



# Visitare Virgo 2018 Estate

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University of Tokyo

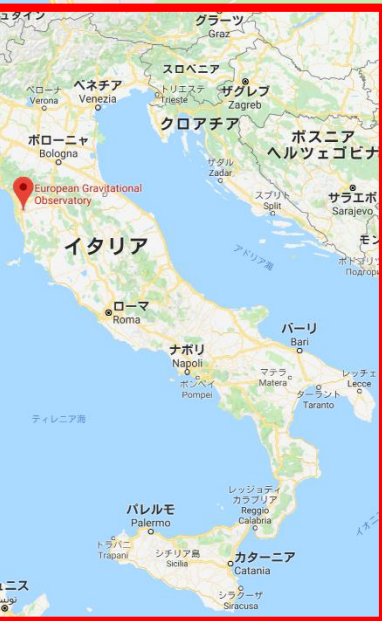
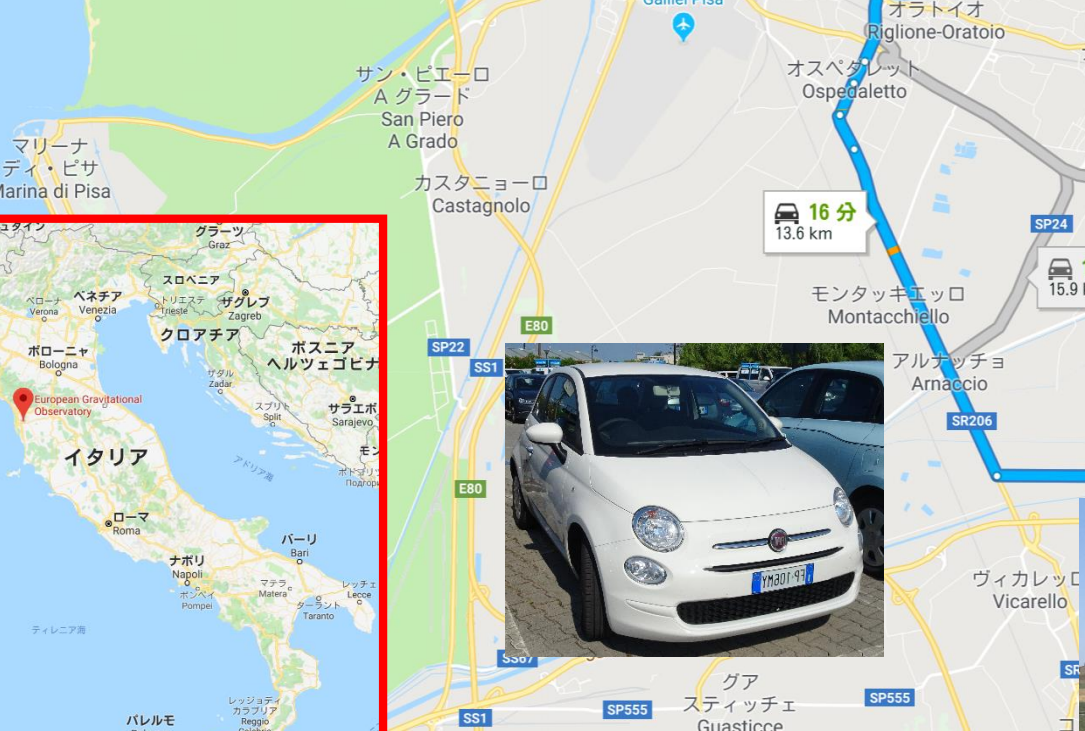
# About

- Host: Alessio Rocchi
- Period:
  - June 5 – 26 @ Virgo
  - June 28 – 29 @ KIW4 Seoul
  - July 2 – 7 @ MG15 Rome
  - July 9 – Aug 11 @ Virgo
- Supported by
  - 東京大学 若手研究者の国際展開事業 (国際研鑽事業)
  - Young Researcher's International Deployment Program
- My first visit to Virgo





# Virgo is Located Close to Pisa





# People Worked With

**ISC etc.:** Diego Bersanetti, Julia Casanueva, Franco Carbognani, Bas Swinkels (NIKHEF), Michal Was (LAPP), Terra Hardwick (LSU)

**Optical Characterization:** Annalisa Allocca, Antonino Chiummo, Jerome Degallaix (LMA)

**Environmental Monitoring:** Federico Paoletti, Irene Fiori

**Injection System:** Eric Genin, Camilla De Rossi, Gabriel Pillant

**Suspensions:** Paolo Ruggi, Valerio Boschi

..... and many more



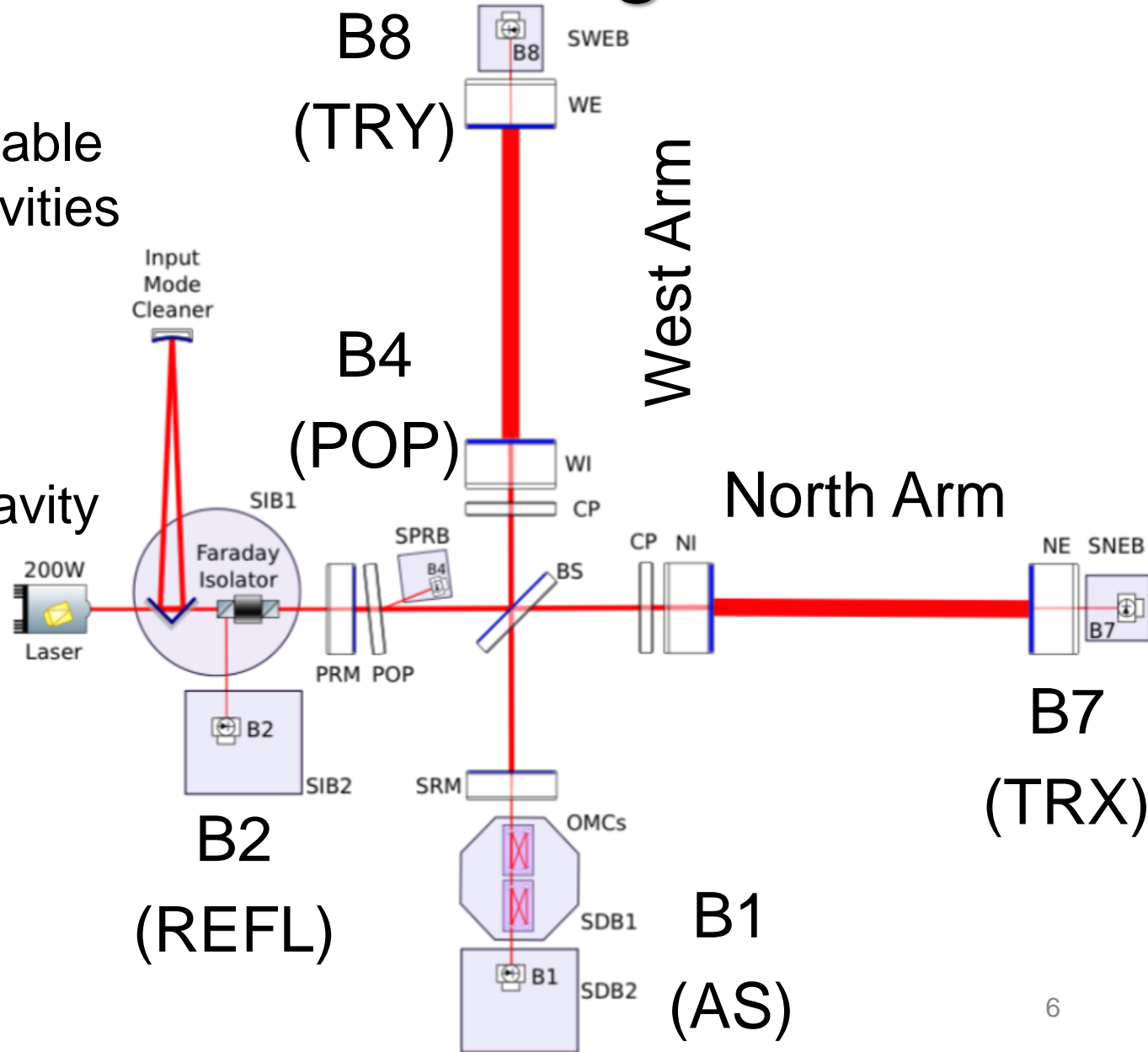


# Contents

- **Advanced Virgo status**
  - interferometer configuration
  - sensitivity
  - lock sequence
  - locking issues
- **Selected commissioning topics**
- **Working environment**
- **Summary**

# Interferometer Configuration

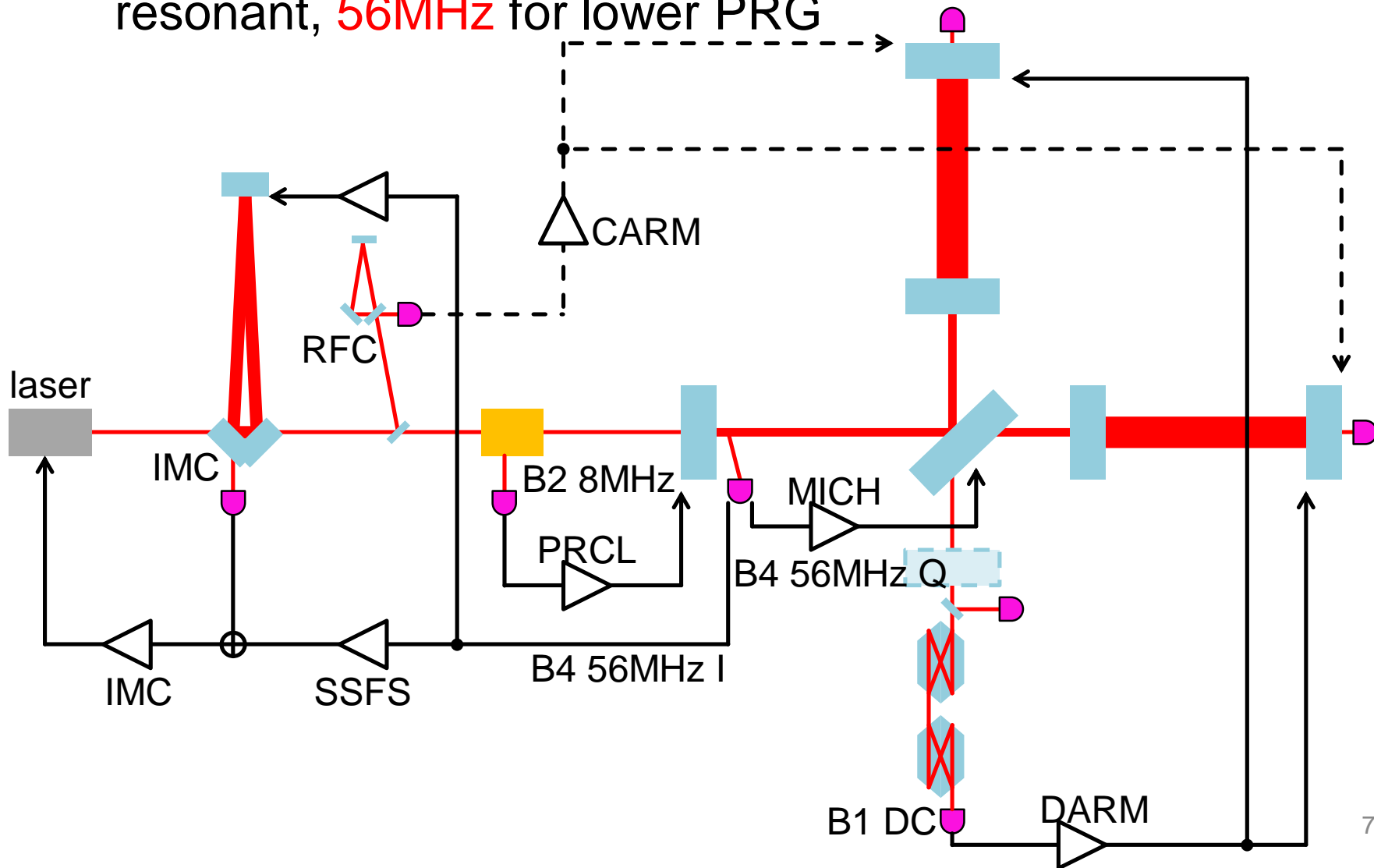
- 3 km arms
- Marginally stable recycling cavities
- No SRM yet (blank SRM)
- Two OMCs
- Reference cavity after IMC





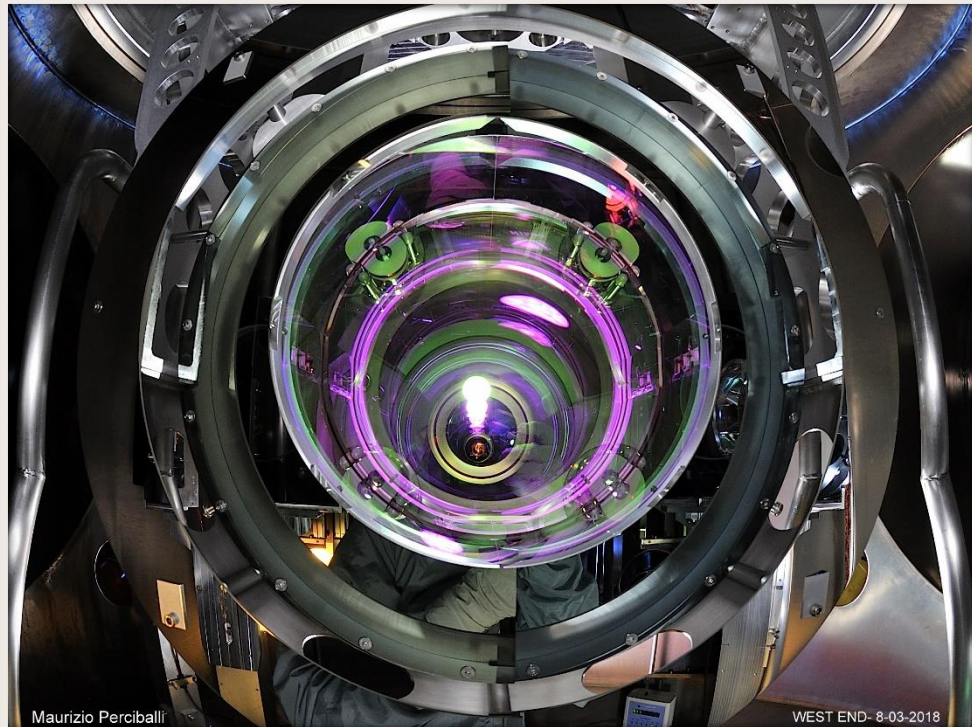
# Full Lock Topology

- Sidebands: 6MHz only lock acquisition, 8MHz for non-resonant, 56MHz for lower PRG



# Status

- See [JGW-G1808906](#) by Raffaele Flaminio for clear summary of the status
- Monolithic suspension installation done in March
- Reached the best BNS range of **35 Mpc** on June 25
- Increased the input power from 13 W to 25 W on June 26



[#40754](#), [#40715](#)

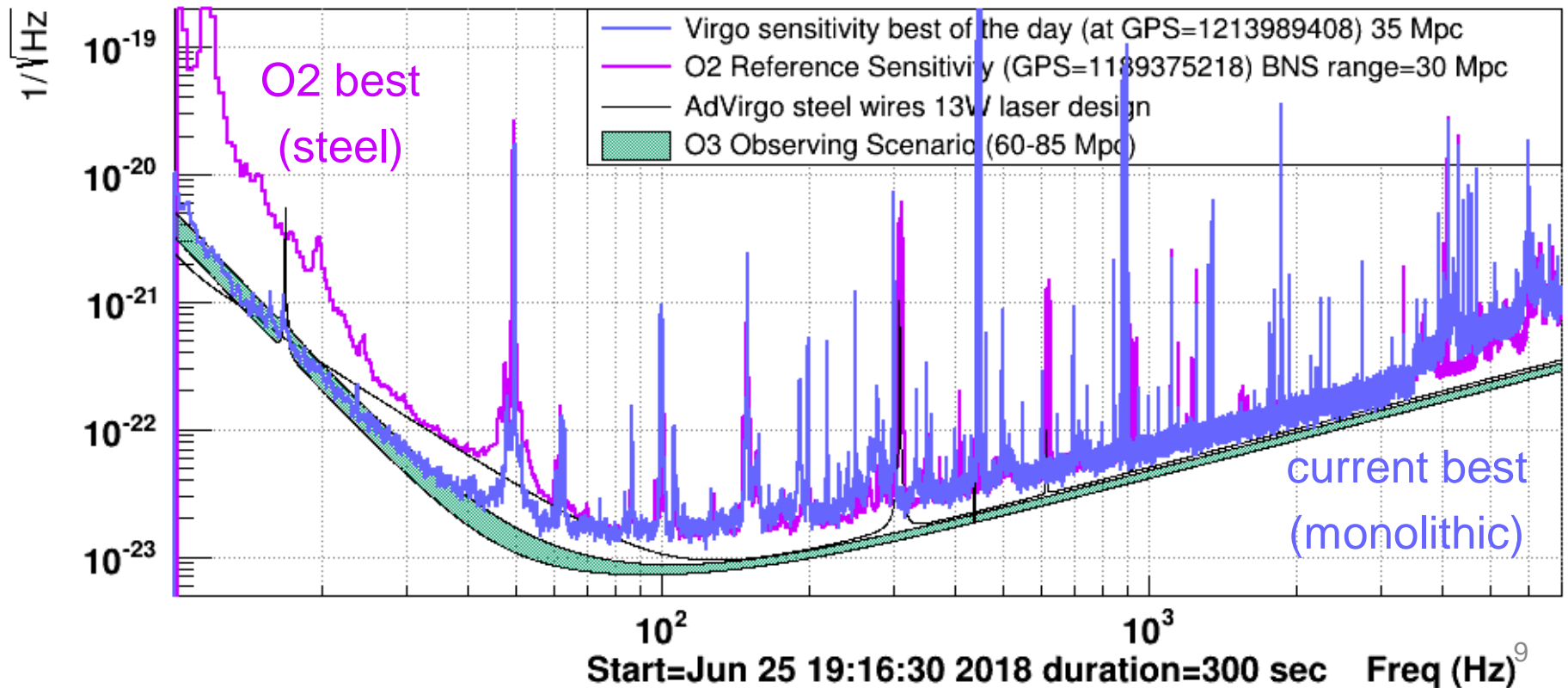




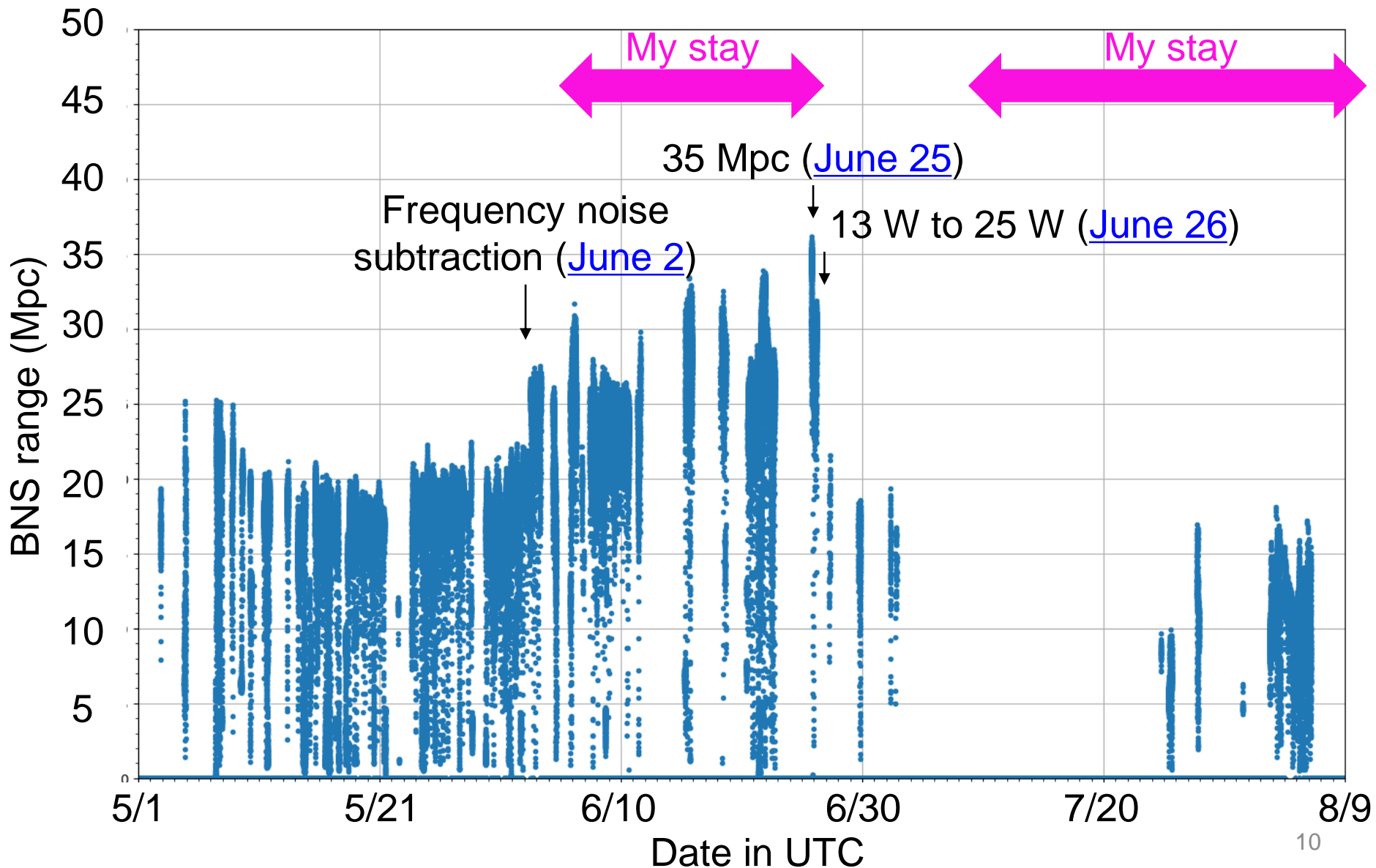
# Best Sensitivity So Far

- BNS range of **35 Mpc** achieved on June 25
- Low frequency sensitivity **compliant with O3 goal**, and better than thermal noise from steel wires

