Acoustic Reflector Localization and Classification

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Outline

- Related Previous Work and Applications
- Acoustic Reflector Localization
- Acoustic Reflector Classification
- Experiments and Results
- Concusions

Applications

- Understanding of acoustic scenes targets several applications that span from audio forensics to source separation

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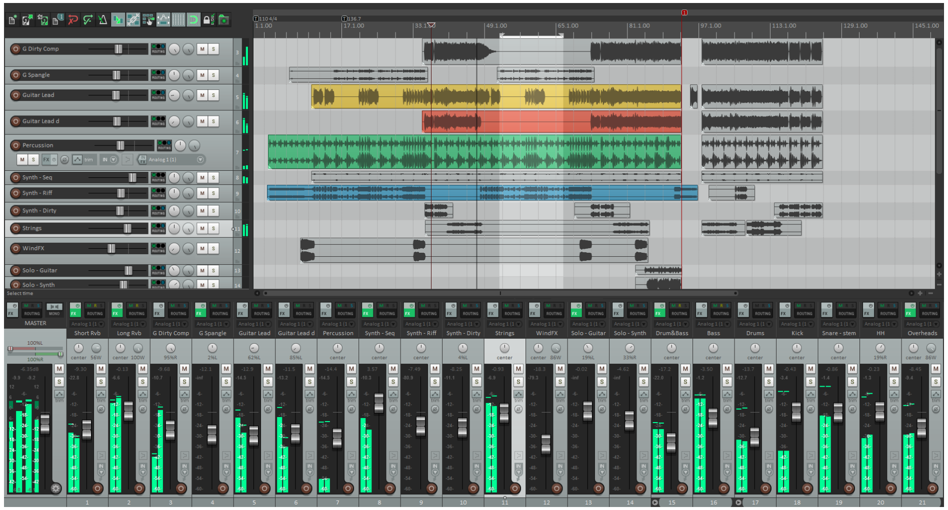
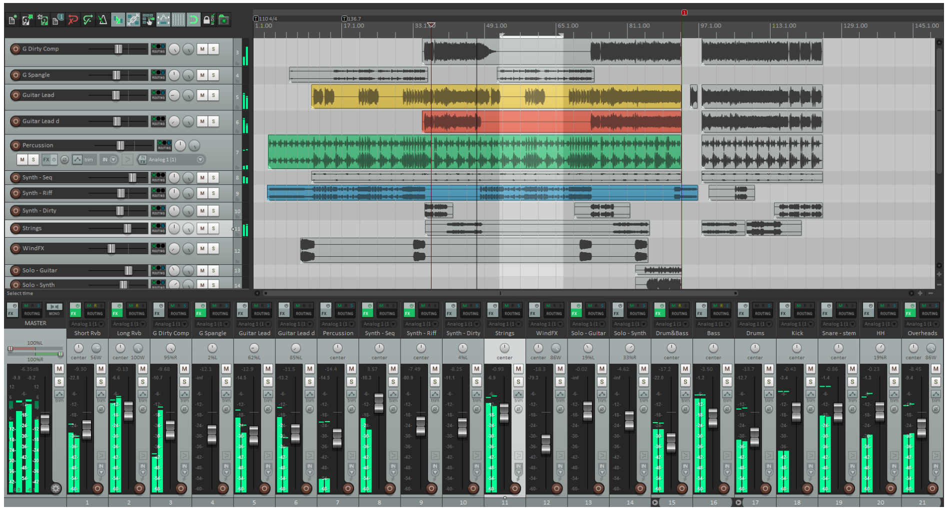


Applications

- Understanding of acoustic scenes targets several applications that span from audio forensics to source separation

- Here, the two main targeted areas are active manipulation of **reverberant spatial audio objects** and **mixed reality**

- It is important to identify not only the position of the acoustic reflectors but also their size, in particular for **non-static listener scenarios**



Related Work – Acoustic Scene Analysis from RIRs

Acoustic Reflector Localization

Acoustic Reflector Classification

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Acoustic Reflector Localization

- Methods using the **space-time domain**[Kuster et al., *JASA*, 2004]
- Geometric approaches using the reflection **time difference of arrival (TDOA)** [Antonacci et al., IEEE TASLP, 2012]
- Geometric approaches joining the reflection **time of arrival (TOA) with direction of arrival (DOA)** [Remaggi et al., IEEE TASLP, 2017].

Acoustic Reflector Classification

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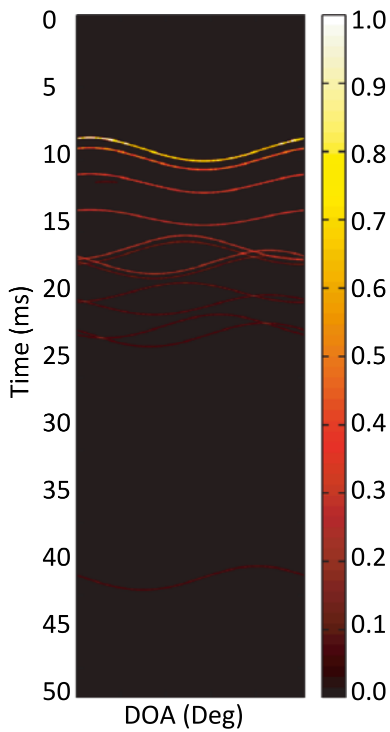

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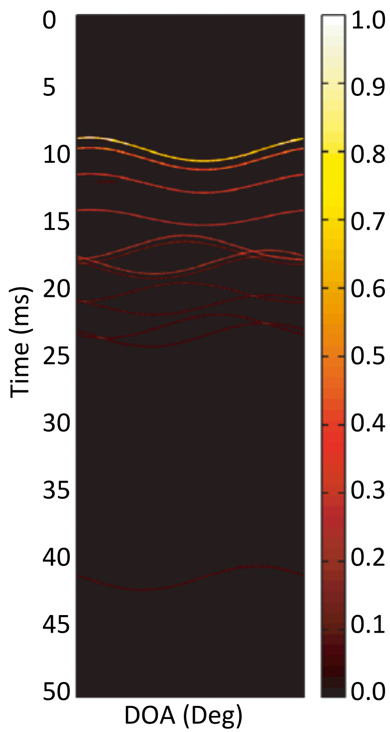

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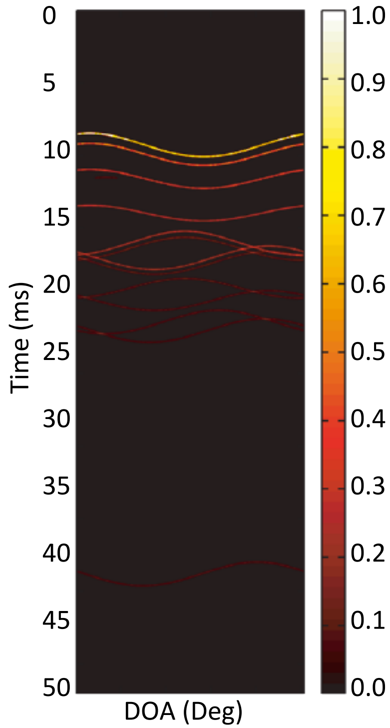

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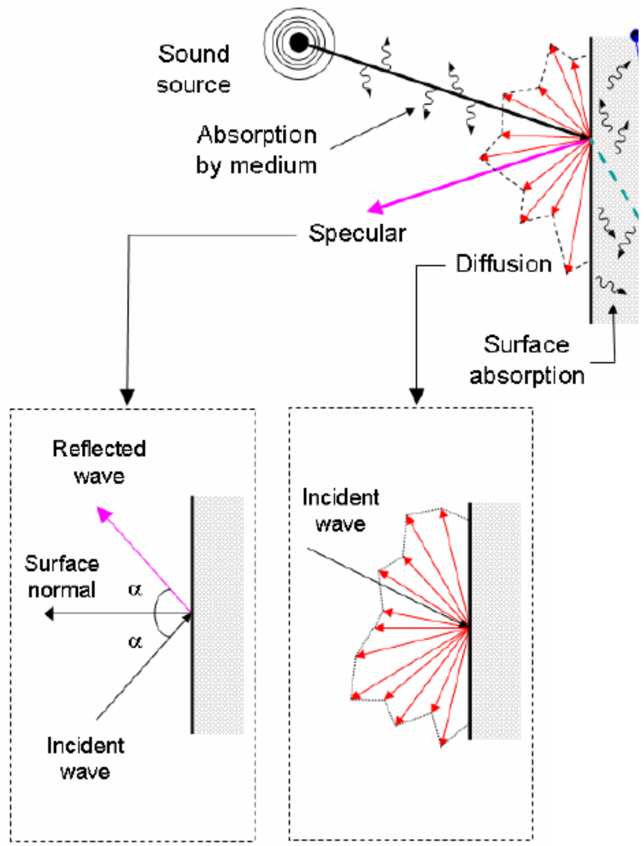

