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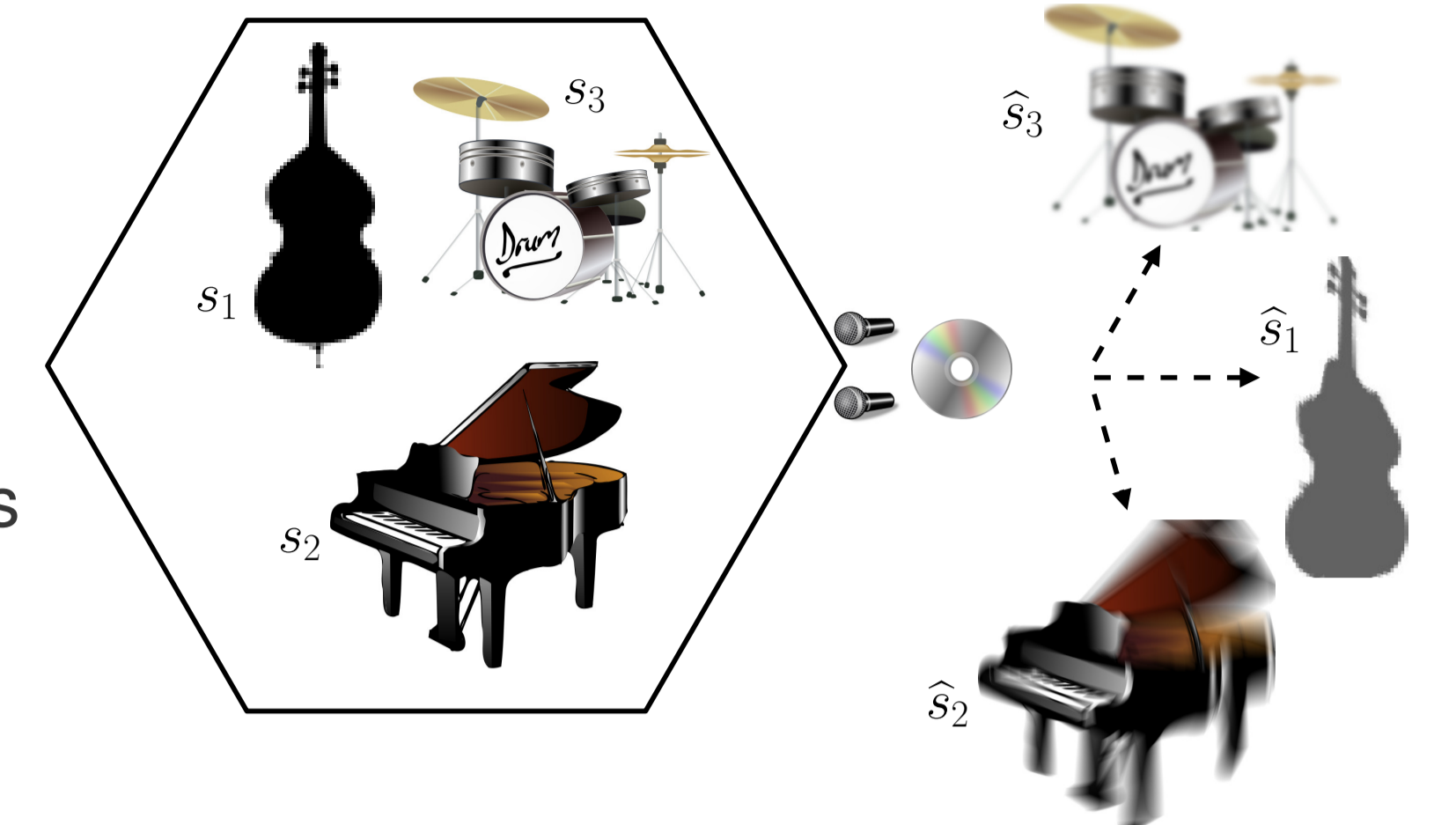
# The PEASS Toolkit - Perceptual Evaluation methods for Audio Source Separation

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## THE PEASS TOOLKIT: overview

