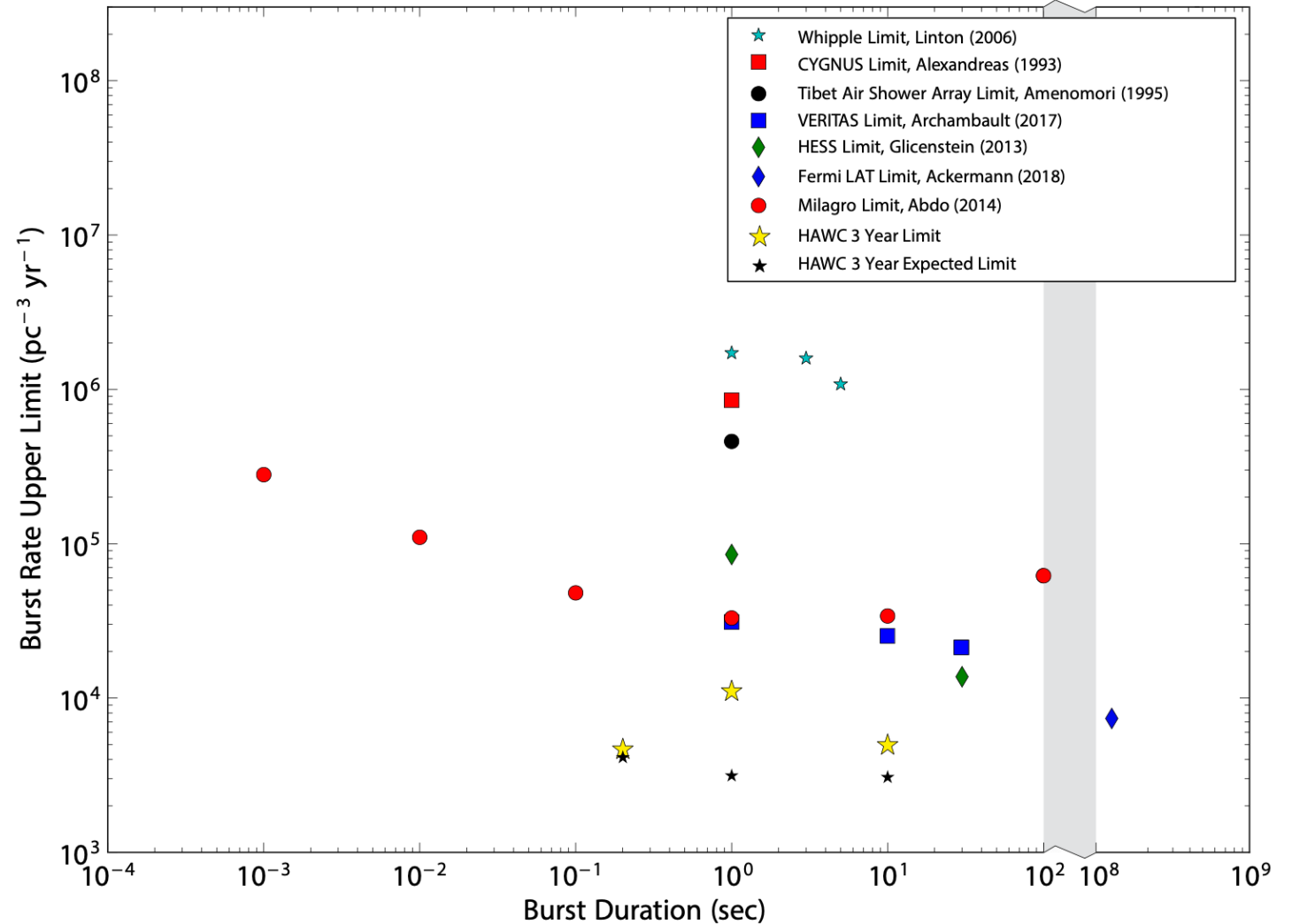
# Expected limits vs threshold

Threshold	Limit
3e-10	4144
1e-10	4144
3e-11	4144
1e-11	4144
3.981e-12	4145
1e-12	4146
3e-13	4152
1e-13	4164
3.162e-14	4190
1e-14	4241

