SPI for LCGT
Do we really need it ? hopefully not.

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LCGT, IFO group meeting
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Questions to be answered

(not necessarily in this presentation)

- Why do we need SPI (benefits) ?
- What is the current status ?
- What do we need to do to implement SPI in reality ?
- Are there alternative ways ?
- Which way shall we go ?

Why do we need SPI ?

Reduction of the RMS mirror motion

- Easy lock acquisition
- Improve stability
- Up-conversion noise
- Other noises coupled with the RMS

Vibration Isolation

- Actually reduce seismic noise
- Heat link vibration

This is the motivation for LCGT SPI

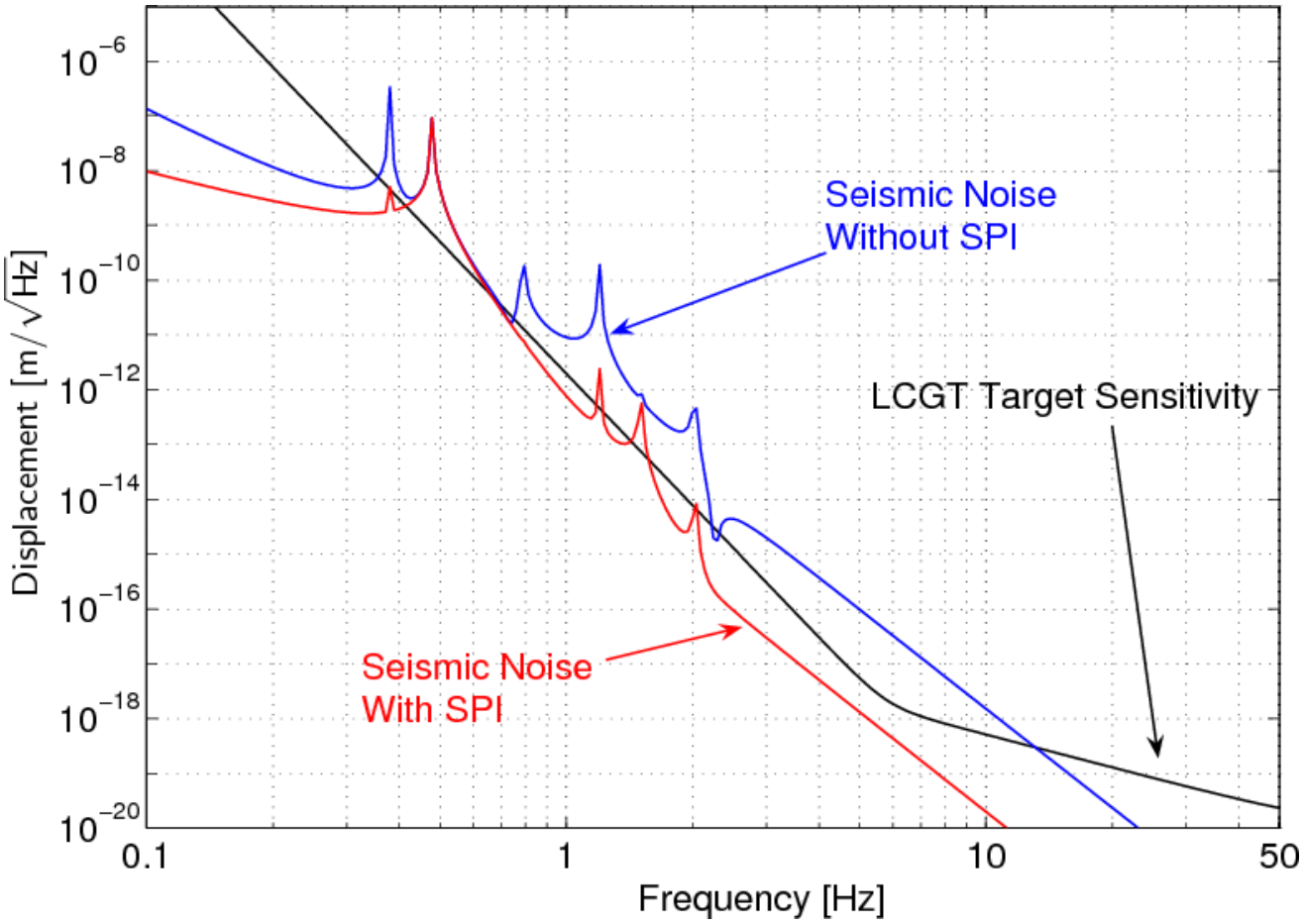
Current Status

- A proof of concept experiment by Aso
- Up to 40dB seismic noise reduction below 10Hz