A toolkit for the perceptual evaluation of audio source separation

- The PEASS Software: a set of objective measures to predict the perceptual quality of the source/image estimates
- The PEASS Listening Test GUI: a Matlab MUSHRA GUI realized for the proposed test protocol
- The PEASS Subjective Database: a set of subjective measures resulting from listening tests (20 subjects  $\times$  80 sounds  $\times$  4 rating criteria)



The PEASS Toolkit is freely available at  
<http://bass-db.gforge.inria.fr/peass/>

- [1] **Subjective and objective quality assessment of audio source separation**, V. Emiya, E. Vincent, N. Harlander, V. Hohmann, IEEE Trans. on Audio, Speech and Language Processing, submitted, 2010.
- [2] **Multi-criteria subjective and objective evaluation of audio source separation**, V. Emiya, E. Vincent, N. Harlander, V. Hohmann, AES 38th Int. Conf. on Sound Quality Evaluation, Pitea, Sweden, June 2010.

## MOTIVATION: the need for a multi-criteria perceptually-based evaluation

Existing model for distortion decomposition [3]:

$$\hat{s}_j(t) - s_j(t) = e_j^{\text{target}}(t) + e_j^{\text{interf}}(t) + e_j^{\text{artif}}(t) \quad (1)$$

- $e_j^{\text{target}}$  denotes the error component related to the target distortion,
- $e_j^{\text{interf}}$  denotes the interference from concurrent sources,
- $e_j^{\text{artif}}$  is the remaining distortion component (artifacts and noise).

Defining and estimating the distortion components  $e_j^{\text{target}}$ ,  $e_j^{\text{interf}}$ ,  $e_j^{\text{artif}}$  is not trivial. Due to the allowed distortions in use today (time-invariant spatial and filtering distortions), the **decomposition is not satisfying**.

**Existing quality measures:** energy ratios SDR, ISR, SIR, SAR are **poorly correlated** with subjective scores.

### Proposed multi-criteria listening test protocol

A series of 4 MUSHRA tests including several dedicated anchors:

- ( $T_1$ ) Rate the *global quality* compared to the reference.
- ( $T_2$ ) Rate the quality in terms of *preservation of the target source*.
- ( $T_3$ ) Rate the quality in terms of *suppression of other sources*.
- ( $T_4$ ) Rate the quality in terms of *absence of additional artificial noise*.

## PROPOSED OBJECTIVE MEASURES: what's new?

A **better distortion decomposition** is achieved by:

- splitting the signals into subbands using gammatone filters;
- segmenting each subband signal into overlapping frames;
- decomposing each frame into distortion components using a matched FIR filter
- reconstructing the full distortion components

Some **auditory-motivated features** are derived using PEMO-Q/PSM [4]:

$$q_j^{\text{overall}} \triangleq \text{PSM}(\hat{s}_j, s_j) \quad (2)$$

$$q_j^{\text{target}} \triangleq \text{PSM}(\hat{s}_j, \hat{s}_j - e_j^{\text{target}}) \quad (3)$$

