# ADAPTIVE INCREMENTAL DYNAMIC ANALYSIS (AIDA)
## PEER Transportation Systems Research Program

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Motivation: IDA vs. PSHA

Incremental dynamic analysis (IDA) uses the same ground motions for all intensity (IM) levels to obtain structural response (EDP)
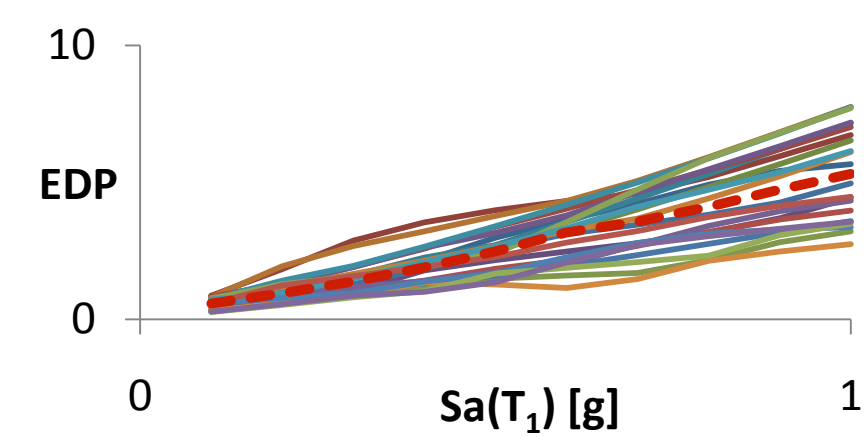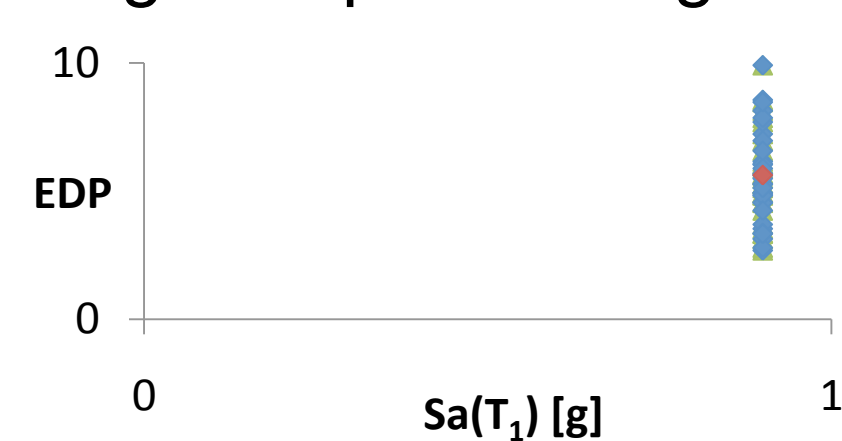

Probabilistic Seismic Hazard Analysis (PSHA) shows that important ground motion properties change as IM levels change
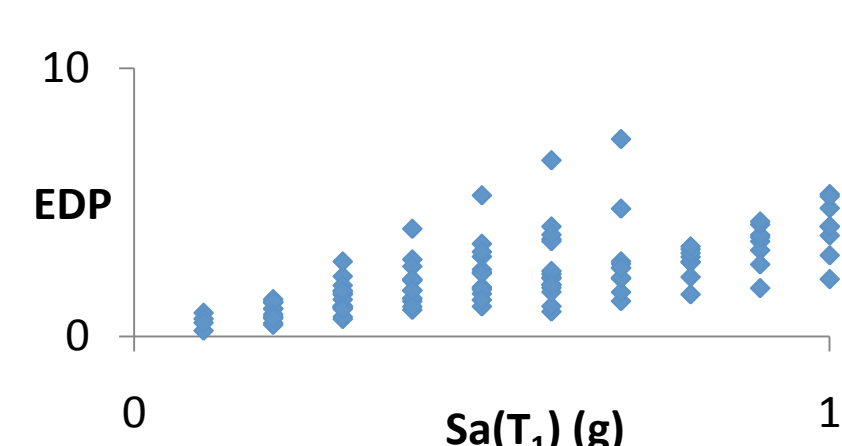