- Use only background to get expected limits
- This is for the 0.2s burst duration
- The expected limits don't change much over the entire range

# Actual vs expected limits with B=10 threshold

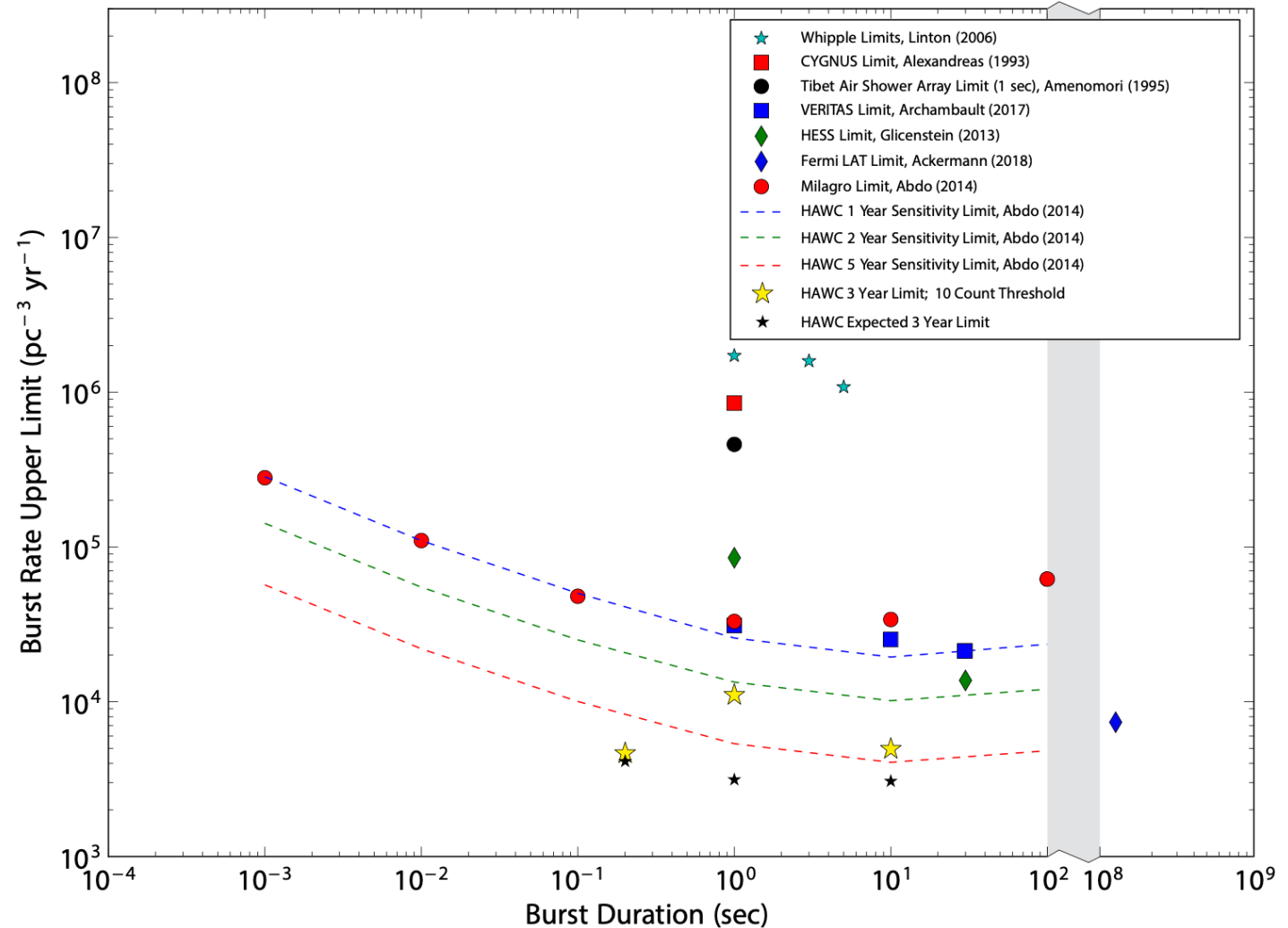
- Using threshold where we have 10 background events
- Yellow stars: HAWC actual limit
- Black stars: HAWC expected limit (only using background)



