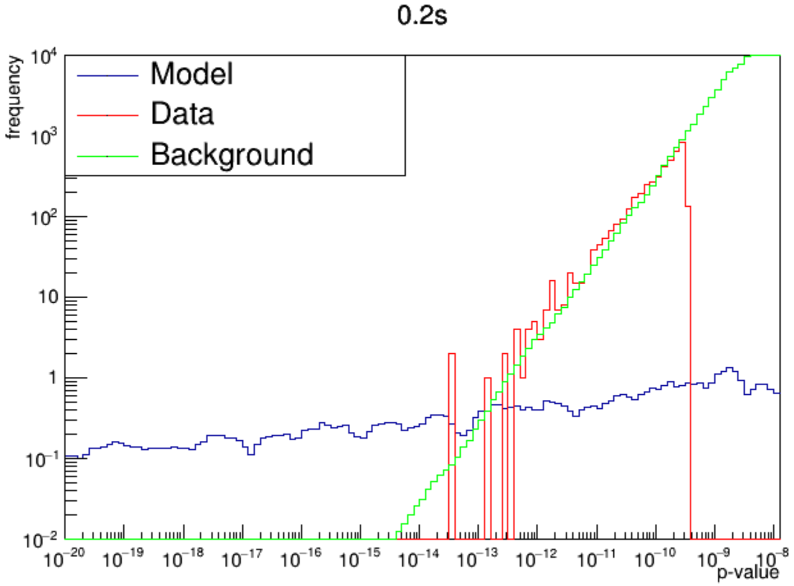
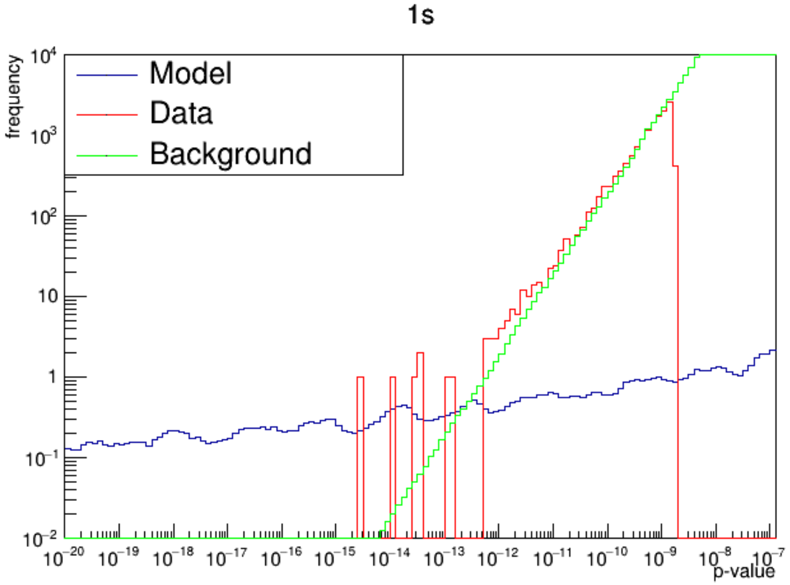
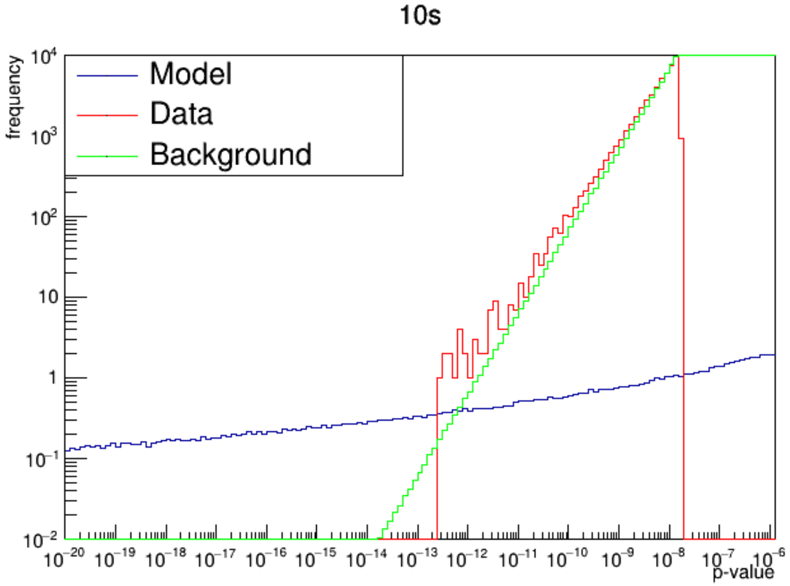
PBH Update