20% in 50 yr return period   2% in 50 yr return period

USGS deaggregations
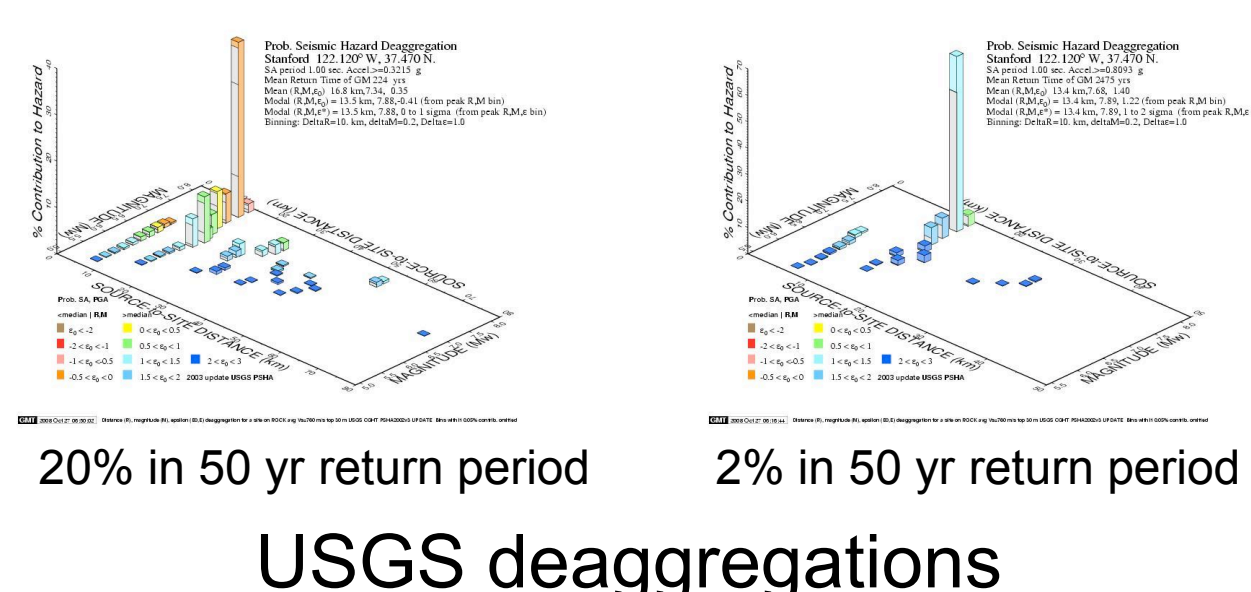
PSHA-consistent ground motions

To match ground motion properties, ground motions can be re-selected at each IM level
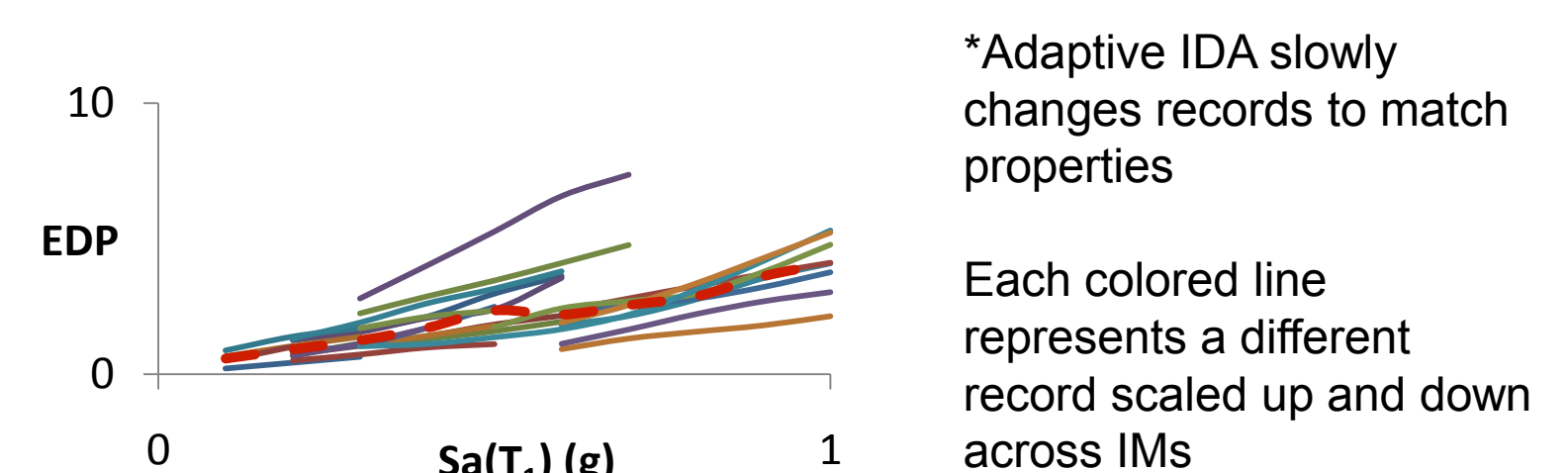
"Single stripe" for single IM level