Sensitivity for best BNS range of the day (35 Mpc)



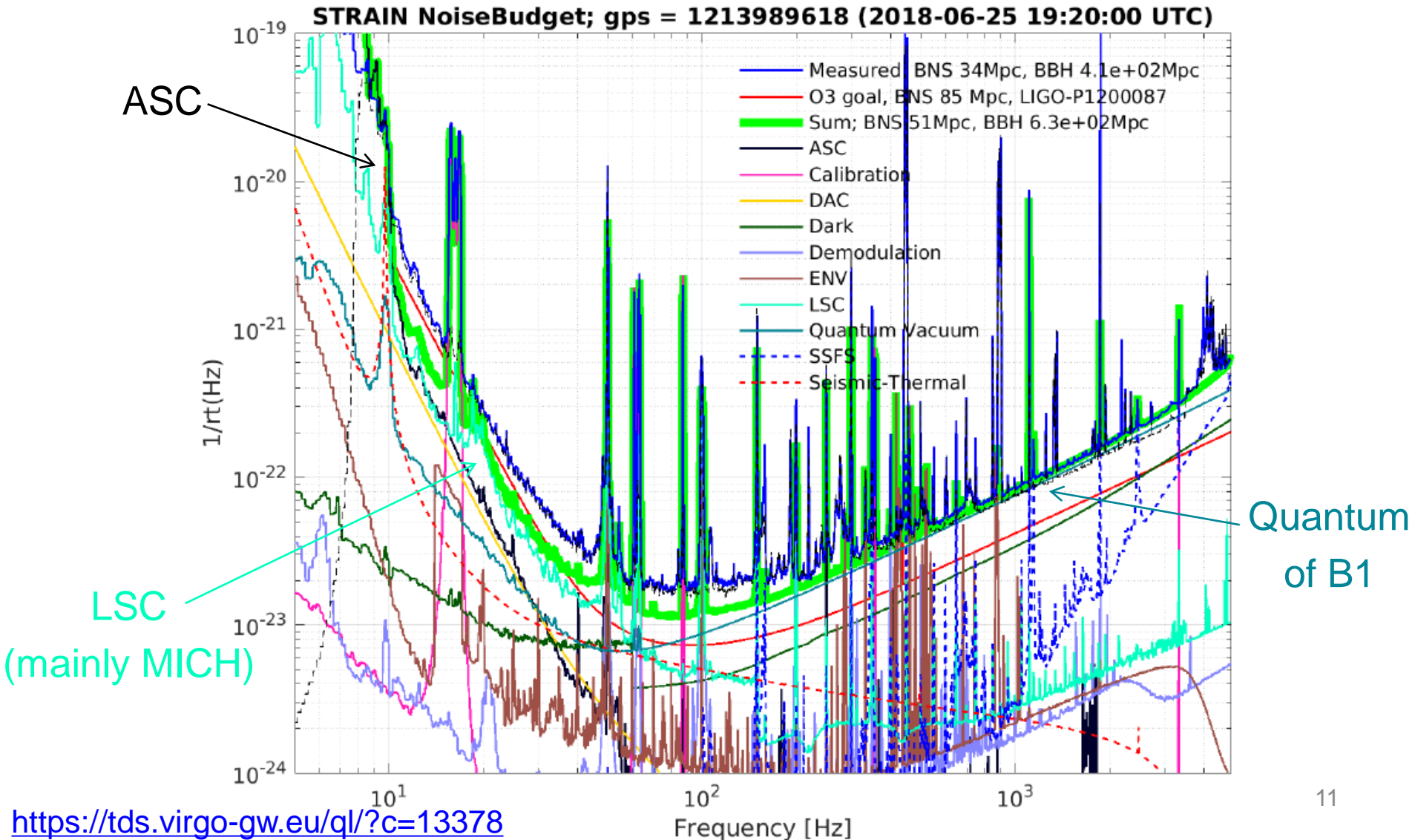
# BNS Inspiral Range Evolution





# Noise Budget at 13 W

- shot noise above 600 Hz, unexplained noise at bucket

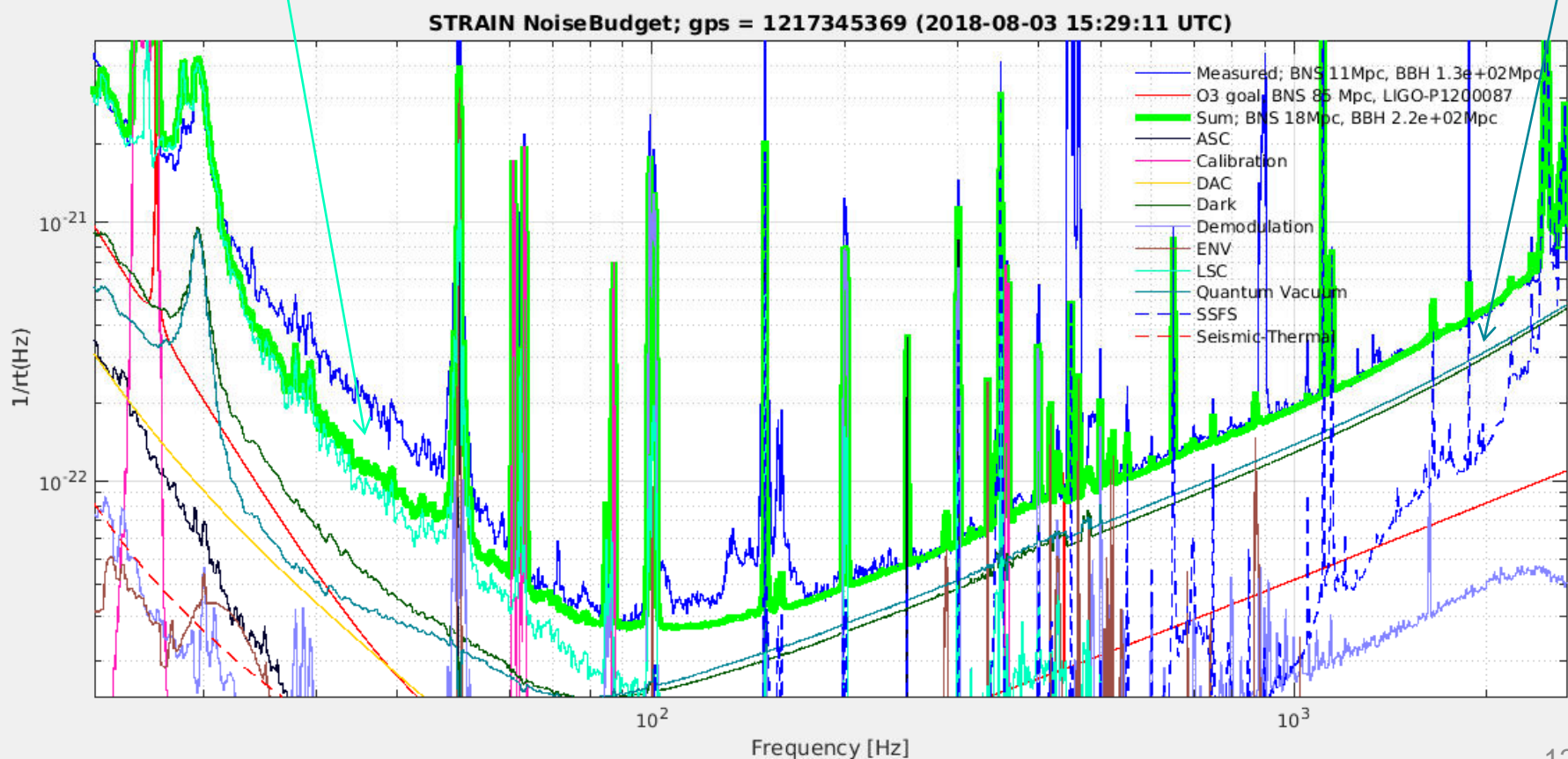


# Noise Budget at 25 W

- Shot noise from B4 for MICH and SSFS (56MHz in PRC is half compared with 13W), couples as **frequency noise**

LSC (mainly MICH)

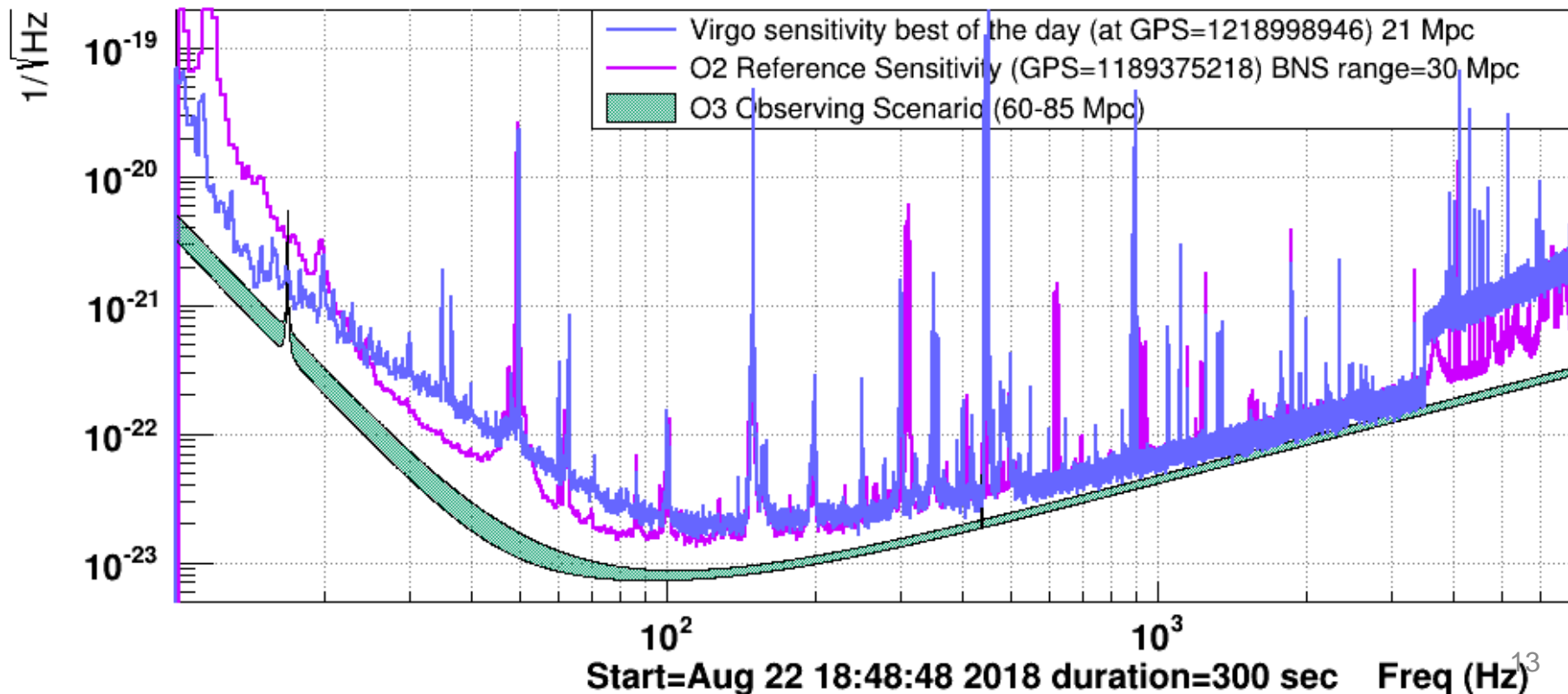
Quantum of B4



# Frequency Noise Subtraction

- Reactivated on Aug 20 ([#42483](#)) after I left
- B2 8MHz I (PRCL) is used for frequency noise sensor ([VIR-0396A-18](#))

Sensitivity for best BNS range of the day (21 Mpc)



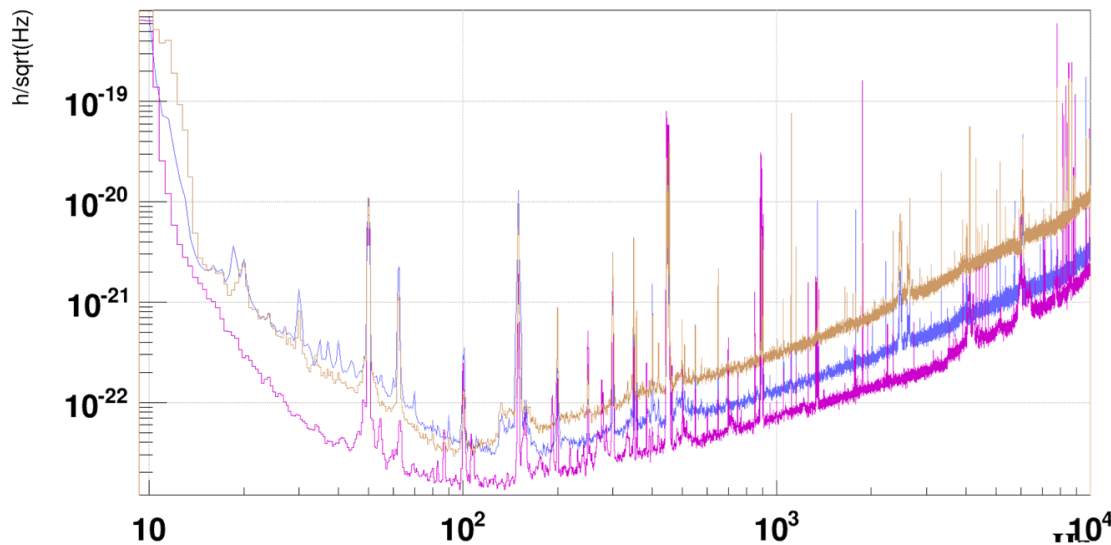


# CMRF Investigations

- Common mode rejection factor (CMRF) and thus the sensitivity depends on the BS alignment ([#42469](#))
- But good working point do not match with 56MHz sideband build-up
- Under investigation...

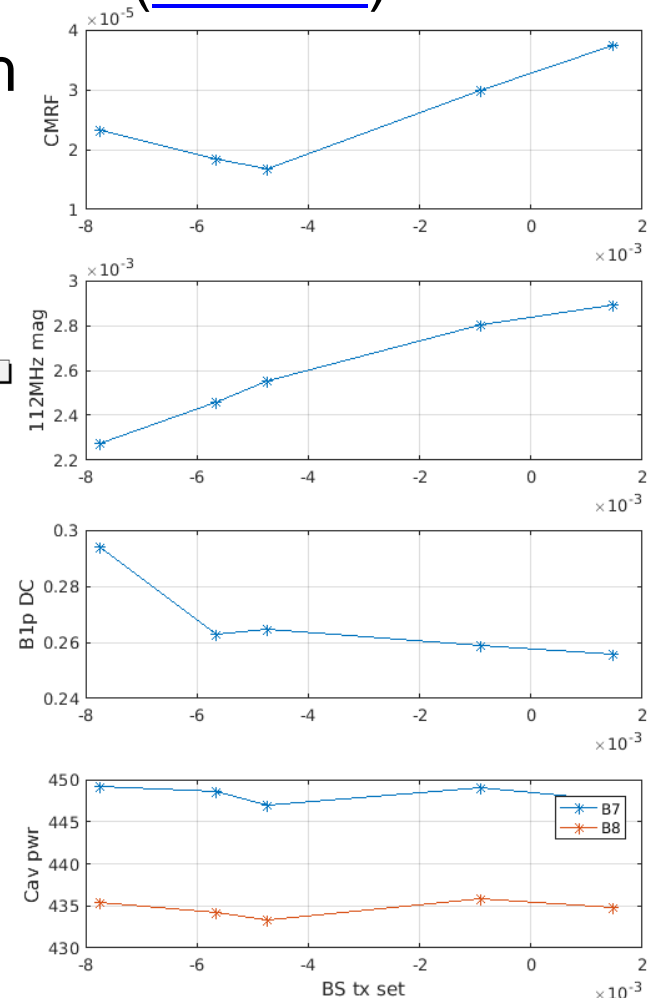
dataDisplay v10r9p1 : started by optics on Aug 17 2018 15:07:07 UTC

V1:Hrec\_hoft\_20000Hz\_\_FFT



1218529050.0000 : Aug 17 2018 08:17:12 UTC

1218536803.00 : Aug 17 2018 10:26:25 UTC dt:2.00s nAv:60

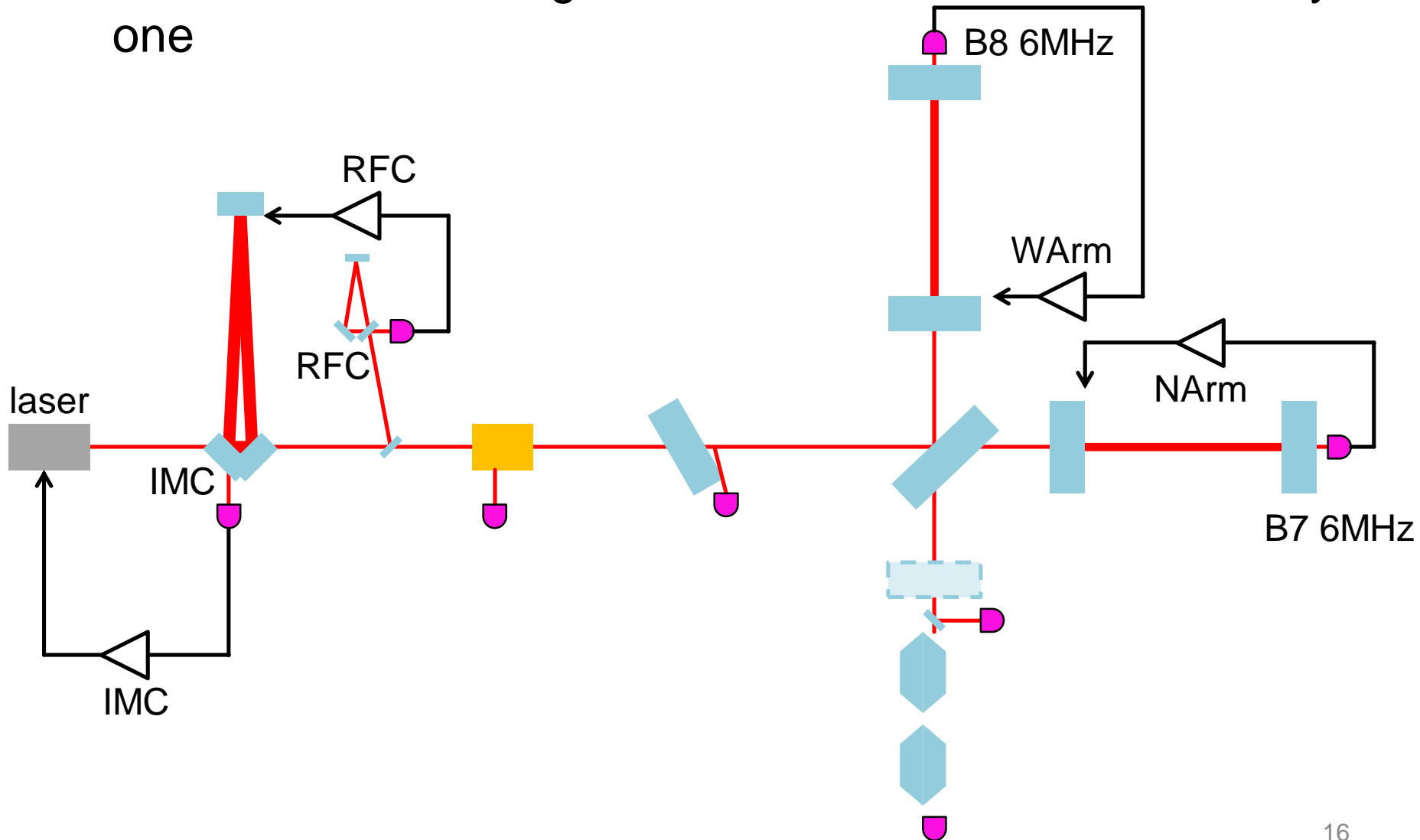


# Locking Issues at 25 W

- Took **a month** to recover the full lock stably after increasing the power from 13 W to 25 W ([#42188](#))
- Photodiode DC/RF saturations
  - power changes by an order of magnitude during variable finesse
  - **broadband PD** for all the ports (digital demodulation)
  - locking with high power (LIGO locks at lower power and increases the power after the full lock)
  - (tentatively) solved by **reducing the modulation depths** and reducing the power on PDs
- Thermal compensation
  - stable lock was not possible without activating the TCS by **compensation plates**