LCGT estimate

Assumptions:

- 40dB suppression of horizontal vibration by SPI everywhere.
- Vertical vibration coupling = 1%



No SPI work since 2006

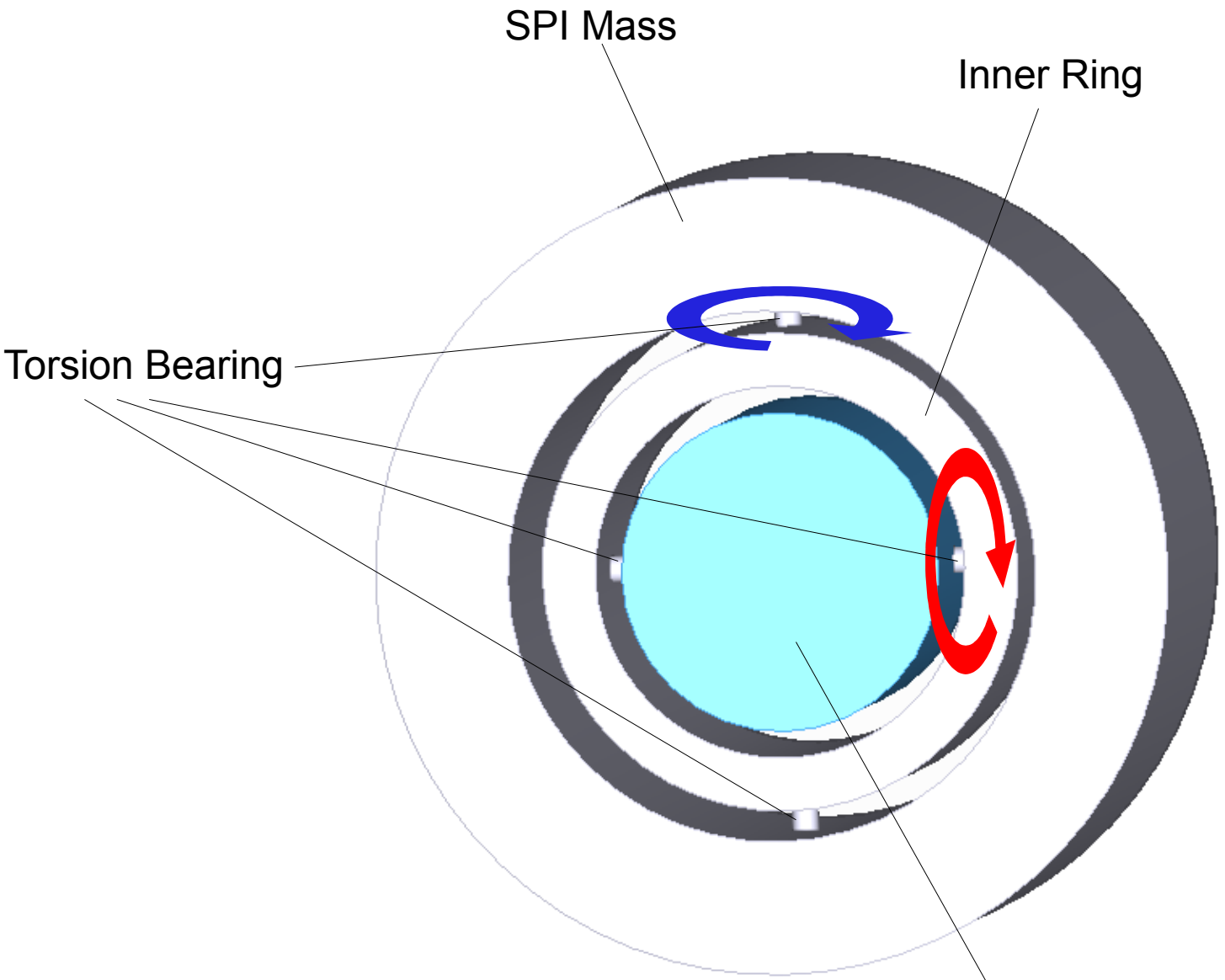
What do we need for LCGT SPI ?

Design of the SPI mass.

