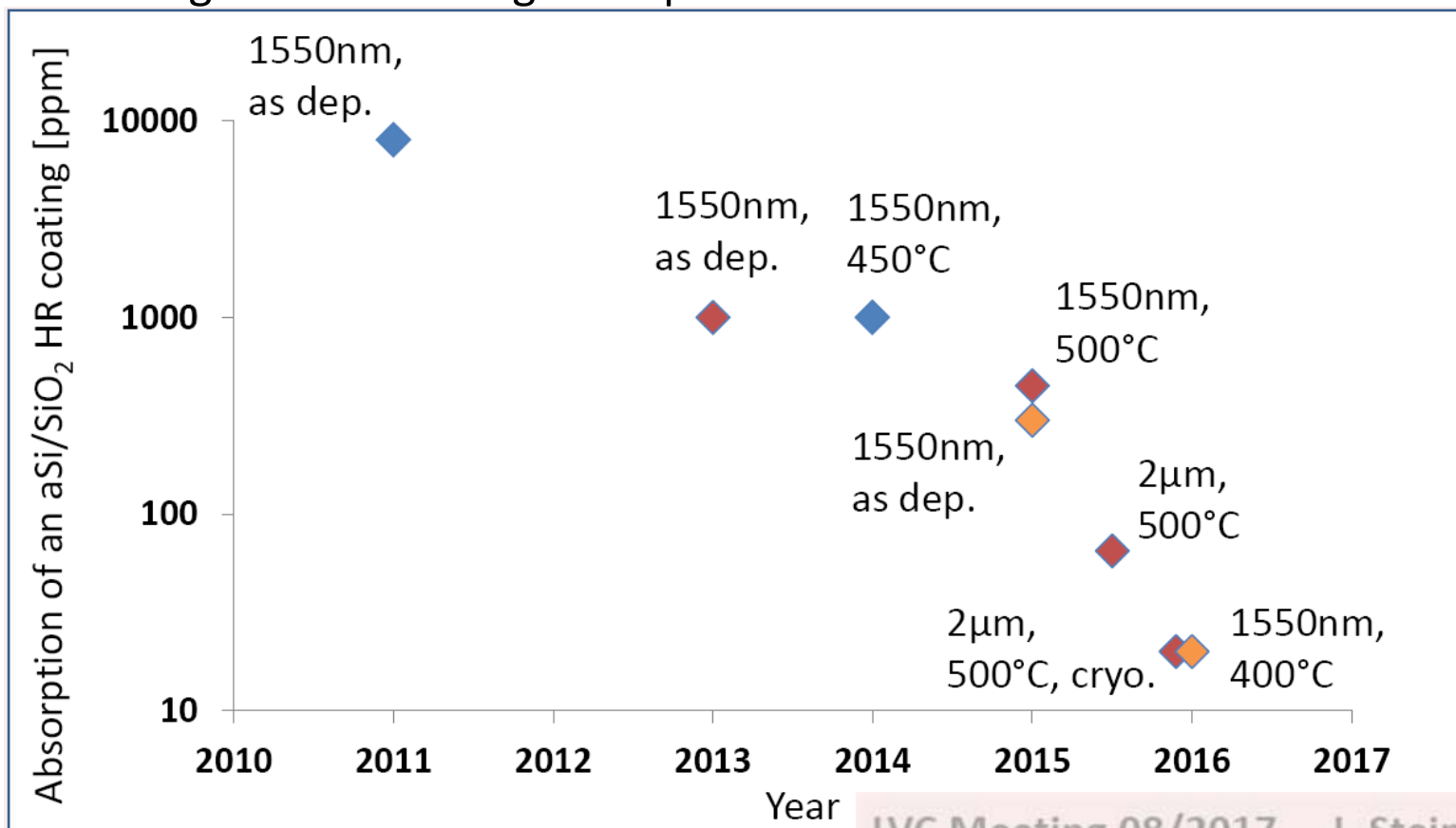


Coatings for ET-LF

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Coatings for ET-LF

- Significant progress in alternatives to silica/tantala since the design study
- Amorphous silicon (aSi)
 - Very low mechanical loss
 - Progress in reducing absorption has been made