# Lock Sequence 1: Lock Arms

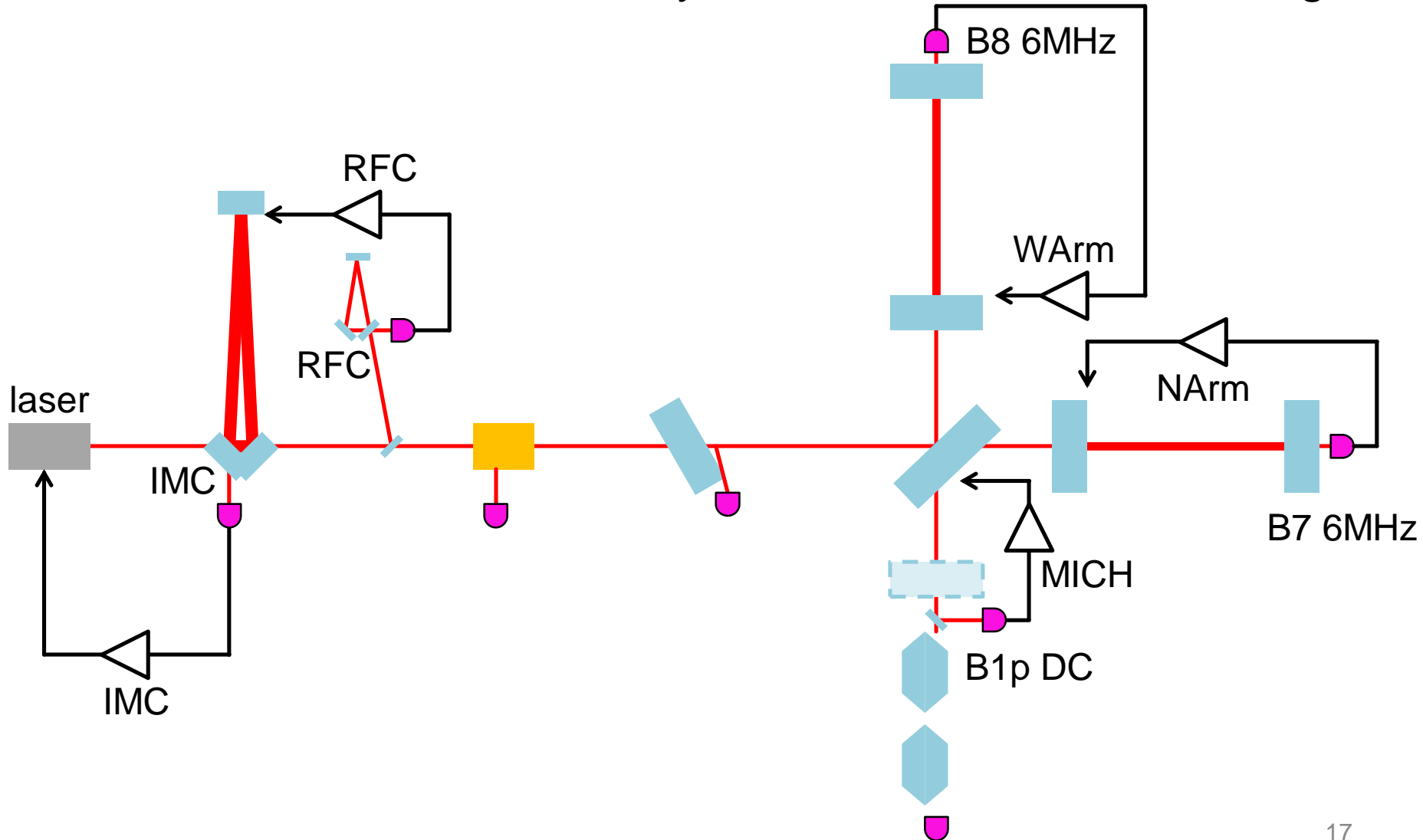
- Lock both arms using arm transmission at 6MHz, one by one





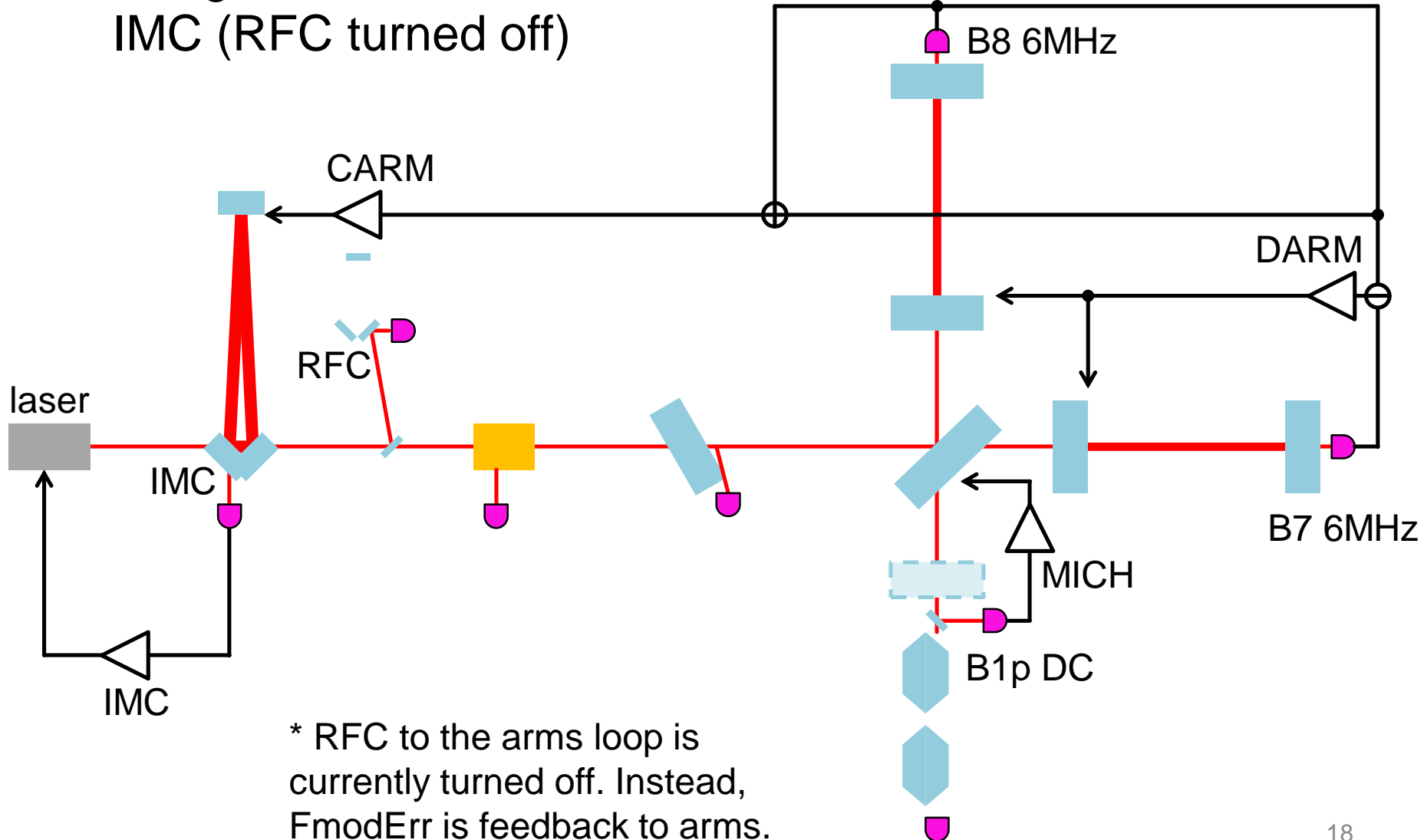
# Lock Sequence 2: Recombined

- Lock MICH to form a Fabry-Perot Michelson at half fringe



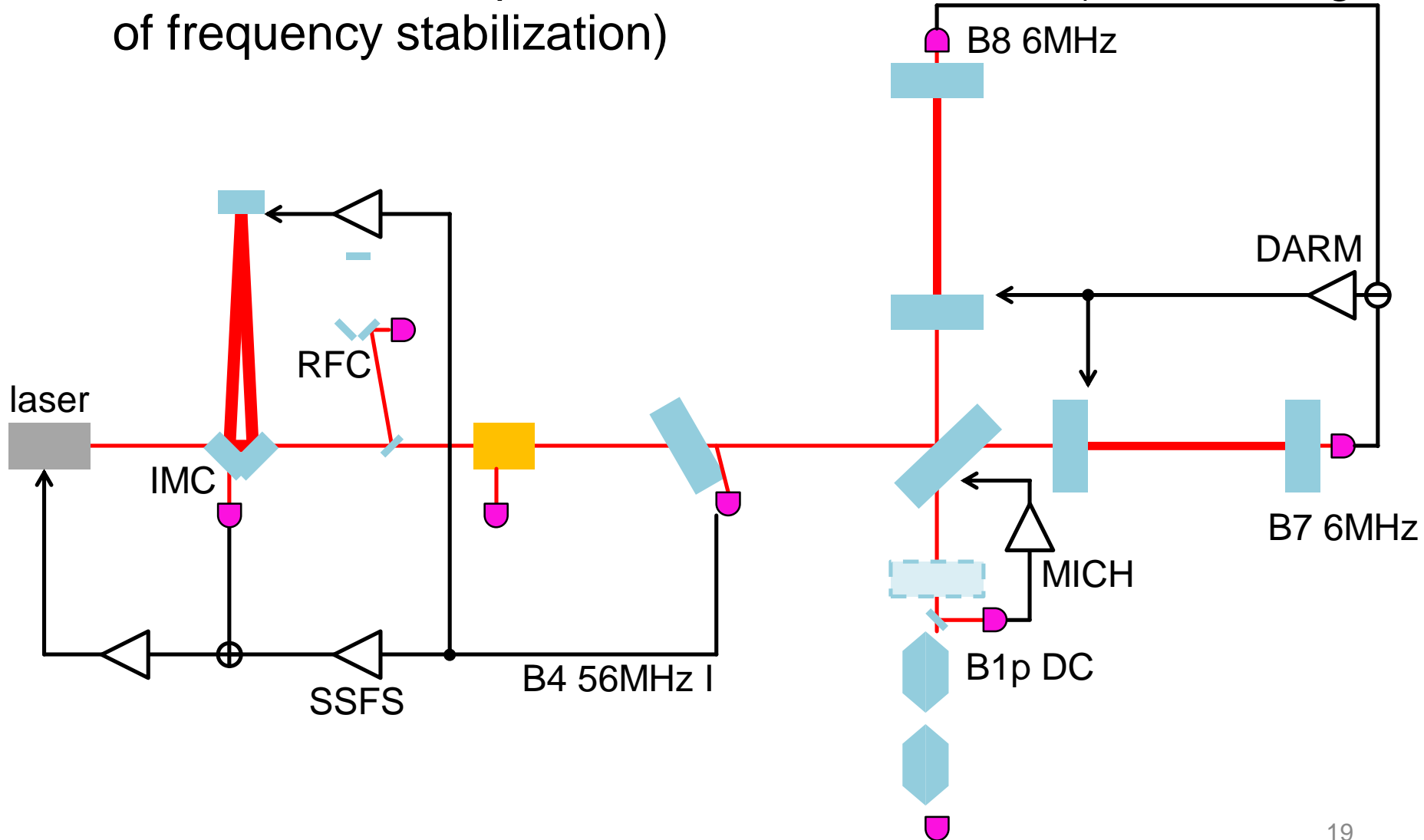
# Lock Sequence 3: CARM to MC

- Change the basis to DARM/CARM and feedback CARM to IMC (RFC turned off)



# Lock Sequence 4: Lock SSFS

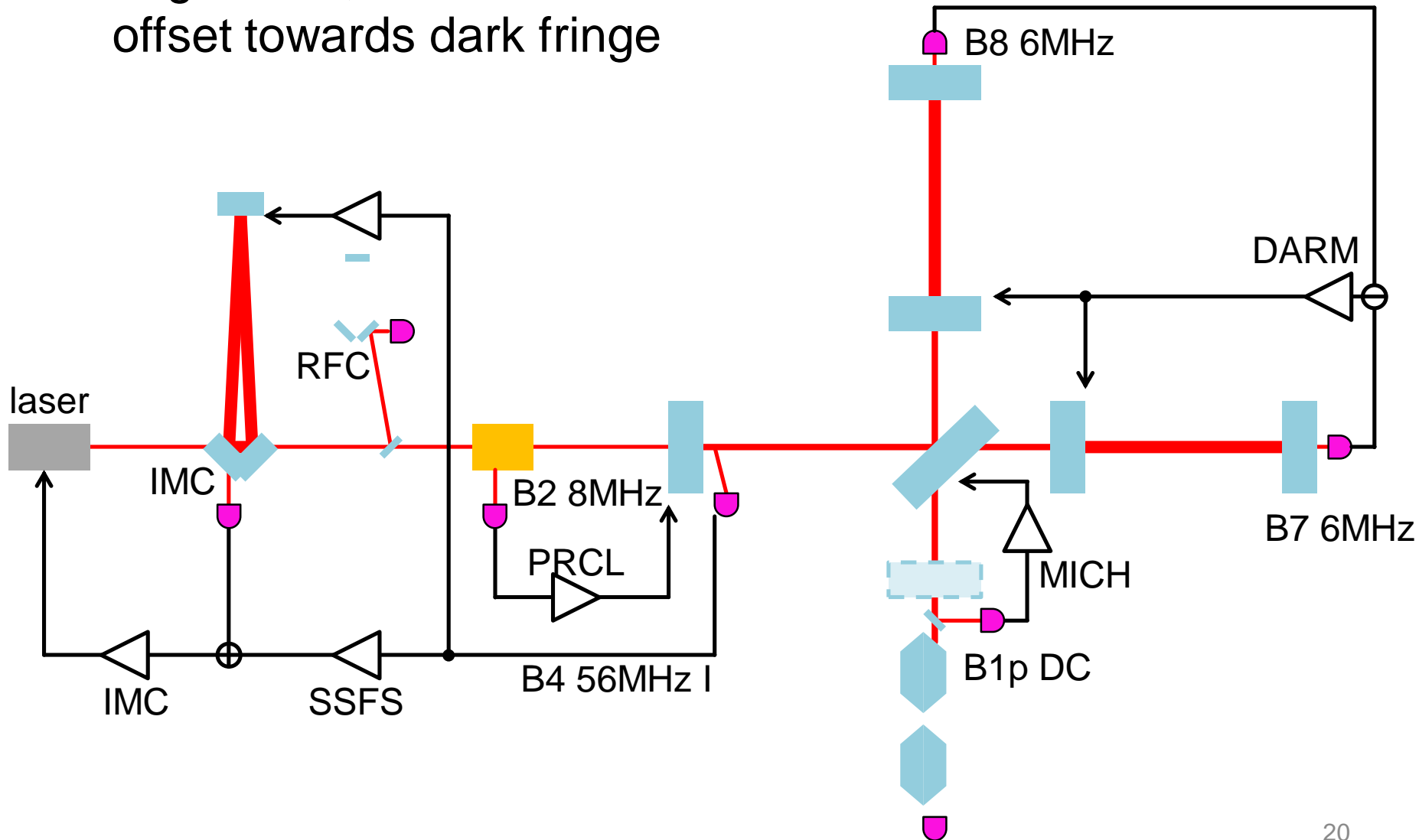
- Switch CARM loop to B4 56MHz I for SSFS (second stage of frequency stabilization)





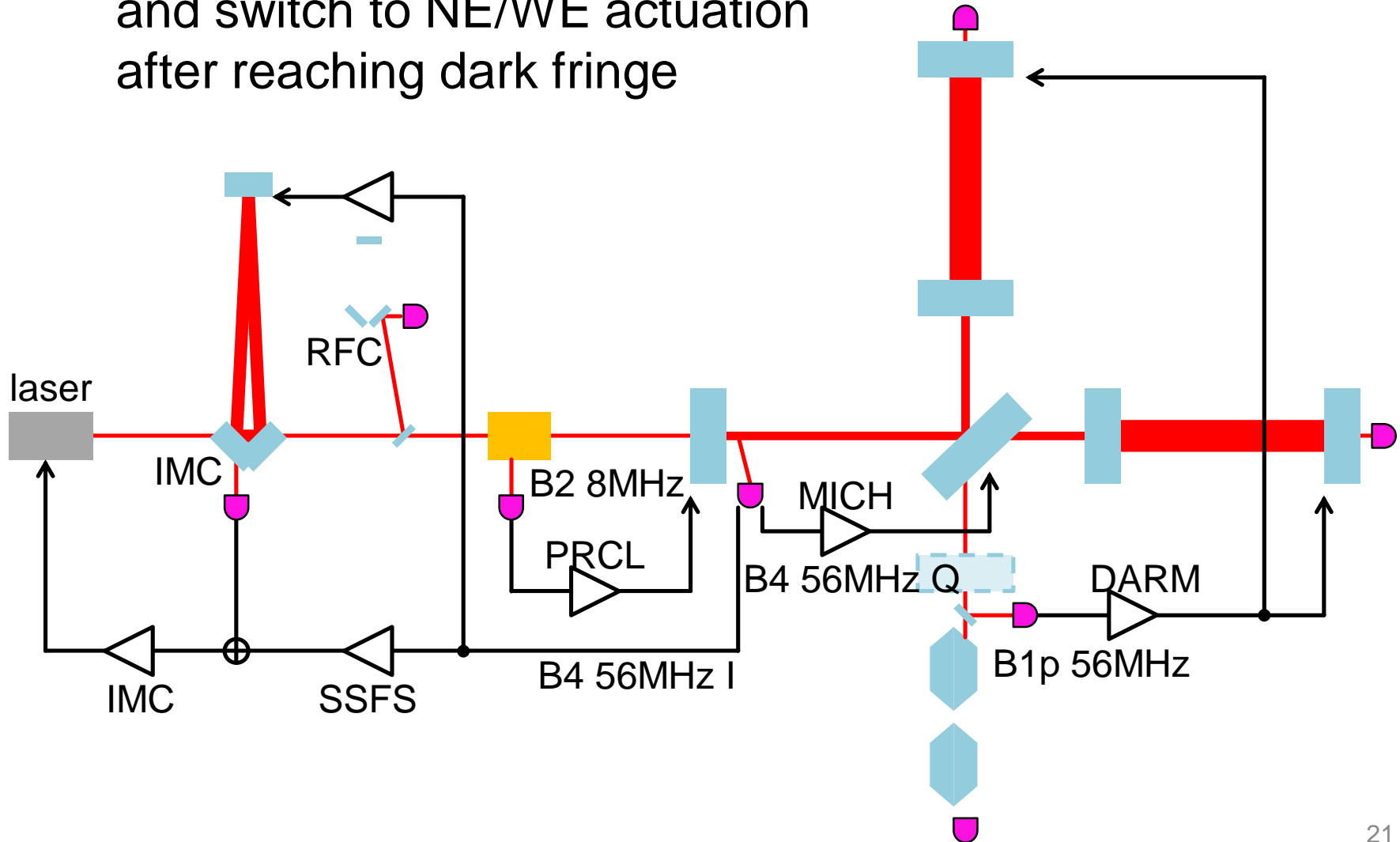
# Lock Sequence 5: Variable Finesse

- Align PRM, lock PRCL at MICH offset 0.7 and reduce MICH offset towards dark fringe



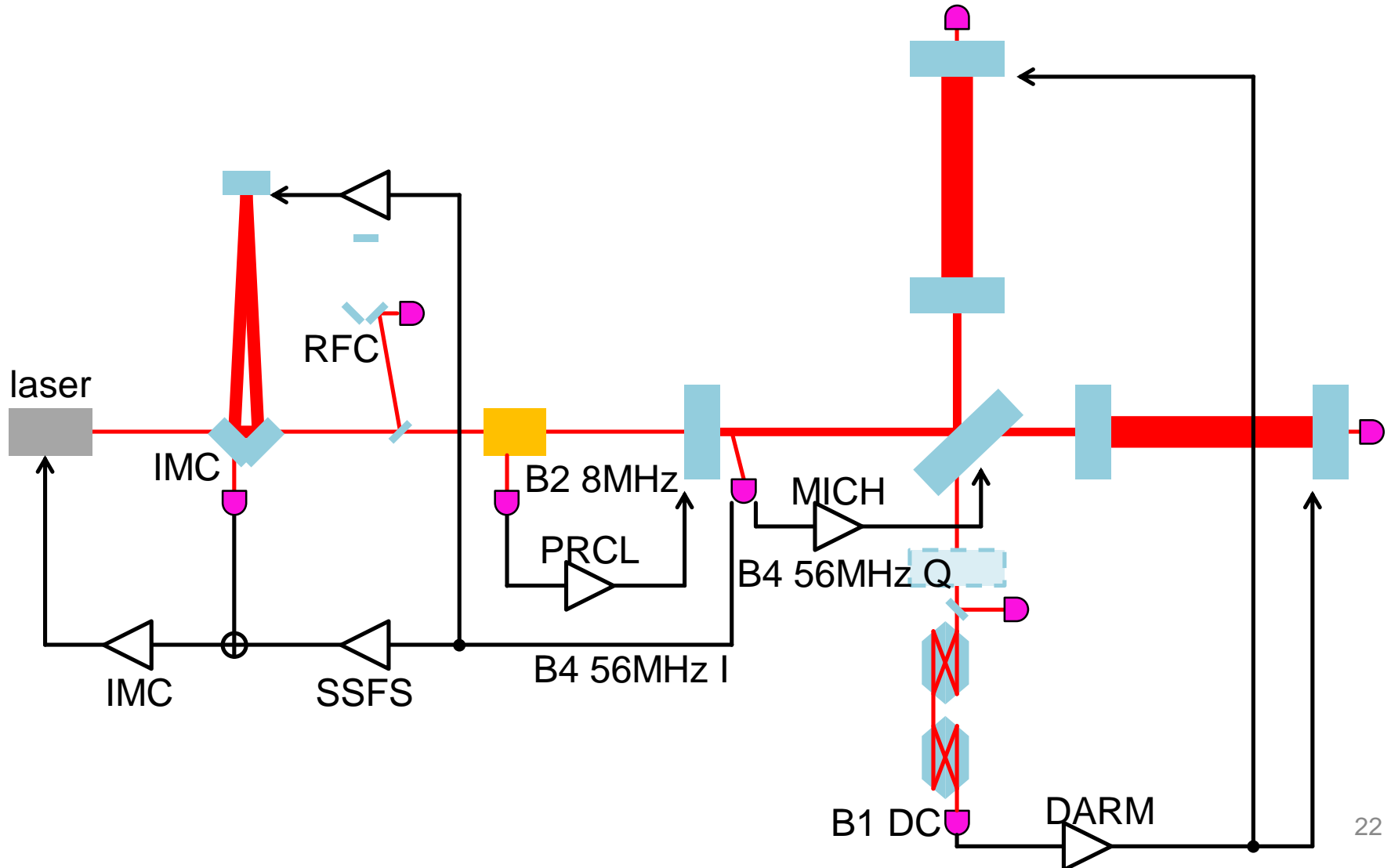
# Lock Sequence 6: Dark Fringe

- Switch to MICH to RF, DARM to dark port (turn 6MHz off), and switch to NE/WE actuation after reaching dark fringe