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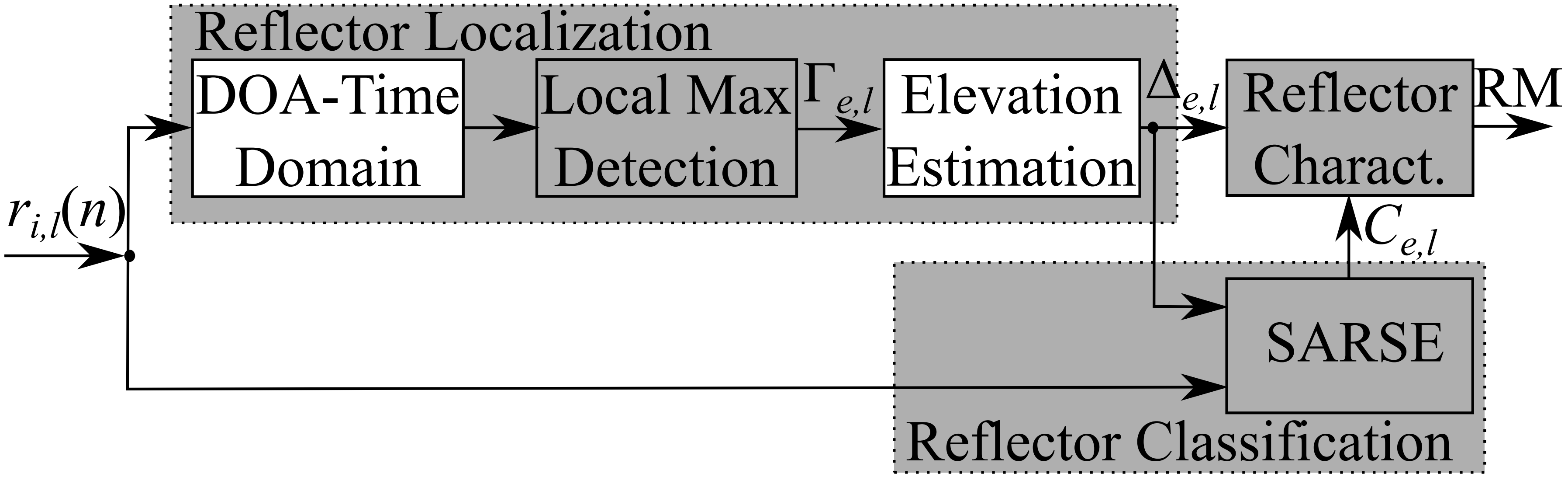
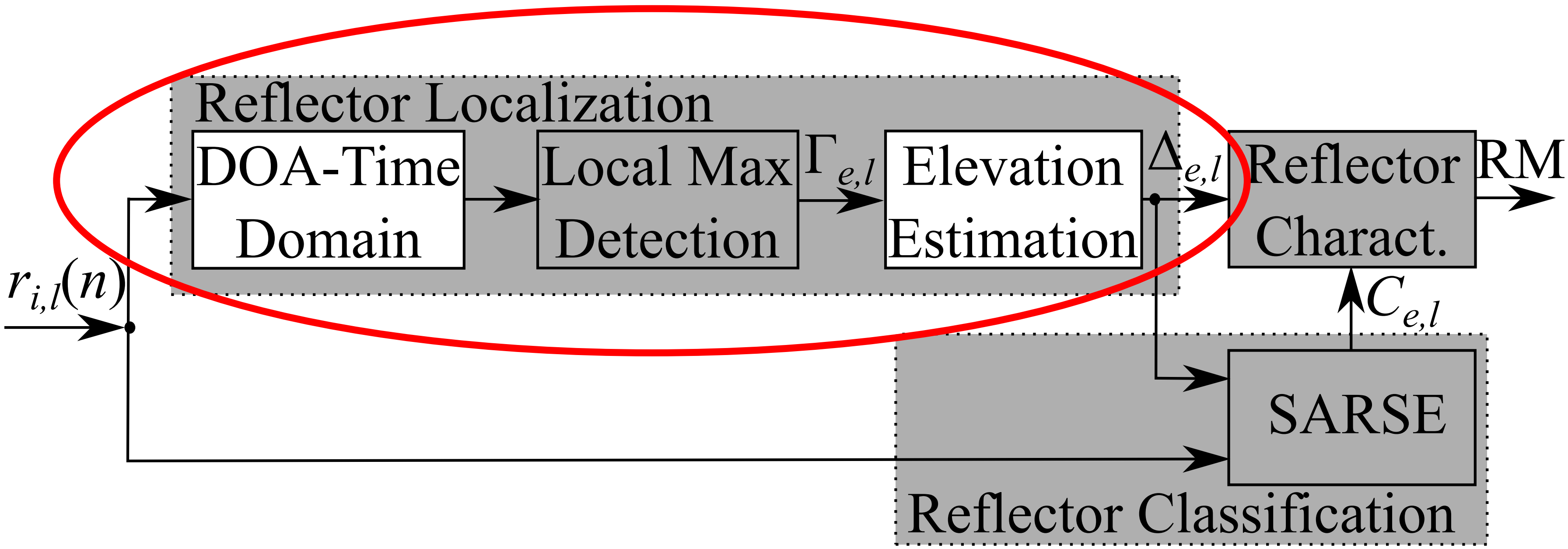


Acoustic Reflector Localization and Classification

- Acoustic reflector localization based on DOA-time domain analysis



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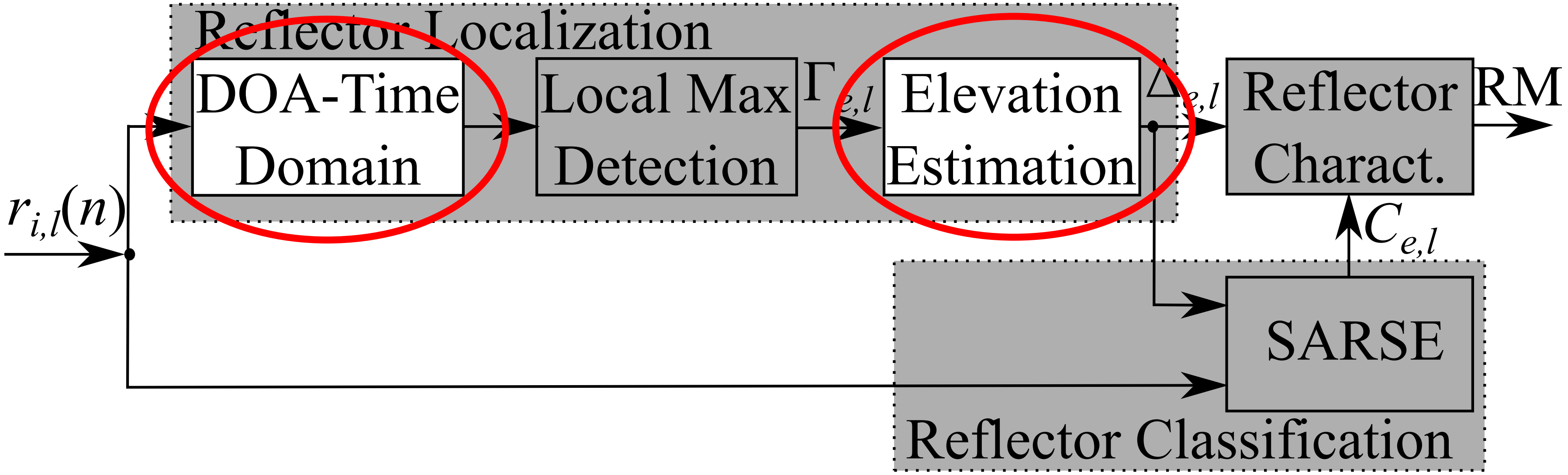

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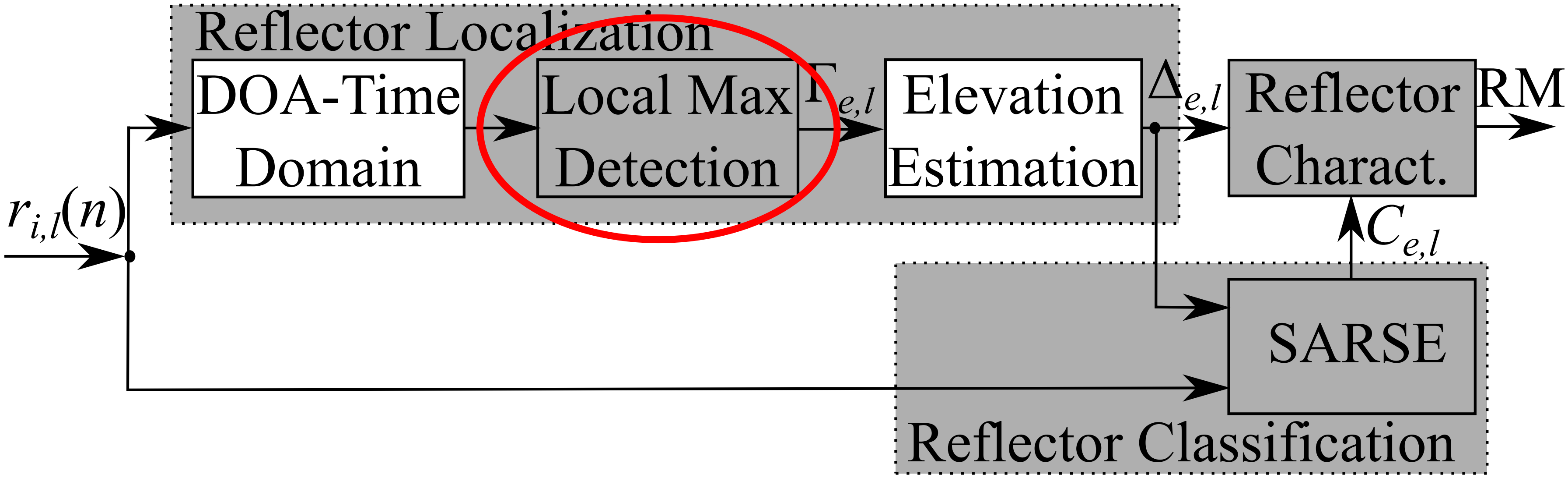

