# 乱流中スカラー源探索に関する研究

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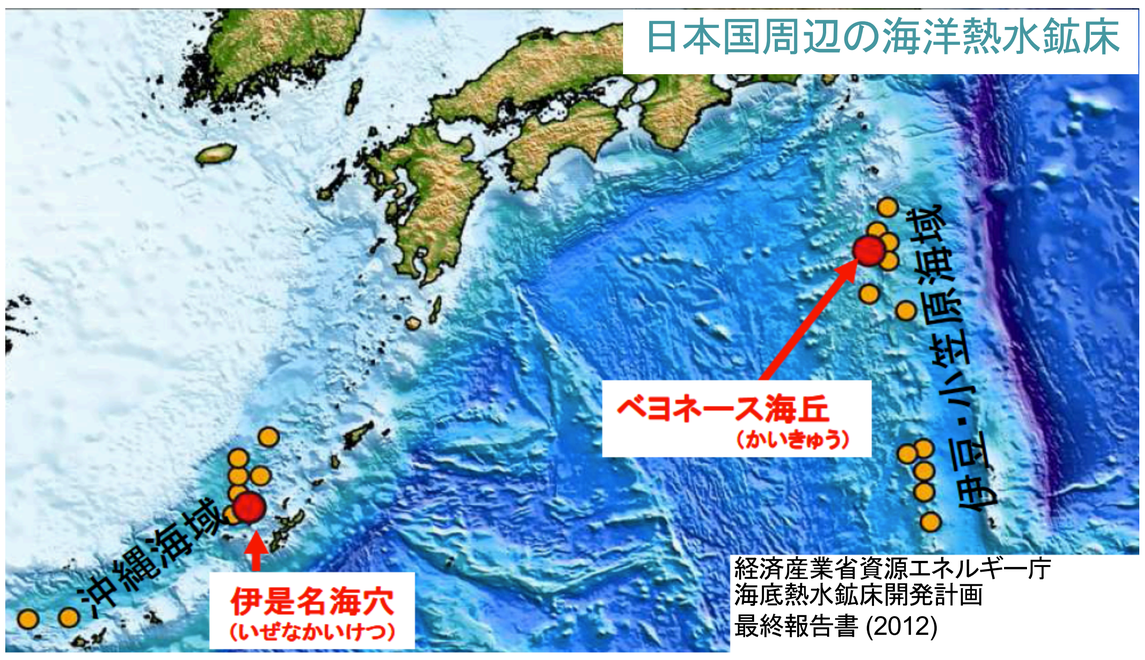
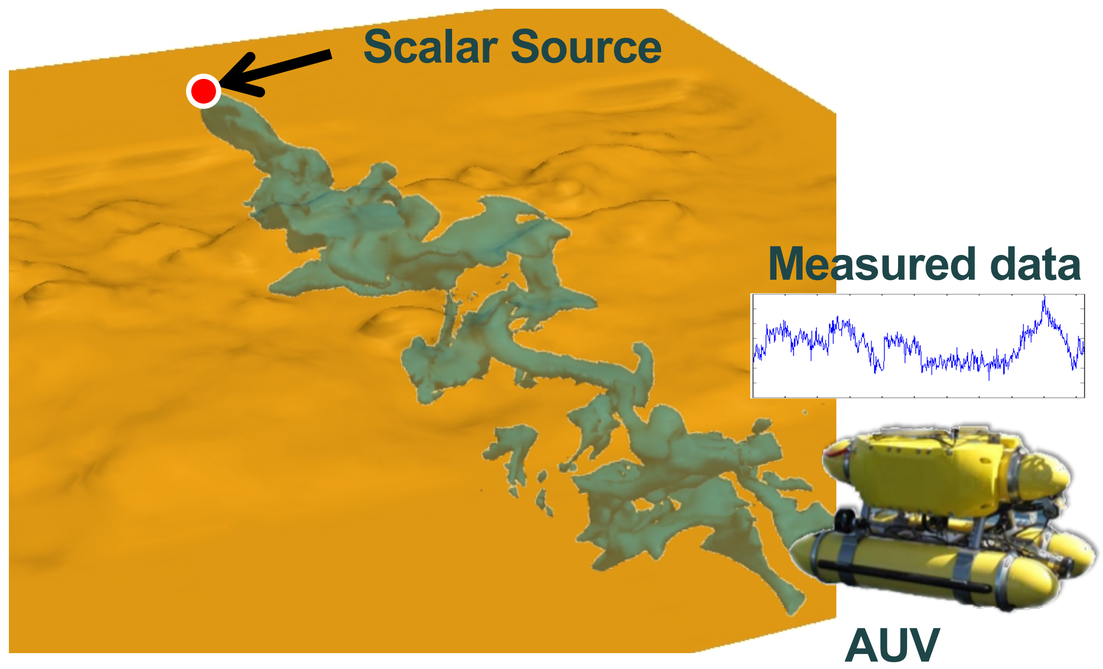
## Exploration of ocean bottom resources using mobile robot