"Multiple stripes" for multiple IM levels

Ground motion continuity is lost when using stripes

AIDA = IDA + PSHA consistency

- Adaptive incremental dynamic analysis (AIDA) makes adaptive changes to ground motions for IDA
- This allows us to vary ground motions as the IM level changes, while partially maintaining ground motion continuity

*Adaptive IDA slowly changes records to match properties

Each colored line represents a different record scaled up and down across IMs

	Single Stripe	Traditional IDA	Multiple Stripes	Adaptive IDA
IM levels	Single	Multiple	Multiple	Multiple
Matching properties	Yes	No	Yes	Yes
Adaptive records	N.A.	No	Yes	Yes*
Continuity in records	No	Yes	No	Yes*

## AIDA algorithm

Potential record selection criteria:
- Magnitude (M) and distance (R) from deaggregation
- Target spectrum, such as the Conditional Mean Spectrum (CMS)

Steps to perform AIDA:
1. Obtain target M/R or CMS for each IM level
2. Determine "bin sizes" (i.e., tolerance for acceptable ground motion properties)
3. Identify all candidate ground motions that fall within target bins
4. Keep ground motions that are usable at multiple IM levels, to maintain continuity
5. Use each ground motion for IDA analysis within its allowable IM range

M, R-based AIDA

PSHA deaggregation implies that M, R change as IM levels change
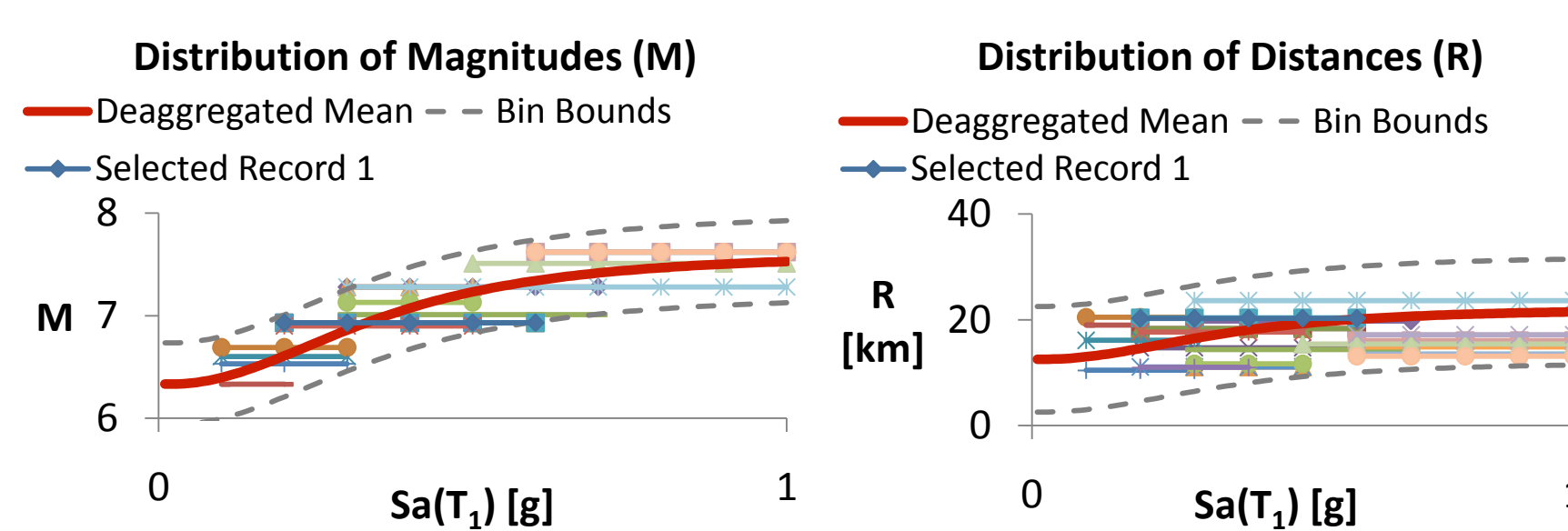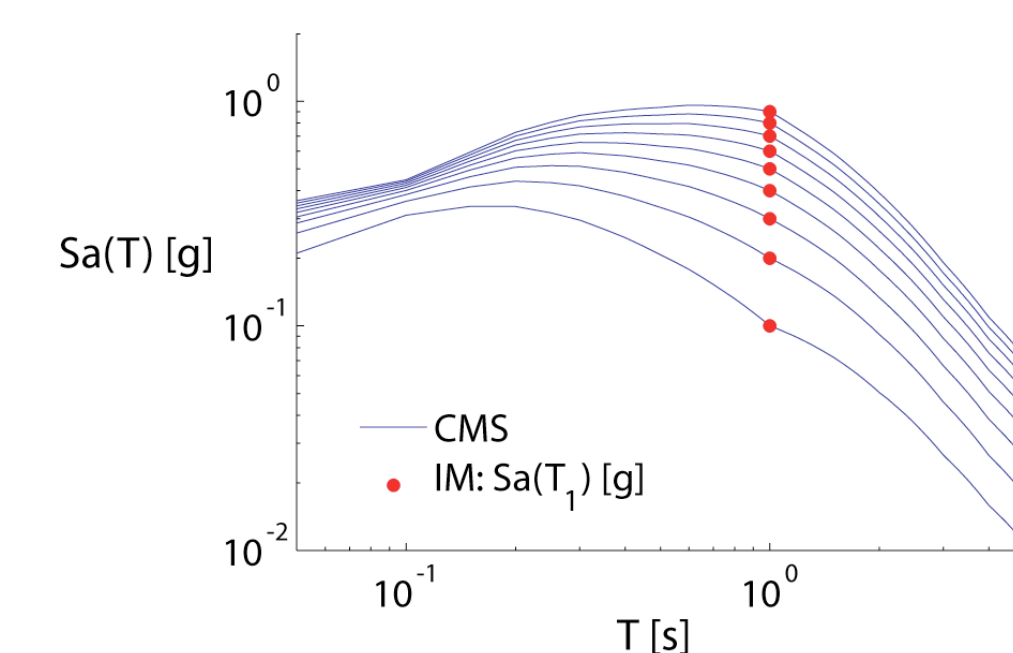