- Independent alignment from the main IFO (compound mirror)
- Cryo-compatible design
- What kind of mirror ?
- Thermal noise ?
- No detailed plan for this

Other issues

- SPI does not provide vertical/rotational vibration isolation
  (Couplings from other degrees of freedom limit the SPI performance)
- Input optics for SPI
- Laser frequency shift
- Larger diameter beam tubes are required.



Sample bearings
http://www.c-flex.com/stable.html

Alternative Solutions

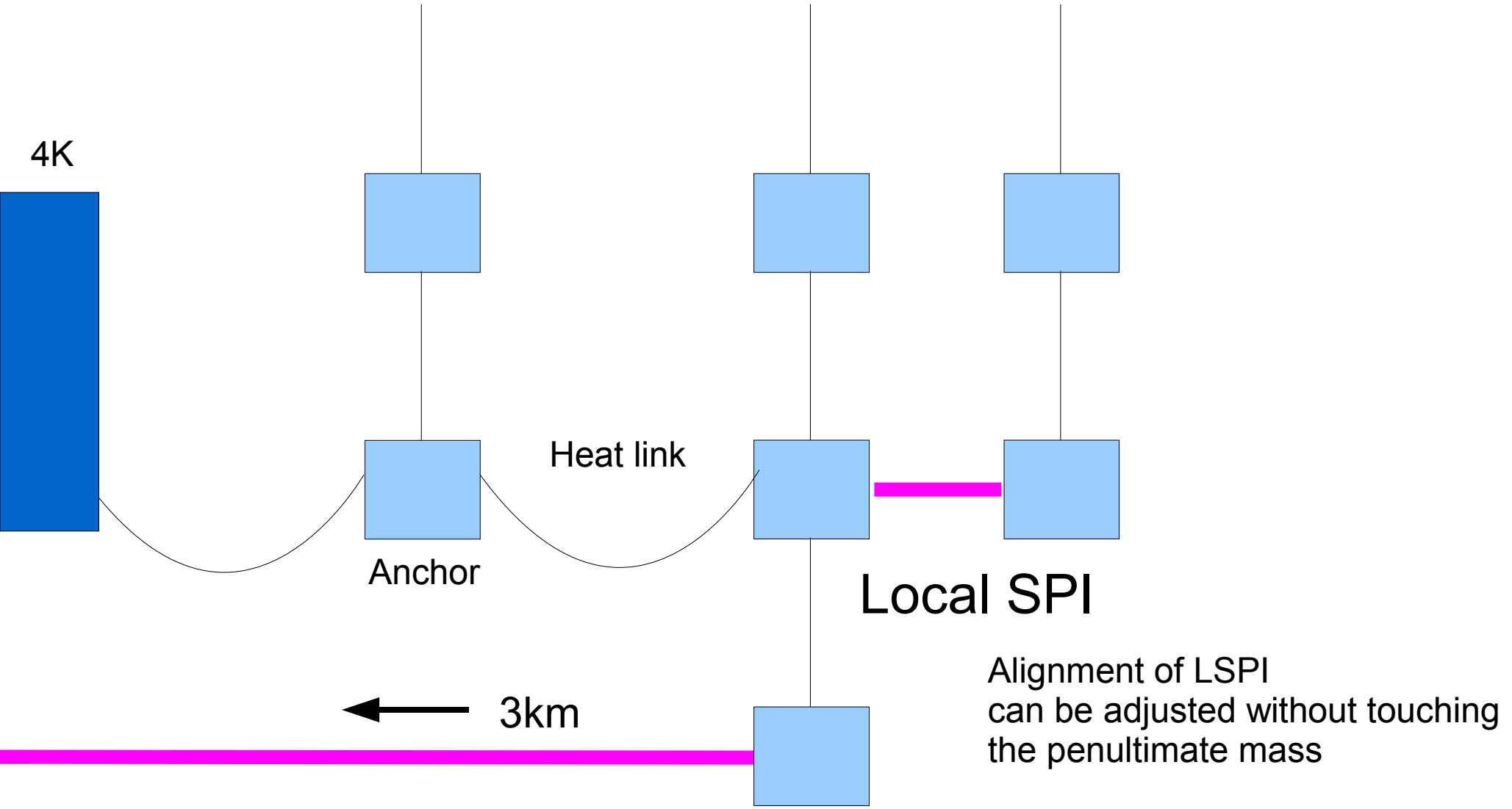
Lock acquisition: Deterministic Lock Procedure
Pre-lock arms by green laser injection from the end mirrors
Pseudo-Random Noise Interferometer