# Lock Sequence 7: DC Readout

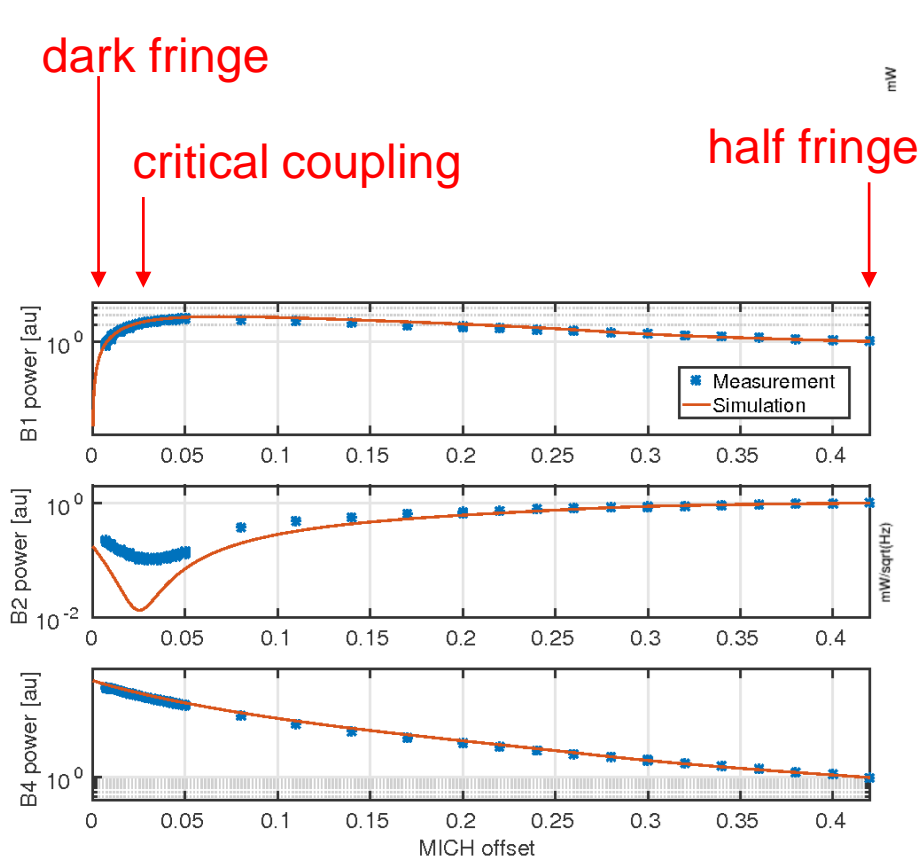
- Lock two OMCs and reach DC readout





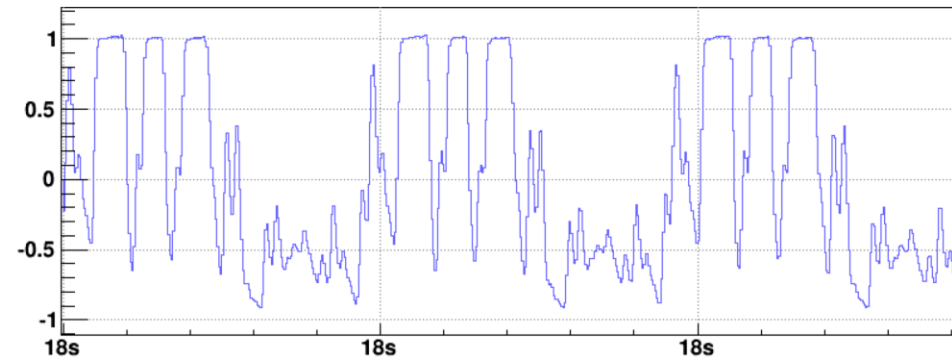
# Photodiode Saturations

- DC and RF saturations prevented from reaching dark fringe reliably



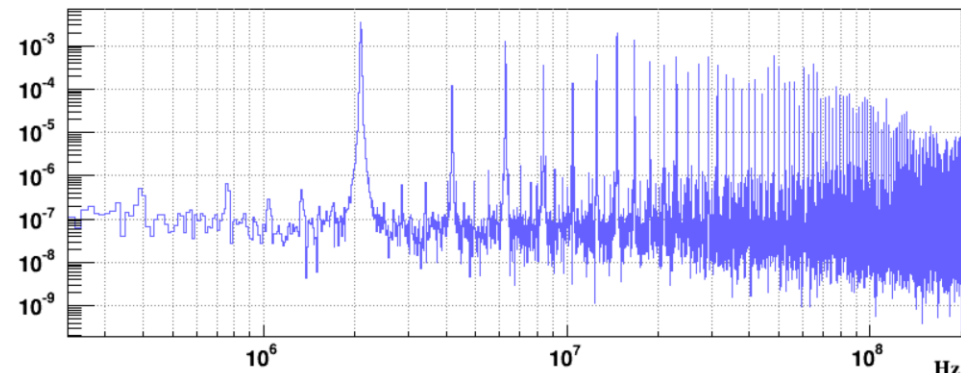
V1:SIB2\_B2\_PD2\_sample\_TIME

[#42036](#)



1214317596.0000 : Jun 29 2018 14:26:18 UTC

V1:SIB2\_B2\_PD2\_sample\_FFT

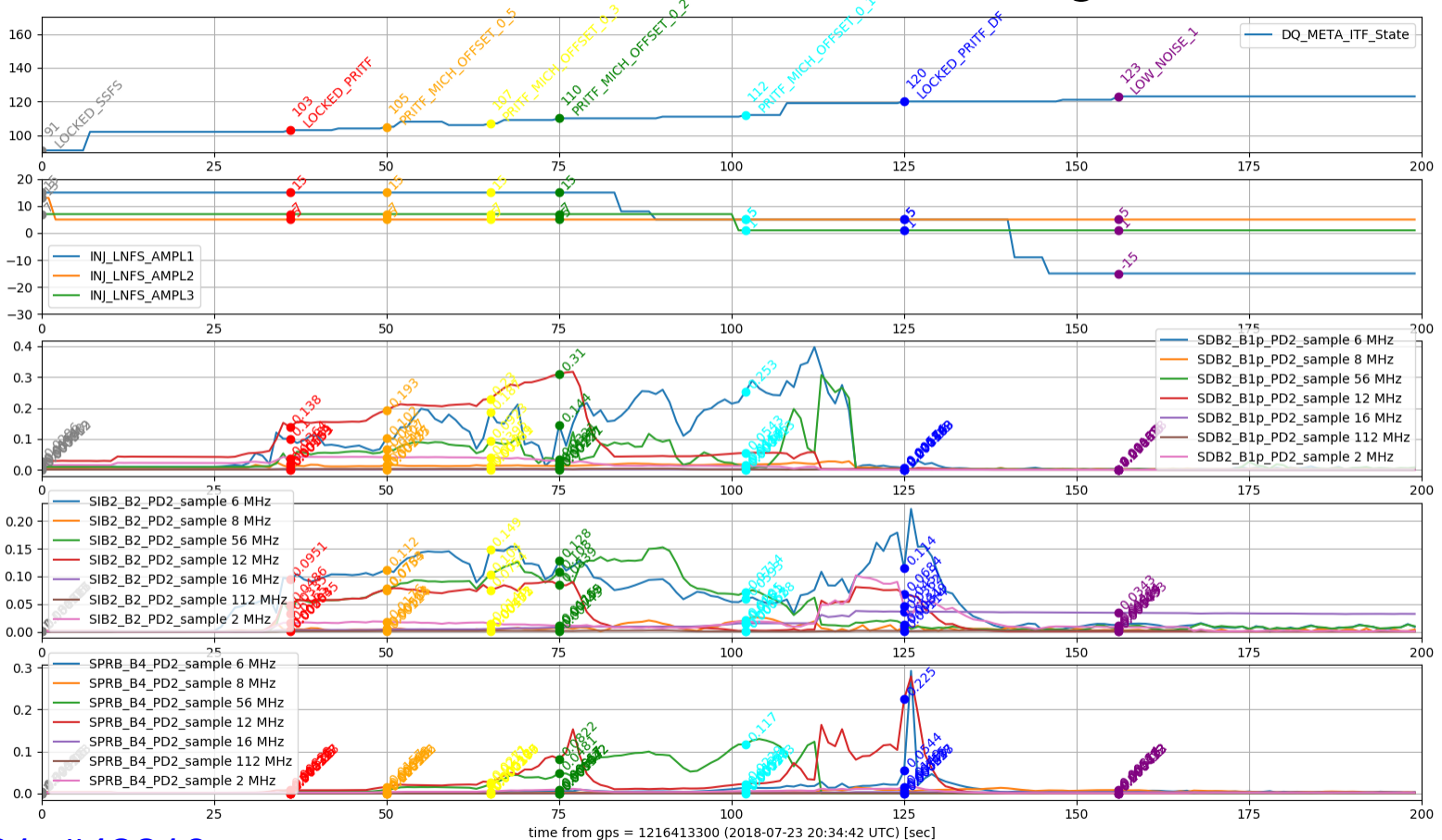


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[VIR-0116A-18](#)

# Photodiode Saturations

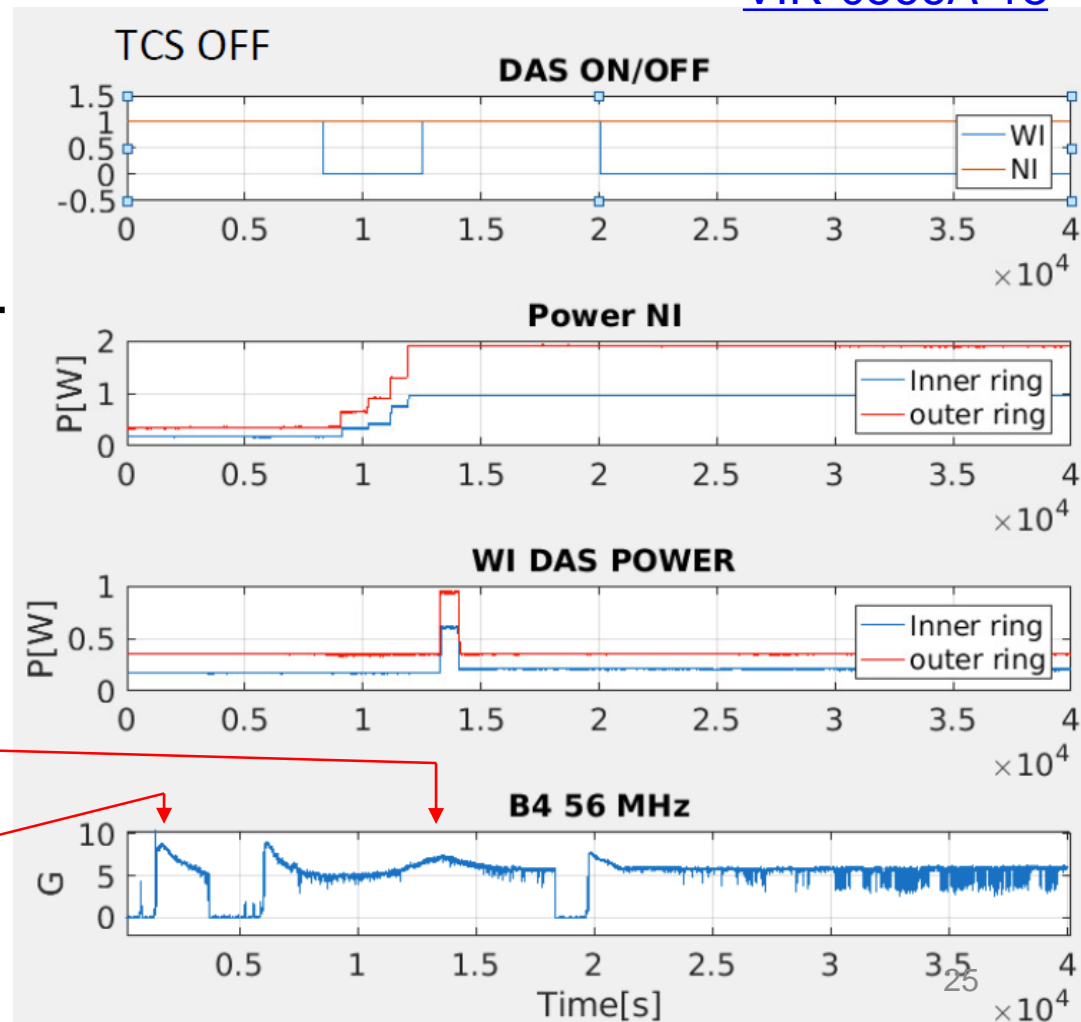
- (tentatively) solved by reducing the modulation depths and reducing the power on PDs
- notches to be installed to have more margins



# Thermal Compensation (TCS)

- NI CO<sub>2</sub> laser helps recovering 56MHz sideband build-up
- WI CO<sub>2</sub> laser have little effect (misaligned?)
- NI CO<sub>2</sub> laser turned always on for stable lock
- Activities in progress...

[VIR-0566A-18](#)



56MHz recovers with TCS

56MHz decays (~1000 sec) without TCS

# Contents

- **Advanced Virgo status**
- **Selected commissioning topics**
  - **thermal compensation (TCS)**
  - **line tracking**
  - **violin mode damping**
  - **graphical user interfaces**
  - **power drop issue**
- **Working environment**
- **Summary**



# Thermal Compensation System

- Double axicon system (DAS)

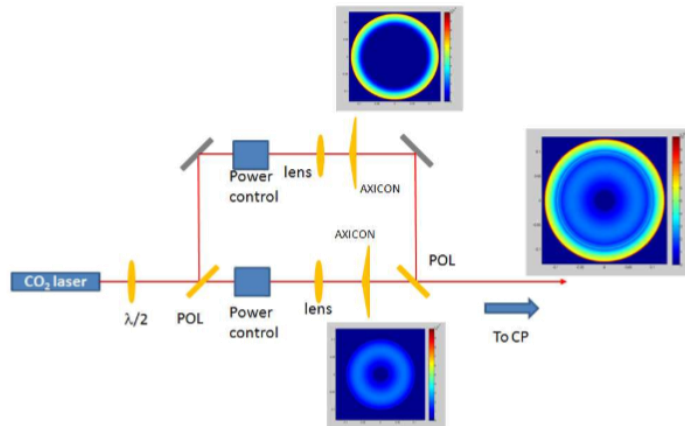
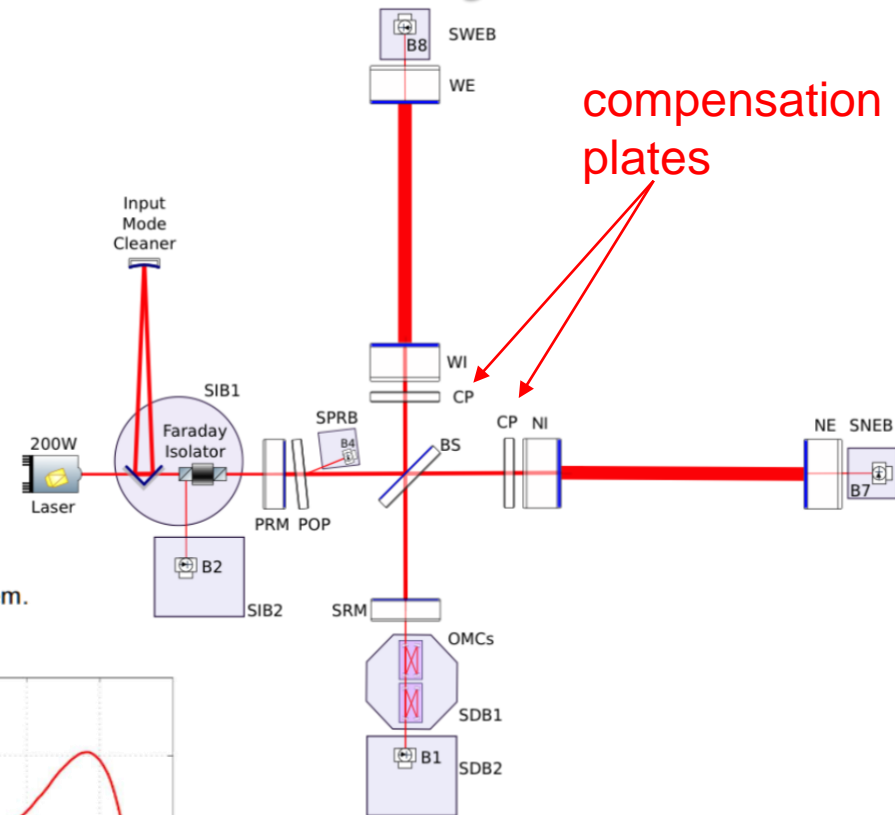
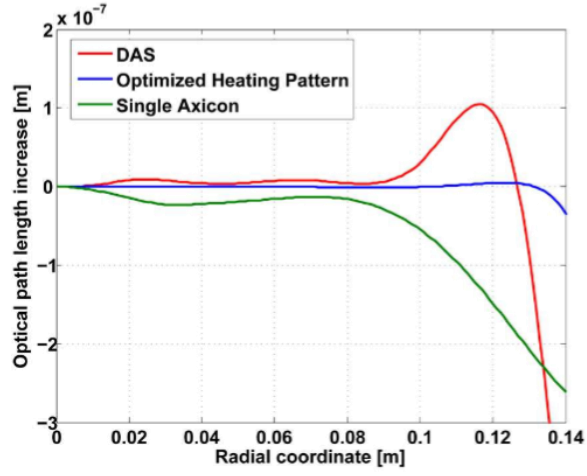
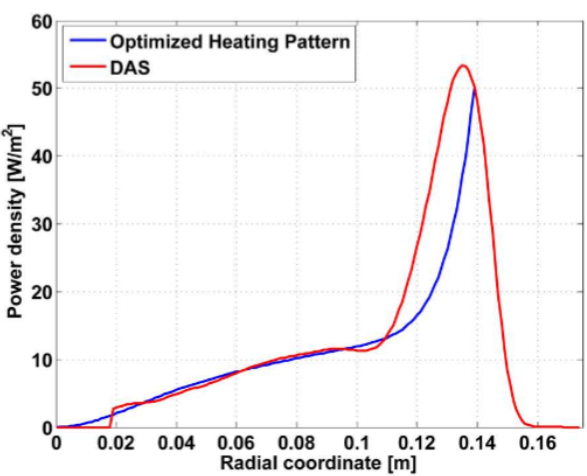


Figure 6.19: Conceptual design of a double axicon compensation system.



compensation plates



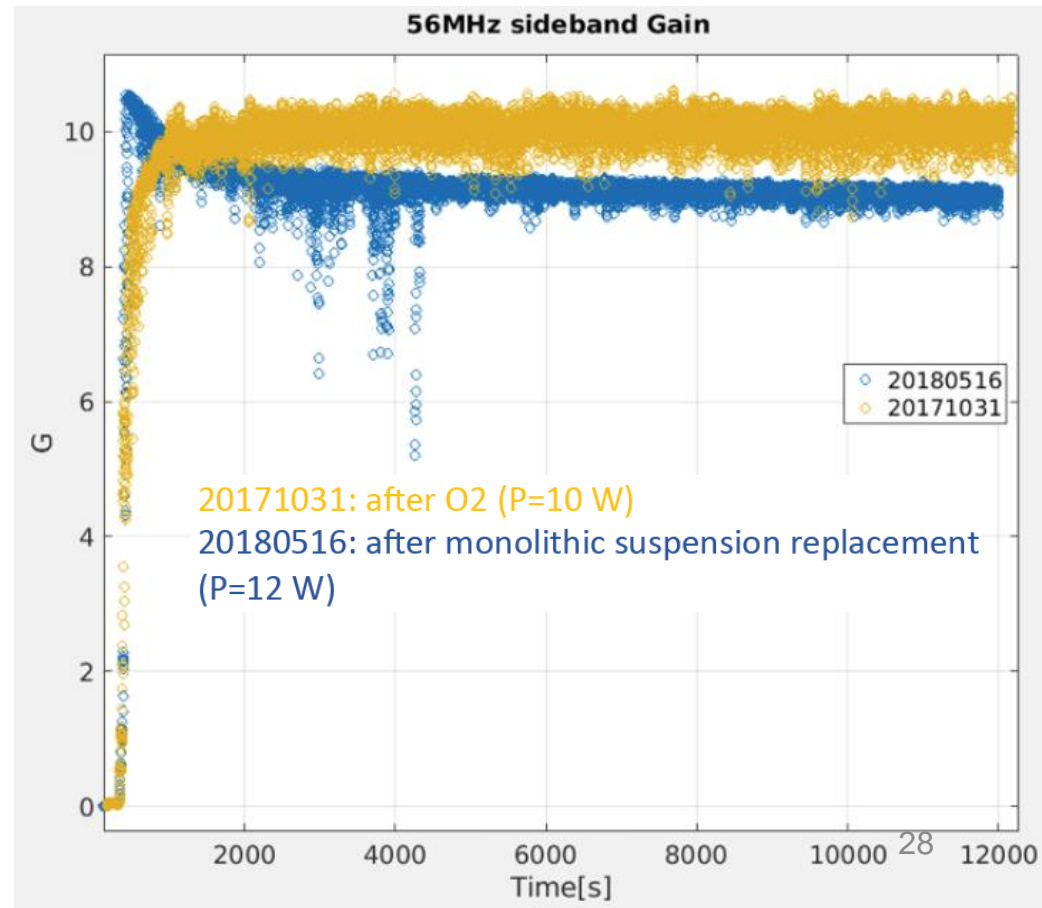
[Advanced Virgo Technical Design Report](#)

Figure 6.20: Left: the double axicon heating pattern (red) compared to the optimized heating pattern (blue). Right: corresponding optical path length increase (optimized heating pattern is in blue and the DAS is in red). Also the OPL given from a single axicon system (green) is reported for comparison.