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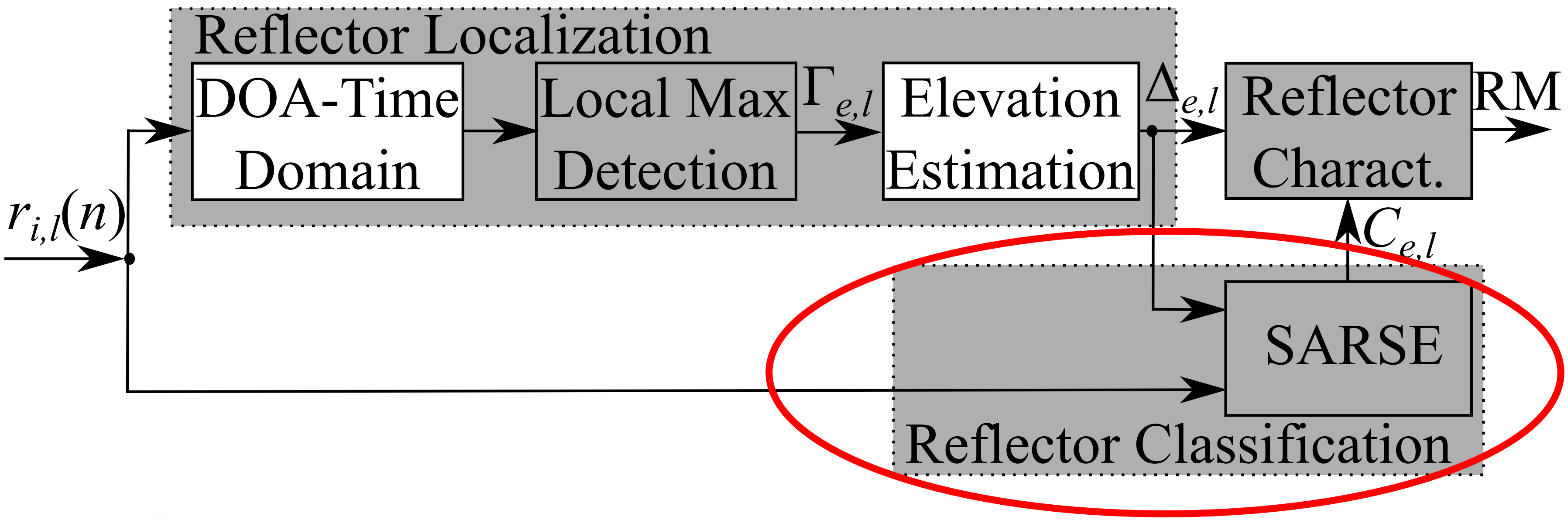

- Acoustic reflector classification algorithm named as Scattering Analysis based Reflector Size Estimator (SARSE)

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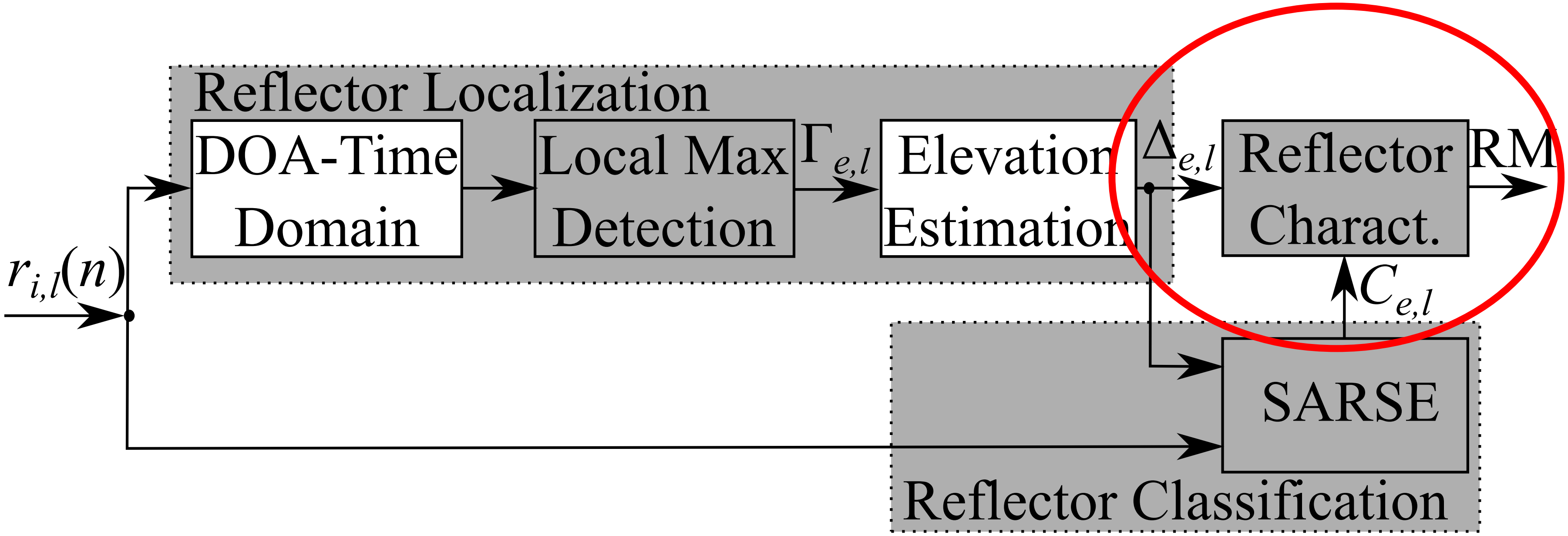

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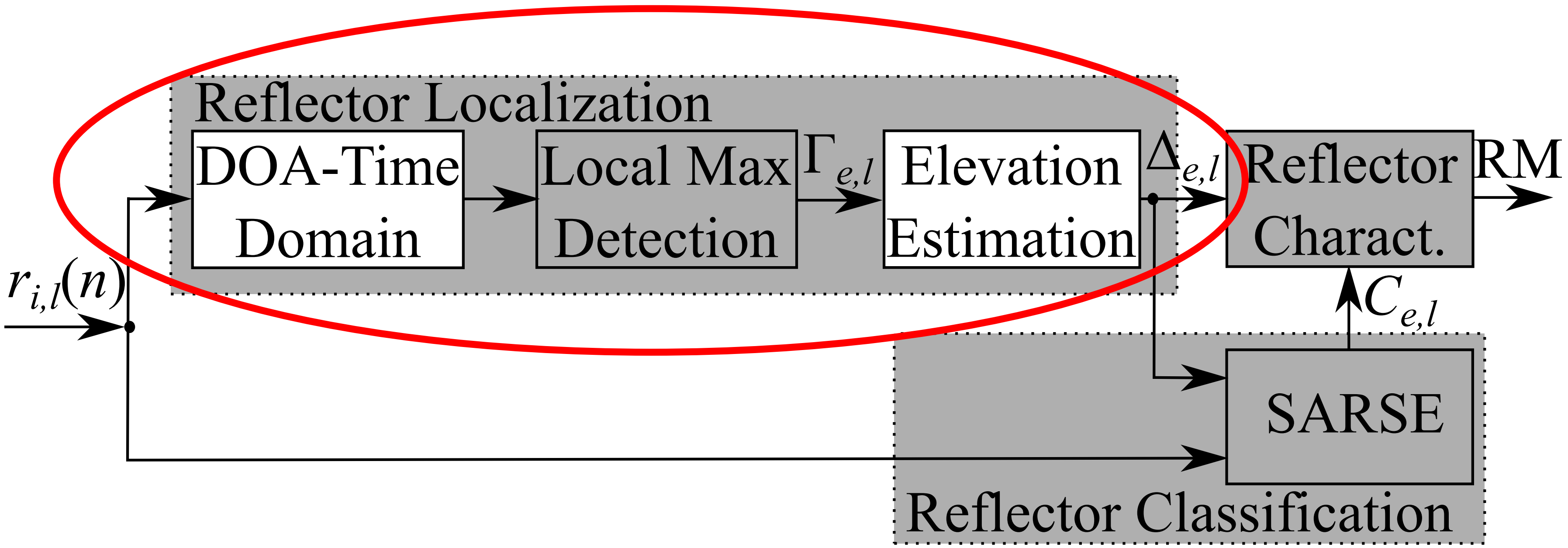

Acoustic Reflector Localization

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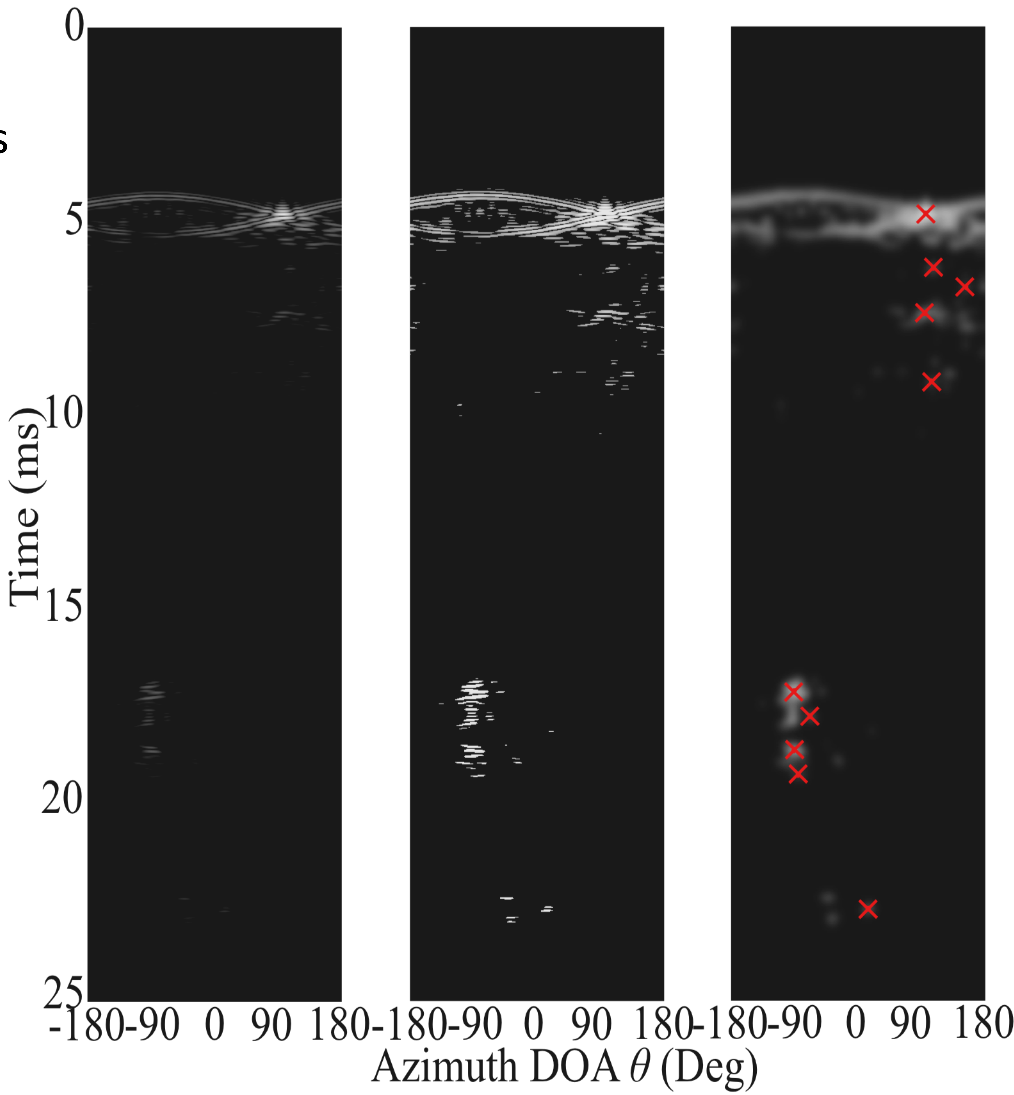