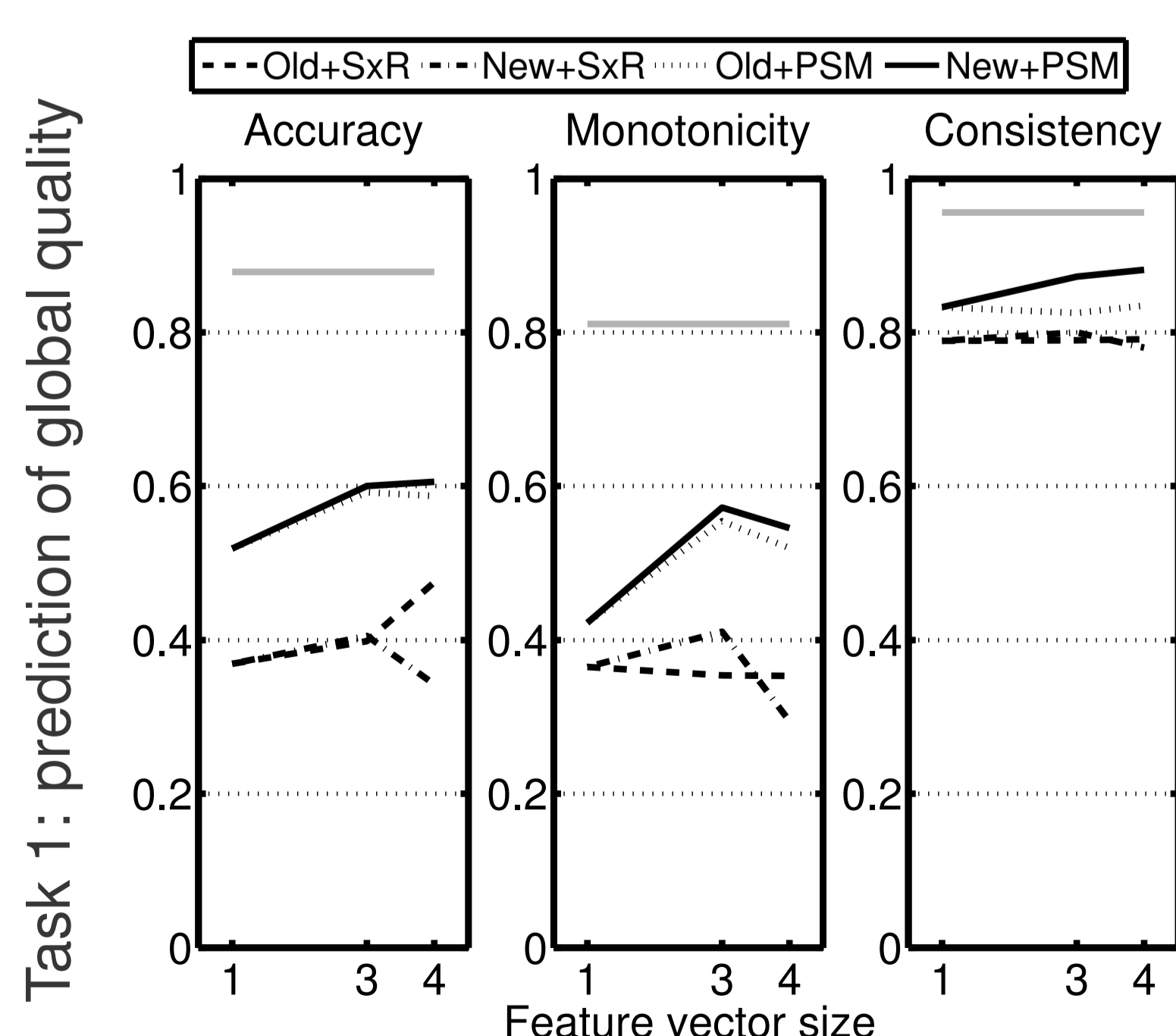
$$q_j^{\text{interf}} \triangleq \text{PSM}(\hat{s}_j, \hat{s}_j - e_j^{\text{interf}}) \quad (4)$$

$$q_j^{\text{artif}} \triangleq \text{PSM}(\hat{s}_j, \hat{s}_j - e_j^{\text{artif}}) \quad (5)$$