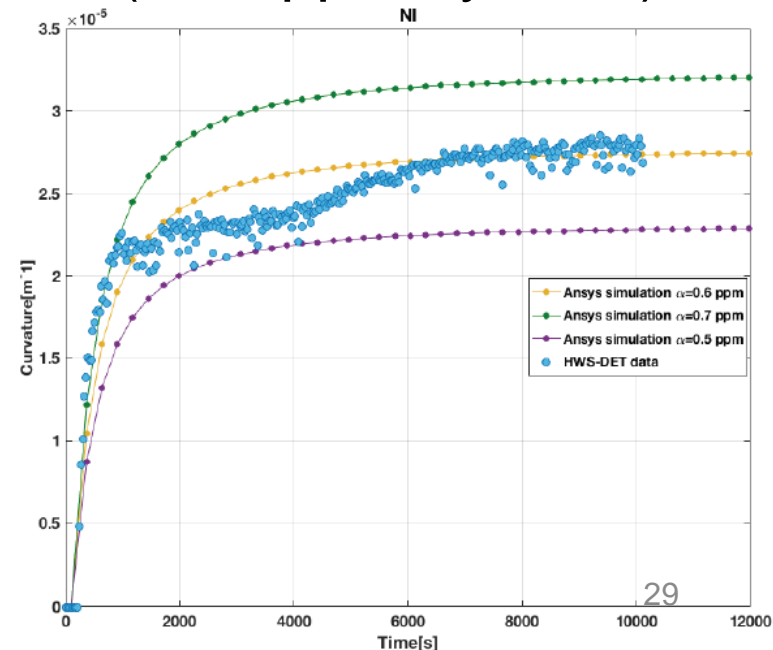
# 56MHz Recycling Gain

- **Overshoots** after the monolithic suspension replacement
- Decay at time constant of  $\sim 1000$  sec ([#41817](#))
  - thermal lensing time constant
  - shorter than mirror bulk heating time constant ( $\sim$  few days)
- Overshoot could be due to **power increase** and/or **absorption increase** (according to study by TCS team)



# Absorption Measurements

- Done by RoC measurements using Hartmann Wavefront Sensor (HWS)
- WI
  - before monolithic:  $0.39 \pm 0.06$  ppm
  - after monolithic:  $0.36 \pm 0.07$  ppm
- NI
  - before monolithic: no measurement (0.19 ppm by LMA)
  - after monolithic:  $0.6 \pm 0.1$  ppm

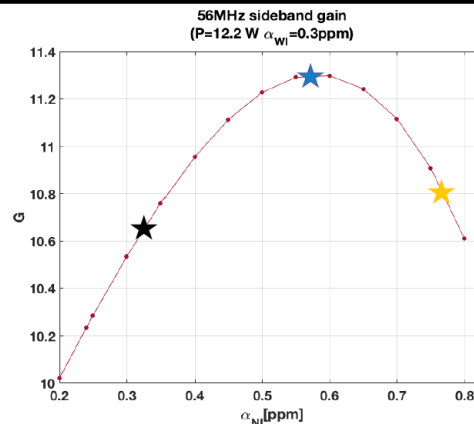


# Overshoot and Absorption

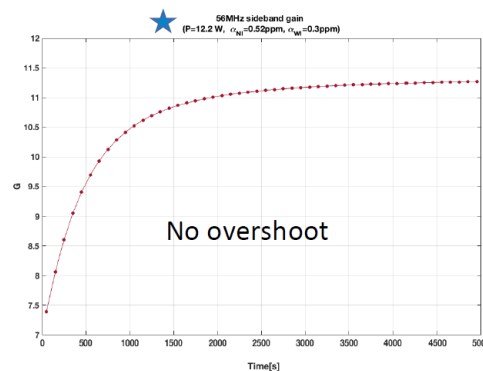
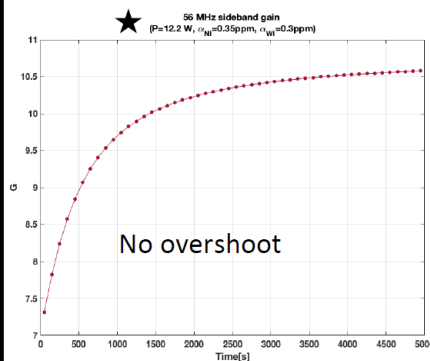
- If we fix input power and WI absorption, there is an optimum NI absorption in terms of 56MHz recycling gain
- Overshoot happens if **NI absorption is higher** than optimal (reaches maximum when NI and WI RoC become equal, but degrades afterwards; never reaches equal if NI absorption is smaller than optimal)

## OSCAR simulations

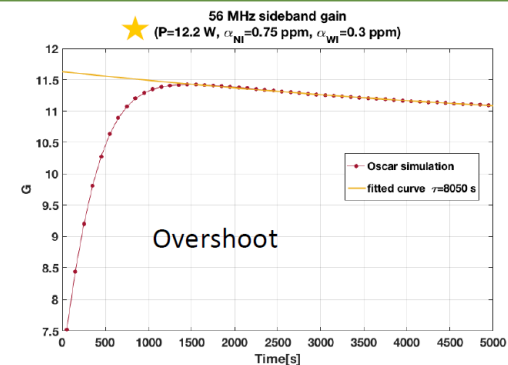
- examples of SB behavior with YAG at different powers (no TCS)



The presence of overshoot at @ $P=12\text{ W}$  is expected from simulations



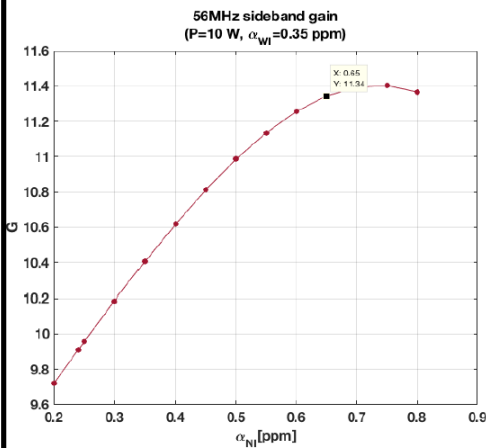
Overshoot time constant depends on absorption budget



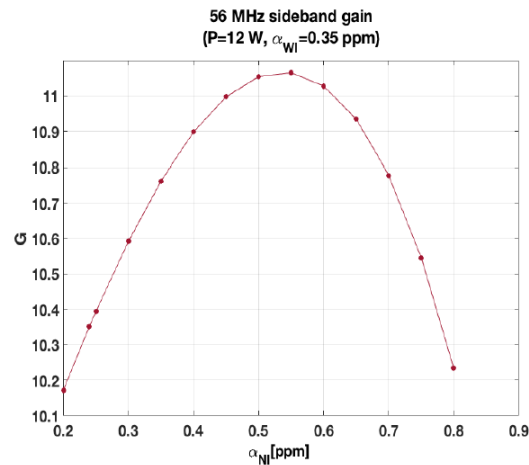
# Overshoot and Absorption

- NI optimum absorption changes with input power
- Overshoot could be from input **power increase** and/or **NI absorption increase**

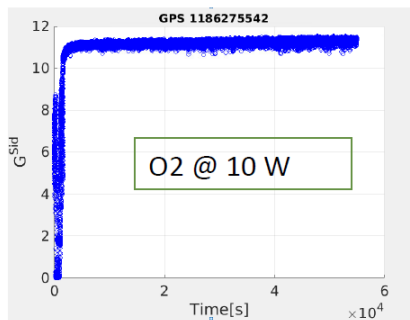
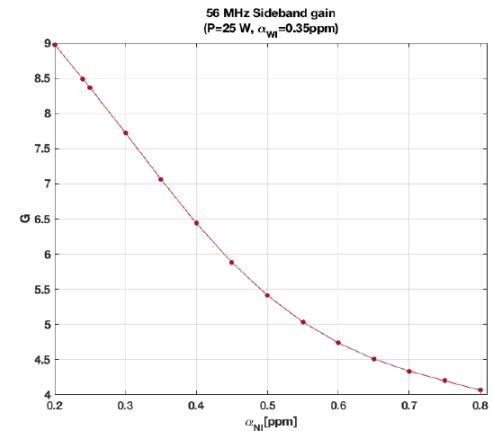
## OSCAR simulations



Coherent with O2 Gain (about 11.3)  $\rightarrow$  0.5 ppm < NI absorption < 0.8 ppm



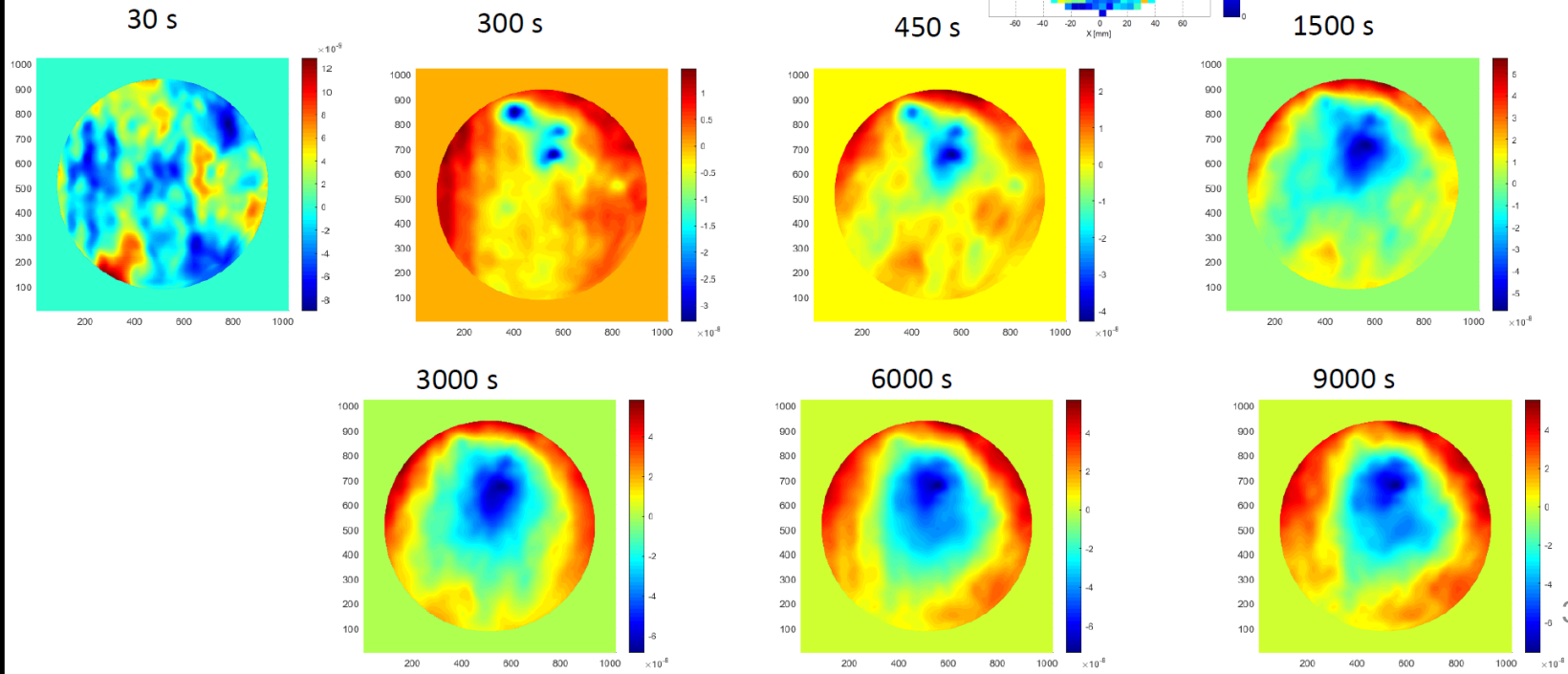
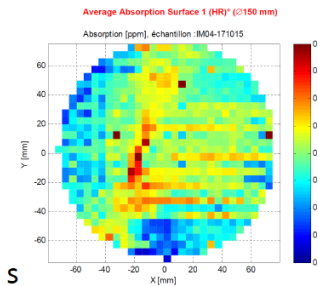
Coherent with May 2018 Gain  $\rightarrow$  0.6 ppm < NI absorption < 0.8 ppm



# Point Absorber Investigation

- NI absorption increase might be from monolithic suspension installation
- Point absorber investigation by Hartmann wavefront sensors

- Thermal lensing due to the YAG at different times
- NI thermal lensing map @ 26.5 W (August 1<sup>st</sup>, 2018)





# Contents

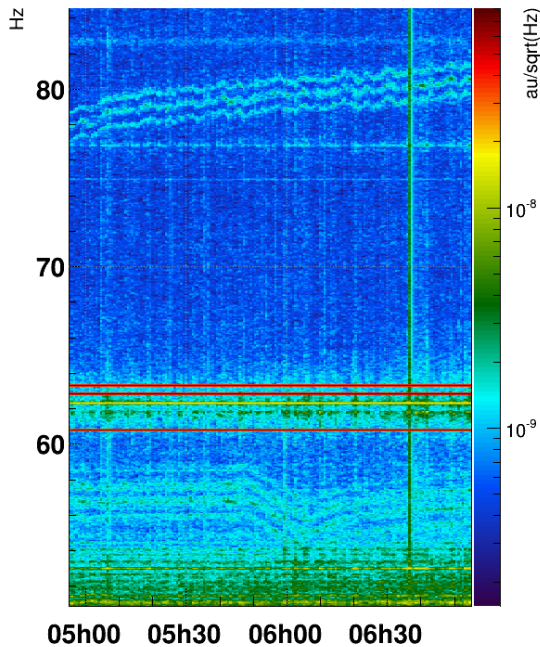
- **Advanced Virgo status**
- **Selected commissioning topics**
  - thermal compensation (TCS)
  - **line noises and line tracking**
  - violin mode damping
  - graphical user interfaces
  - power drop issue
- **Working environment**
- **Summary**

# Line Noises

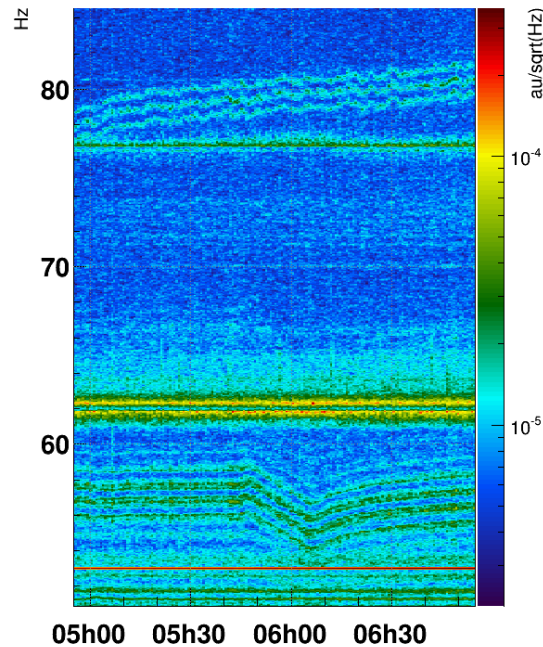
- There are so many lines
- Some identified by tracking the line frequency offline
- Online tracking also useful for monitoring mirror **temperature**, **parametric instability** investigations etc.

dataDisplay v10r9p1 : started by swinkels on May 31 2018 10:48:55 UTC

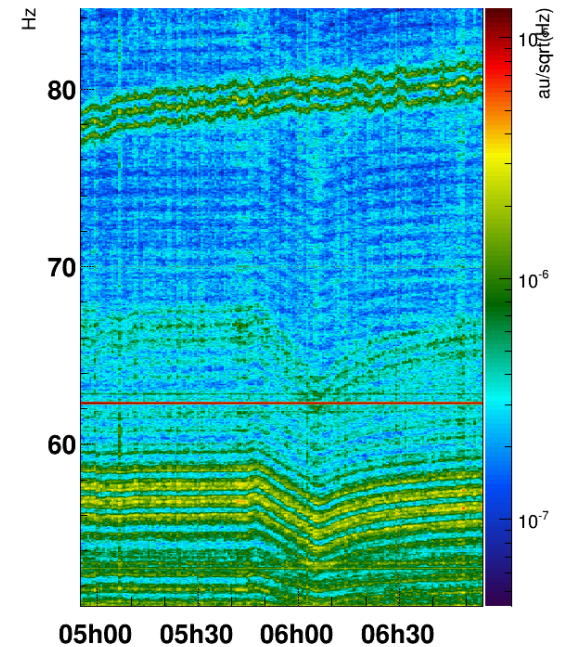
V1:LSC\_DARM\_FFTTIME



V1:LSC\_MICH\_FFTTIME



V1:LSC\_PRCL\_FFTTIME



[#41624](#)

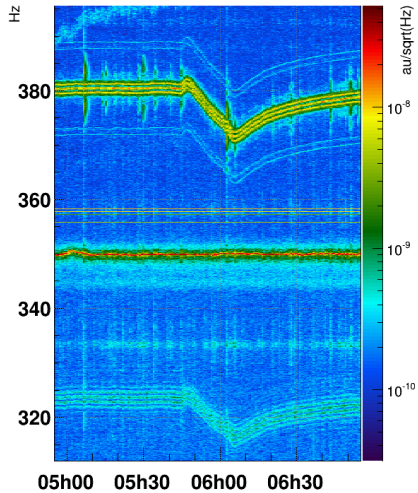


# Moving Lines around 380 Hz etc.

- Correlated with DAQ room temperature change ([#41624](#))

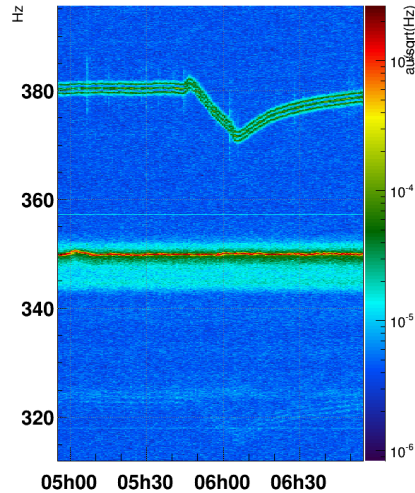
dataDisplay v10r9p1 : started by swinkels on May 31 2018 10:48:55 UTC

V1:LSC\_DARM\_FFTTIME



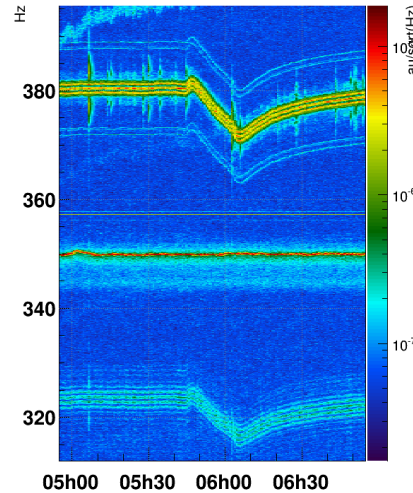
1211691318.00 : May 30 2018 04:55:00 UTC dt:20.00s nAv:4

V1:LSC\_MICH\_FFTTIME



1211691318.00 : May 30 2018 04:55:00 UTC dt:20.00s nAv:4

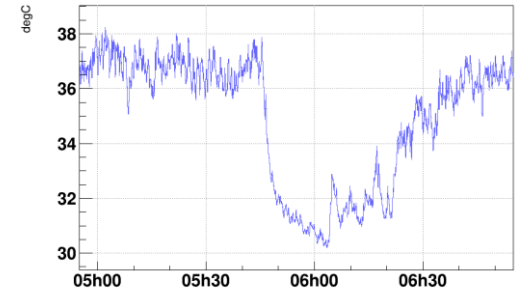
V1:LSC\_PRCL\_FFTTIME



1211691318.00 : May 30 2018 04:55:00 UTC dt:20.00s nAv:4

dataDisplay v10r9p1 : started by swinkels on May 31 2018 12:44:35 UTC

V1:ENV\_DAQR\_BOX\_TE\_TIME



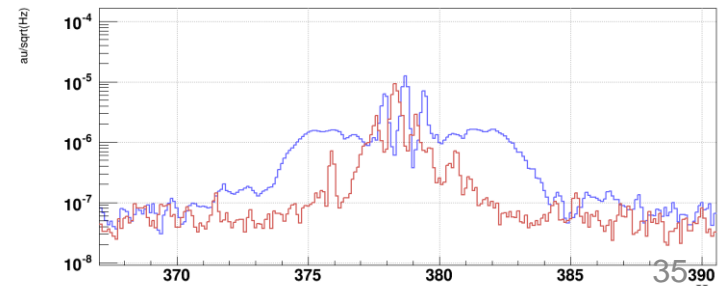
1211691318.0000 : May 30 2018 04:55:00 UTC



