

The Interplay of Machine Learning-based Resonant Anomaly Detection Methods

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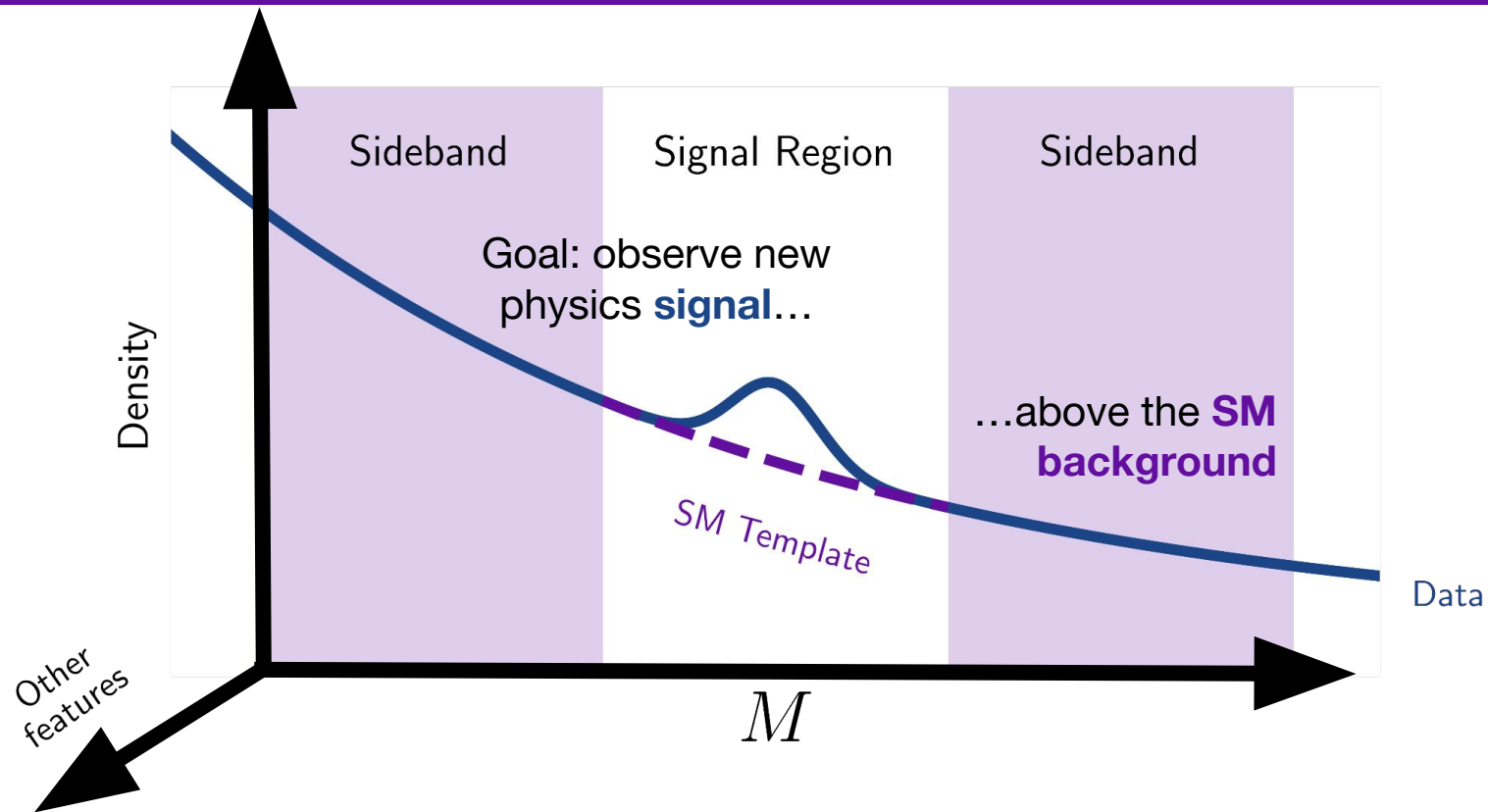
Hammers & Nails 2023

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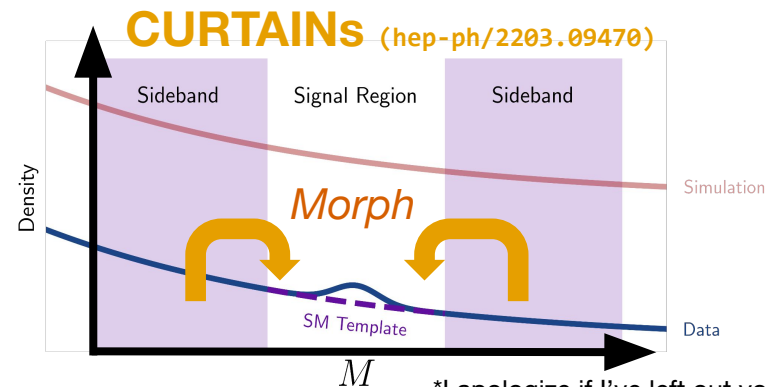
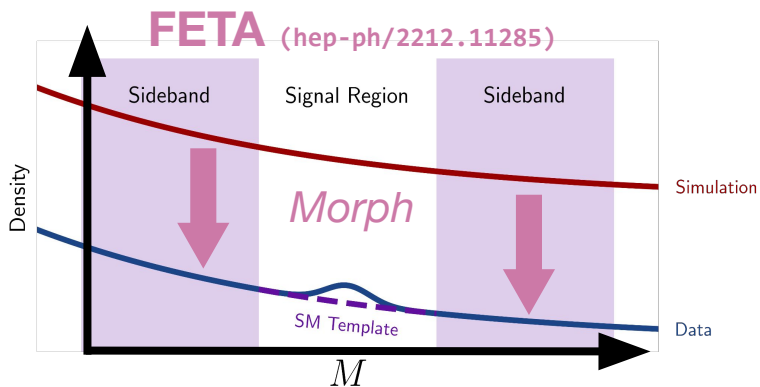
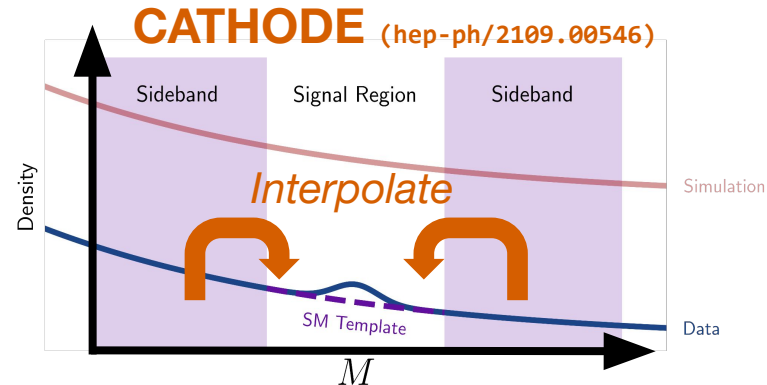
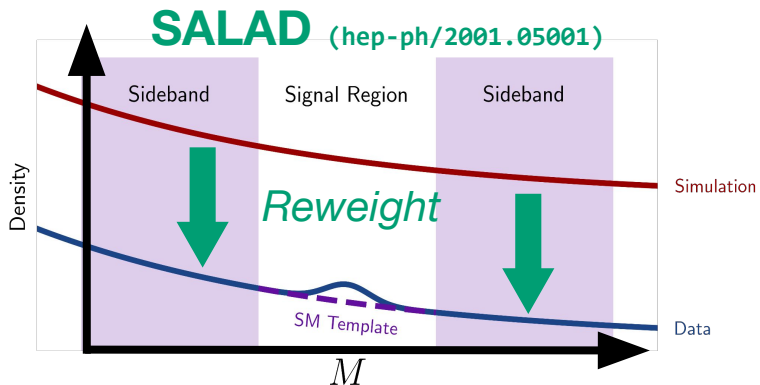