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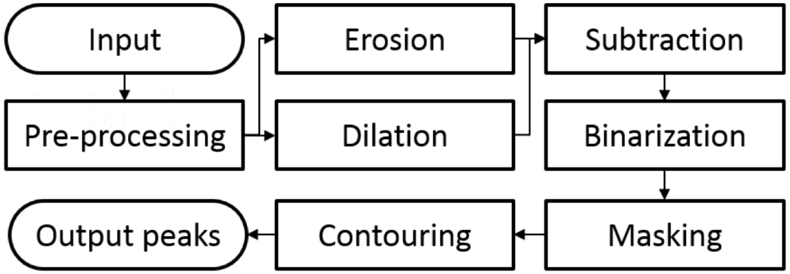

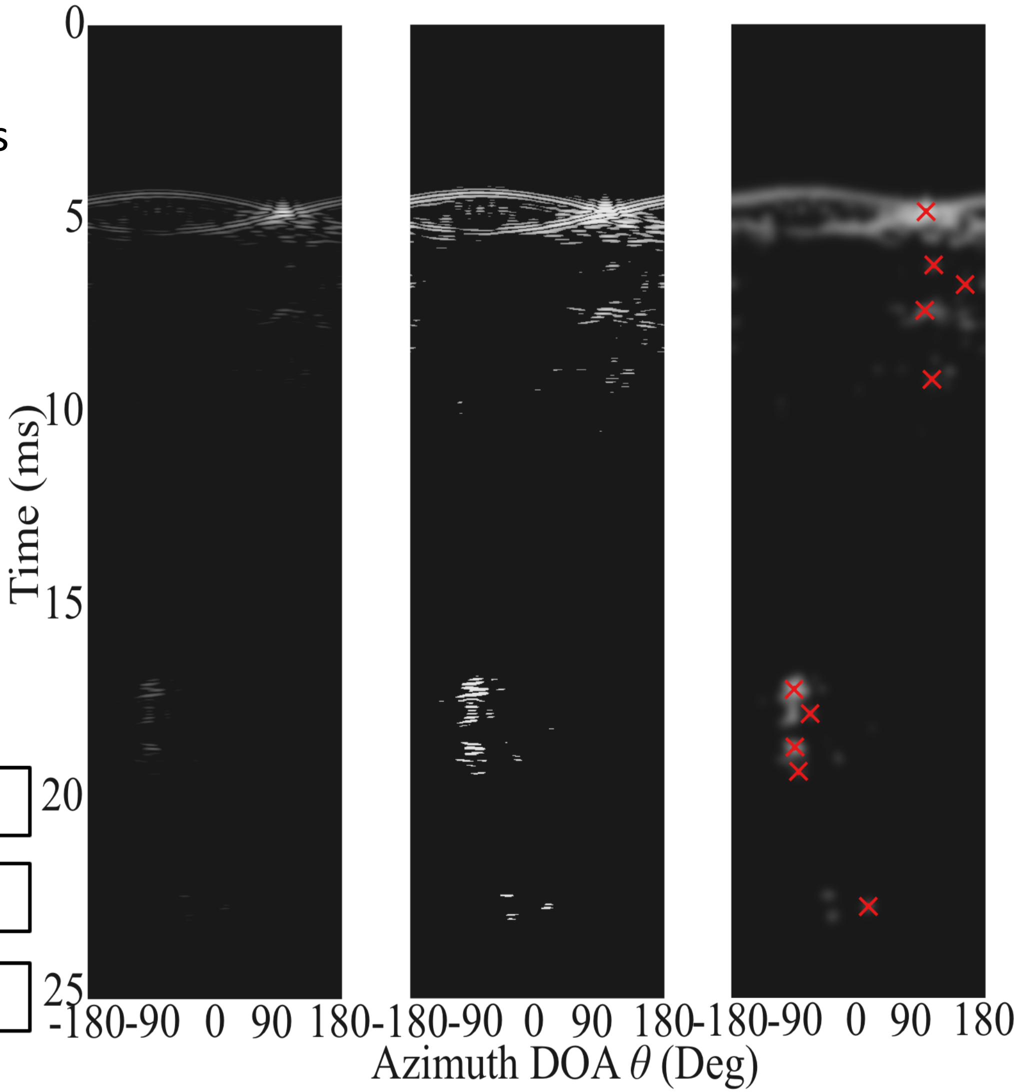

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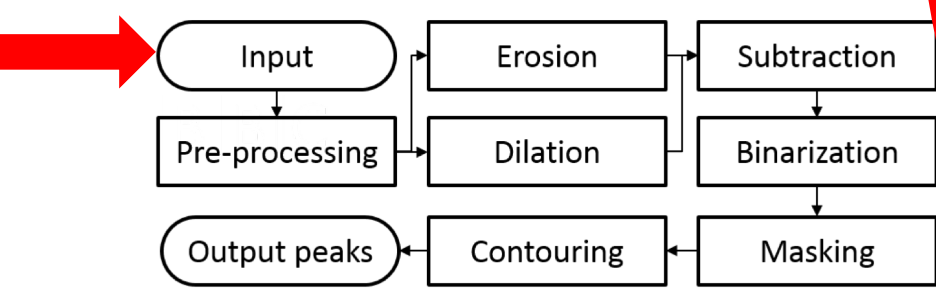

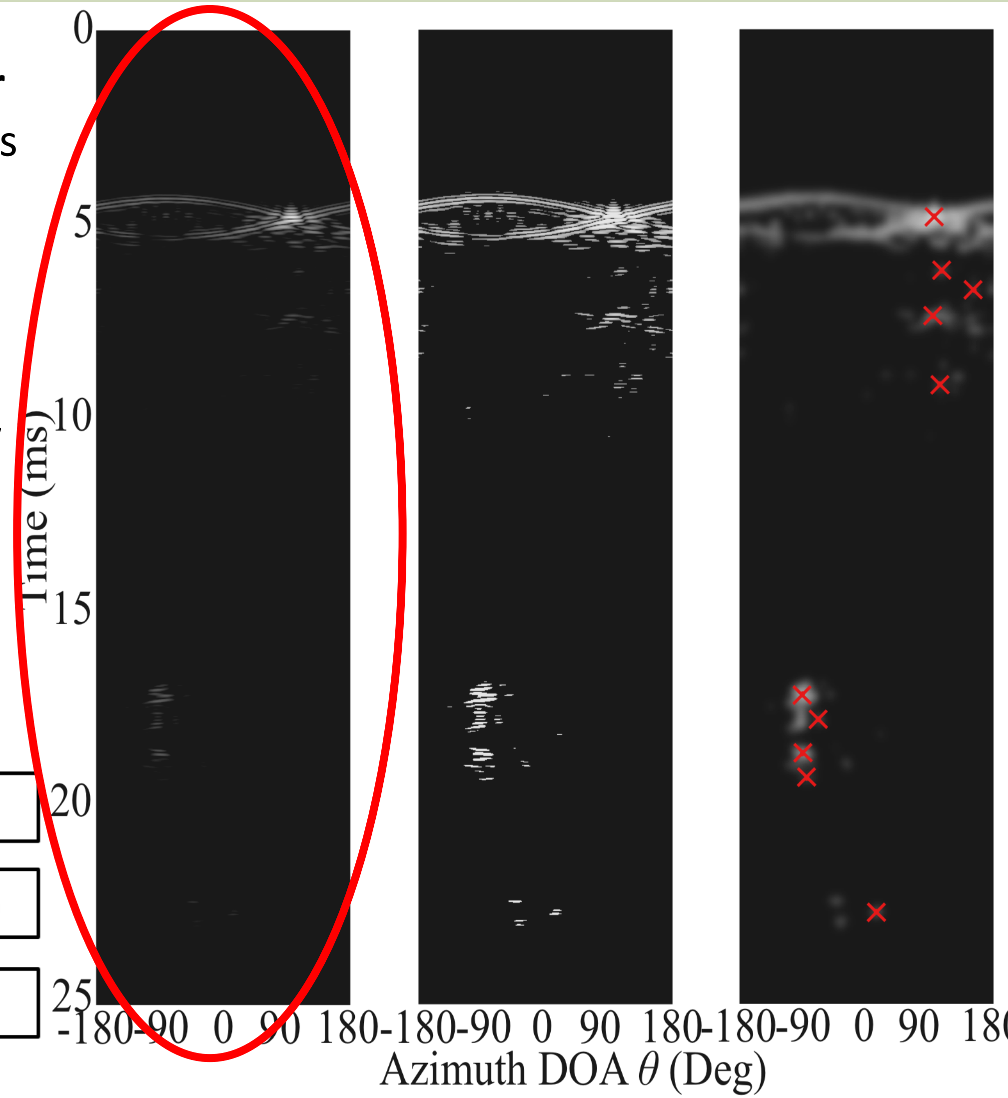

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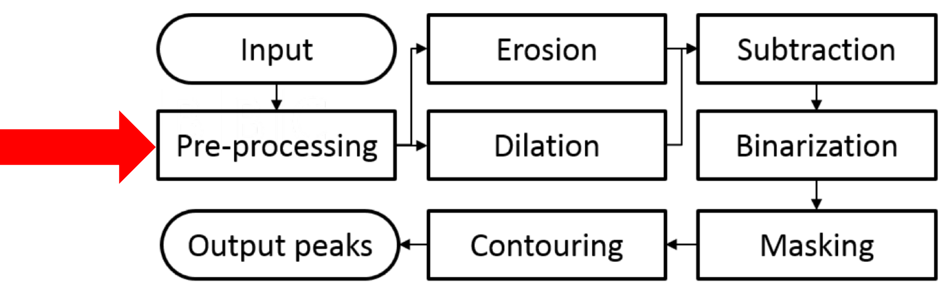