Coatings for ET-LF

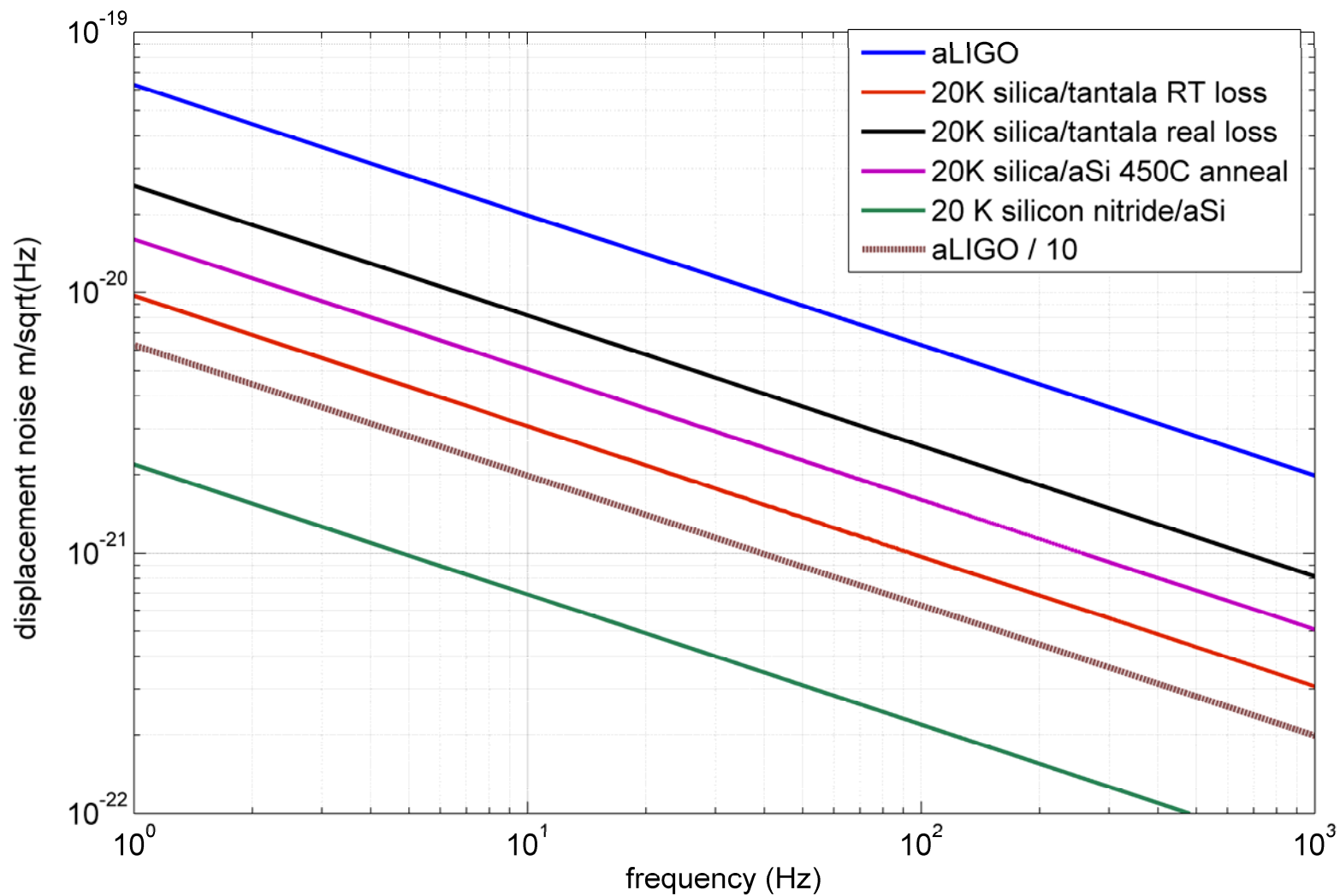
- aSi absorption can be x7 lower at 2 μ m than at 1550nm – potential strong driver for change in wavelength
- Multi-material coating designs using some silica/tantala layers on top of silica /aSi can allow some thermal noise gain while maintaining reasonably low absorption
- Thermal noise in any aSi/silica coating dominated by high mechanical loss silica layer. Silicon nitride of interest as alternative low index material

Coatings for ET-LF

Coating	ETM coating TN reduction factor	Absorption
aLIGO 300 K (1064nm, 6.2cm beam)	1	<1ppm
silica/tantala 20K (1550nm, 9cm beam)	x2.4	<1ppm
silica/aSi 20K (1550nm)	x4.8	~20ppm
silica/tantala // silica/aSi 20K (1550nm, 9cm)	x3	~5ppm
aSi/Si ₃ N ₄ 20 K (2000nm)	x29	~29ppm

Note: these numbers are approximations only, and based on current results at the time of the ET workshop. A fuller discussion detailing different types of aSi coating etc can be found in LIGO-G1701726. Reference to G1700882 (GWADW talk, Iain Martin) may also be useful, but note some absorption numbers (silicon nitride) have reduced dramatically since then.

Coatings for ET-LF



Open questions / other approaches

- Can we get **aSi-based coatings** <1ppm absorption?
- **120 K operation?** Some more work needed here during workshop
 - Silica loss lower (depending on annealing state). Cooling by radiation, less limited by heat extraction. Less TN benefit from cooling.
- 2um may allow use of **a-Ge coatings** – higher index than aSi, thinner coatings. What is loss, absorption?
- **Crystalline coatings** still of interest (both AlGaAs and AlGaP) – may be scalable to large diameters on the timescale of ET?
 - Similar potential TN reduction to aSi/SiN. AlGaAs already has <1ppm absorption
- **Nano-layer coatings** to suppress crystallisation and enable higher heat-treatment temperatures
 - May be useful for squeezing best possible performance out of amorphous oxide coatings