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Resonant anomaly detection as a search strategy

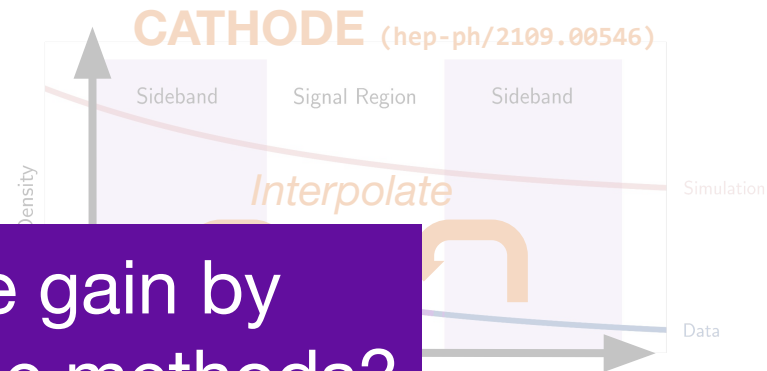
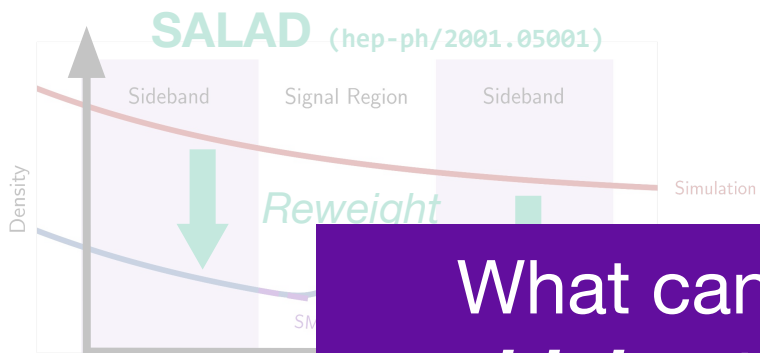


Many* ML techniques can construct the SM Template

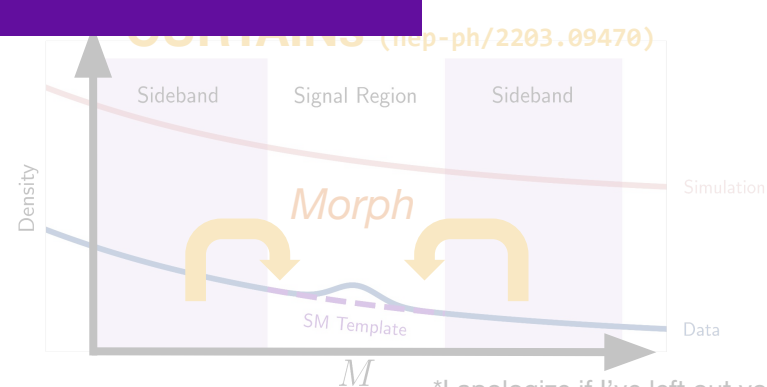
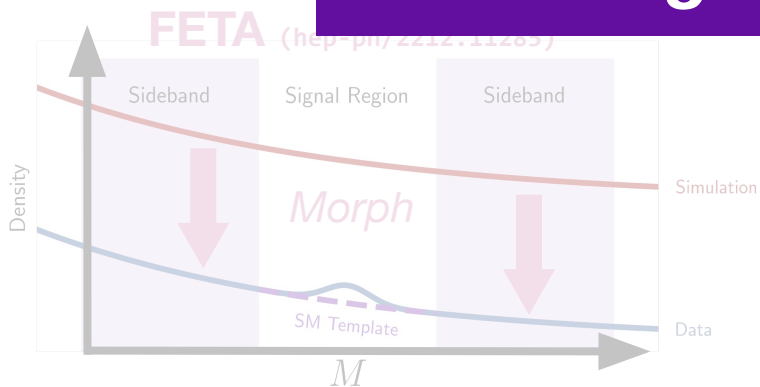


*I apologize if I've left out your favorite!

