

NCal commissioning shift of September 26

Investigating parasitic coupling

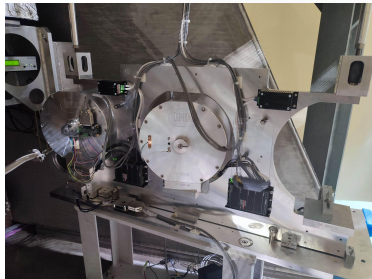
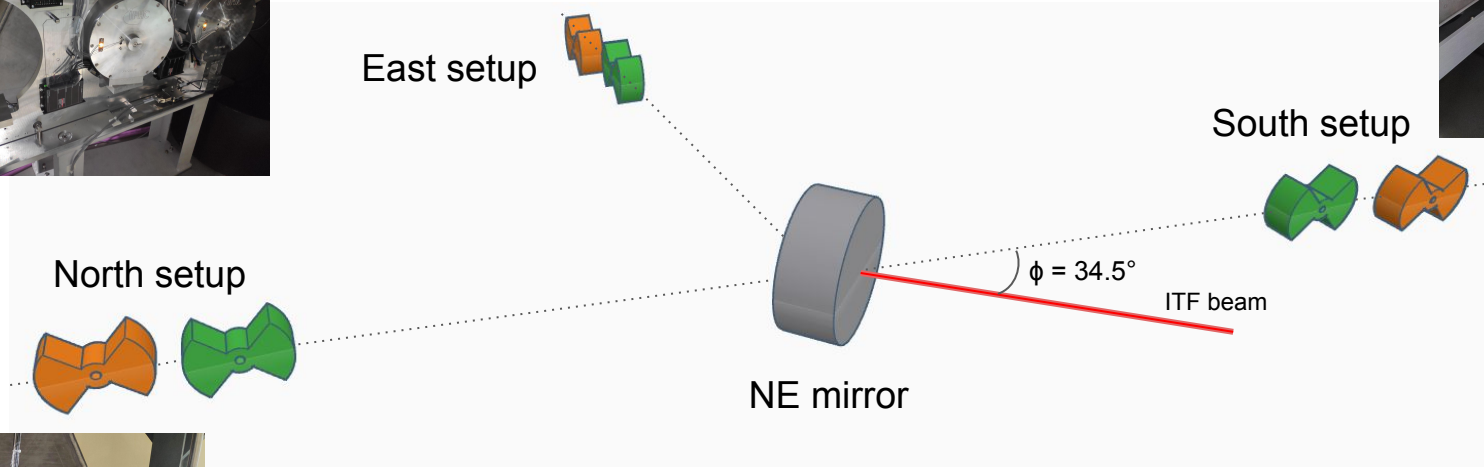
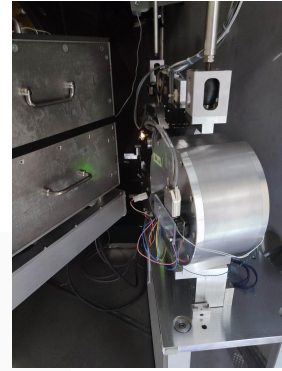
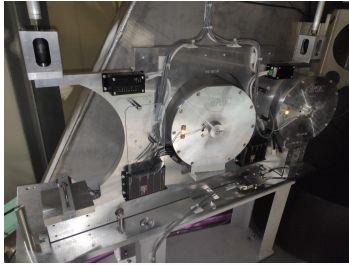
VIR-0955A-23

Antoine Syx and the NCal team
31/10/23

NCal setup for O4

Reorganized in the morning of the shift

- 3 “**Green**” NCals at 1.7 m
 - 3 “**Orange**” NCals at 2.1 m
- 2 distances to compute mirror offset