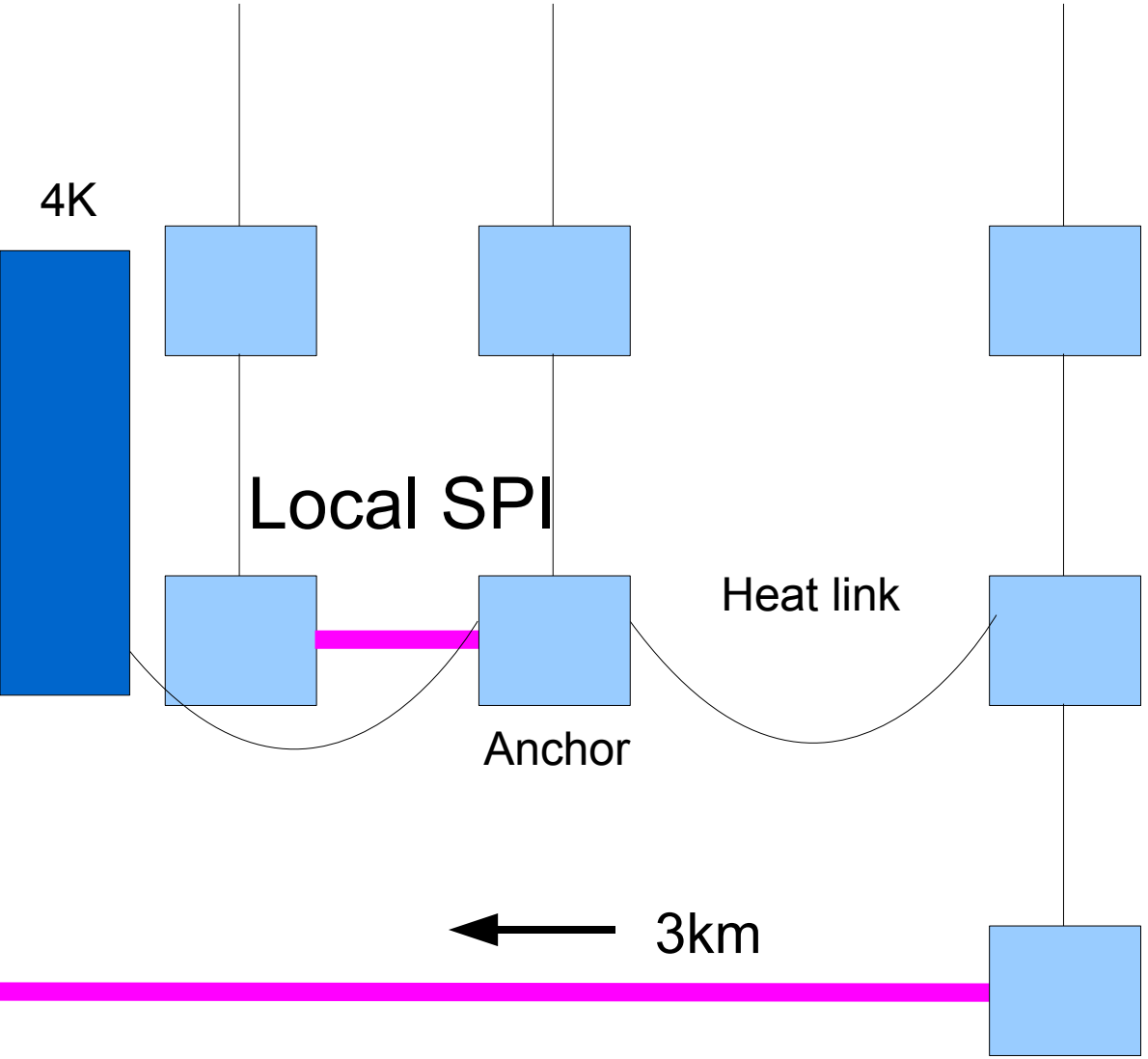
Stability, RMS reduction: Hierarchical control (feedback to upper stages)
Adaptive noise canceling

Heat link vibration

LCGT specific

- Better heat link isolation
- Local SPI
- Local SPI on the heat link anchor
- Active vibration isolation of cold head