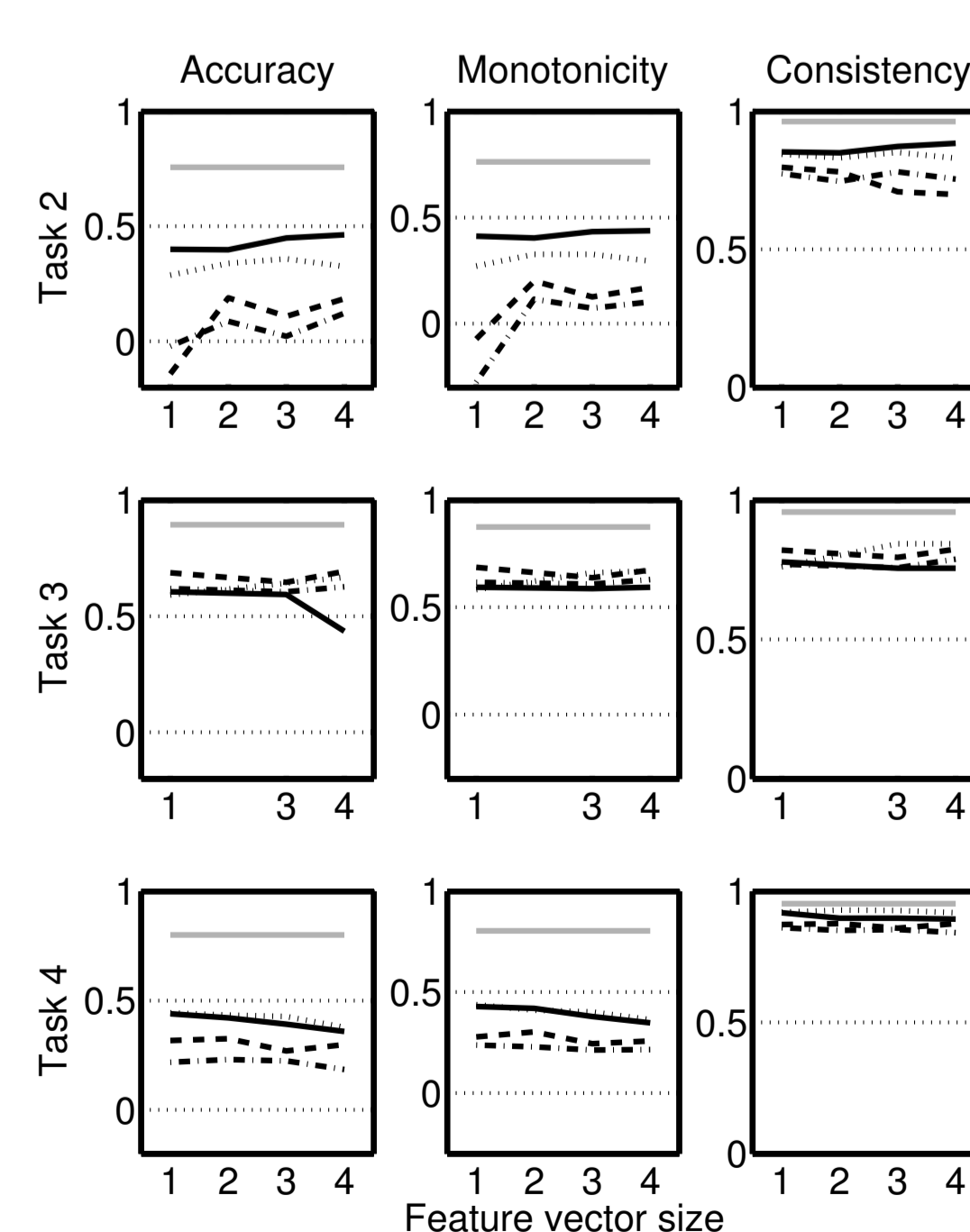
By combining the 4 features in a non-linear way to predict subjective scores ( $T_1$ ) – ( $T_4$ ), a set of objective measures is finally output:

- **OPS:** the Overall Perceptual Score,
- **TPS:** the Target-related Perceptual Score,
- **IPS:** the Interference-related Perceptual Score,
- **APS:** the Artifacts-related Perceptual Score.