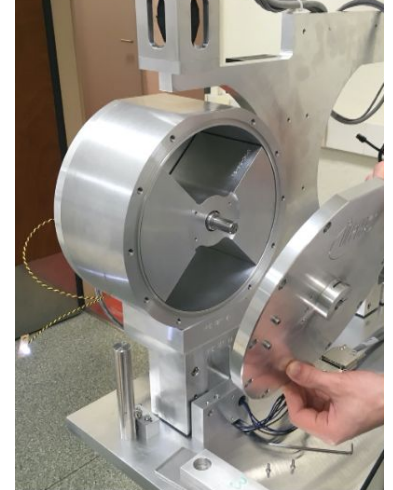
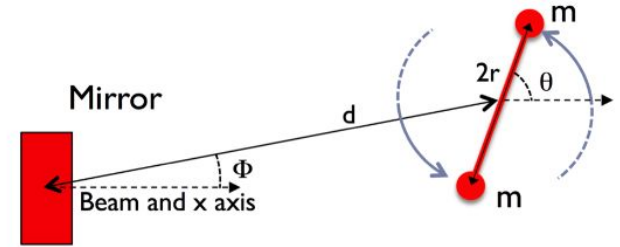
- Monitoring mirror offset using pairs of opposite NCals
- Measurements using Near and Far triplets
 - ◆ Hrec/Hinj and mirror position relative to NCals

NCal reminder

Force along the beam axis (first order):

$$F_{\text{beam axis}} \approx \frac{9GmMr^2}{2d^4} \cos(\Phi) \cos(2\theta)$$

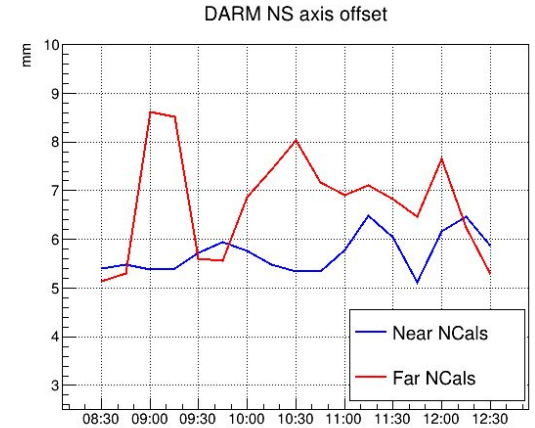
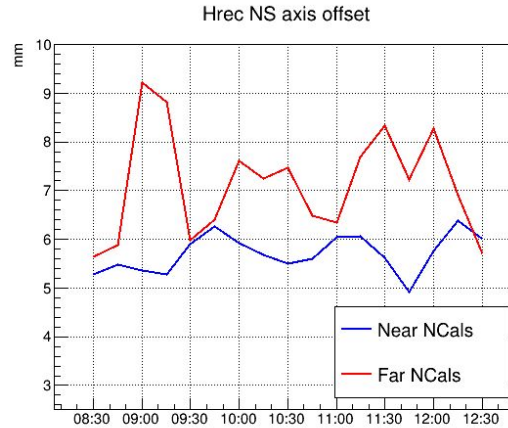
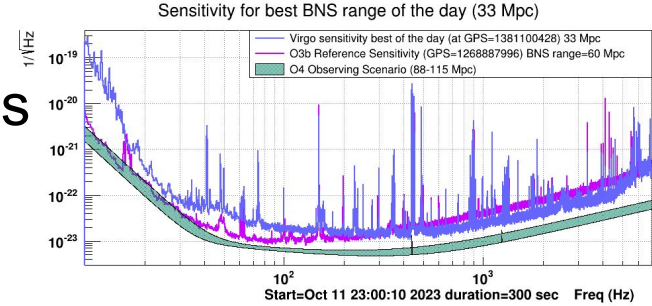
- NCal to mirror distance is a key parameter
- ◆ Mirror position is not well known
 - ◆ Pair of NCals on opposite sides of the mirror helps
 - Measure mirror position by amplitude comparison
 - Use mean amplitude to neglect d effect at first order



Mirror offset using pairs of Near and Far NCals

Typical results

- Near NCals mirror offset:
 - Hrec mean = 5.7 mm
 - DARM mean = 5.7 mm
- Far NCals mirror offset:
 - Hrec mean = 7.1 mm
 - DARM mean = 6.7 mm