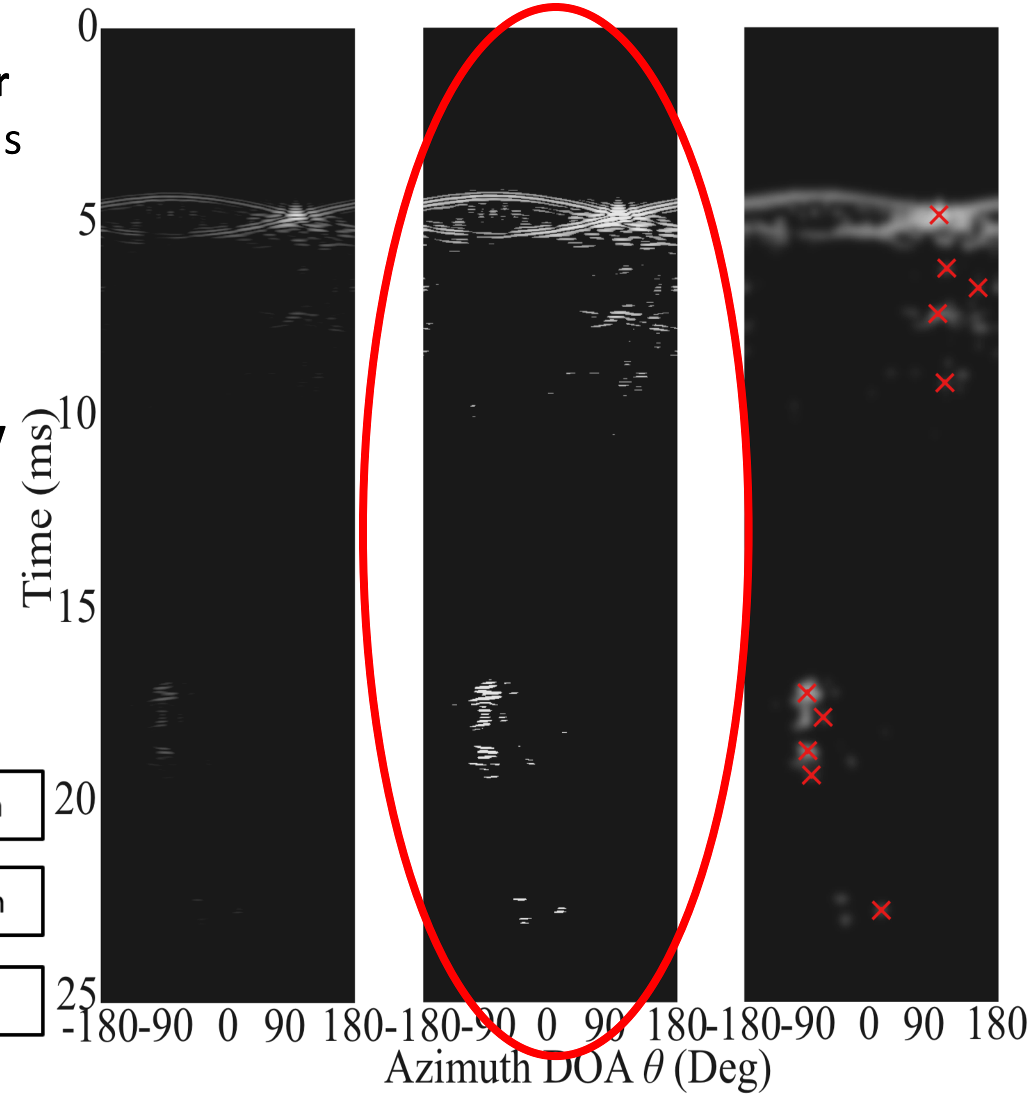

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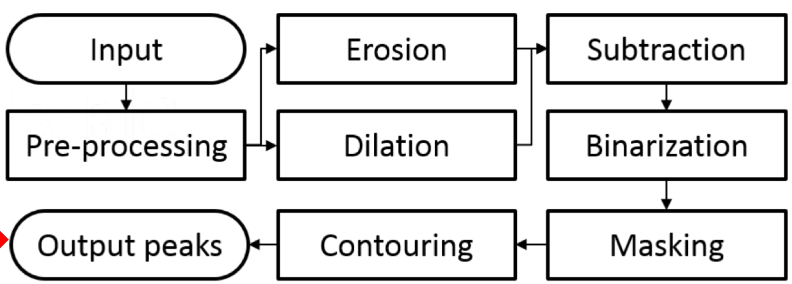
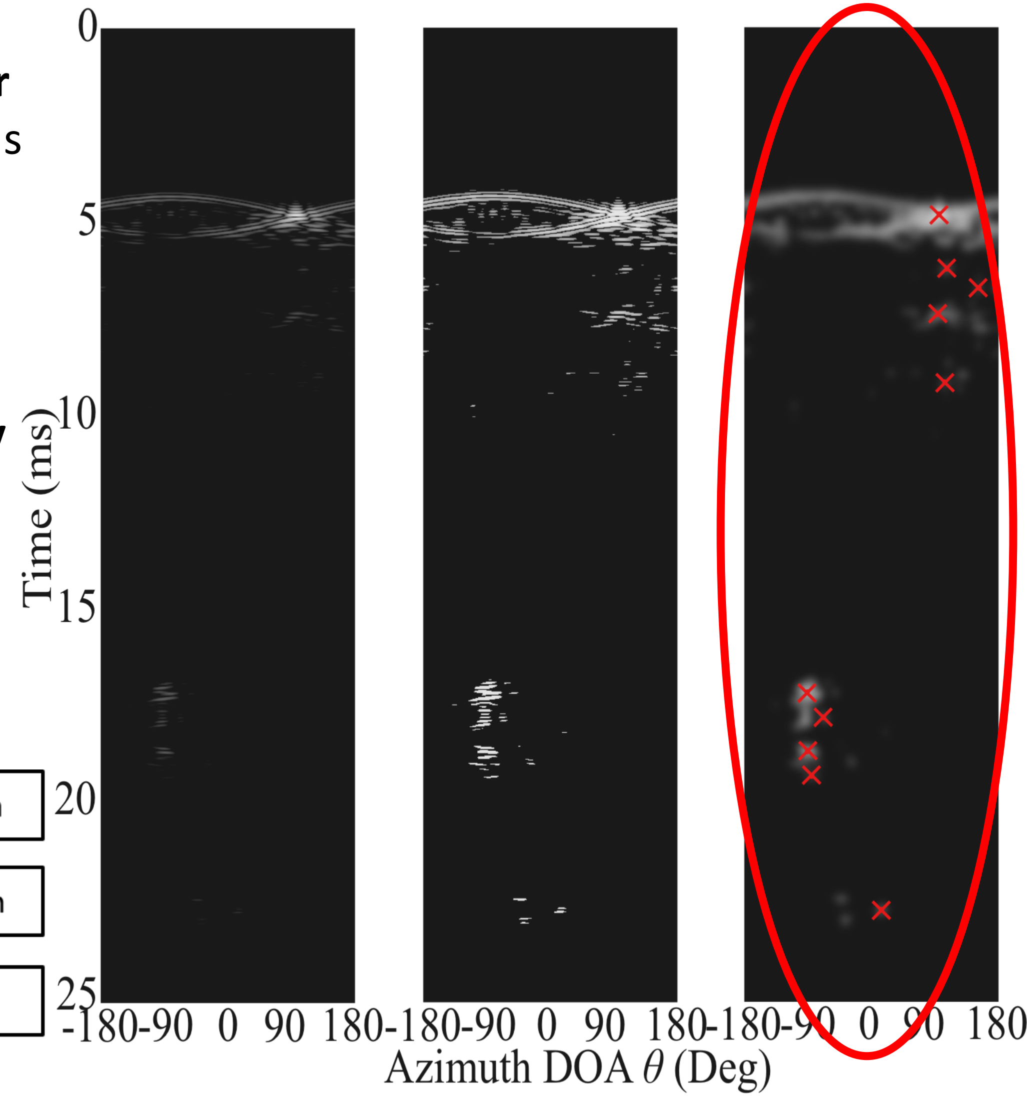
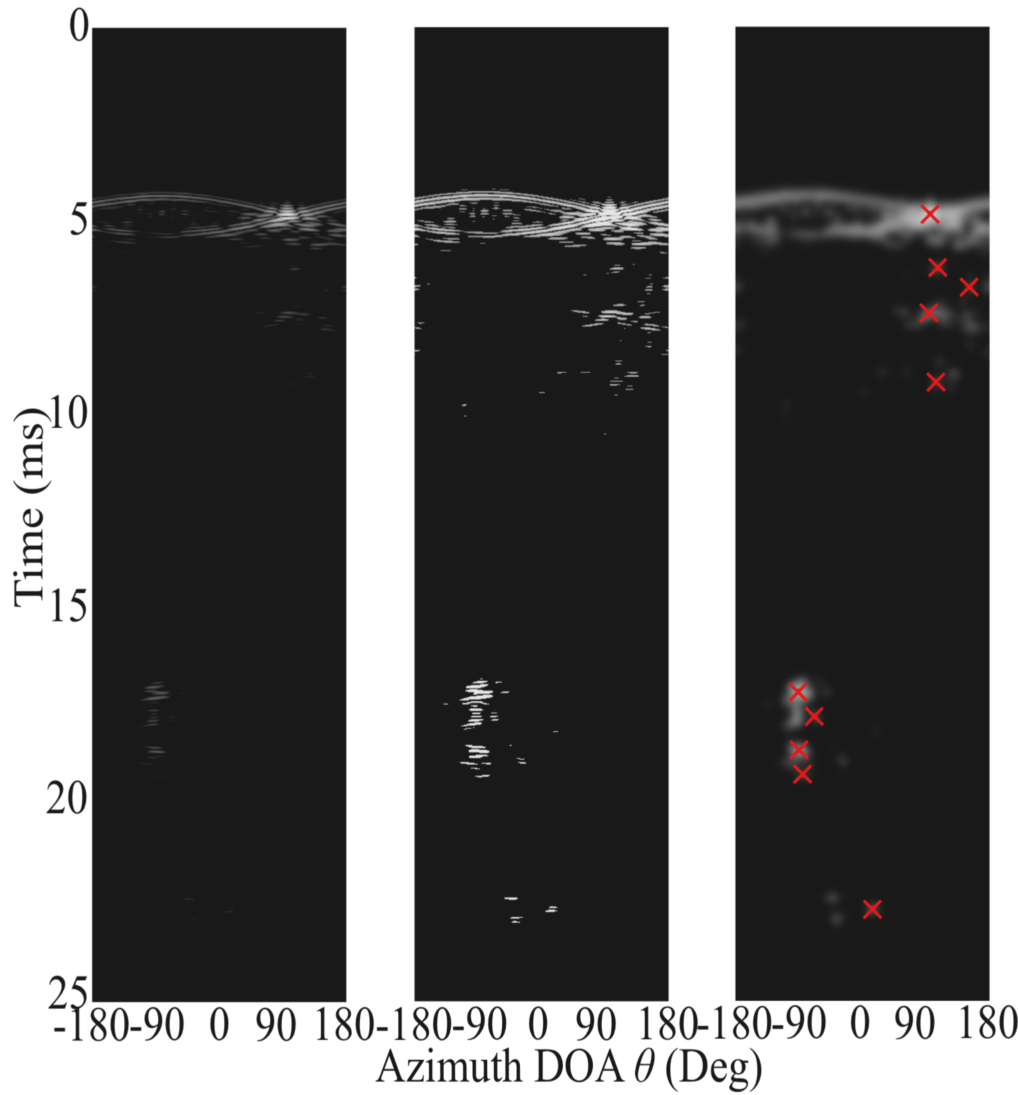