- Identified to be **timing noise** by tapping GPS synchronized 10 MHz timing box in DAQ room ([#41763](#))

dataDisplay v10r9p1 : started by hardwick on Jun 8 2018 15:51:34 UTC

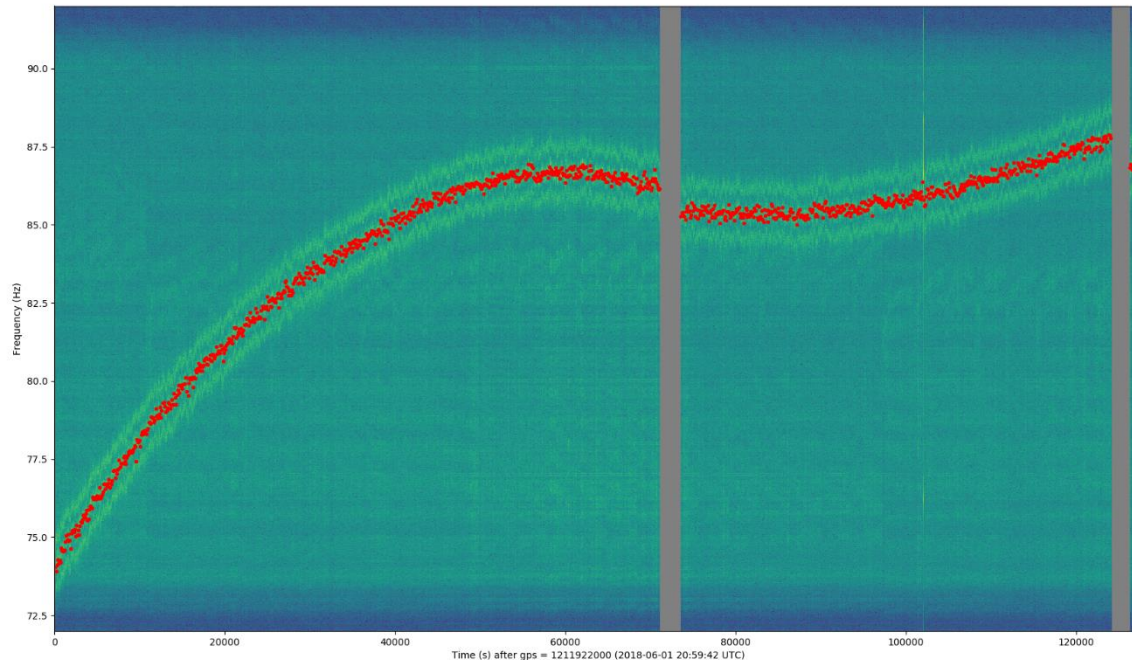
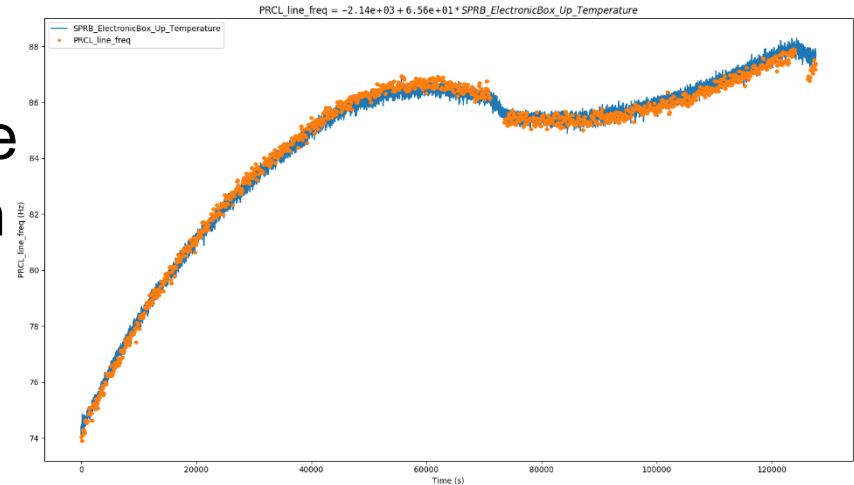
V1:LSC\_PRCL\_FFT



1212504749.0000 : Jun 8 2018 14:52:11 UTC  
1212504823.00 : Jun 8 2018 14:53:25 UTC dt:10.00s

# Moving Lines around 80Hz

- Correlation with SPRB electronics box temperature found by brute force search ([#41819](#))
- Another timing noise! ([#41821](#))

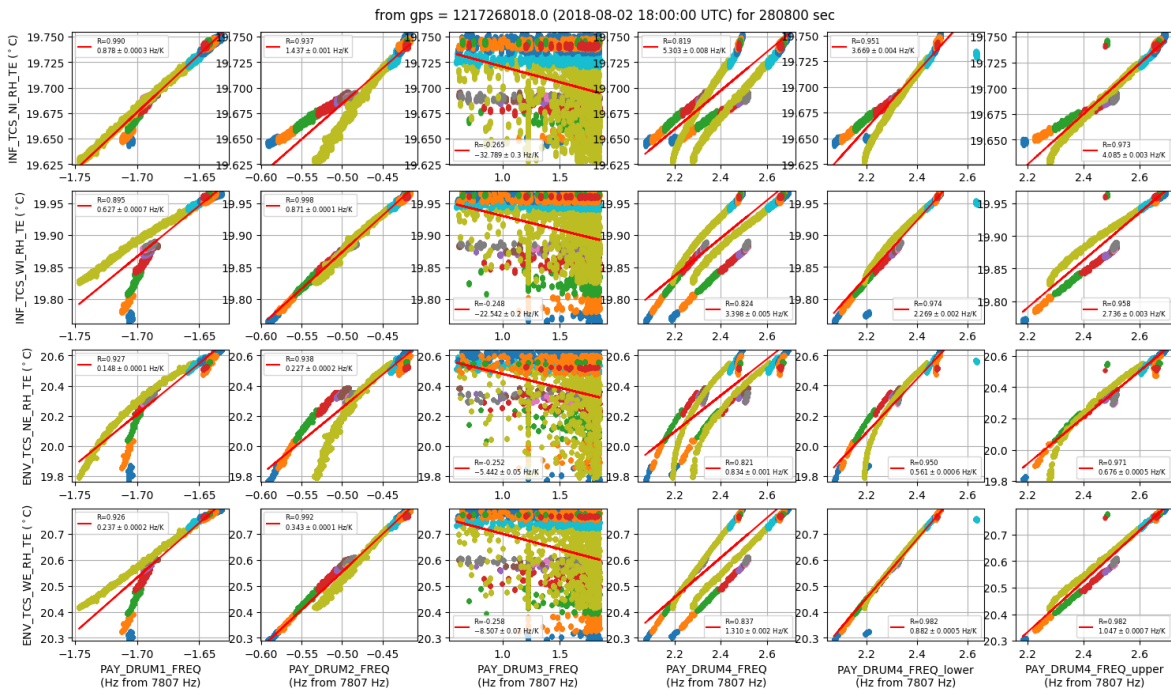


Very cool tool

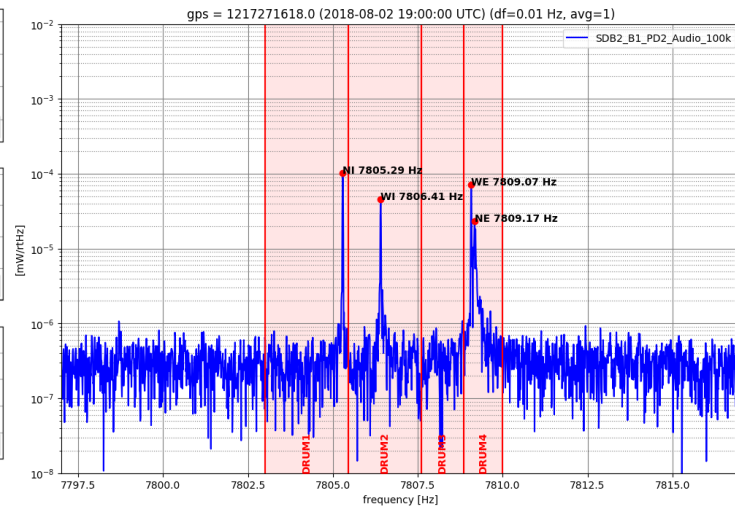
Bas Swinkels,  
Brute force correlation  
of drifting lines  
[VIR-0420A-18](#)

# Online Line Freq & Ampl Tracking

- Can be used to monitor the **mirror temperature** (and parametric instability damping in the future)
- Mirror identification possible by correlating with ring heater temperature (and some by kicking each mirror)
- Super useful FFT code by Bas ([#38844](#)), modified to track multiple modes ([#41883](#))



multiple modes ([#41883](#))



[#42370](#) etc

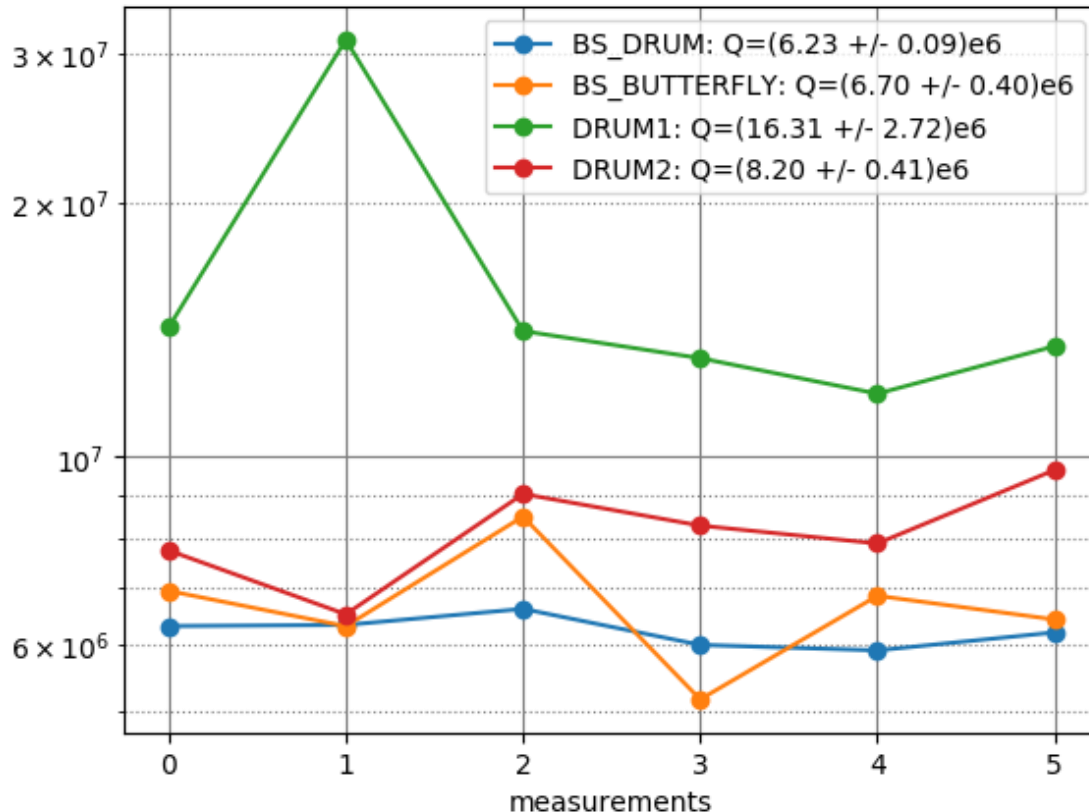
In Virgo, you can also save the processed data as DAQ channels!



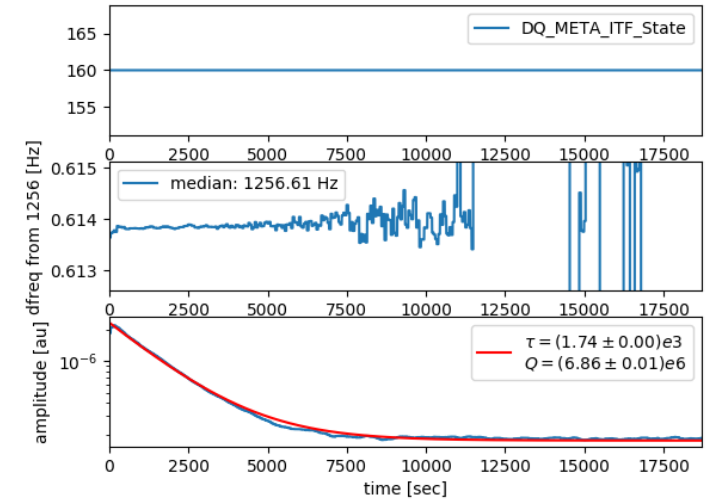
# Q-Value Measurement

- Done by tracking the amplitude of the lines (#41935)

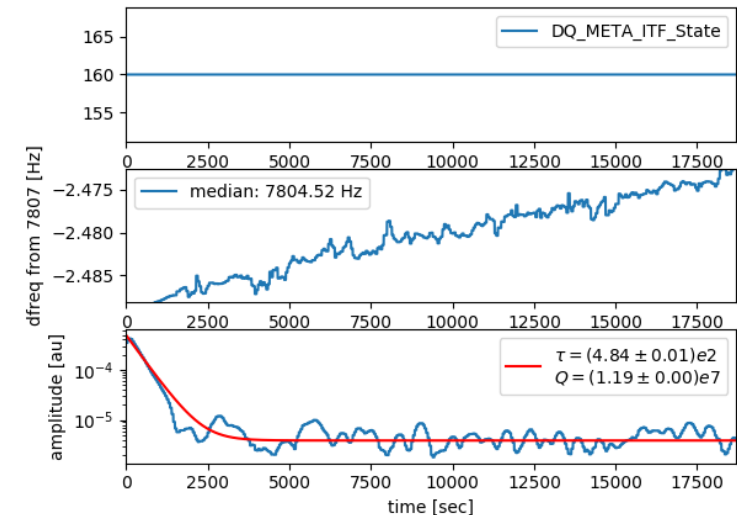
BS DRUM (1875.5 Hz):  $(6.2 \pm 0.1)e6$   
 BS BUTTERFLY (1256.5 Hz):  $(6.7 \pm 0.4)e6$   
 NI DRUM (7804.5 Hz):  $(1.6 \pm 0.3)e7$   
 WI DRUM (7807.5 Hz):  $(8.2 \pm 0.4)e6$



BS\_BUTTERFLY from gps = 1213569525.0 (2018-06-20 22:38:27 UTC)  
 locked for 18703 sec



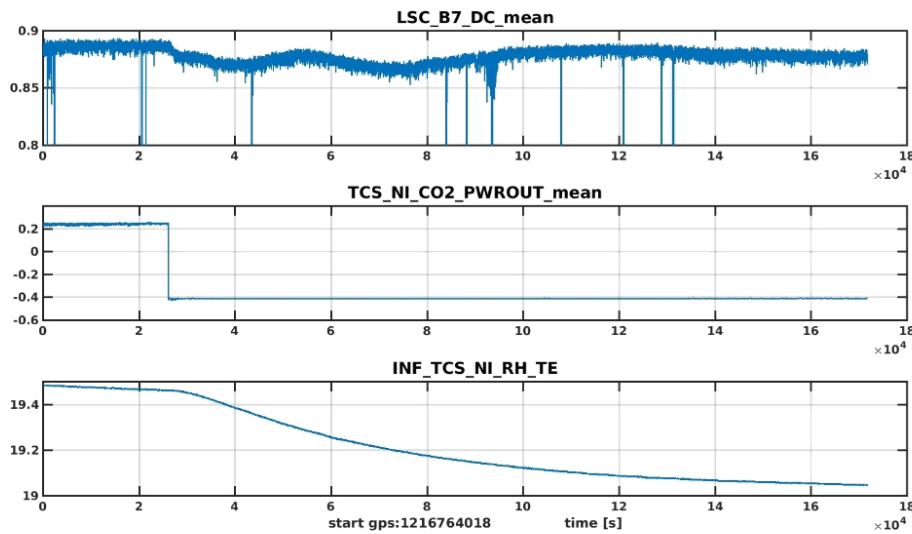
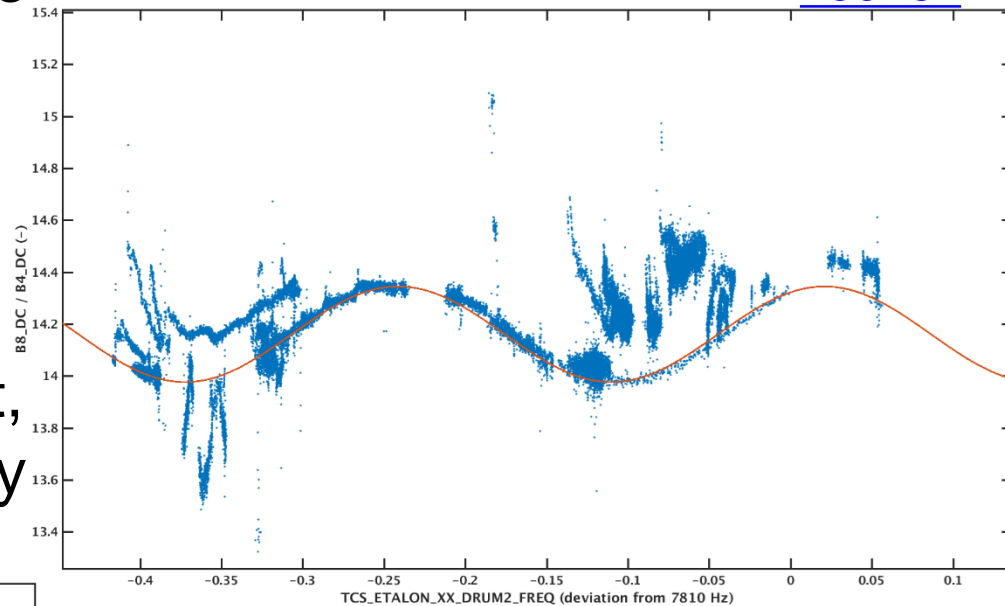
DRUM1 from gps = 1213569525.0 (2018-06-20 22:38:27 UTC)  
 locked for 18703 sec



# Input Mirror Etalon Effect

- NI/WI are non-wedged so that the **reflectivity can be tuned** by tuning the temperature
- Arm finesse can be tuned by
  - Warm ~3%
  - Narm ~2%
- Very interesting and neat, but adds more complexity

[#39767](#)

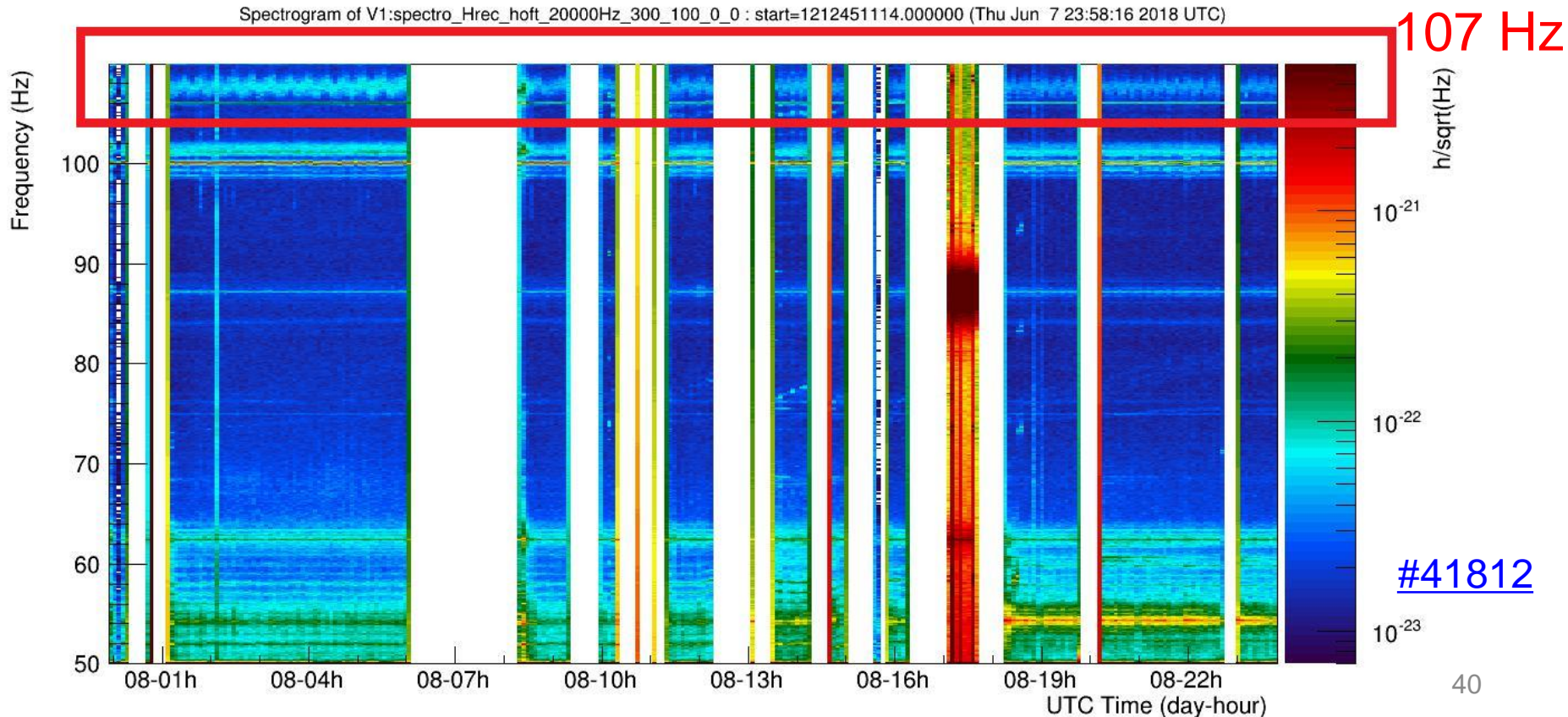


TCS DAS turning off reduces ring heater temperature (mirror temperature) from radiative coupling, which leads to modulation of the arm transmission via etalon effect.