On DARM: 1 mm between Near and Far NCals results

- Corresponds to an amplitude variation of **0.24% per NCal**
- ◆ Systematics from NCal geometry: < 0.15%
 - ◆ Hint for a parasitic coupling

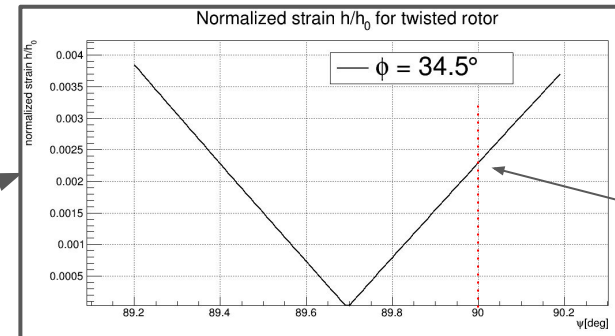
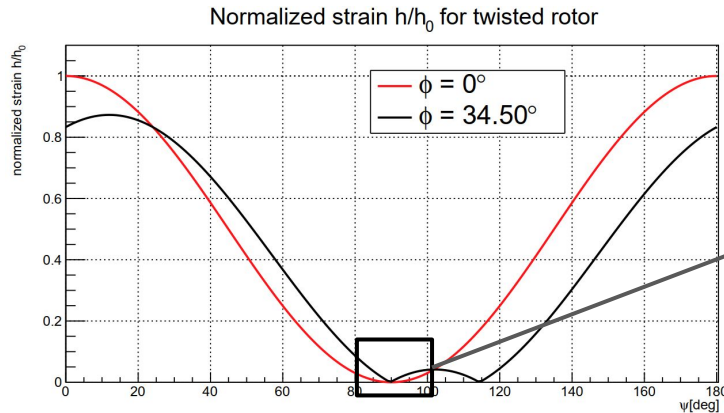
Virgo NCal mission September 26

See logbook entries [61796](#) & [61798](#)

- Twisted East NCals by 90°
 - Theoretically (FEM) $h(t)$ reduced
 - 0.23% of its value at 1.7 m
 - 0.15% of its value at 2.1 m
 - Study parasitic couplings with mirror
- Twisting precision of about 2.5 mrad (mechanical)
 - Expected residual coupling of [0.13; 0.33]% at 1.7 m and [0.05; 0.25]% at 2.1 m
 - Remark: Similar uncertainty for mirror offset of 6 mm