Many* ML techniques can construct the SM Template

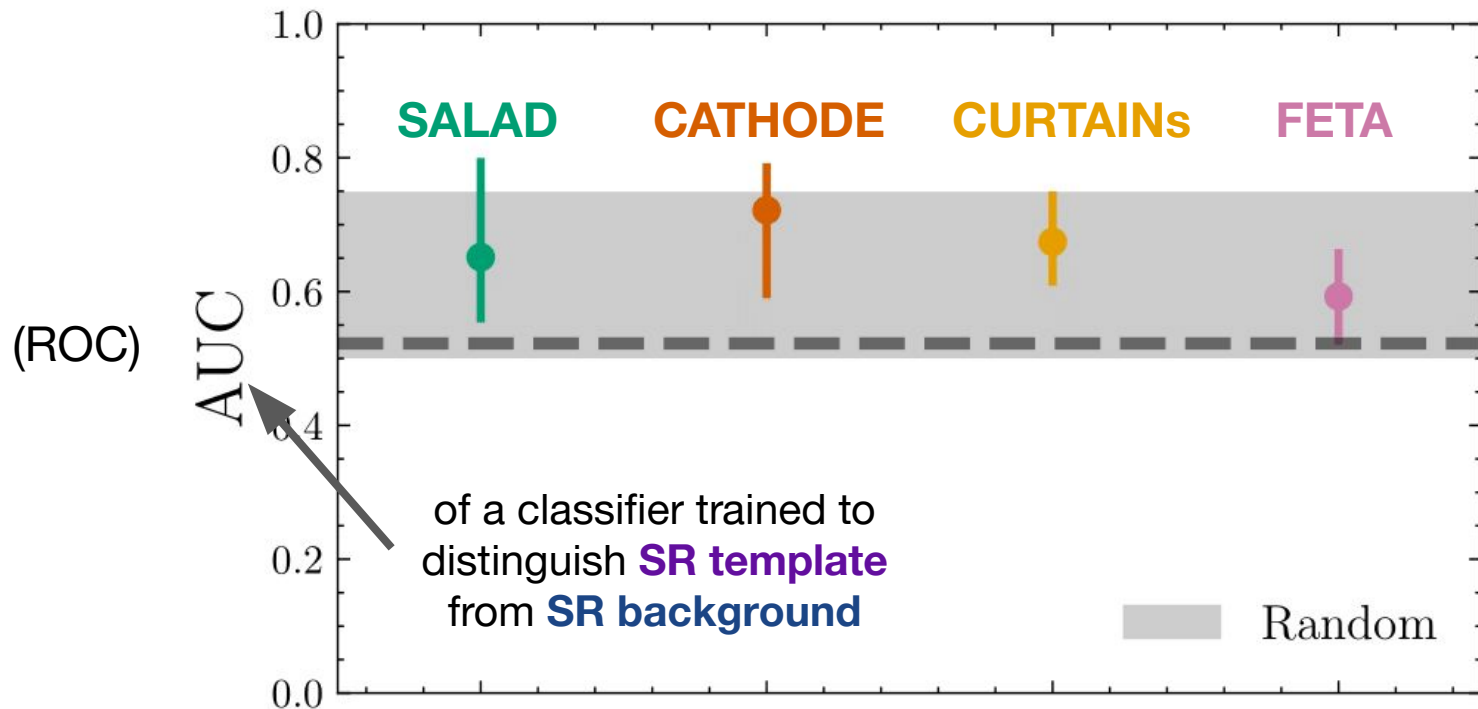


What can we gain by **combining** these methods?