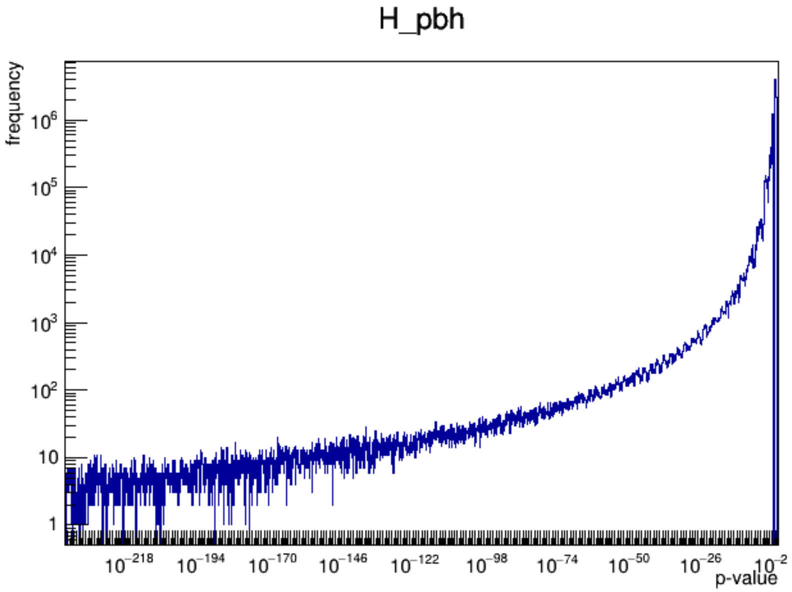
Group meeting 2/28/19

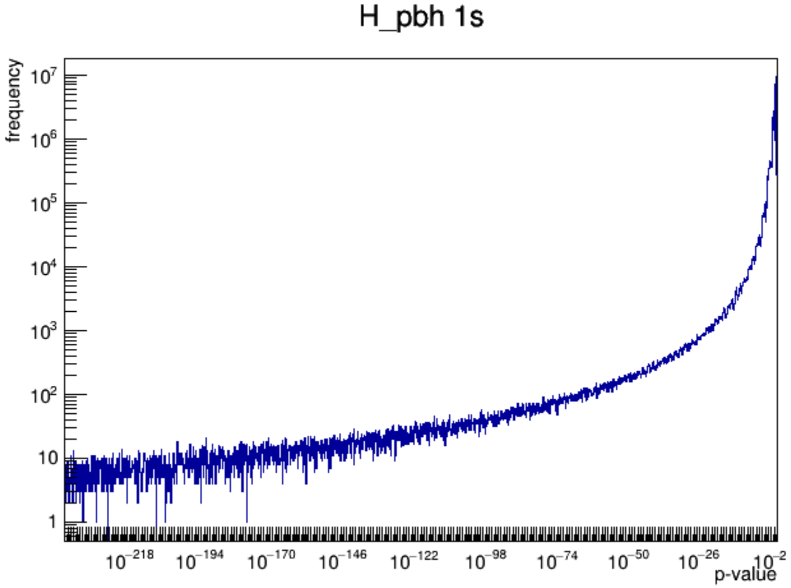
Threshold studies

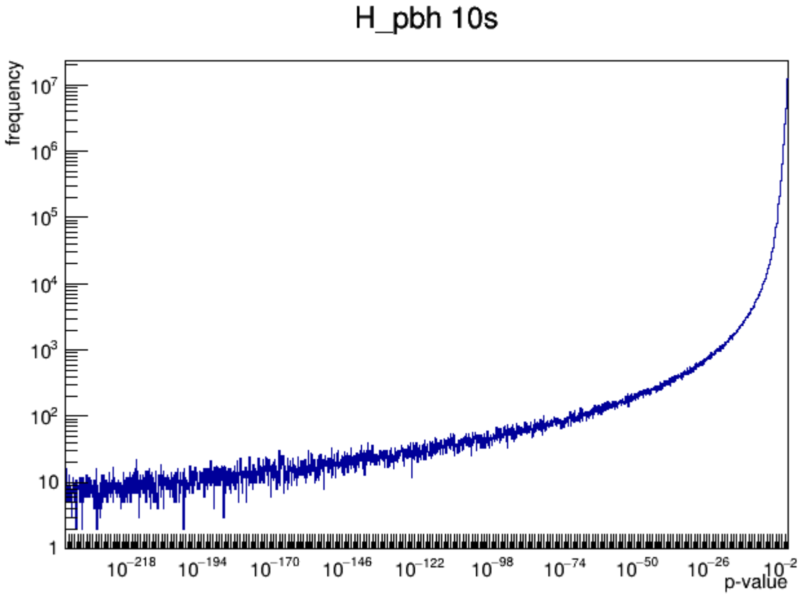










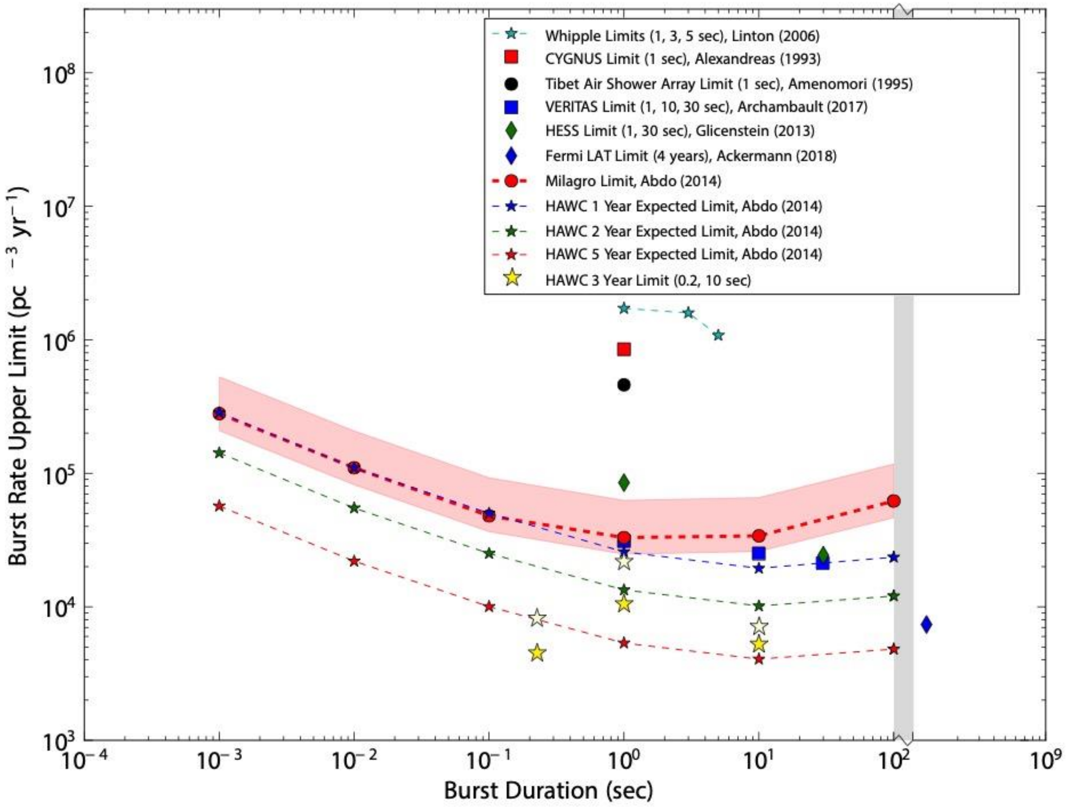