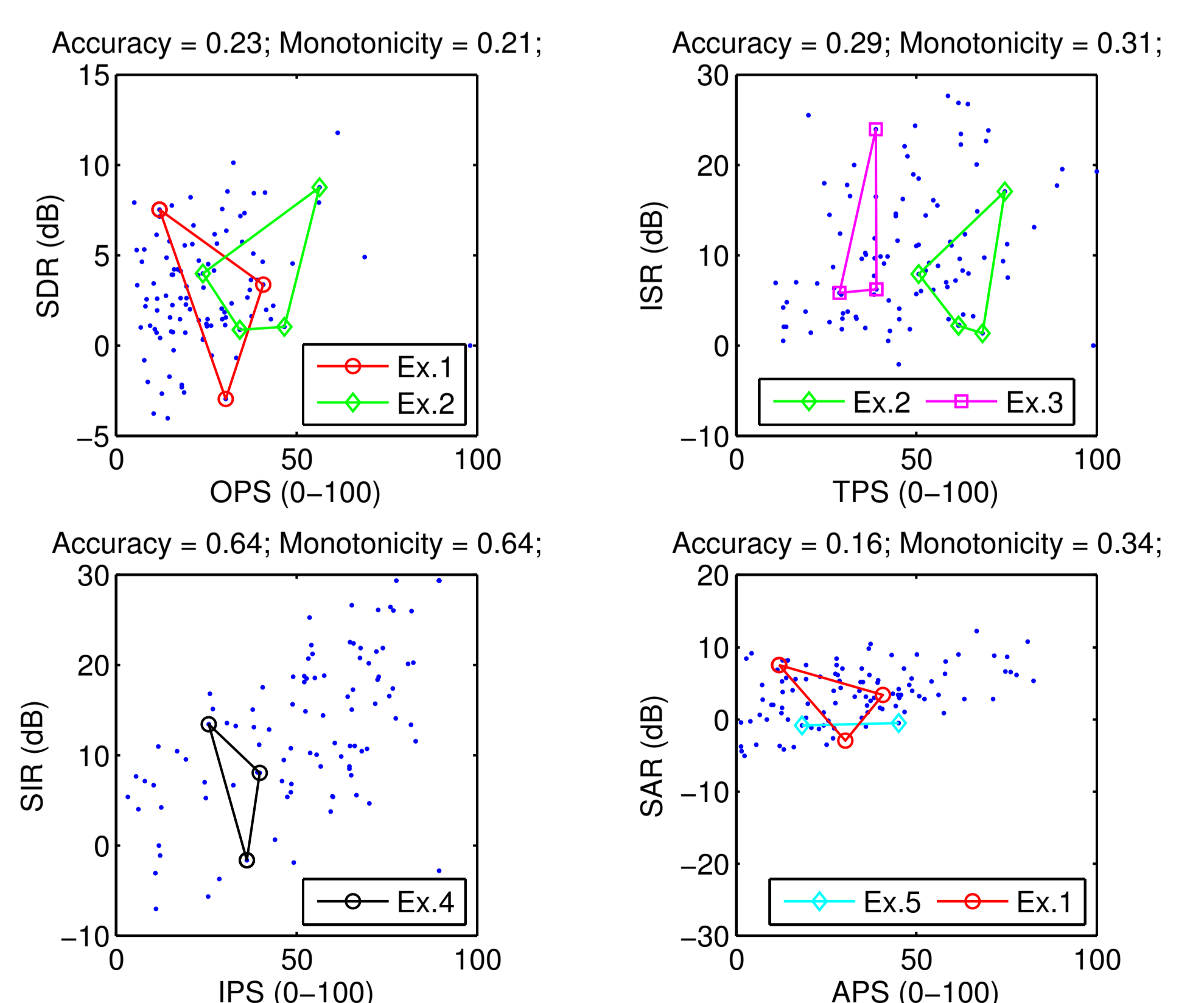
## EVALUATION RESULTS: prediction performance and evaluation at SiSEC 2010



Prediction results (cross-validation on the PEASS database) for the 4 tasks: curves are various combinations of the old/new decompositions with the energy ratio/PEMO-Q measures, as a function of the number of features.



DEMO SiSEC 2010



BSS eval vs. PEASS: scatter plots of the SiSEC 2010 results for the set of Professionally produced music recordings.

[3] E. Vincent, R. Gribonval, C. Févotte, *Performance measurement in blind audio source separation*, IEEE Trans. on Acoustics, Speech and Signal Proc., 14 (4), 2006.

[4] R. Huber, B. Kollmeier, *PEMO-Q – A New Method for Objective Audio Quality Assessment Using a Model of Auditory Perception*, IEEE Trans. on Acoustics, Speech and Signal Proc., 14 (6), 2006.