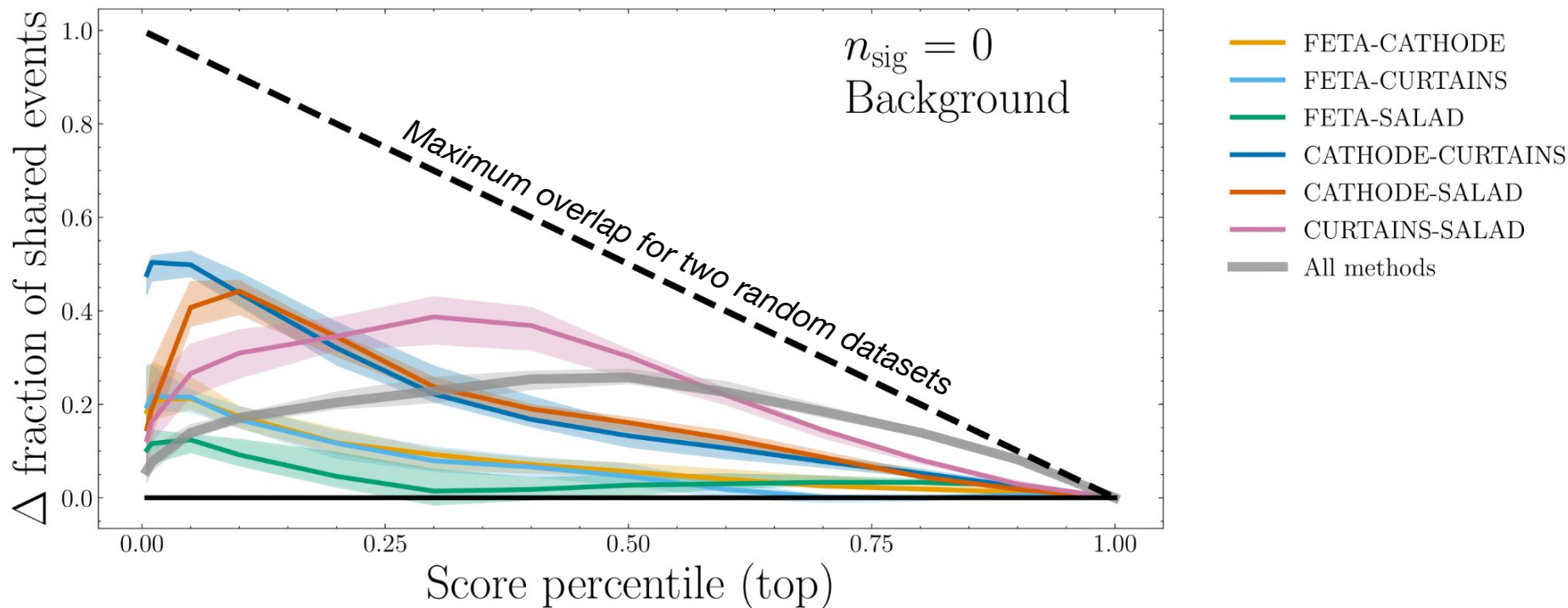


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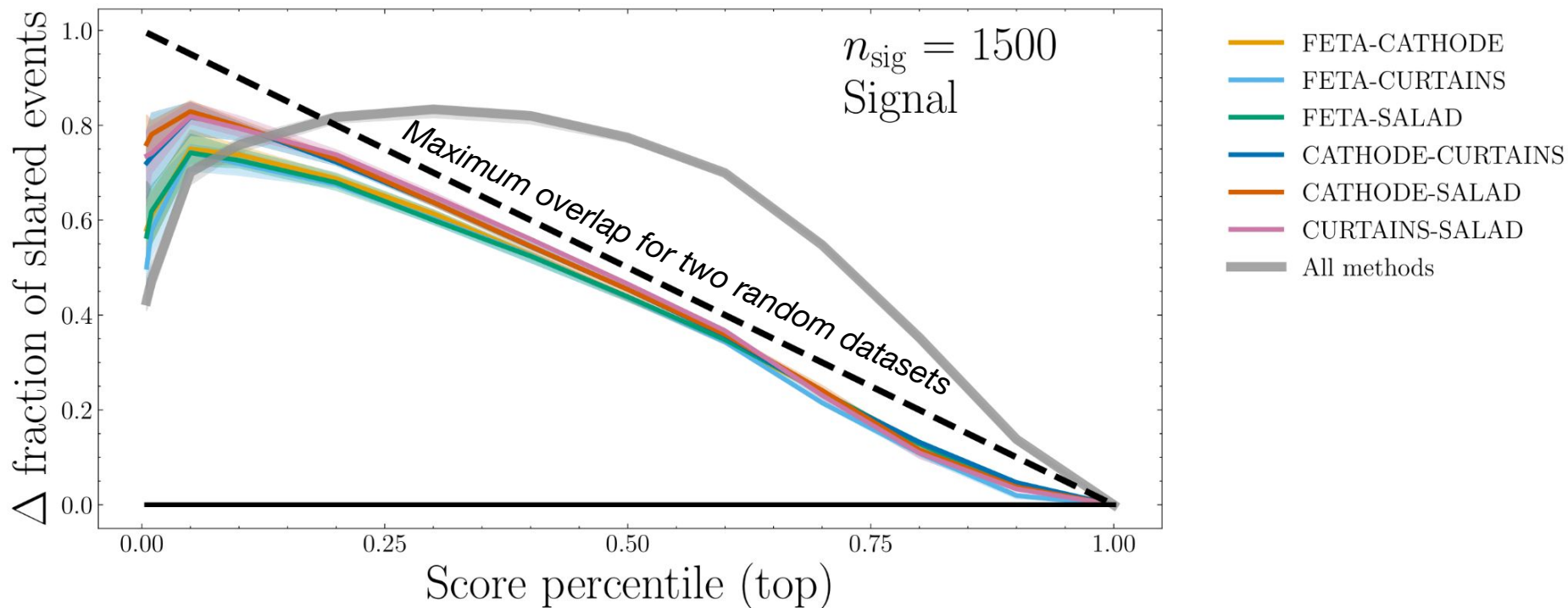
Study #1: are the samples good proxies for SM background?



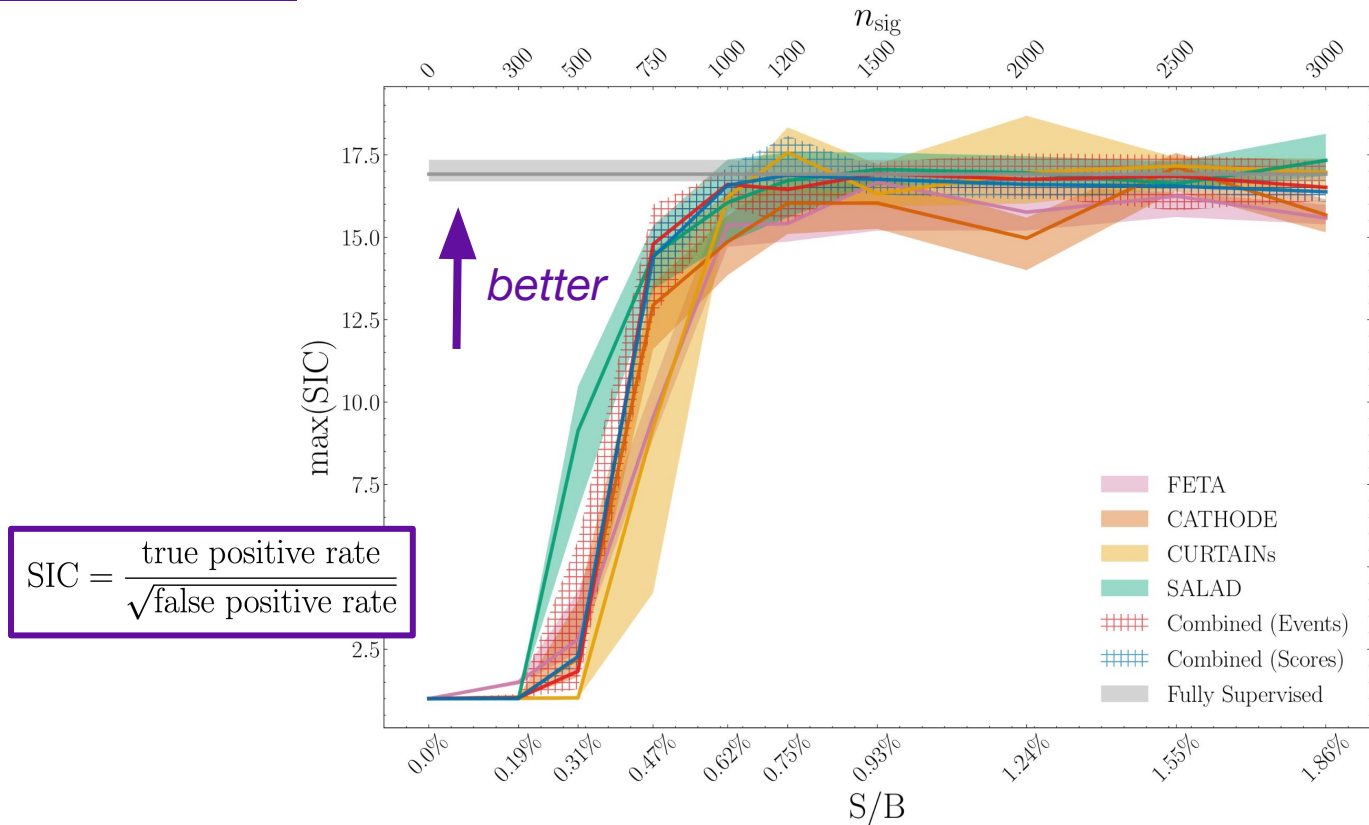
Study #2: do the samples agree on “anomalous” background?



