# Current status of Virgo commissioning 09/09/2022

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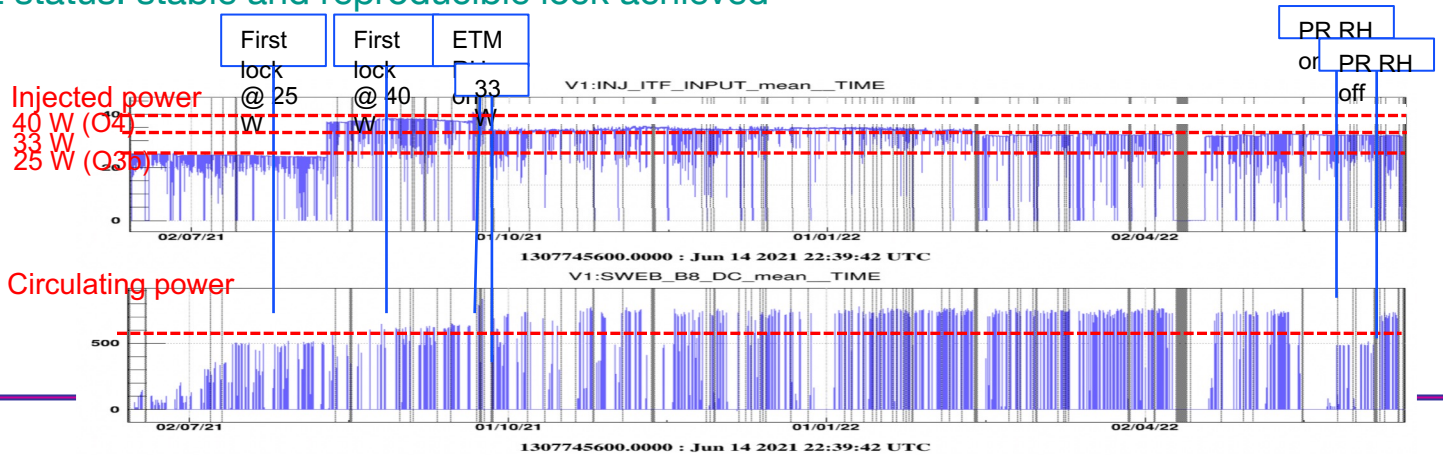
# ITF phase I commissioning

- January 2021: start of ITF commissioning
- August 2021: first lock of the interferometer with the O3 input power level (25W)
- September 2021: first lock with the O4 input power level (40 W)
- October 2021: decrease input power to 33 W due to locking instabilities
- November 2021 ÷ June 2022: work on interferometer control and automation, several issues on locking stability
- July 2022: installation of new actuator for RoC control of PR mirror (CHRoCC)
- Current status: stable and reproducible lock achieved

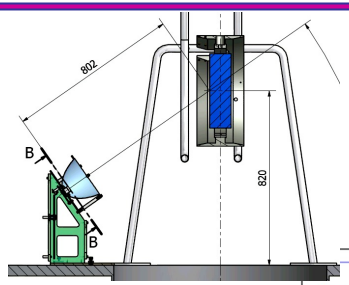


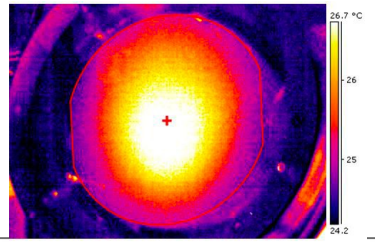
# The challenge of double recycling in Virgo

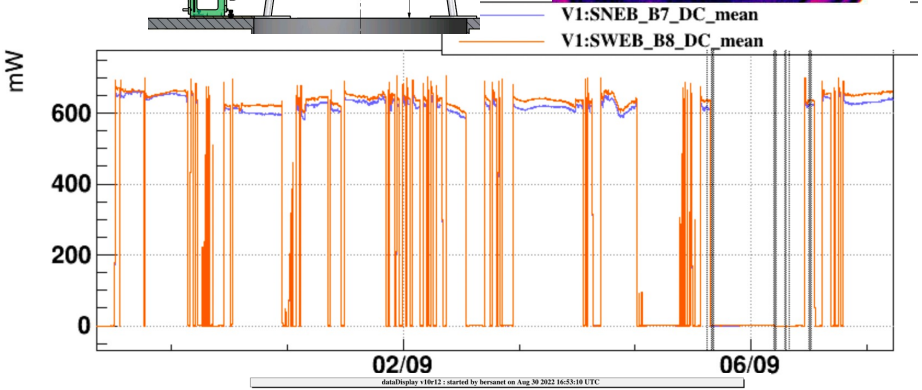
- In AdV design the PRC and SRC optical cavities are close to instability region
  - makes mode matching and alignment extremely critical
  - difficult to measure cavity mismatch, as most HOMs resonate simulteneously
- PRM designed to reach proper RoC at full optical power
  - cold RoC error of -40 m
  - to be compensated with PRM RH in principle
  - however compensation limited to <10 m due to hardware issues
- Compensation of PR RoC was done until last July with TCS ($CO_2$ actuators on input CPs)
  - however SR cavity matching is affected too
  - optomechanical couplings (optical spring) depending on both PRM and SRM RoC
  - limited bandwidth of DARM transfer function, which determines ITF sensitivity
  - Alignment of $CO_2$ actuators was not properly controlled