# Backups

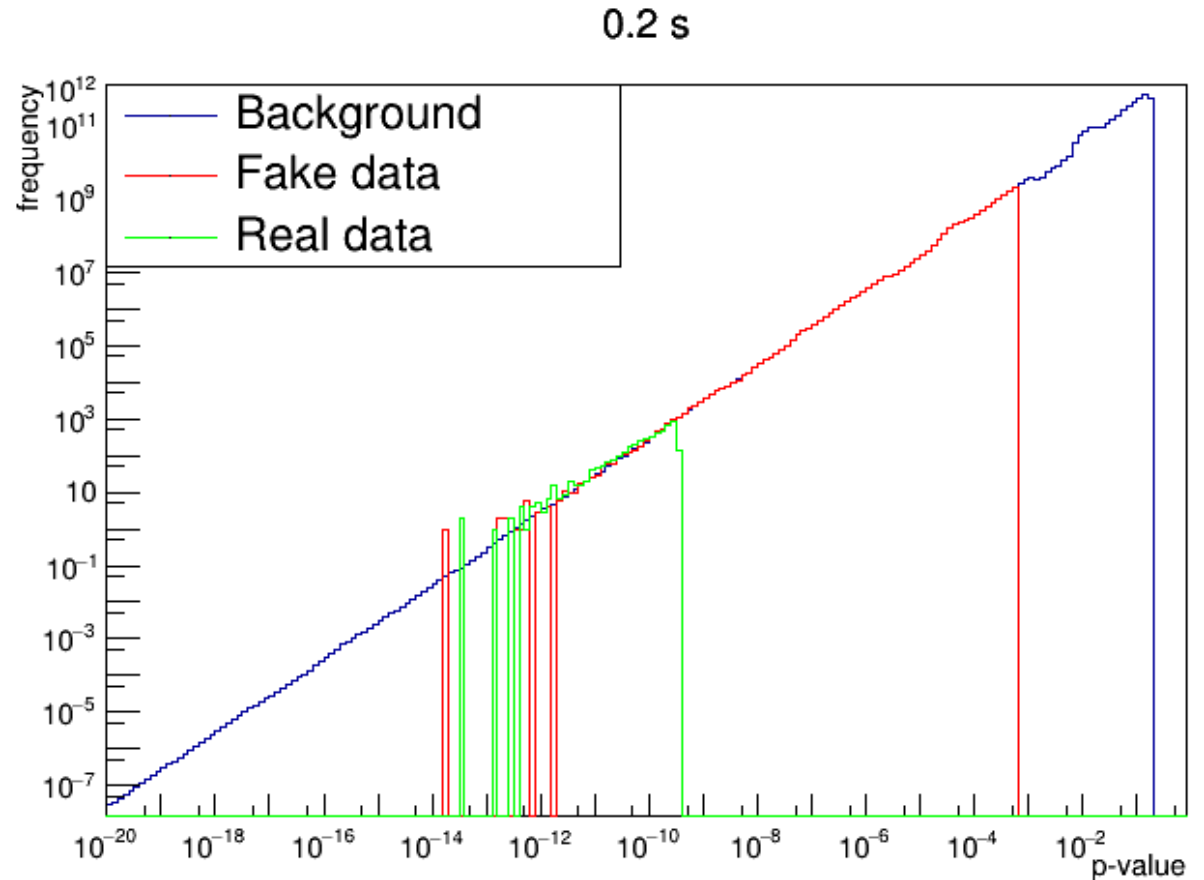
# Actual vs expected limits with B=10 threshold

- Using threshold where we have 10 background events
- Yellow stars: HAWC actual limit
- Black stars: HAWC expected limit (only using background)
- Same plot as slide 5 but with HAWC expected lines included