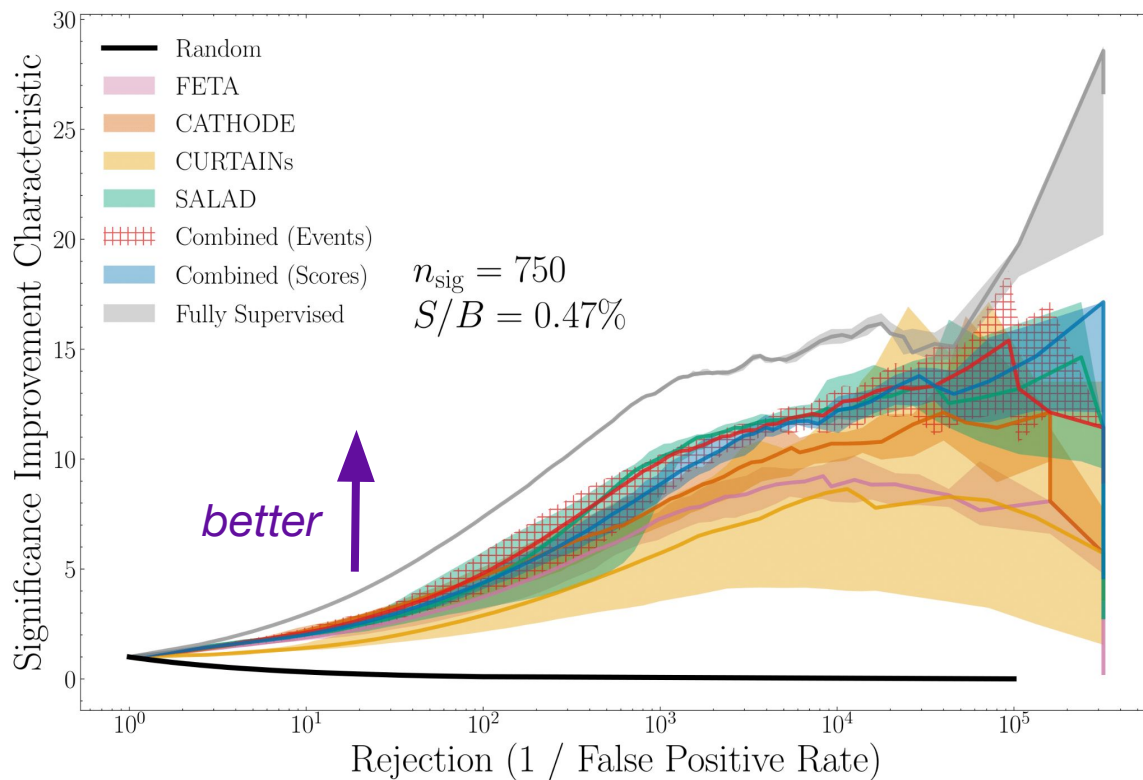
Study 3: do the samples agree on signal?



Combination appears to stabilize and improve performance...



...across a range of signal efficiencies

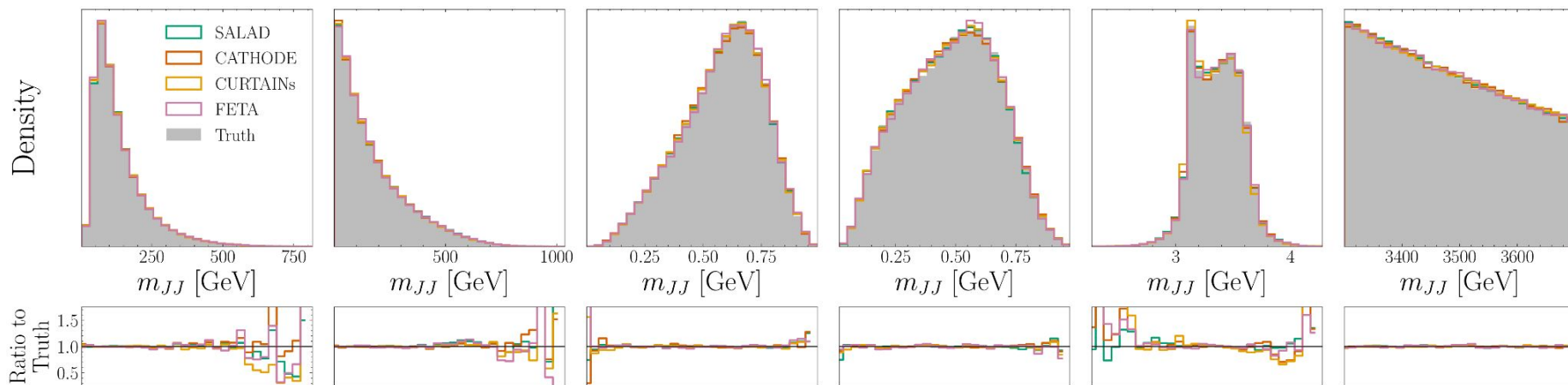


Closing thoughts

- The LHC Olympics dataset has been almost exclusively used for resonant AD.
We should be testing on a variety of signal models!
- SALAD appears to beat the combined methods, but reweighting needs regions of overlapping support.
 - **What signals could break SALAD?**
 - Would the combination of samples still perform well on these models?
 - Note that sample combination can be **weighted** (though not explored here).