[#42318](#)

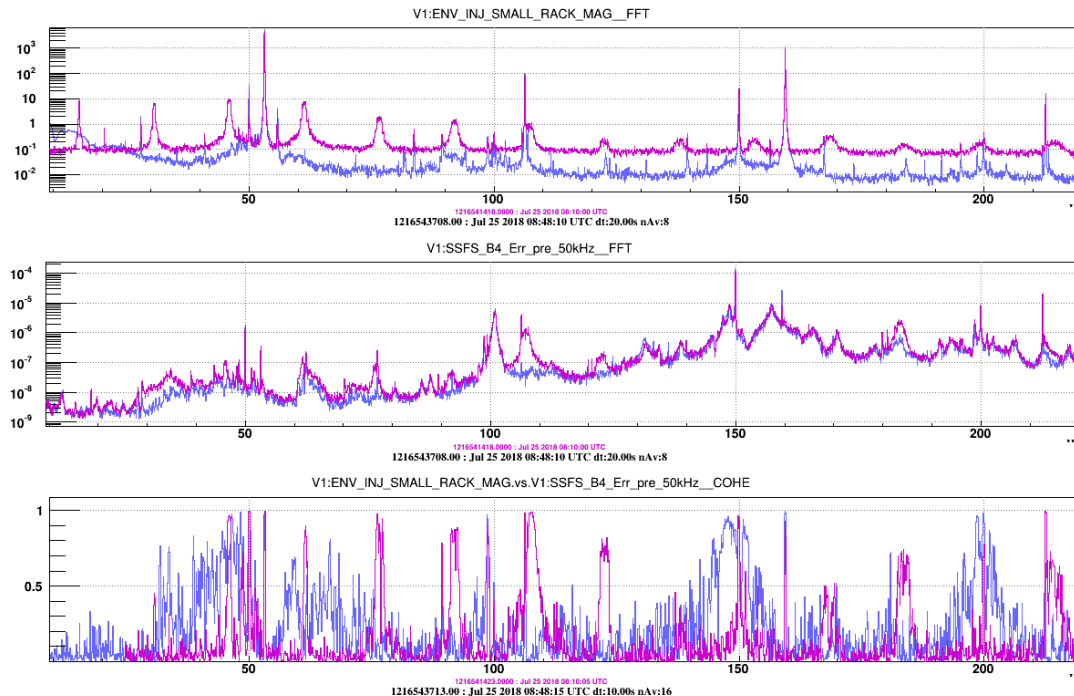
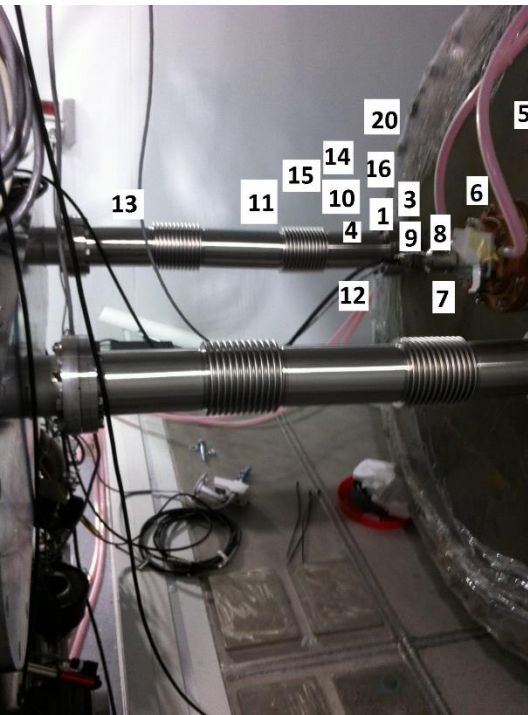
# Frequency Modulated Lines

- Some lines are modulated, with time-varying period
- Resembles arm transmission with etalon
- Size of the etalon object can be estimated by counting number of fringes (etalino; see also [#27328](#), [#27648](#))



# 107Hz Noise Story

- Found in May 2017 ([#37744](#))
- Coherence with reference cavity (RFC) error found ([#41824](#))
- Tapping tests at RFC ([#41947](#))
  - scattered light? for some lines → beam dump installed
- Finally identified to be **magnetic noise** (15.3 Hz and harmonics) from **picomotor driver** on July 25, 2018 ([#42212](#))





# Contents

- **Advanced Virgo status**
- **Selected commissioning topics**
  - thermal compensation (TCS)
  - line noises and line tracking
  - **violin mode damping**
  - graphical user interfaces
  - power drop issue
- **Working environment**
- **Summary**



# Violin Mode Damping

- Looks ugly, contributes to actuation range, takes time to damp ( $Q \sim 2e7$  [#41728](#))
- So, we damped by actively feeding back to **marionette** ([#41949](#))

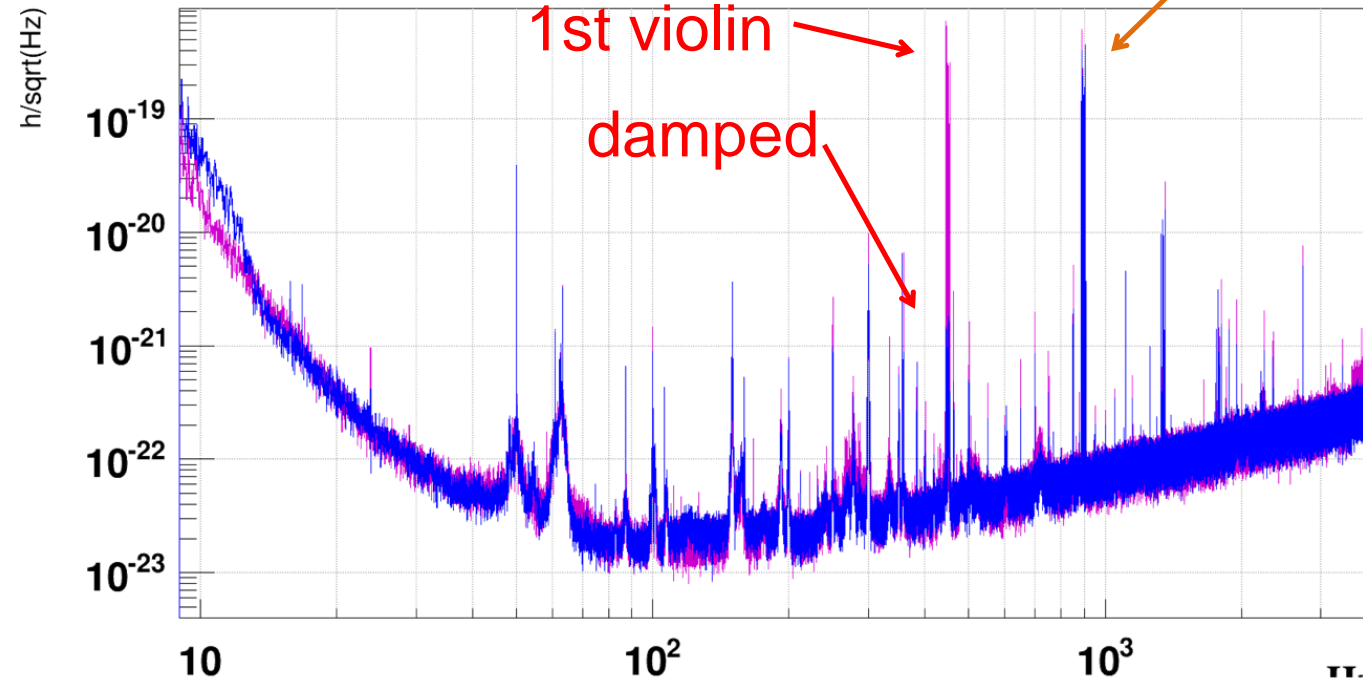
dataDisplay v10r9p1 : started by michimura on Jun 22 2018 16:45:23 UTC

V1:Hrec\_hoft\_20000Hz\_\_FFT

2nd violin

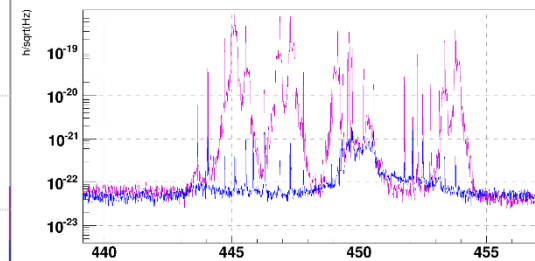
1st violin

damped



dataDisplay v10r9p1 : started by michimura on Jun 22 2018 16:45:23 UTC

V1:Hrec\_hoft\_20000Hz\_\_FFT



1213720900.0000 : Jun 22 2018 16:41:22 UTC  
1213720900.00 : Jun 22 2018 16:41:22 UTC dt:100.00s nAv:9

1213720900.0000 : Jun 22 2018 16:41:22 UTC

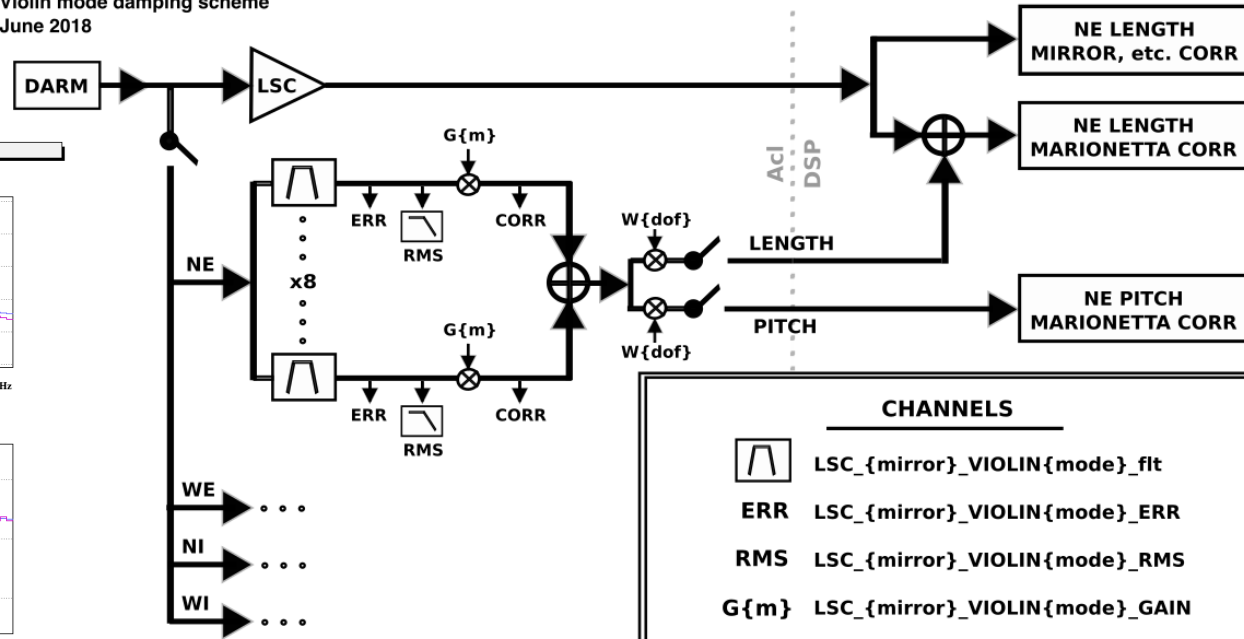
1213720900.00 : Jun 22 2018 16:41:22 UTC dt:100.00s nAv:9

# Damping Scheme

- 4<sup>th</sup> order Butterworth bandpass filter, 0.2 Hz wide
- Select between two BPF to shift phase (~60deg)

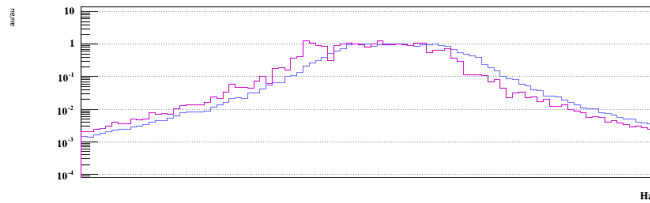
#41922

Advanced VIRGO  
Violin mode damping scheme  
June 2018



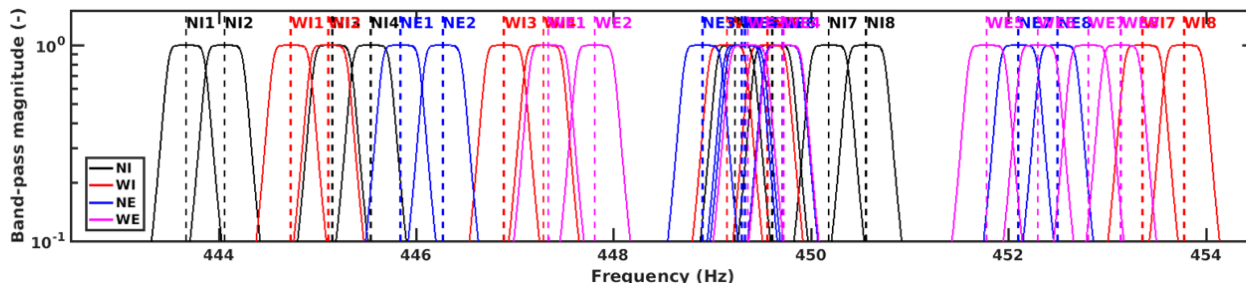
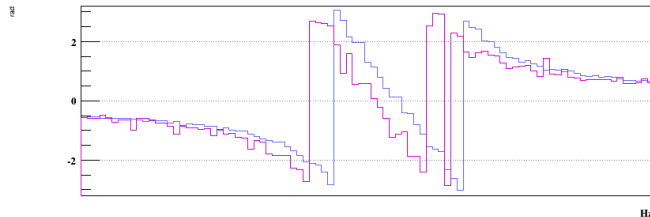
dataDisplay v10r9p1 : started by michimura on Jun 20 2018 15:01:56 UTC

V1:LSC\_NE\_VIOLIN1\_ERR.over.V1:LSC\_DARM\_TRFCT



1213542286.00 : Jun 20 2018 15:04:28 UTC dt:100.00s movAvg

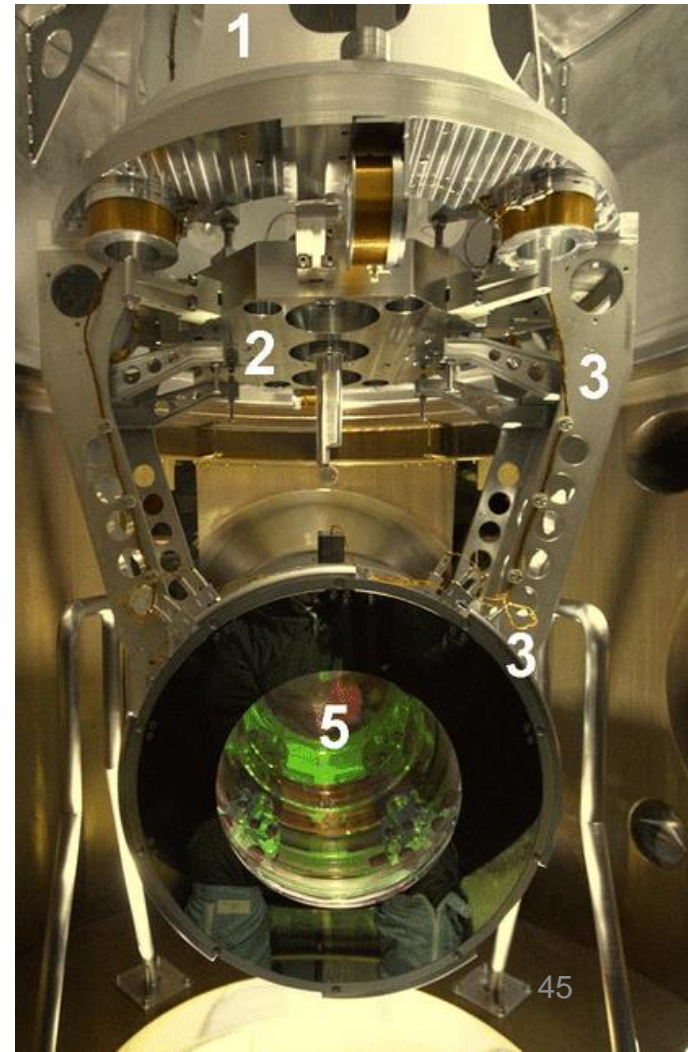
V1:LSC\_NE\_VIOLIN1\_ERR.over.V1:LSC\_DARM\_TRFCT\_Phase



CHANNELS	
	LSC_{mirror}_VIOLIN{mode}_fit
ERR	LSC_{mirror}_VIOLIN{mode}_ERR
RMS	LSC_{mirror}_VIOLIN{mode}_RMS
G{m}	LSC_{mirror}_VIOLIN{mode}_GAIN
CORR	LSC_{mirror}_VIOLIN{mode}_CORR
W{dof}	LSC_ASC_{mirror}_{dof}_NOISE_CORR
	{mirror}_LOCK_FLAG
LEN, PIT	LSC_ASC_{mirror}_{dof}_NOISE_OUT
MAR CORR	Sc_{mirror}_MAR_{dof}_CORR
.....	
{mirror} = NE, WE, NI, WI	
{mode} = 1 - 16	
{dof} = TX, TY, Z	

# Next Step

- Include to **automated** locking procedures (Metatron)
  - Currently only manually turned on (and probably never turned on by Virgo people so far...)
- Damp 2nd mode
- It was a nice little project to grasp control system and commissioning coordination (shift scheme) in Virgo



# Contents

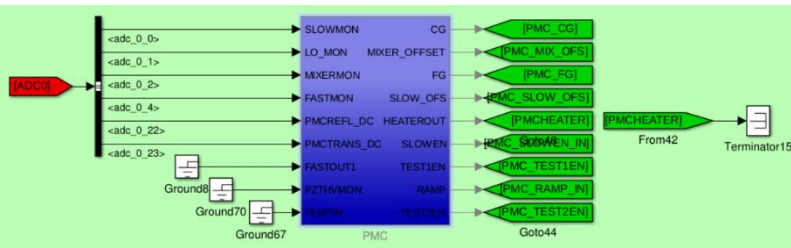
- **Advanced Virgo status**
- **Selected commissioning topics**
  - thermal compensation (TCS)
  - line noises and line tracking
  - violin mode damping
  - **graphical user interfaces**
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- **Working environment**
- **Summary**



# Virgo has Less GUIs

- Hard to see and check what's happening (harder for visitors)