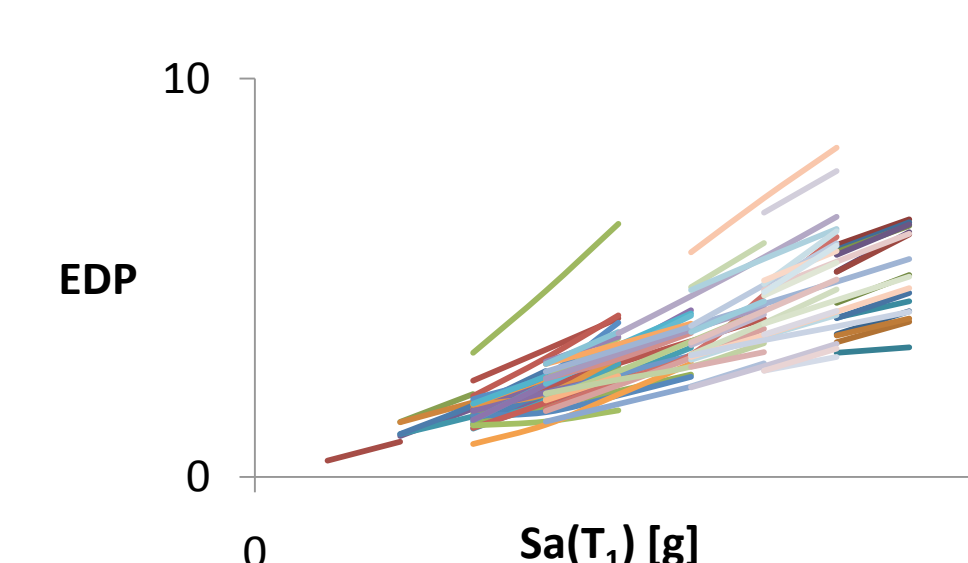AIDA selects ground motions that match deaggregation results
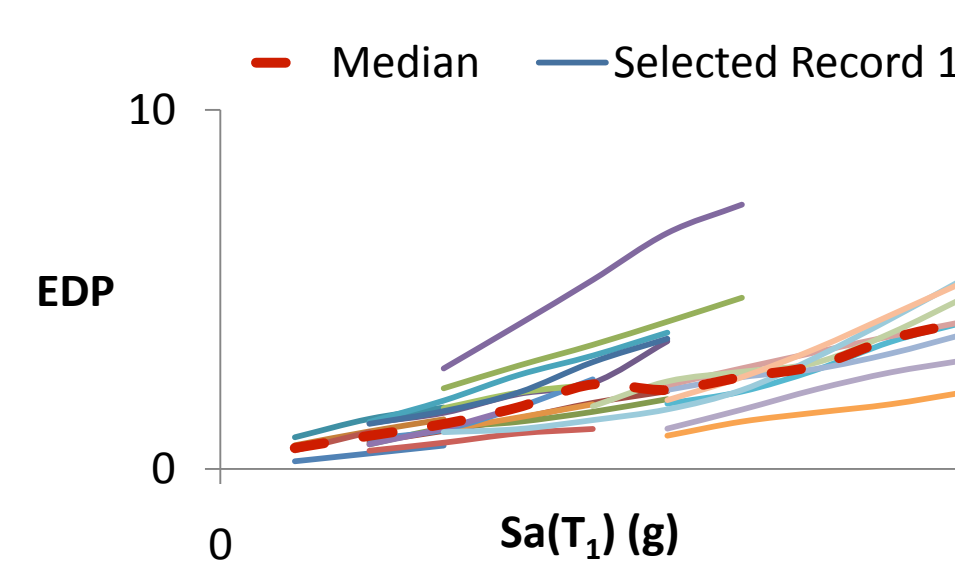
CMS-based AIDA