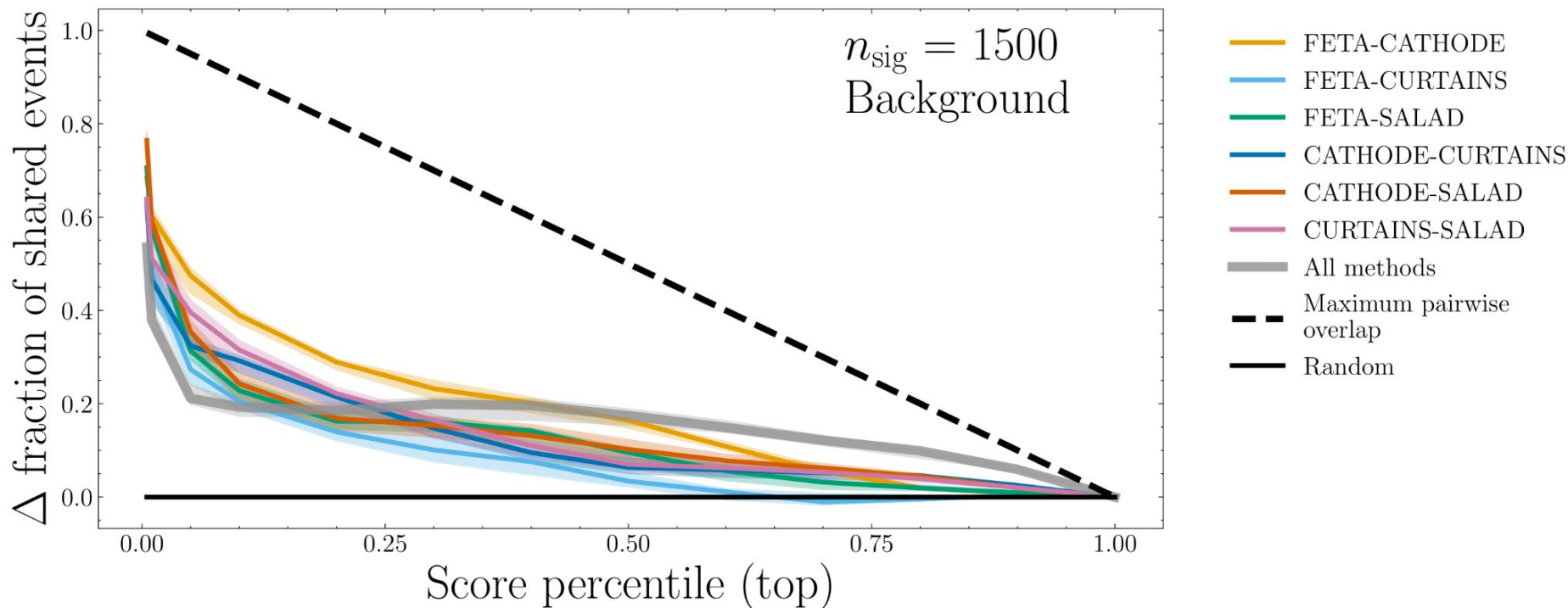
Backup slides

The LHC Olympics Dataset

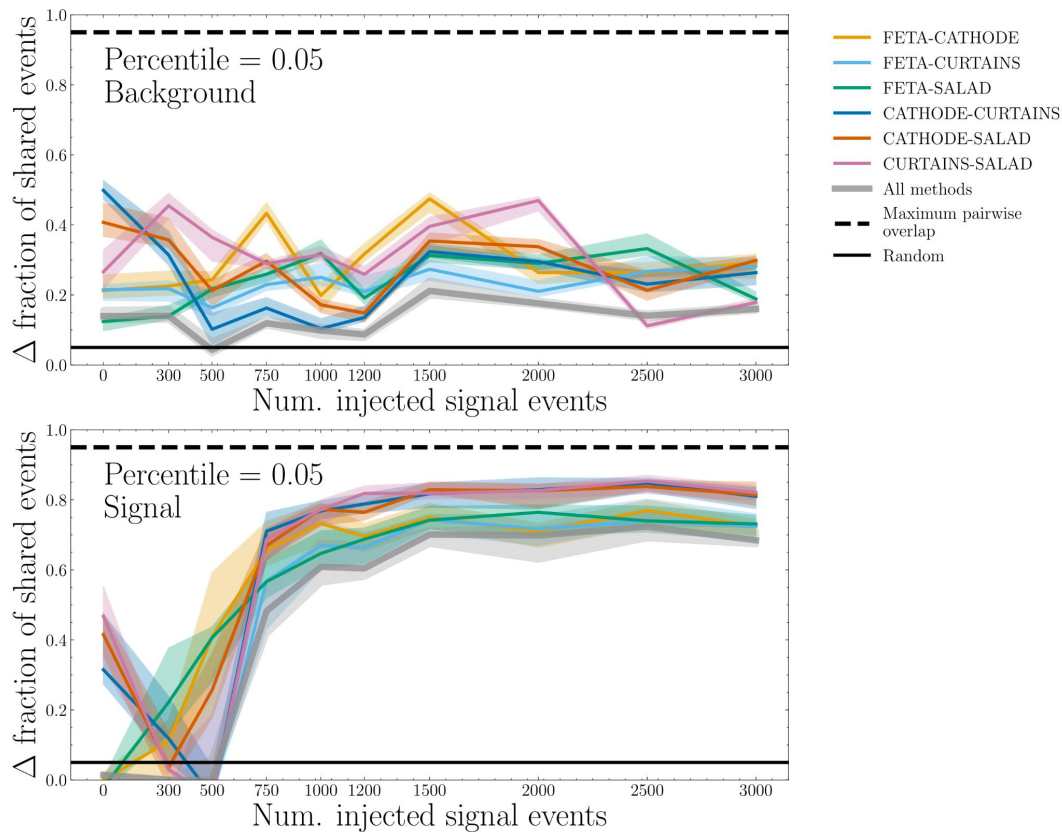


Method	Training data	Validation data	# samples	Oversampling
SALAD	793k SIM, 696k DAT	198K SIM, 174K DAT	1,045k	N/A
CATHODE	696k DAT	174K DAT	400k	3
CURTAINS	373k DAT	93k DAT	1,887k	4
FETA	793k SIM, 696k DAT	198K SIM, 174K DAT	732k	6

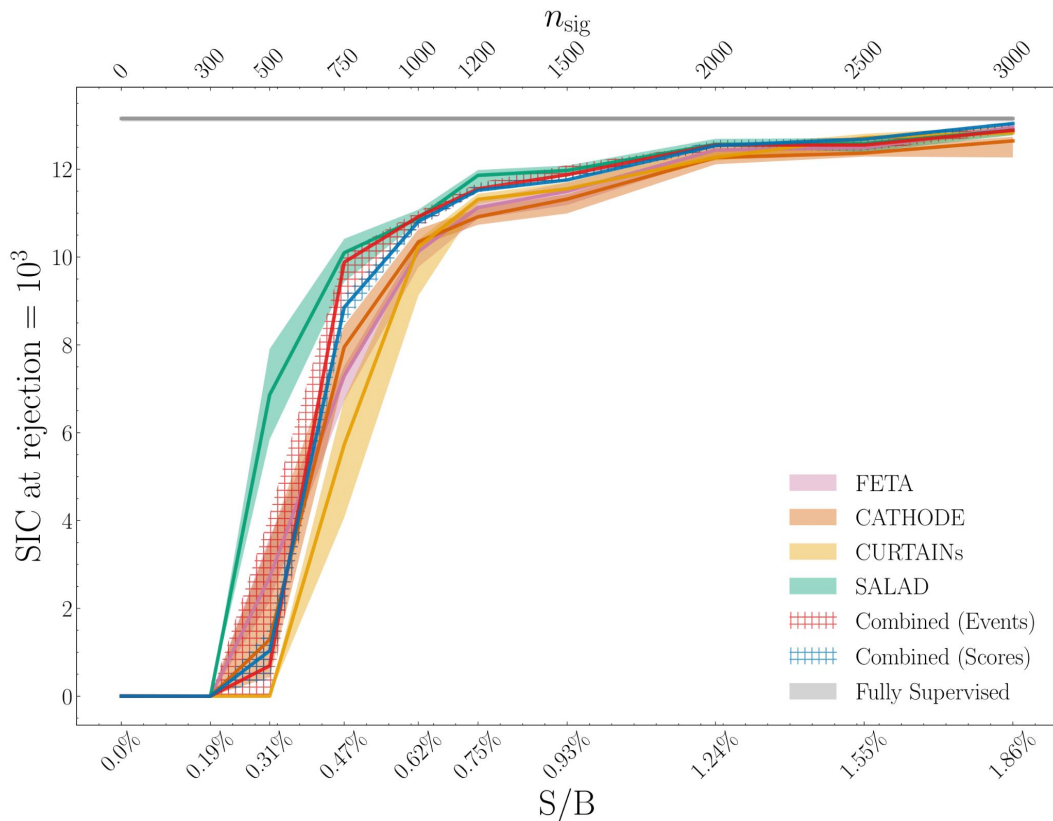
Background overlaps do not agree when there is signal