Acoustic Reflector Localization

- By knowing the TOA and azimuth DOA of the reflections, the segments are analyzed looking at their elevations, and the elevation DOA estimated as the angle providing the maximum signal energy



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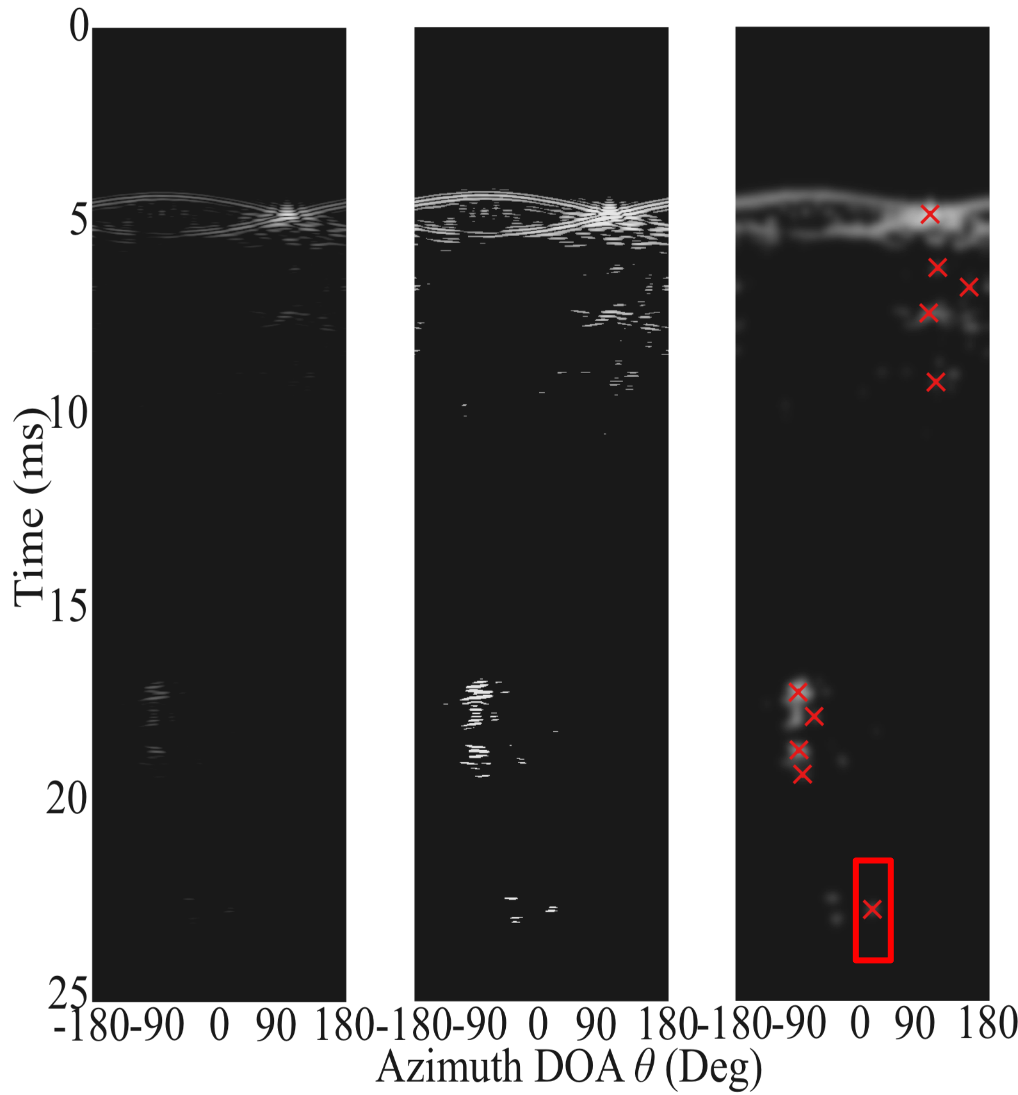

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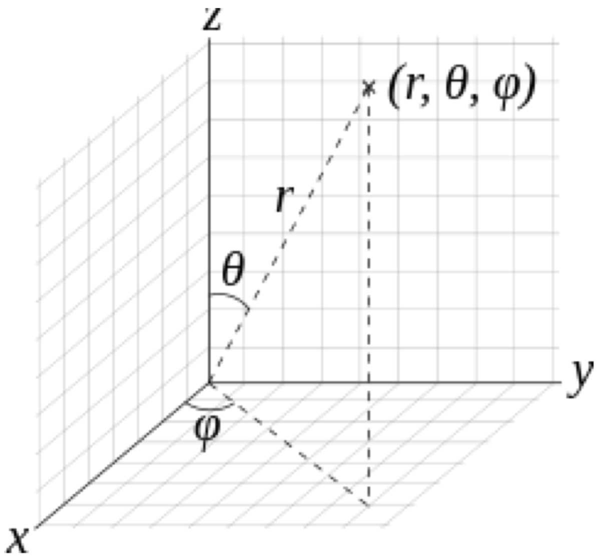

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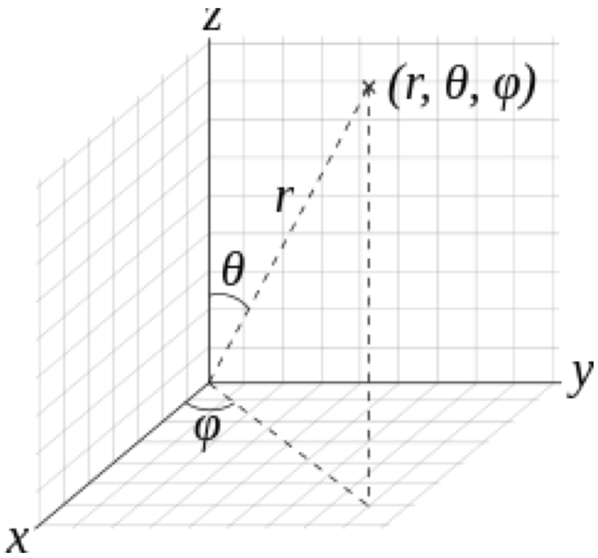

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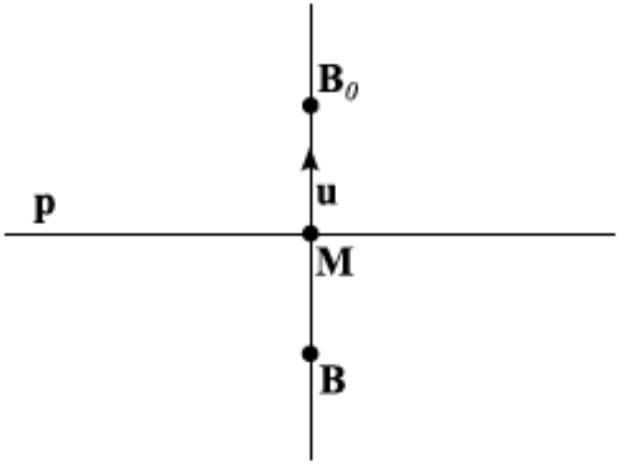
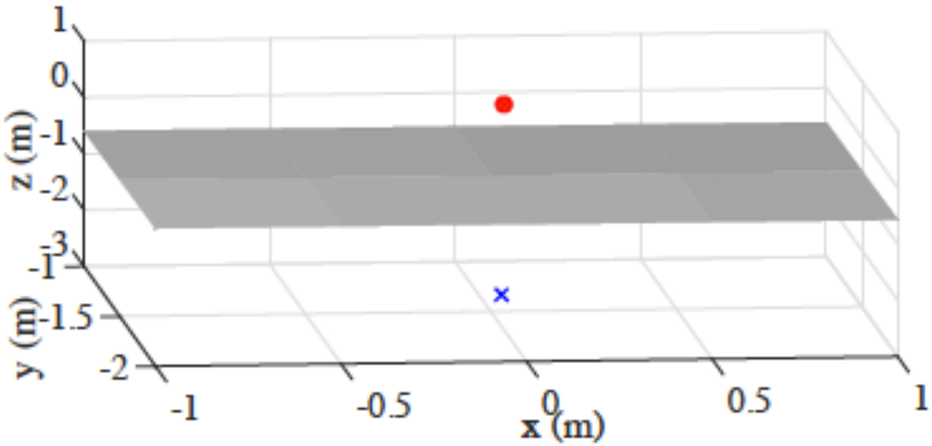
- Loudspeaker-image source bisection algorithm [Dokmanić et al., *PNAS*, 2014]