4K
Heat link
Anchor
Local SPI
3km
Alignment of LSPI
can be adjusted without touching
the penultimate mass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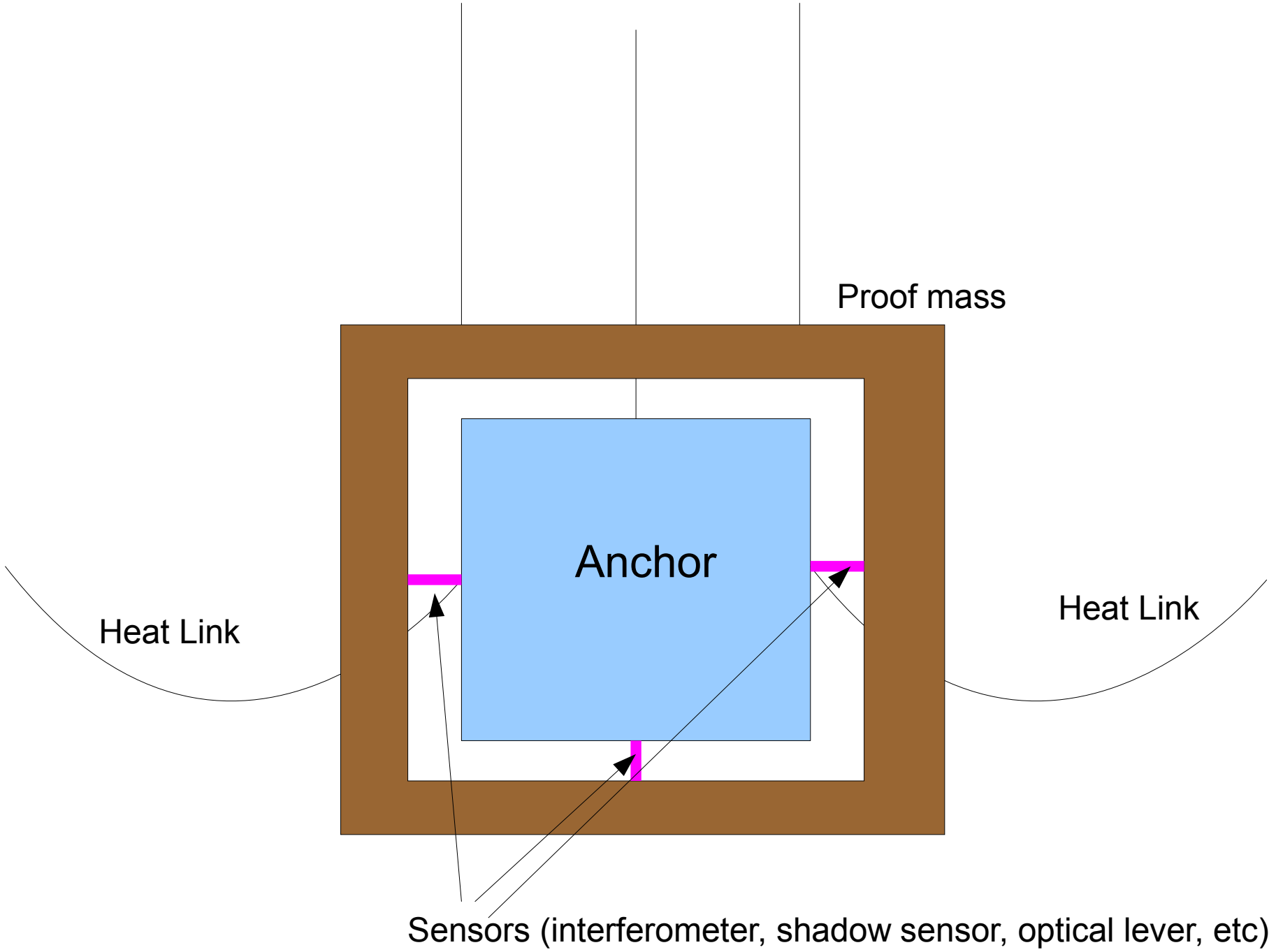

Copy the quietness of the proof mass to the anchor mass

My understanding of the current situation

- There has been only proof of concept experiments for SPI

  (No practical design for LCGT)
- Most of the advantages of SPI seem to be achievable by alternative means
- The only remaining purpose of the SPI is the heat link vibration suppression.
- Even for that, there are several alternative solutions.
- Technological maturity of SPI is not much more than those alternatives.

My recommendations

- Another 3km interferometer for heat link vibration suppression seems overkill for me.
- We should put more effort on alternative solutions with the elimination of the global SPI in mind.