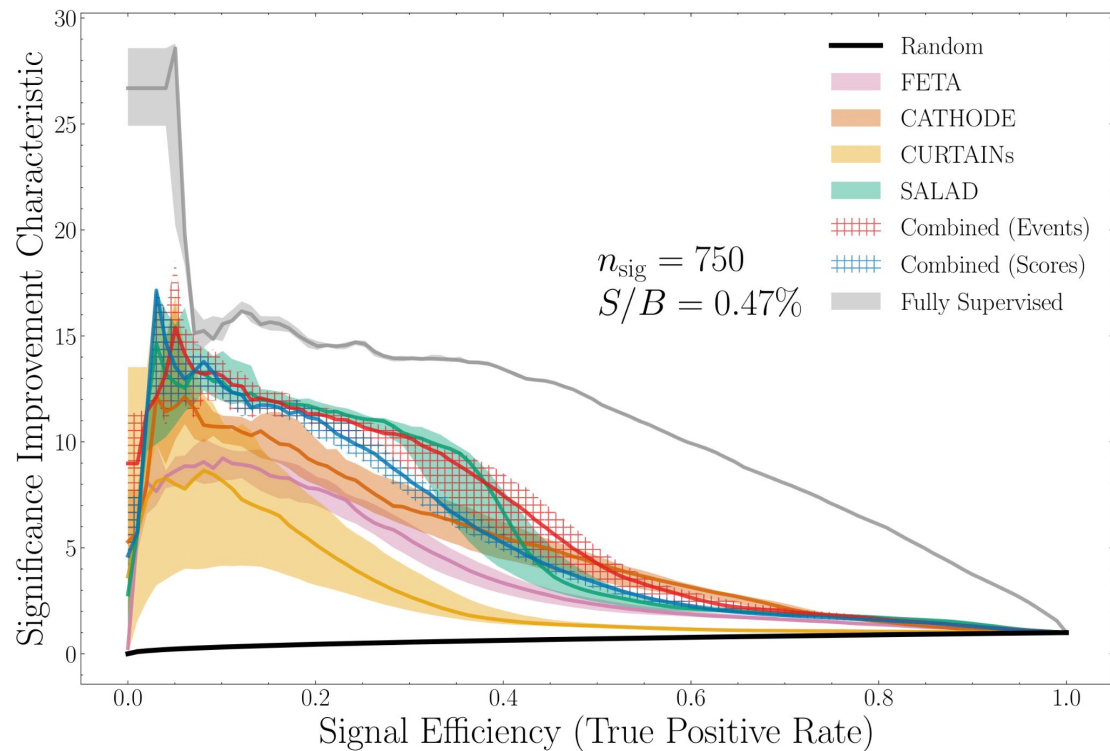
The overlap of signal-like events is stable with n_{sig}