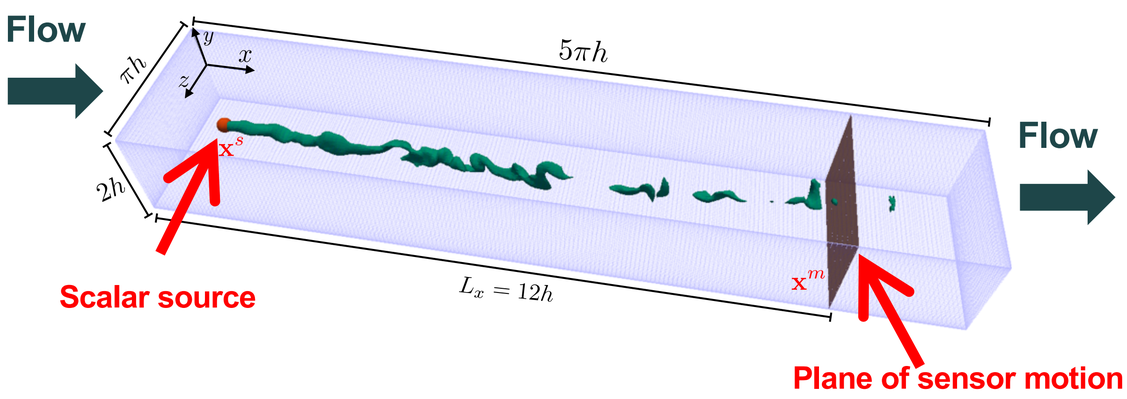




Example: Hydrothermal mineral deposit in ocean
Issue: proximity might not be feasible

Idea: Use of a robot moving away from the scalar source to measure scalar information
Purpose: Use this information in order to reconstruct scalar source characteristics

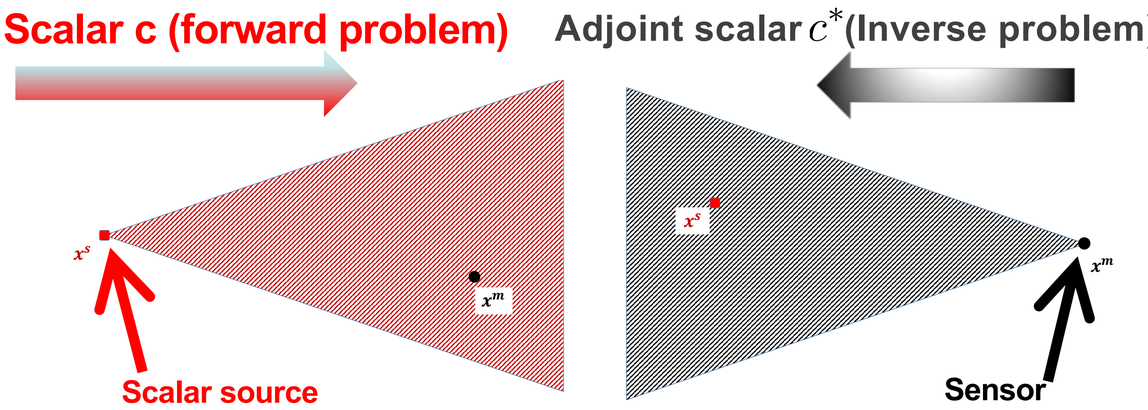
## Source reconstruction based on sensor information

### Simulation set-up:




- Fully developed channel turbulence ($Re_\tau$ = 150)
- Place the source source in the center of the channel
- Estimate source source based on downstream single sensor information

### Adjoint concept



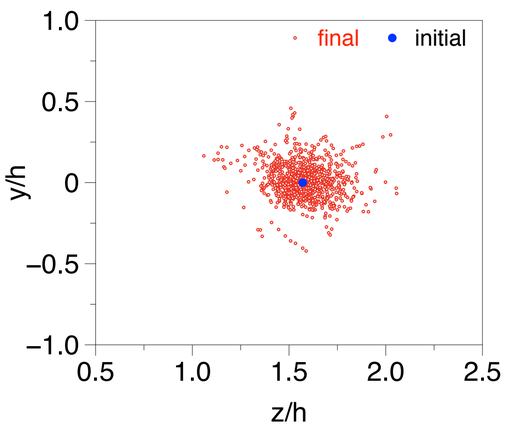

$$\langle c^*, \delta(\mathbf{x}-\mathbf{x}^s)\rangle = \langle \delta(\mathbf{x}-\mathbf{x}^m), c\rangle \qquad \langle\cdot\rangle = \int_T \int_\Omega \cdot \; d\Omega dt.$$