Threshold studies

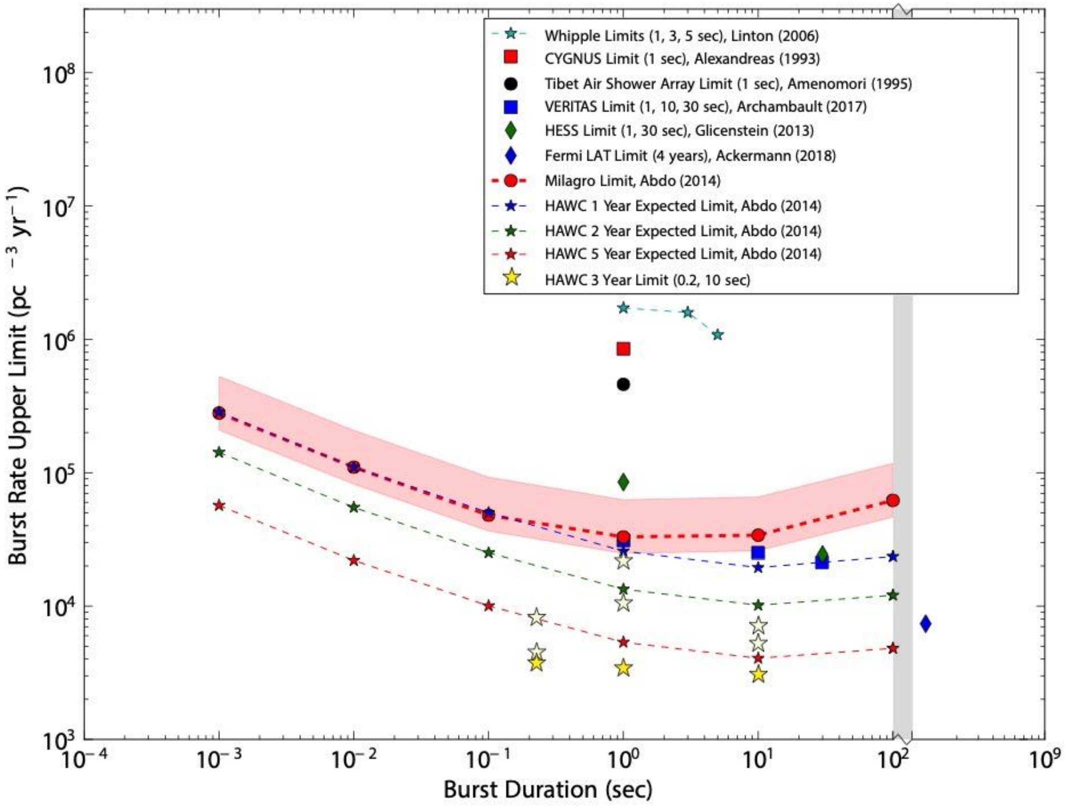
0.2 s		1 s		10 s	
Upper threshold	Limit	Upper threshold	Limit	Upper threshold	Limit
1e-12	4636	1e-12	10167	1e-11	5186
3.162e-14	3895	2.5e-15	3819	2.5e-13	2969