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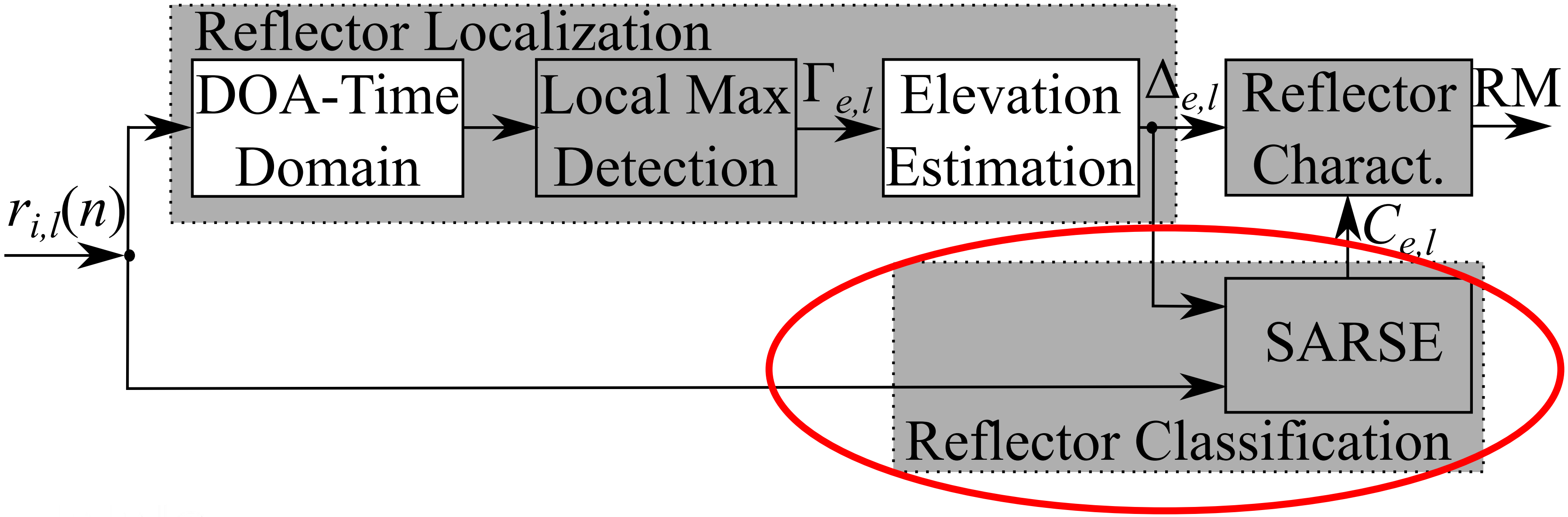
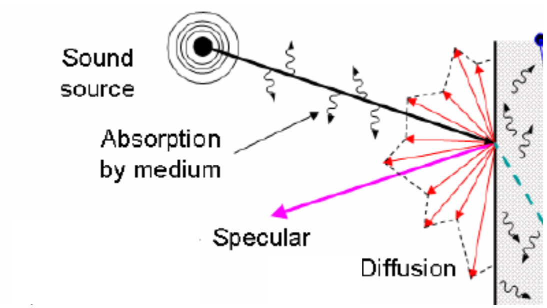


Acoustic Reflector Classification – The SARSE Algorithm



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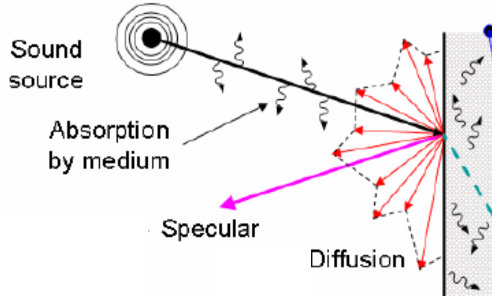

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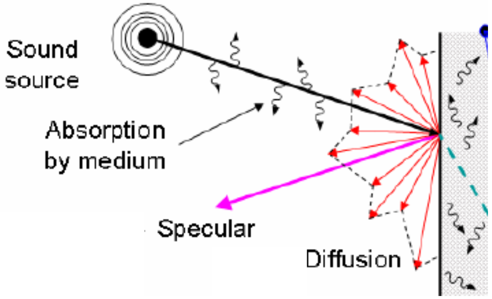

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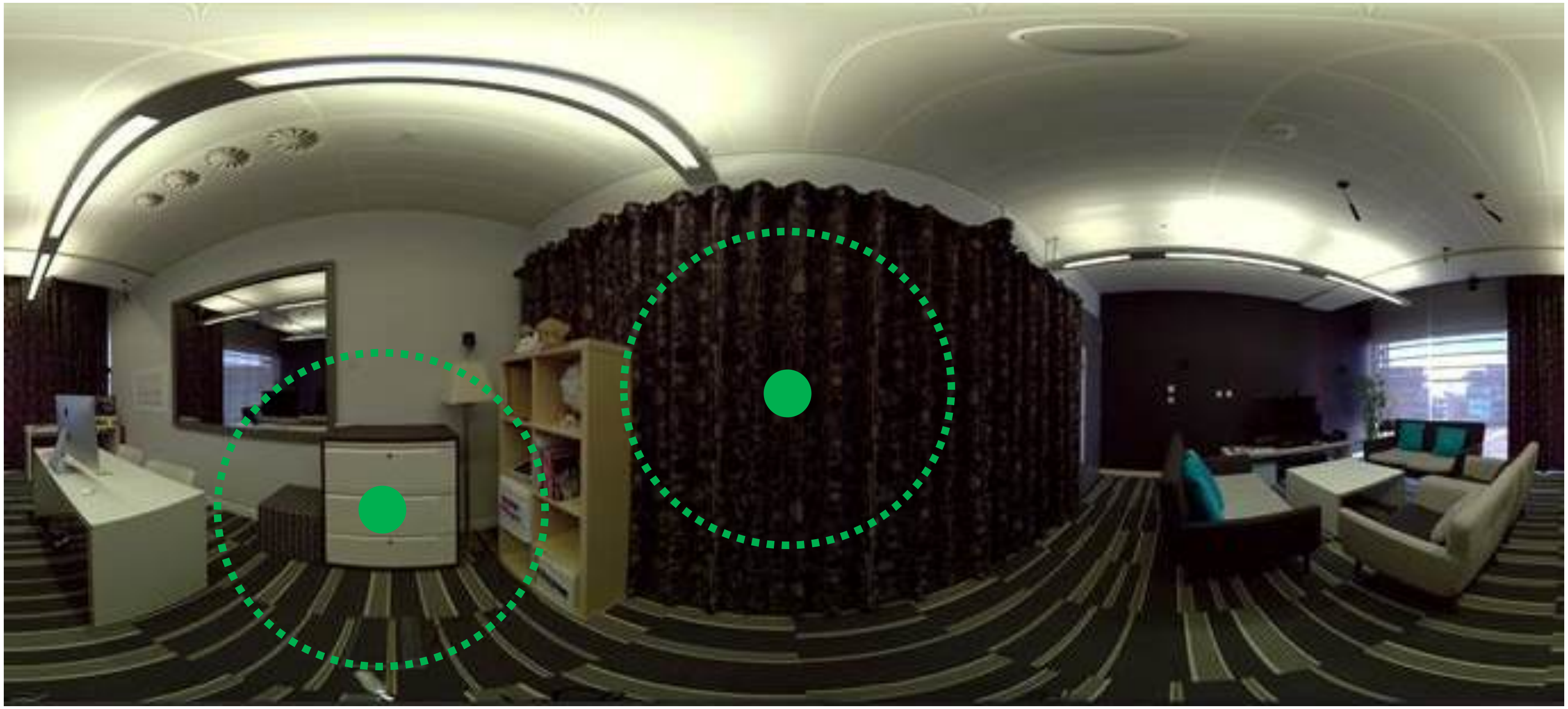