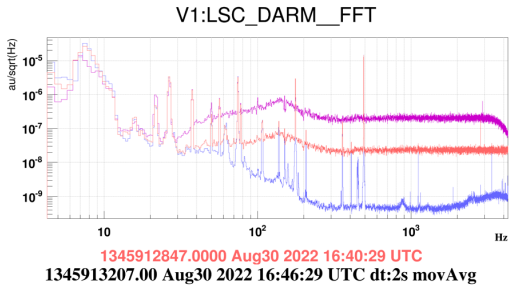
# ITF commissioning with CHRoCC

- Central Heating for Radius of Curvature Compensation (CHRoCC) installed in mid July on PRM
- SRM RoC independently tuned with ring heater
- CHRoCC pre-commissionedg with HWS
- PRM & SRM RoCs tuned in CITF
- Full lock achieved in the new configuration
  - Sensibly more stable than before
- Currently tuning thermal working point
- OMC lock and DC readout achieved



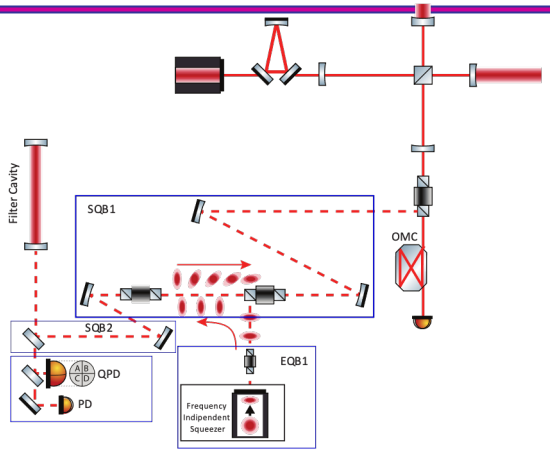



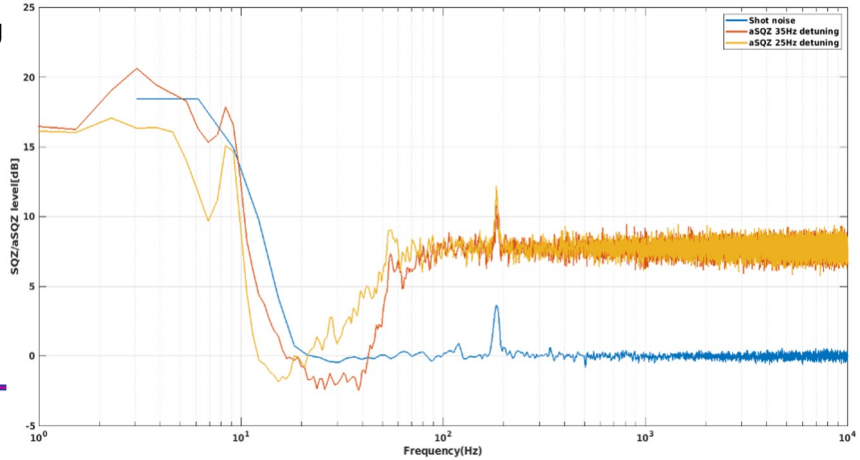
# ITF working point tuning

- Stable and reproducible locking in dark fringe achieved
  - No more jumps in ITF state
  - DARM optical spring at quite low frequency, anyway not affecting ITF lock
- DC readout achieved
  - automation to be completed
- Open points on ITF tuning
  - Band of DARM TF lower than expected (max 300 Hz instead of ~450 Hz)
    - » Depending on both curvatures and alignments of CITF optics
  - SB gain lower than expected
    - » ~ a factor 2 wrt CITF with TCS on
    - » ~ a factor 3 wrt CITF with TCS on
- Open points in ITF control
  - Still missing suitable error signals for the control of some angular d.o.f.
    - » SR & BS

# QNR commissioning

- Precommissioning of QNR subsystem completed
  - In-air bench with SQZ source (AEI), sensors & actuators for filter cavity control
  - Suspended benches for beam delivery to FC and to interferometer
  - Filter cavity for squeezing ellipse rotation
- Commissioning of frequency-dependent squeezing (FDS) completed with external homodyne detector
  - Double stage longitudinal and angular control of filter cavity with auxiliary beams
    - » 532 nm from SHG of main SQZ laser
    - » 1064 nm from subcarrier laser (FC) with 1.2 GHz detuning
  - Commissioning of frequency-dependent squeezing (FDS)
    - » FSD measured down to 20 Hz FC detuning (better than target 40 Hz)
    - » Filter cavity control automated
  - Ready to be injected  on ITF
- Final commissioning on interferometer once locking configuration is consolidated



# Long term commissioning plan