- Lower threshold is p = 1e-125 for all of the above
- The first upper threshold corresponds to where the MC matches the data
- The second upper threshold corresponds to where there are no more events

Preliminary results, plotted



Data/MC agreement threshold



0 data threshold

Future work

- Run more MC until get ~25 events in p = 1e-180 bin in H_pbh
  - This yields ~1% error on limit value
- Spring break next week
- Committee meeting April 9 or 10
- APS April meeting April 13-16

Backup

5. For each PBH, determine the p-value p of N given the thrown B. Josh uses a Poisson valued as

$$prob(\geq N) = \sum_{i=N}^{\infty} \frac{B^i \exp(-B)}{i!} = 1 - \frac{\Gamma(N,B)}{\Gamma(N)} \tag{1.1}$$

where $\Gamma(N)$ is the gamma function and $\Gamma(N,B)$ is the upper incomplete gamma function.

Upper Limit with Log Likelihood

- **For each value of D, the PBH burst duration:**

1. Calculate the background Poisson log-likelihood

$$\ln \mathcal{L}_0 = \sum_p \left[H_{data}(p) \ln \left(H'_{bkg}(p) \right) - H'_{bkg}(p) \right]$$

Observed “bursts” from Josh’s simple-grb results

Background distribution scaled to the time of the searched data

2. Calculate the model Poisson log-likelihood

$$\ln \mathcal{L}_1 = \sum_p \left[H_{data}(p) \ln \left(H_{model}(p) \right) - H_{model}(p) \right]$$

Observed “bursts” from Josh’s simple-grb results

PBH distribution + background distribution (both scaled)

*factorial term neglected as it will cancel out later

Upper Limit with Log Likelihood

3. Calculate the TS for the rate of PBH bursts, R, being evaluated

$$TS = 2\left[\ln \mathcal{L}_1 - \ln \mathcal{L}_0\right]$$

4. Find the value of R that yields the largest TS → TS_{max}

5. Define: $$TS_{99} = TS_{max} - 5.41$$

6. Starting with the rate that yielded TS_{max}, repeat steps 1 – 3 until:

$$TS = TS_{95}$$

The rate that satisfies this expression is the limit for the PBH burst duration currently being evaluated.

0.2s				1s				10s			
Threshold	1e-20	1e-80	1e-125	Threshold	1e-20	1e-80	1e-125	Threshold	1e-20	1e-80	1e-125
2e-10	17959	5797	5464	1e-9	-	13248	12361	1e-8	71537	9089	7898
1e-10	18325	5844	5505	1e-12	-	10816	10167	1e-11	27702	5712	5186
1e-12	12029	4877	4636	1e-14	16537	6272	5901	-	-	-	-
1e-14	9840	4279	4084	1e-15	11011	3914	3693	1e-13	7304	3240	3054
3.162e-14	8809	4071	3895	2.5e-15	10294	3819	3608	2.5e-13	6839	3145	2969
1e-17	24214	5768	5420	1e-18	33794	5147	4771	1e-16	15868	4260	3944
1e-20	-	7517	6937	1e-21	-	6514	5924	1e-19	70946	5381	4886