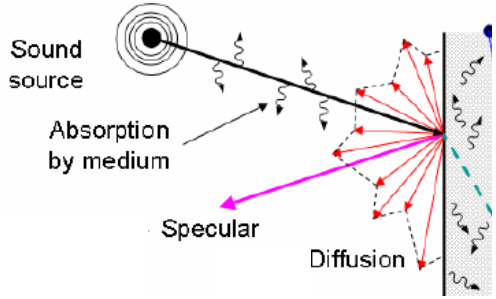

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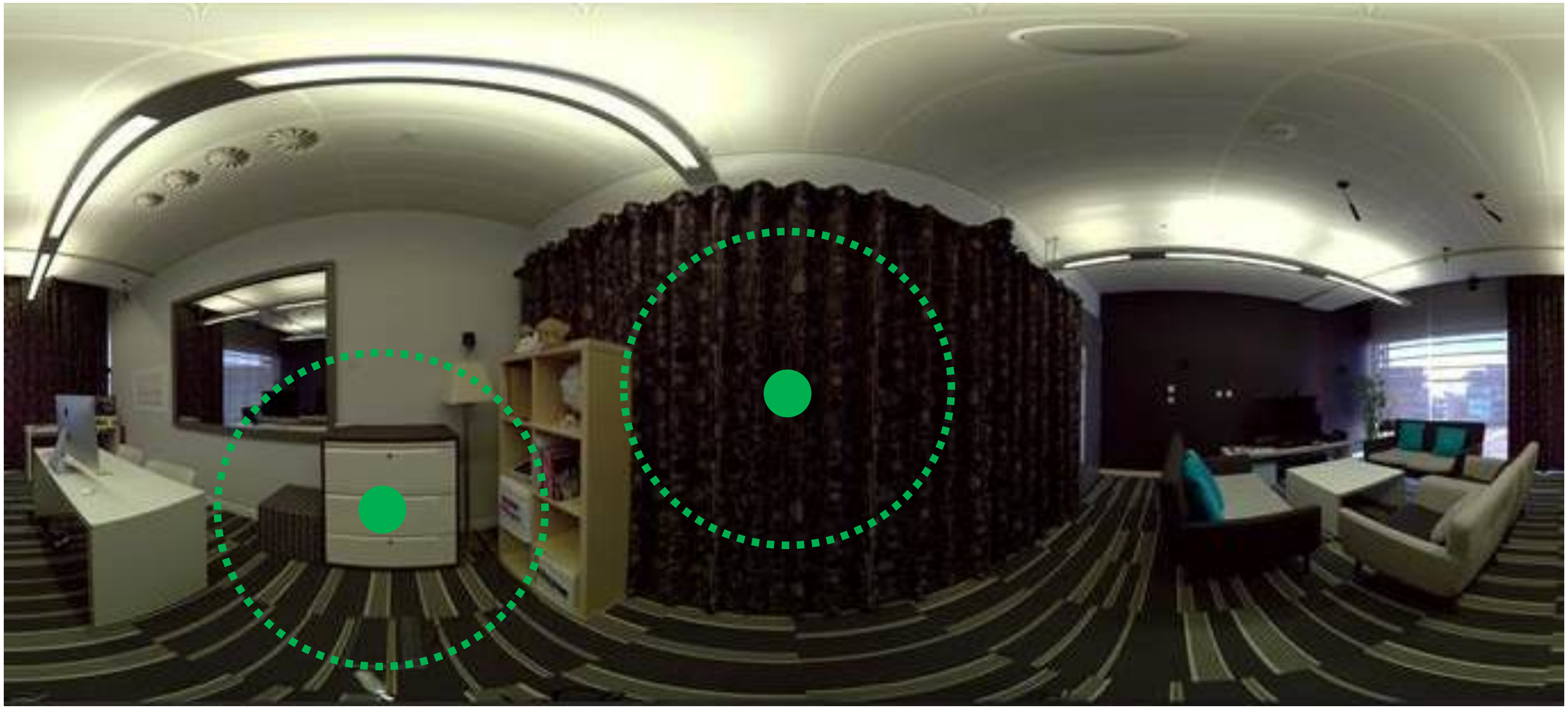

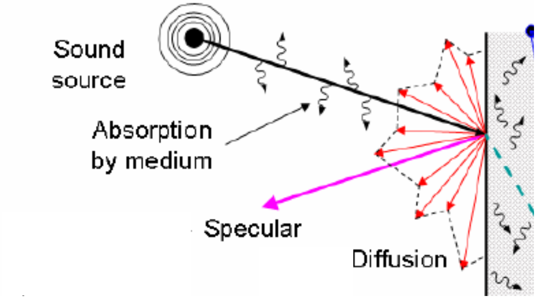

$$K = 1 - \frac{E^{sp}}{E^{sc}}$$

Partial reflection
Scattering coefficient

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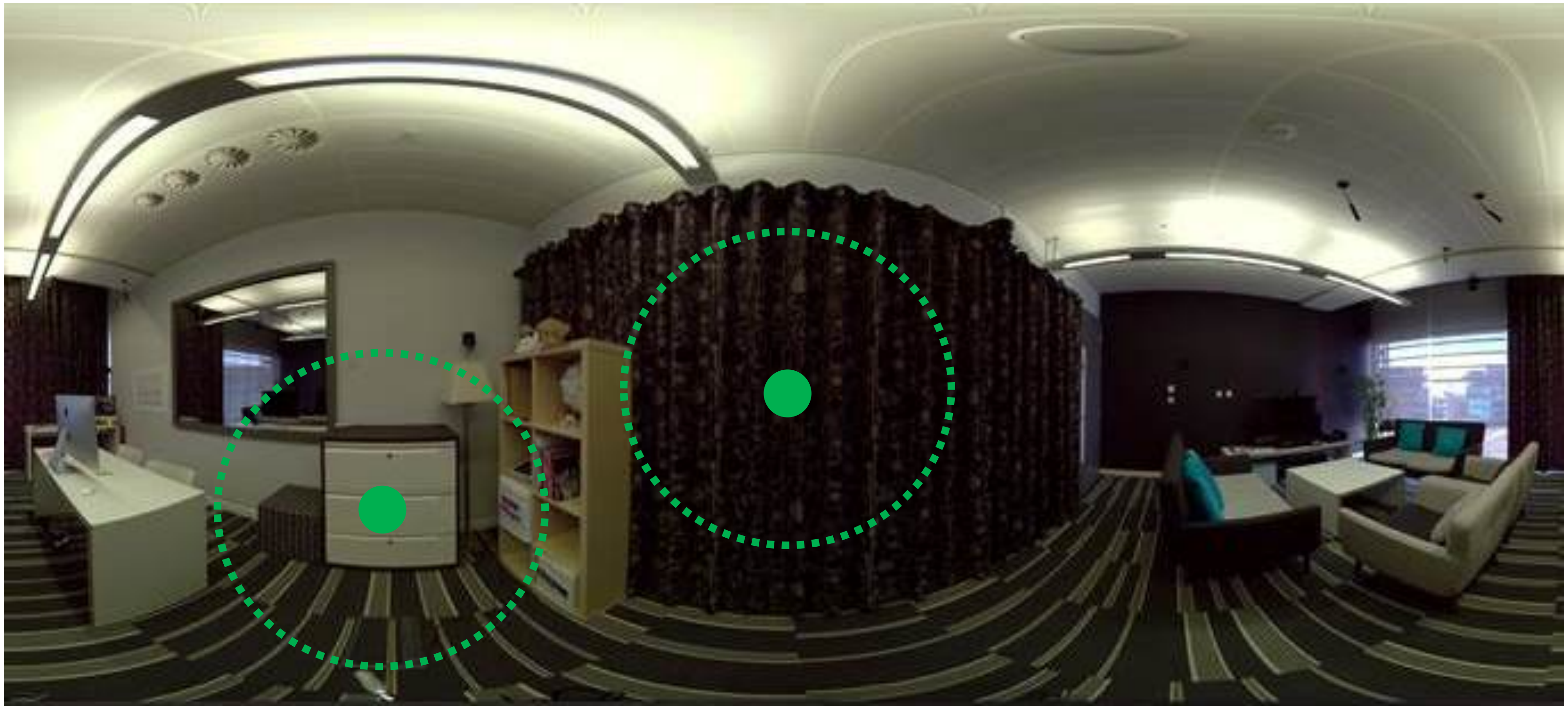

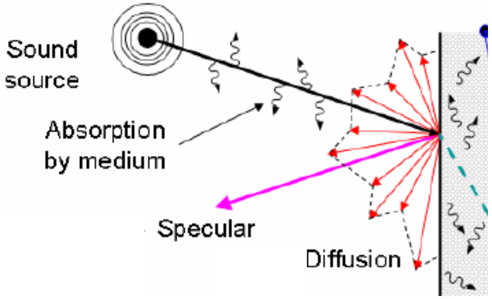

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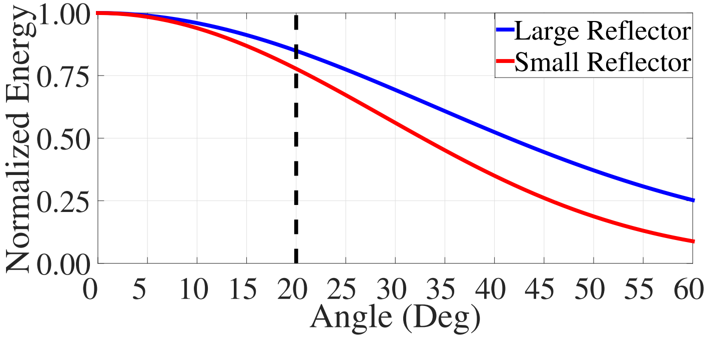

Experiments and Results

Classification

- Considering planar reflectors as positives (i.e. class = 1) and small reflectors as negatives (i.e. class = 0)
- Precision $= \frac{TruePositives}{TruePositives + FalsePositives}$
- Recall $= \frac{TruePositives}{TruePositives + FalseNegatives}$
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BBC Usability Laboratory	5.6 x 5.2 x 2.9 m^3	275 ms	83 %	100 %	89 %	0.91
Vislab	7.8 x 6.1 x 4.0 m^3	326 ms	100 %	100 %	100 %	1.00
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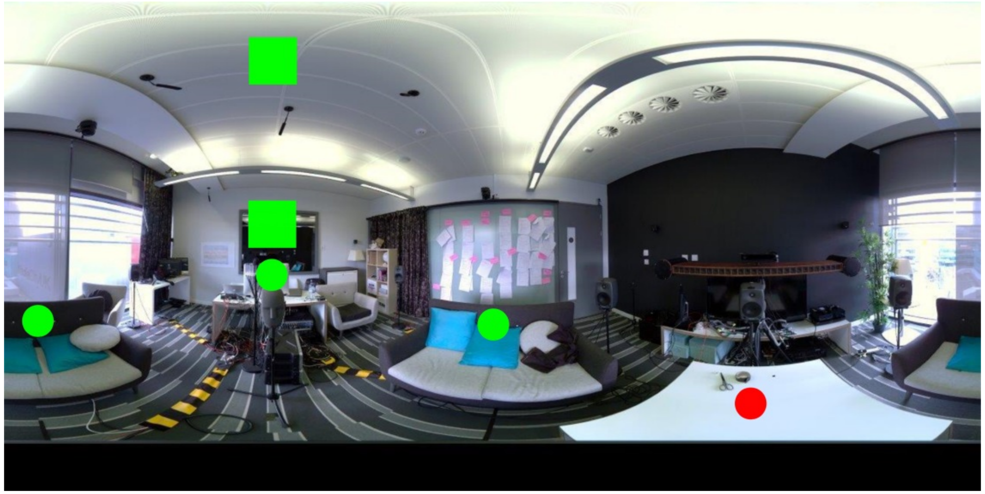
- The results reported in the table below is the average over all the image sources

Dataset	ε	ε_{SARSE}
BBC Listening Room	141 cm	**118** cm
BBC Usability Laboratory	197 cm	**150** cm
Vislab	388 cm	**178** cm
VML	**128** cm	148 cm
Average	214 cm	**149** cm



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- Future work may focus on extending the analysis on a greater number of rooms, finding alternative classification algorithms, and combining this method with vision-based methods.

Any Questions?

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