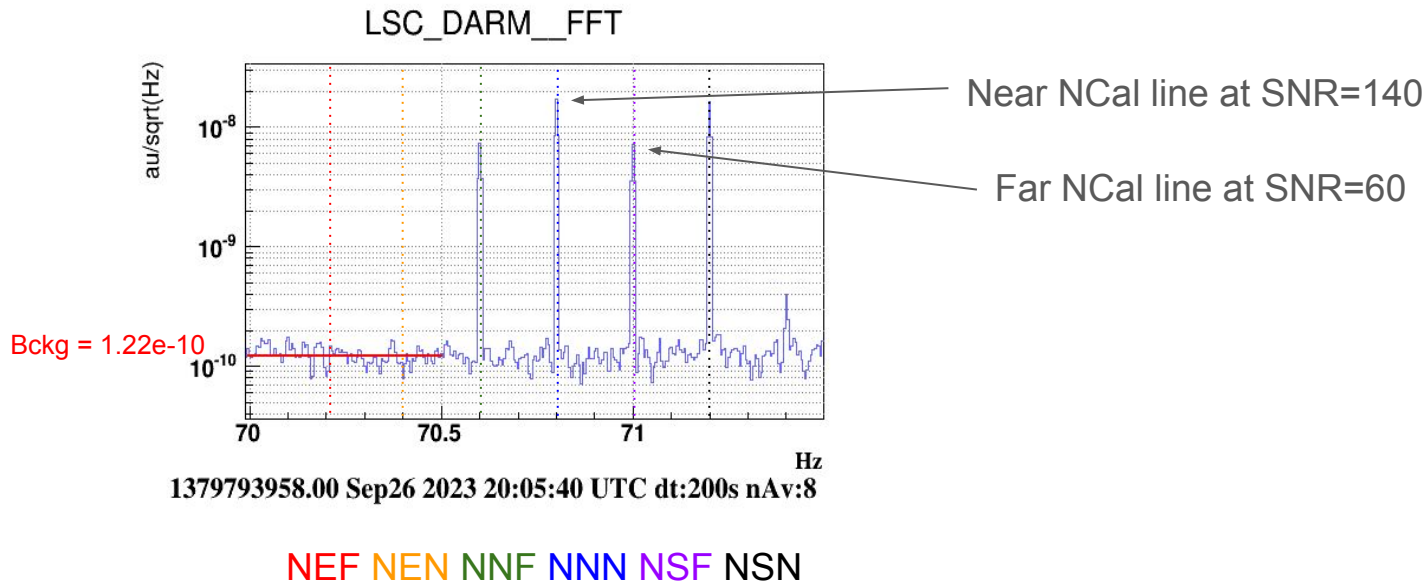


East NCals were twisted back to 12° after tests



90° twist

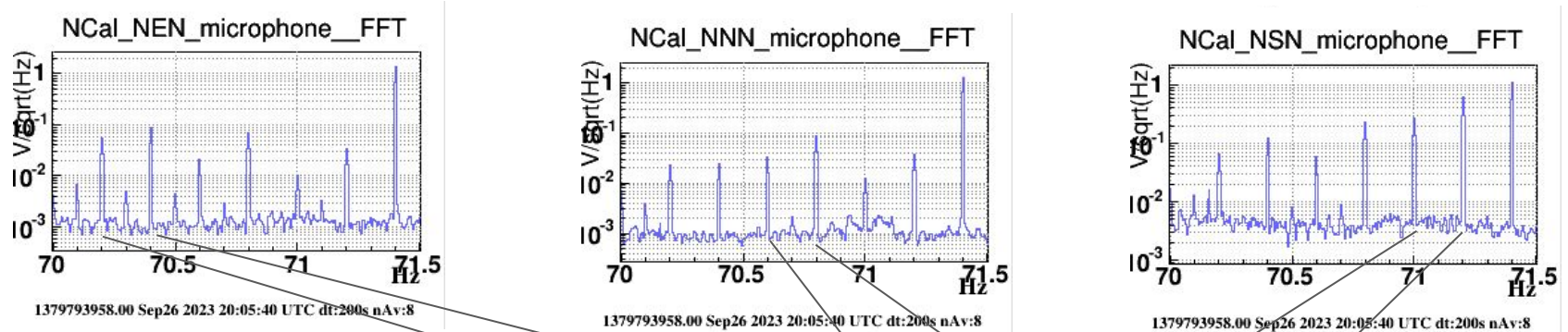
Focus on East suspended @ 70 Hz (twist $\psi=90^\circ$)



- No visible coupling with ~10 min of data
- Near East line coupling below $\sqrt{1/8}/140 = 0.25\%$
- Far East line coupling below $\sqrt{1/8}/60 = 0.59\%$

Acoustic coupling on East Suspended @ 70 Hz (twist $\psi=90^\circ$)

- Comparing each NCal acoustic noise in their near setup microphone to NEN coupling of < 0.25%



Parameter	NEF	NEN	NNF	NNN	NSF	NSN
Near mic factor	0.63	1	0.38	1	3.20	7.15
Upper limit coupling (%)	0.16	0.25	0.10	0.25	0.81	1.80

Summary

- 2 triplets of NCals around NE mirror at 1.7 m and 2.1 m
 - Mirror offset along NS axis
 - Hrec/Hinj
 - 1 mm offset between Near and Far NCals measurements
 - Parasitic coupling at the level of 0.25% ?
 - Acoustic coupling study
 - Upper limit depends on the NCal: from 0.10% to 1.80%
- Need longer data with NCals twisted of 90° to constrain upper limit
- ◆ Will be turned during November 7 maintenance
- Magnetic coupling study also in progress