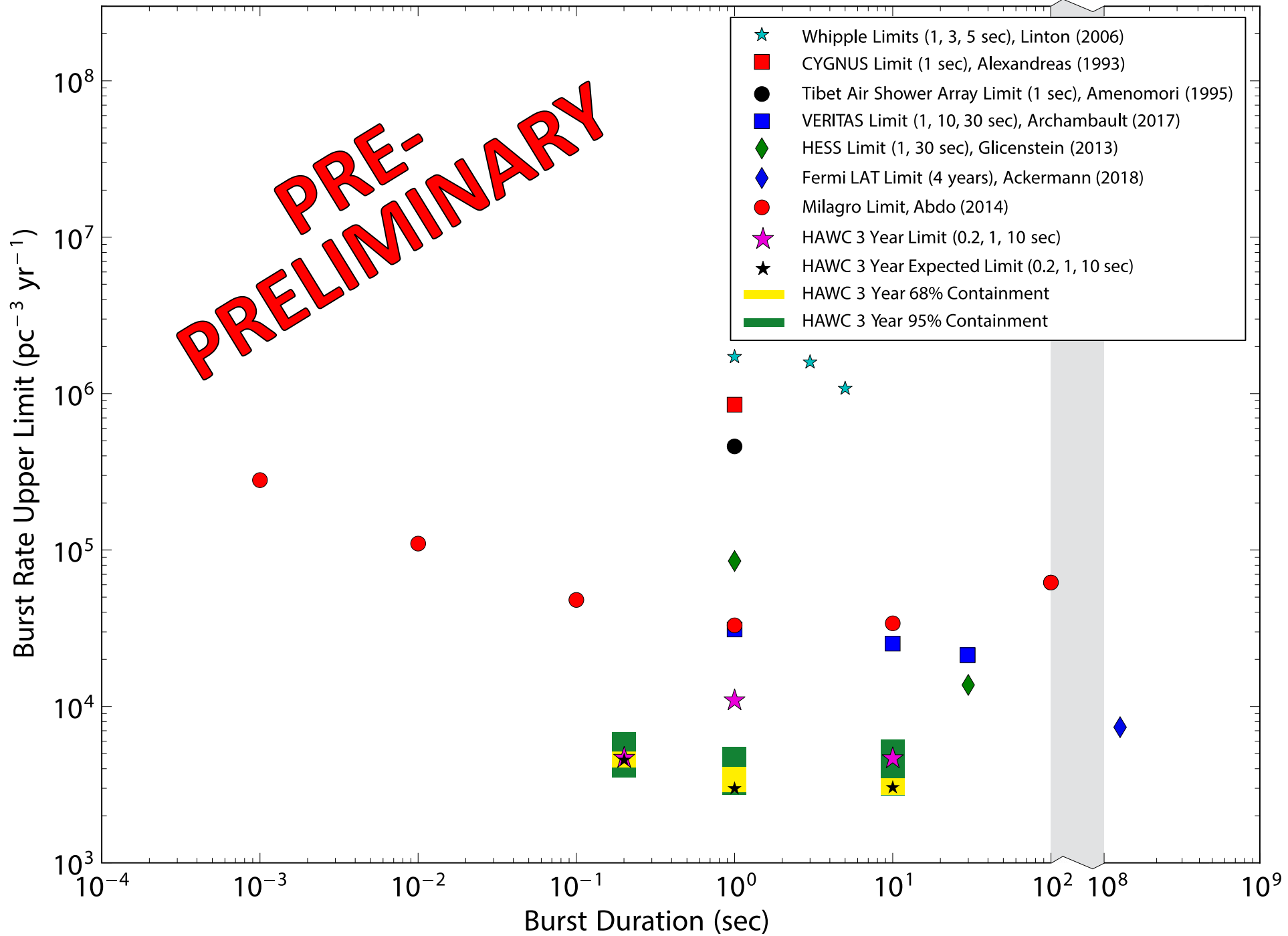


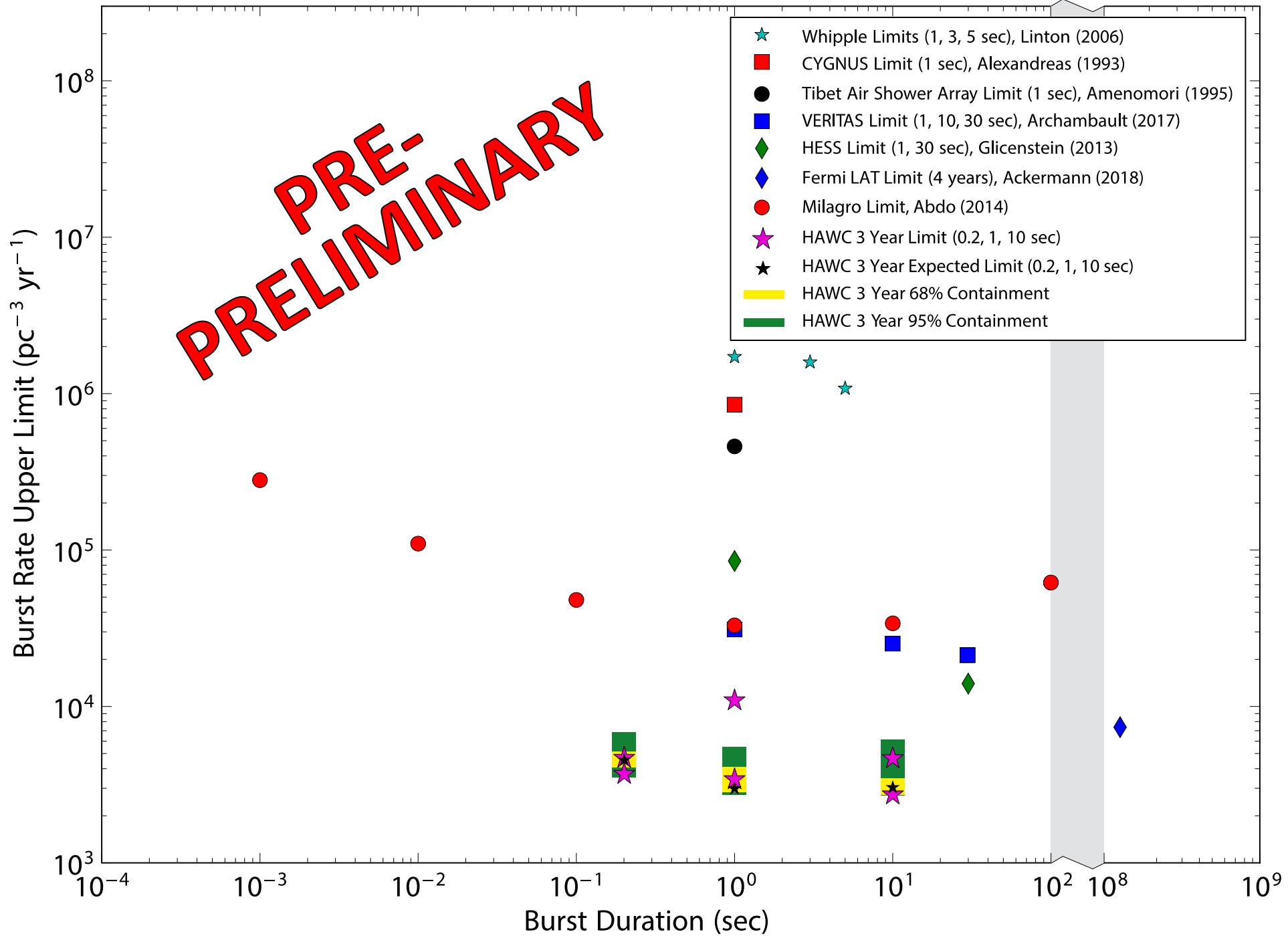
# Brazil bands (very preliminary)

- Poisson fluctuate each background bin to create “fake data” file
- Run the limit calculation with these “fake data” files to get new limit value
- Repeat 1000 times to get the brazil bands
- Only run 10 for now









# Expected and actual limits using different thresholds

EXPECTED		0.2s		1s		10s	
Threshold	Limit	p-value cut	Limit	p-value cut	Limit	p-value cut	
Bkg = 25	4144	1e-11	3357	1.585e-11	3178	5.012e-11	
Bkg = 10	4145	3.981e-12	3358	6.31e-12	3178	1.995e-11	
Data = 0	4190	3.162e-14	3575	2.512e-15	3192	2.512e-13	

ACTUAL		0.2s		1s		10s	
Threshold	Limit	p-value cut	Limit	p-value cut	Limit	p-value cut	
Bkg = 25	4981	1e-11	11238	1.585e-11	5615	5.012e-11	
Bkg = 10	4833	3.981e-12	11012	6.31e-12	5091	1.995e-11	
Data = 0	3820	3.162e-14	3492	2.512e-15	2860	2.512e-13	