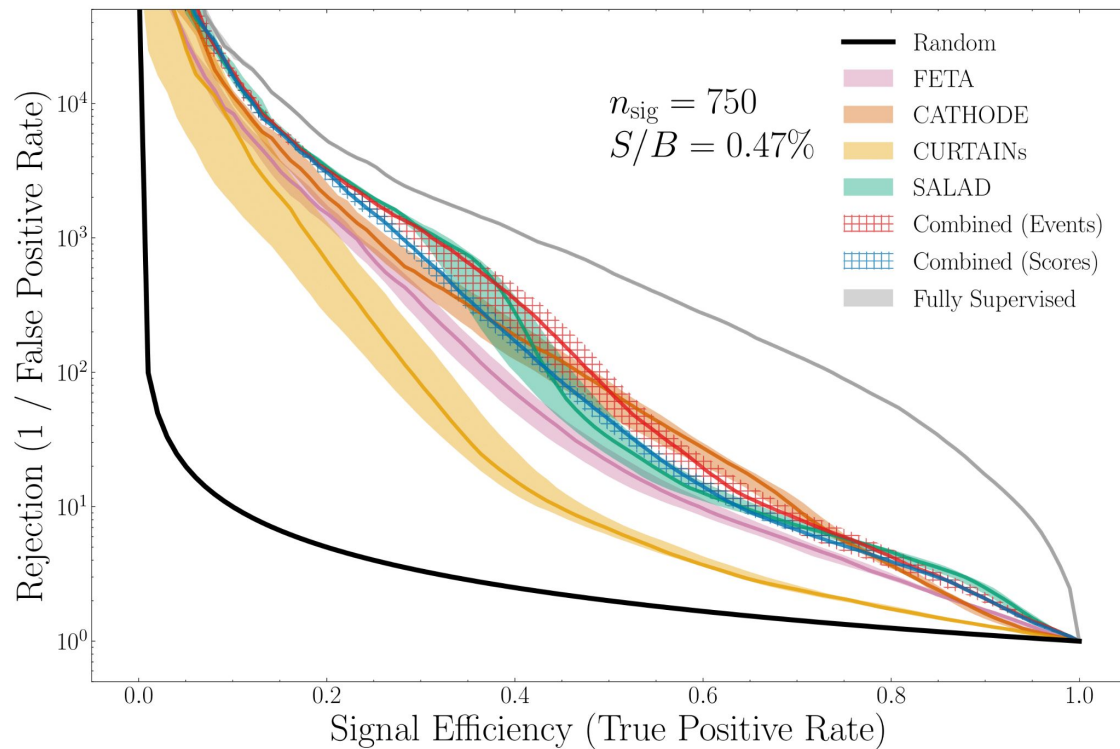
SIC at rejection = 1000



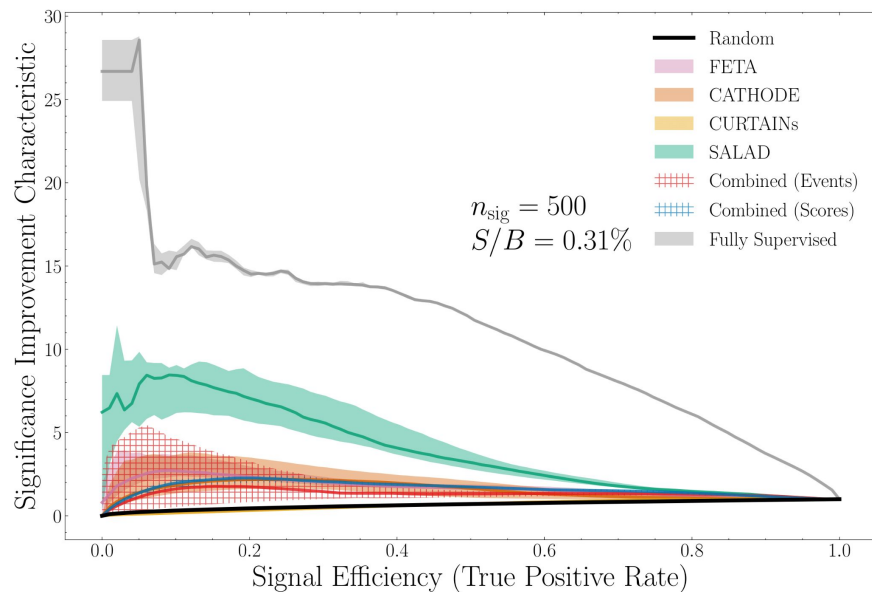
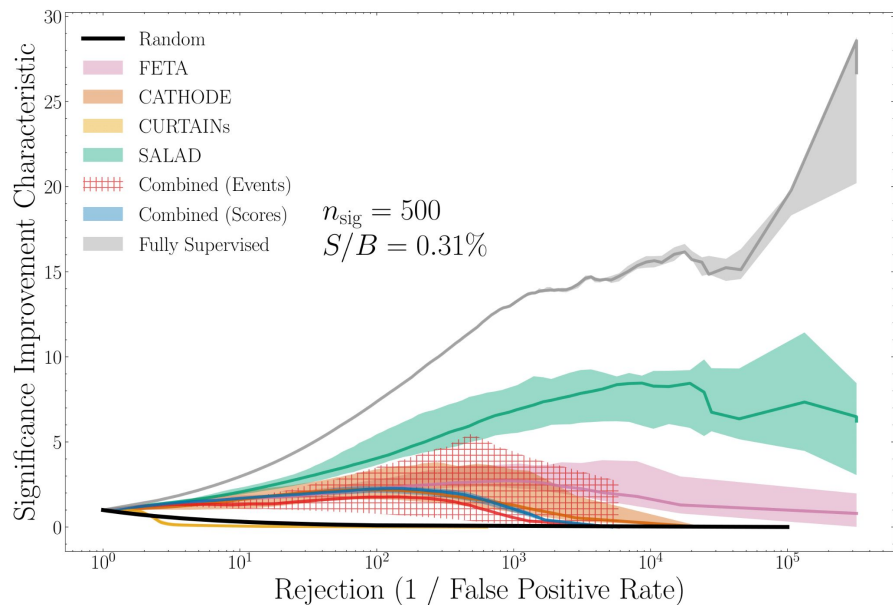
Classifier SIC for $n_{sig} = 750$



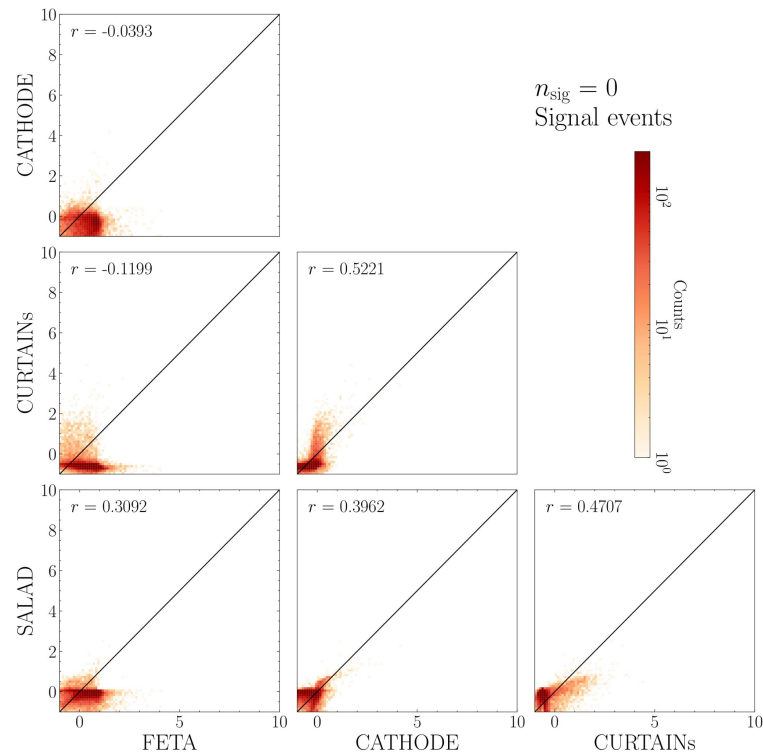
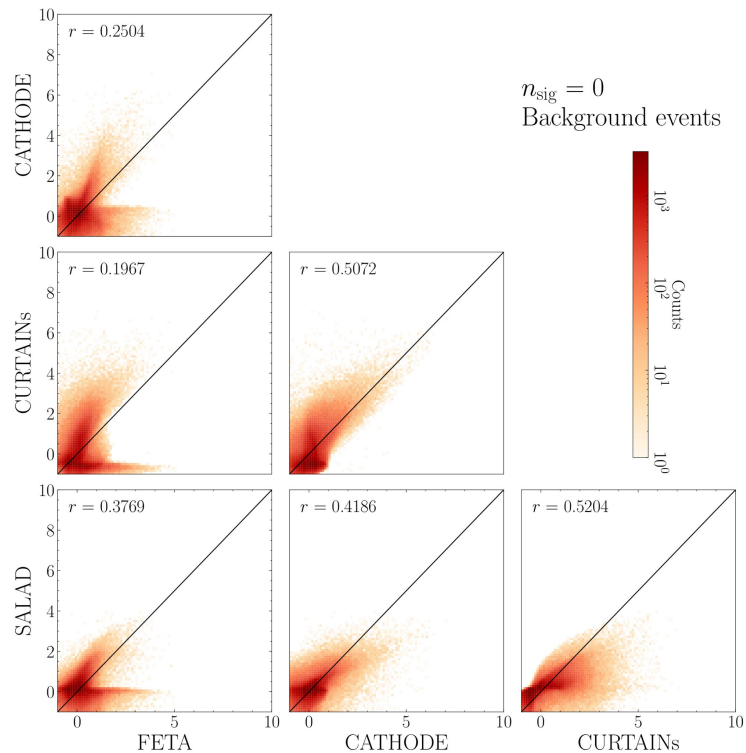
Classifier rejection for $n_{sig} = 750$



Classifier metrics for $n_{sig} = 500$



Correlations of scores: background only



Correlations of scores: $n_{sig} = 1500$