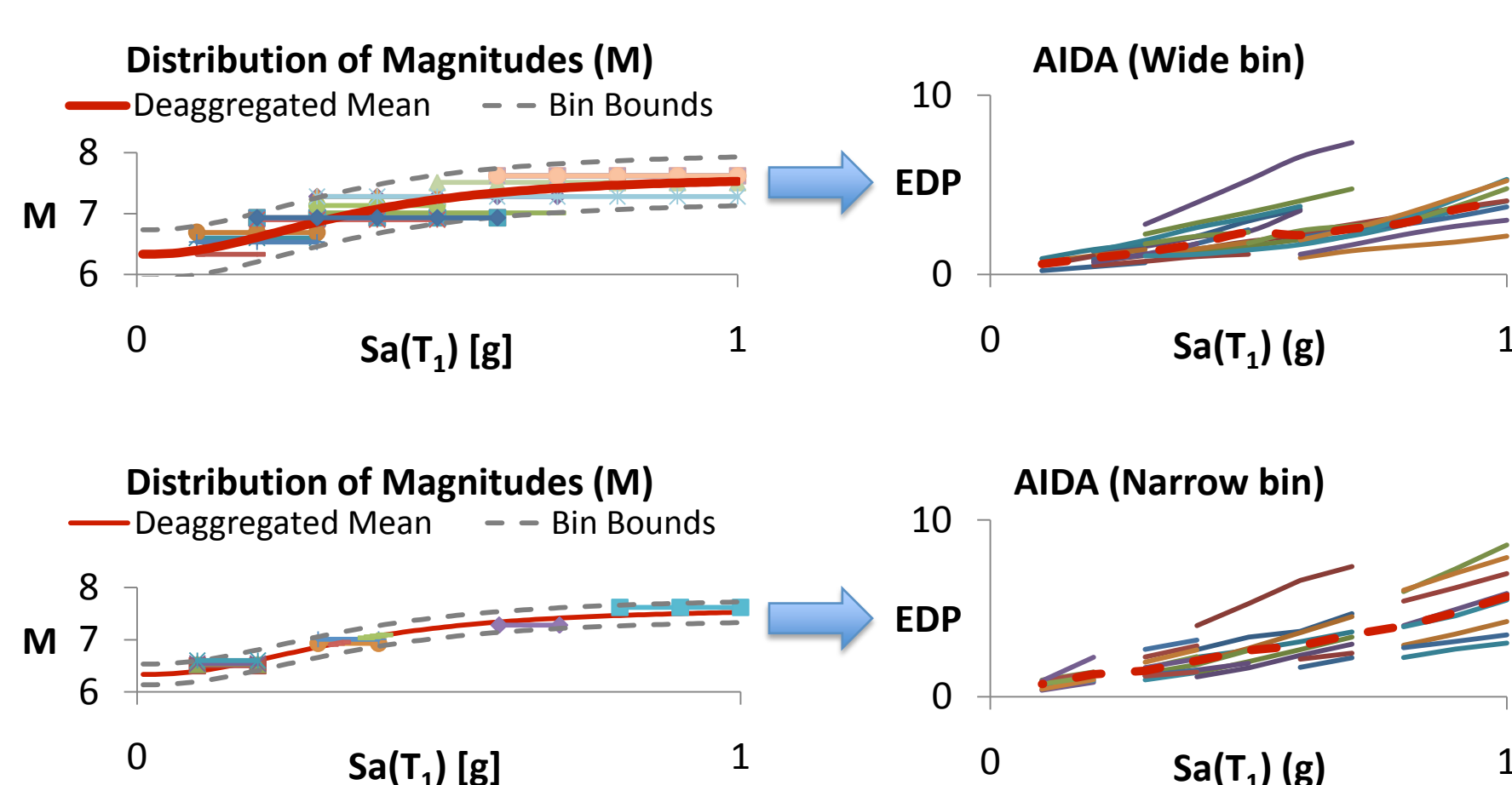CMSs change as IM levels change

AIDA selects ground motions to reflect such changes

Bin size?

Effect of bin size (wide vs. narrow bins):

Bin size determines the degree of overlapping of ground motions

Challenges

- How frequently do we change records?
- What is the optimum number of records for each IM level?
- How does AIDA work for different structures and sites?
- To determine how much ground motions overlap, we need some optimization schemes (e.g. common records that minimize the sum of ranks over a specified IM range)

Conclusions

- AIDA matches ground motion properties at various IM levels, and maintains continuity by overlapping some ground motions
- Selection criteria can vary (e.g. M, R vs. CMS), and their bin size determines the degree of overlapping of ground motions
- Examples were used to illustrate the application of AIDA with variable selection criteria
- AIDA combines IDA and PSHA deaggregation, and hence an improvement over IDA for ground motion selection