### Minimization problem:

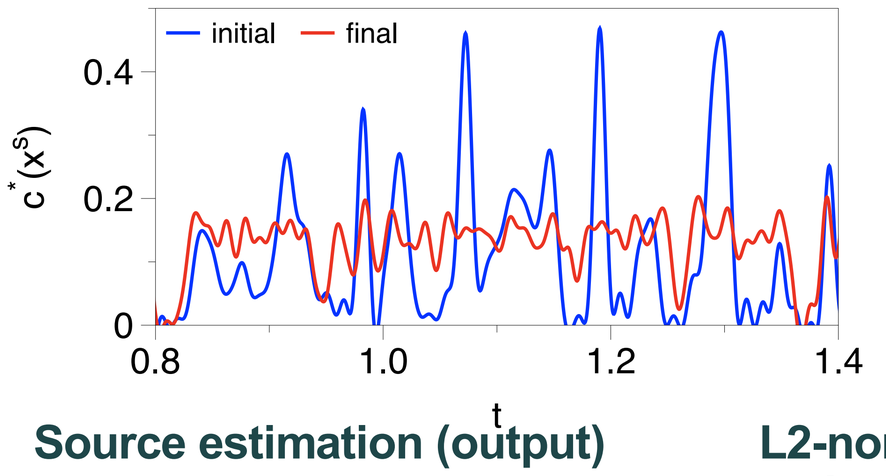
Find sensor trajectory that minimizes ratio between fluctuations and intensity of the adjoint field at scalar source location

## Estimation Performance

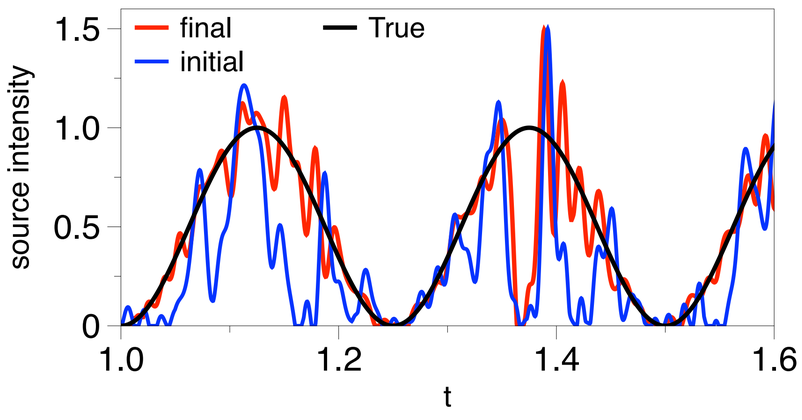
### Sensor arrangement



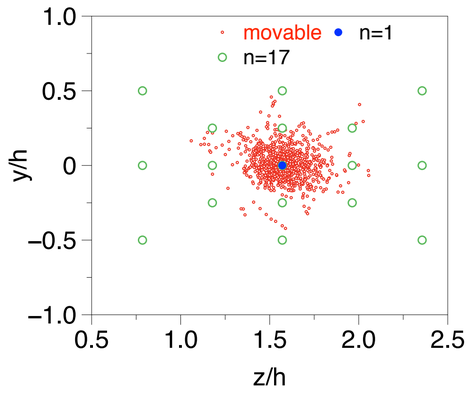

### Adjoint field at scalar source



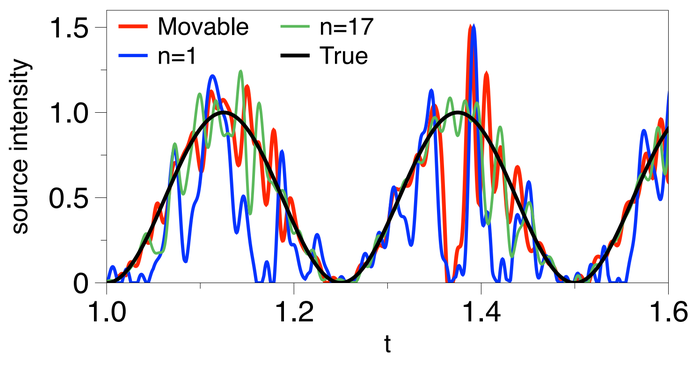

### Source estimation (output)




### Sensor arrangement




### Source estimation (output)




### L2-norm error between source intensity and estimated value:

| $f$ | Movable | Stationary | |
|---|---|---|---|
| | | n=1 | $n = 17$ |
| | $\ell^2_{norm}$ | $\ell^2_{norm}$ | $\ell^2_{norm}$ |
| 2 | 0.22 | 0.40 | 0.10 |
| 4 | 0.24 | 0.38 | 0.13 |
| 8 | 0.21 | 0.41 | 0.13 |
| 16 | 0.20 | 0.40 | 0.13 |

$$\ell^2_{norm} = \sqrt{\frac{1}{\Delta T}\int_{t_0}^{T}\left(\phi^{true}(t) - \phi^{est}(t)\right)^2 dt}$$