## Simulink



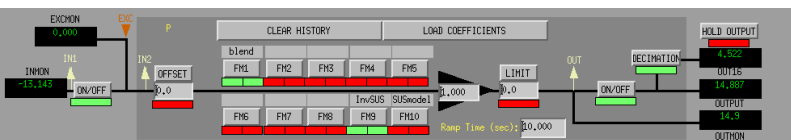
## Acl (Algorithms for Control and Locking)

```

LSC_Acl - DARM algo
/virgoData/VirgoOnline/LSC_DARM.cfg

1  ##----- DARM - Sensing
2  # DARM offset for the B7/B8 basis
3  ACL_CONST_CH B7B8_SET "au" 0 LSC_FREQ 0.0
4
5  # Plain and normalized error signals
6  ACL_SUM_CH DARM_6MHz_I "ma" 1.0 1 B7_6MHz_I 1 B8_6MHz_I 1 B7B8_SET
7  ACL_SUM_CH DARM_6MHz_I_NORM "au" 1.0 1 B7_6MHz_I_NORM 1 B8_6MHz_I_NORM 1 B7B8_SET
8
9  ACL_SUM_CH DARM_56MHz_I "ma" 1.0 1 B7_56MHz_I 1 B8_56MHz_I 1 B7B8_SET
10 ACL_SUM_CH DARM_56MHz_I_NORM "au" 1.0 1 B7_56MHz_I_NORM 1 B8_56MHz_I_NORM 1 B7B8_SET
11
12 ACL_SUM_CH DARM_INPUT "au" 1.0 0 DARM_6MHz_I 0 DARM_6MHz_I_NORM 0 DARM_56MHz_I 0 DARM_56MHz_I_NORM 0 Bip_6MHz_I 0 Bip_6MHz_Q
13 0 Bip_6MHz_I_NORM 0 Bip_56MHz_I 0 Bip_119MHz_I_NORM 0 B1_DC_INPUT 0
14
15 #ACL_SUM_CH DARM_INPUT "au" 1.0 0 DARM_6MHz_I 0 DARM_6MHz_I_NORM 0 DARM_56MHz_I 0 DARM_56MHz_I_NORM 0 B1_DC_INPUT 0 B1_DC_OUT
16 0 Bip_6MHz_I_NORM 0 Bip_56MHz_I 0 Bip_119MHz_I_NORM 0 Bip_119MHz_I_NORM_B1 0 DARM_56MHz_I 0 DARM_56MHz_I_NORM 0 B1_DC_OUT 0 B1_DC_OUT_Q
17
18 ##----- DARM sine excitation for UGF servo
19
20 define DARM_LINE_FREQ 87.1
21 # nameOut _unit - samplingFreq - freq - phase
22 ACL_STIMLINE_CH DARM_Line "v" LSC_FREQ DARM_LINE_FREQ 0
23
24 ##----- DARM - Noise sources for loop measurements
25 # old, can be removed
26 ACL_SUM_CH DARM_NOISE "au" 1 0 LSC_NOISE 0 DARM_Line
27
28 # new
29 ACL_CONST_CH DARM_NOISE_ON "m" 1 LSC_FREQ 0.0
30 ACL_CONST_CH DARM_LINE_AMPL "m" 1 LSC_FREQ 0.0
31 ACL_OP_CH DARM_NOISE "m" scalar DARM_NOISE_ON LSC_NOISE DARM_LINE_AMPL DARM_Line
32
33 ##----- DARM - Trigger parameters
34 # If MC lock with both arms, DARM should not stop when engaging MC
35 ACL_OP_CH DARM_ENABLE "au" "=" CARM_DARM_ON
36 #ACL_OP_CH DARM_ENABLE "au" "=" CARM_DARM_ON
37
38 # If user requests, trigger the data to flow through the loop up to the CORR
39 ACL_OP_CH DARM_TRIGGER "au" "=" CARM_DARM_ENABLE
40 #ACL_OP_CH DARM_TRIGGER "au" "=" CARM_DARM_ENABLE
41 #ACL_RELAY_CH DARM_TRIGGER "au" LSC_FREQ 0 0 -2 DARM_TRIGGER 0.5 0.5 >=
42
43 ##----- DARM - Loop input and loop filters
44 ACL_CONST_CH DARM_GAIN "au" 0 LSC_FREQ 1.0
45
46 # gain filtering
47
48
  
```

## MEDM



## DSP (Digital Signal Processors)

Input	Output	Filename	GUARD	Gain	Gname	@Frequency	When
Slot07_00	slotHi	NULL	no	1			
Slot07_01	slotCorr	NULL	no	1			
Slot07_02	slotCorr	NULL	no	1			
Slot04_01	noise	NULL	no	0			
NOISE	noise	noise	no	1			
noise	noise	lnoise_fit	no	0		0	after
ADD	f	NULL	no	6			
SIG_GEN	noise	sigi	no	0.1			
noise	txCorHi	NULL	no	0			
noise	tyCorHi	NULL	no	0			
noise	zCorHi	NULL	no	0			
ADC1	HIH_Non	NULL	no	1			
ADC2	HIH_Non	NULL	no	1			
ADC3	HIH_Non	NULL	no	1			
ADC4	HIH_Non	NULL	no	1			
GLB_00	LOCK_FLAGS	NULL	no	1			
GLB_01	DC_zCorr	NULL	no	1			
GLB_02	B7_IC	NULL	no	1			
GLB_03	PA_ON	NULL	no	1			
GLB_04	txHi	NULL	no	1			
GLB_05	tyHi	NULL	no	1			
GLB_06	PA_txCorr	NULL	no	1			
GLB_07	PA_tyCorr	NULL	no	1			
GLB_08	DC_zCorHi	NULL	no	1			
GLB_09	DC_zCorHa	NULL	no	1			
GLB_0a	DC_zCorHi	NULL	no	1			

## LIGO / KAGRA

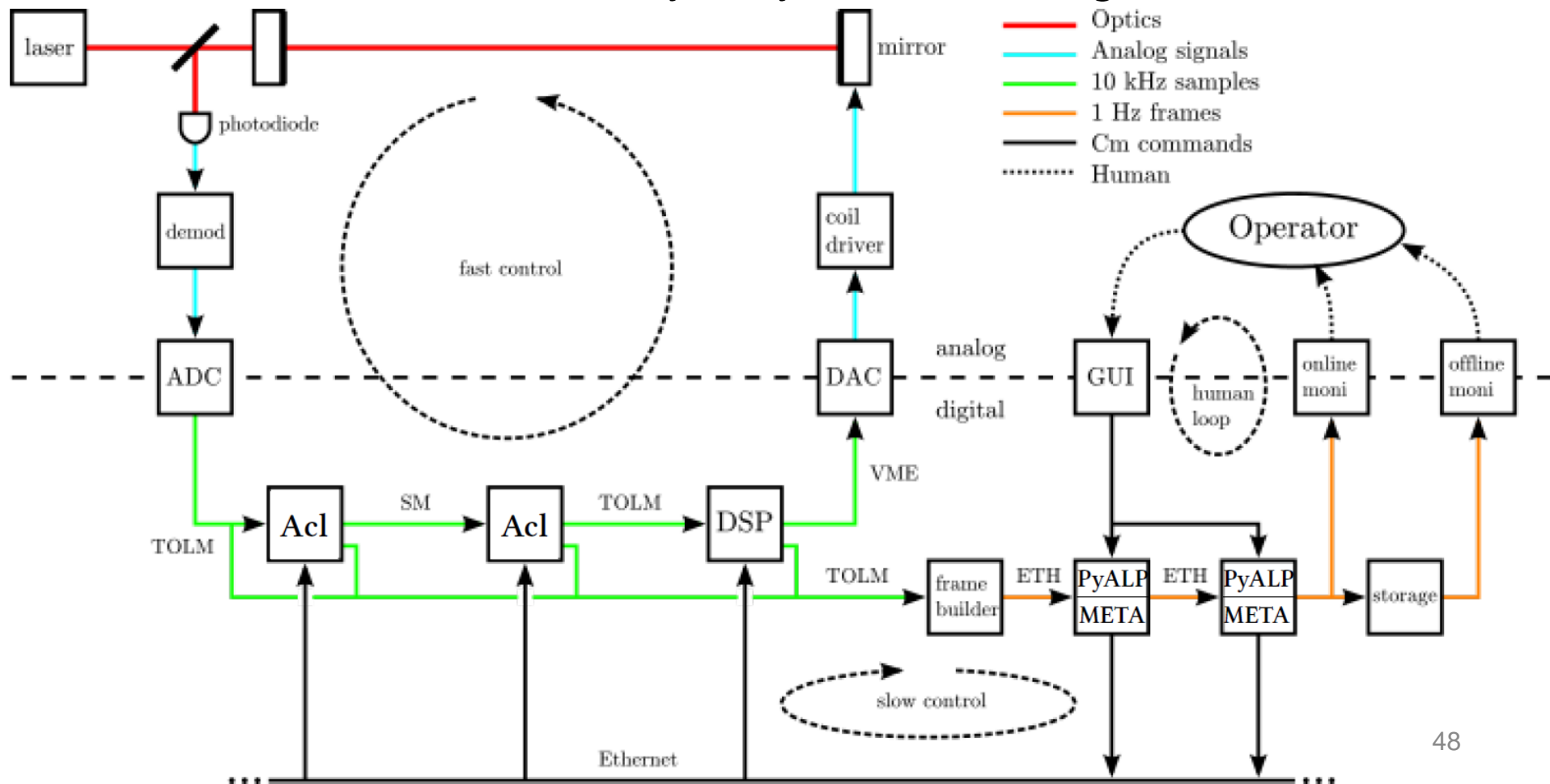
## Virgo

Acl command to change a gain  
 cm\_send('LSC\_Acl', 'AcConstChSet', MICH\_GAIN, 300, 10)



# Acl and DSP

- Developed by different institutes, completely different language
- I concentrated basically only on **Acl** during the visit



# Motivations for Making GUIs

- GUIs help understand the diagram of the signal flow
- You can quickly change the parameters with GUIs
- People can work together easier with GUIs
  
- I thought we can increase the number of people who can involve into commissioning with GUIs
- This time, I made some GUIs equivalent to MEDMs (but Simulink equivalent is also definitely necessary)

# LSC Overview

LSC Overview
GPS time: 1217929546.18 (now)  
GPS time: 1217929543 (frame)
server OK

### NArm

NArm\_INPUT channel: **2.76e-08**

B7_6MHz_I_NORM	1
B1p_6MHz_I	0
B1p_6MHz_I	0.0

NArm\_LOCK\_ON: **1**

NArm\_INPUT: **2.76e-08** | NArm\_TRIG: **1** | NArm\_GAIN: **300** | NArm\_OUT filters: **Arm\_control\*Arm\_mains \*Arm\_boost\_DARM\_violin** | NArm\_CORR: **-7.26e-02**

DRIVING: NI: 1, NE: 1, WI: 0, WE: 0, PR: 0, BS: 0

### WArm

WArm\_INPUT channel: **-3.49e-07**

B8_6MHz_I_NORM	1
B1p_6MHz_I	0
B1p_6MHz_I	0.0

WArm\_LOCK\_ON: **1**

WArm\_INPUT: **-3.49e-07** | WArm\_TRIG: **1** | WArm\_GAIN: **-300** | WArm\_OUT filters: **Arm\_control\*Arm\_mains \*Arm\_boost\_DARM\_violin** | WArm\_CORR: **1.36e-01**

DRIVING: NI: 0, NE: 0, WI: 1, WE: 1, PR: 0, BS: 0

### DARM

DARM\_INPUT channel: **0.00e+00**

B1p_6MHz_I	0
B1p_56MHz_I	0
B1p_6MHz_I	0.0

DARM\_LOCK\_ON: **0** | DARM\_UGF: **92.56**

DARM\_INPUT: **0.00e+00** | DARM\_TRIG: **0** | DARM\_GAIN: **1.862** | DARM\_OUT filters: **\_FILTER\_NO** | DARM\_CORR: **0.00e+00**

DRIVING: NI: 0, NE: 0, WI: 0, WE: 0, PR: 0, BS: 0

### CARM

CARM\_INPUT channel: **0.00e+00**

CARM_6MHz_I_NORM	0
B4_6MHz_I	0
CARM_6MHz_I_NC	0.0

CARM\_LOCK\_ON: **0**

CARM\_INPUT: **0.00e+00** | CARM\_TRIG: **0** | CARM\_GAIN: **1** | CARM\_OUT filters: **\_FILTER\_NO** | CARM\_CORR: **0.00e+00**

DRIVING: NI: 0, NE: 0, WI: 0, WE: 0, PR: 0, BS: 0

### MICH

MICH\_INPUT channel: **5.00e-01**

B1p_SUM_NORM	1
SSFS_B4_56MHz_Q	0
B1p_SUM_NORM	0.0

MICH\_LOCK\_ON: **1** | MICH\_UGF: **54.1**

MICH\_INPUT: **5.00e-01** | MICH\_TRIG: **1** | MICH\_GAIN: **150** | MICH\_OUT filters: **MICH\_control\_MICH\_mai ns** | MICH\_CORR: **7.10e-01**

DRIVING: NI: 0, NE: 0, WI: 0, WE: 0, PR: 0, BS: 1

### PRCL

PRCL\_INPUT channel: **0.00e+00**

B2_6MHz_I_NORM	0
B2_8MHz_I_NORM	0
B2_6MHz_I_NORM	0.0

PRCL\_LOCK\_ON: **0** | PRCL\_UGF: **44.19**

PRCL\_INPUT: **0.00e+00** | PRCL\_TRIG: **0** | PRCL\_GAIN: **-4965** | PRCL\_OUT filters: **PRCL\_control\*PRCL\_violin\_PRCL\_boost** | PRCL\_CORR: **0.00e+00**

DRIVING: NI: 0, NE: 0, WI: 0, WE: 0, PR: 0, BS: 0

# ASC Overview

ASC Overview
GPS time: 1217929640.98 (now)  
GPS time: 1217929638 (frame) server OK

## ASC Overview

Ramp time

### Sensing Matrix

TX	B1p_QD1_V_56MHz_I		B2_QD1_V_8MHz_I		B5_QD1_V		B5_QD1_V_56MHz_I		B4_QD1_V_56MHz_I		B5_QD2_V_norm		B5_QD2_V_56MHz_Q		
	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp
BS_TX_INPUT	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp
PR_TX_INPUT	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp
DIFFp_TX_INPUT	0	0.0	pp	-6	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp
DIFFm_TX_INPUT	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp
COMMp_TX_INPUT	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp
COMMm_TX_INPUT	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp

TY	B1p_QD1_H_56MHz_I		B2_QD1_H_8MHz_I		B5_QD1_H		B5_QD1_H_56MHz_I		B4_QD1_H_56MHz_I		B5_QD2_H_norm		B5_QD2_H_56MHz_Q		
	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp
BS_TY_INPUT	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp
PR_TY_INPUT	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp
DIFFp_TY_INPUT	0	0.0	pp	-3	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp
DIFFm_TY_INPUT	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp
COMMp_TY_INPUT	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp
COMMm_TY_INPUT	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp	0	0.0	pp

### Driving Matrix

TX	DIFFm_TX_CORR		COMMm_TX_CORR			
	0	0.0	pp	0	0.0	pp
NE_TX_CORR	0	0.0	pp	0	0.0	pp
WE_TX_CORR	0	0.0	pp	1	0.0	pp
NI_TX_CORR	0	0.0	pp	0	0.0	pp
WI_TX_CORR	1	0.0	pp	0	0.0	pp

TY	DIFFm_TY_CORR		COMMm_TY_CORR			
	0	0.0	pp	0	0.0	pp
NE_TY_CORR	0	0.0	pp	0	0.0	pp
WE_TY_CORR	0	0.0	pp	1	0.0	pp
NI_TY_CORR	0	0.0	pp	0	0.0	pp
WI_TY_CORR	1	0.0	pp	0	0.0	pp

#### PR TX

PR\_TX\_INPUT: 5.11e-04

PR\_TX\_GAIN: 4

PR\_TX\_CORR: 8.32e-01

PR\_TX\_SET: -0.2

#### BS TX

BS\_TX\_INPUT: 2.79e-06

BS\_TX\_GAIN: 30

BS\_TX\_CORR: 8.37e-05

BS\_TX\_SET: 0

#### DIFFp TX

DIFFp\_TX\_INPUT: 5.65e-06

DIFFp\_TX\_GAIN: 0.08

DIFFp\_TX\_CORR: 8.00e-04

DIFFp\_TX\_SET: -0.01

#### DIFFm TX

DIFFm\_TX\_INPUT: 1.83e-05

DIFFm\_TX\_GAIN: 7

DIFFm\_TX\_CORR: 1.28e-04

DIFFm\_TX\_SET: 0

#### COMMp TX

COMMp\_TX\_INPUT: 1.35e+00

COMMp\_TX\_GAIN: 1

COMMp\_TX\_CORR: 1.35e+00

COMMp\_TX\_SET: 0

#### COMMm TX

COMMm\_TX\_INPUT: 0.00e+00

COMMm\_TX\_GAIN: 0

COMMm\_TX\_CORR: 0.00e+00

COMMm\_TX\_SET: 0

#### PR TY

PR\_TY\_INPUT: 1.43e-04

PR\_TY\_GAIN: 4

PR\_TY\_CORR: 9.11e-03

PR\_TY\_SET: 0

#### BS TY

BS\_TY\_INPUT: -1.06e-06

BS\_TY\_GAIN: 39

BS\_TY\_CORR: -4.12e-05

BS\_TY\_SET: 0

#### DIFFp TY

DIFFp\_TY\_INPUT: -1.08e-06

DIFFp\_TY\_GAIN: 0.55

DIFFp\_TY\_CORR: 2.75e-02

DIFFp\_TY\_SET: -0.05

#### DIFFm TY

DIFFm\_TY\_INPUT: -2.21e-06

DIFFm\_TY\_GAIN: 3.5

DIFFm\_TY\_CORR: -7.73e-06

DIFFm\_TY\_SET: 0

#### COMMp TY

COMMp\_TY\_INPUT: 1.48e+00

COMMp\_TY\_GAIN: 2

COMMp\_TY\_CORR: 2.96e+00

COMMp\_TY\_SET: 0

#### COMMm TY

COMMm\_TY\_INPUT: 0.00e+00

COMMm\_TY\_GAIN: 0

COMMm\_TY\_CORR: 0.00e+00

COMMm\_TY\_SET: 0



# ISC Photodiodes and Quadrants

ISC Photodiodes

GPS time: 1217929577.21 (now)  
GPS time: 1217929574 (frame)

server OK VIRGO

Ramp time 0.0

### SNEB B7

DC

PD1_DC_100Hz	6.13e-01	1.248
PD2_DC_100Hz	1.48e-02	0
DC	7.86e-01	(blended)

6MHz

PD1_6MHz_ph0	1.31e-07	0
PD1_6MHz_Q	9.18e-08	0
PD2_6MHz_ph0	7.84e-07	1.248
PD2_6MHz_Q	9.02e-07	1.248

56MHz

PD1_56MHz_ph0	0	0
PD1_56MHz_Q	0	0
PD2_56MHz_ph0	5.14e-07	1.248
PD2_56MHz_Q	1.42e-06	1.248

SWEB B8

DC

PD1_DC_100Hz	5.76e-01	1.248
PD2_DC_100Hz	1.25e-02	0
DC	7.49e-01	(blended)

6MHz

PD1_6MHz_ph0	1.32e-07	1.248
PD1_6MHz_Q	3.96e-08	0
PD2_6MHz_ph0	1.45e-07	1.248
PD2_6MHz_Q	1.71e-06	0

56MHz

PD1_56MHz_ph0	0.009	1.248
PD1_56MHz_Q	1.23e-05	1.248
PD2_56MHz_ph0	1.02e-05	0
PD2_56MHz_Q	1.29e-04	0

SPRB B4

DC

PD1_DC	1.03e-02	TD select
PD2_DC	1.36e-02	1
DC	1.36e-02	

6MHz

PD1_6MHz_ph0	4.32e-07	1.248
PD1_6MHz_Q	2.59e-04	0
PD2_6MHz_ph0	7.27e-07	1.248
PD2_6MHz_Q	1.07e-05	0

56MHz

PD1_56MHz_ph0	0.009	1.248
PD1_56MHz_Q	1.41e-04	0
PD2_56MHz_ph0	1.27e-04	0
PD2_56MHz_Q	4.69e-04	0

DCPHI

DC

PD1_DC	3.87e-03	weights
PD2_DC	2.53e-02	1
DC	2.53e-02	(blended)

SSFS B4

DC

PD1_DC	0	0
PD2_DC	0	0
DC	0	0

### SIB2 B2

DC

PD1_DC	2.25e-02	weights
PD2_DC	1.57e-02	1
DC	1.57e-02	

6MHz

PD1_6MHz_ph0	5.82e-04	0
PD1_6MHz_Q	6.70e-04	0
PD2_6MHz_ph0	4.40e-04	1
PD2_6MHz_Q	2.99e-04	1

8MHz

PD1_8MHz_ph0	0	0
PD1_8MHz_Q	0	0
PD2_8MHz_ph0	3.56e-04	1
PD2_8MHz_Q	5.06e-04	1

SDB2 B1s1

DC

PD1_DC	2.27e-06	weights
PD2_DC	1.8	1
DC	4.47e-06	(blended)

6MHz

PD1_6MHz_ph0	0.009	1
PD1_6MHz_Q	4.57e-07	1
PD2_6MHz_ph0	0	0
PD2_6MHz_Q	0	0

SDB2 B1s2

DC

PD1_DC	9.44e-06	weights
PD2_DC	0	1
DC	7.27e-06	(blended)

SDB2 B1

DC

PD1_DC	1.36e-02	TD BALANCE
PD2_DC	1.21e-02	0.513
DC	4.40e-03	

ISC Quadrants

GPS time: 1217929661.14 (now)  
GPS time: 1217929658 (frame)

server OK VIRGO

Ramp time 0.0

### SNEB B7

DC

QD1_Sum	1.36e-05	QD2_Sum	4.01e-05
QD1_H	-2.15e-05	QD2_H	-3.30e-05
QD1_V	6.40e-05	QD2_V	2.67e-05

SWEB B8

DC

QD1_Sum	-2.65e-05	QD2_Sum	-2.15e-05
QD1_H	3.55e-02	QD2_H	2.41e-02
QD1_V	-3.10e-04	QD2_V	5.90e-05

SPRB B4

DC

QD1_Sum	3.95e-03	QD2_Sum	7.45e-05
QD1_H	1.21e-06	QD2_H	2.10e-05
QD1_V	-1.09e-05	QD2_V	1.79e-04

56MHz

QD1_56MHz_ph0	0.018	QD1_56MHz_Q	-3.09e-08
QD2_56MHz_ph0	0.018	QD2_56MHz_Q	-6.06e-08

ASC 56MHz

QD1_H_56MHz	1.69e-11	QD1_V_56MHz	4.67e-08
QD2_H_56MHz	1.32e-11	QD2_V_56MHz	7.04e-08

8MHz

QD1_H_8MHz	1.59e-06	QD1_V_8MHz	5.05e-06
QD2_H_8MHz	0.306	QD2_V_8MHz	4.89e-05

DCPHI

DC

QD1_H_DPHI	1.59e-06	QD1_V_DPHI	6.85e-05
QD2_H_DPHI	0	QD2_V_DPHI	3.18e-05

### SIB2 B2

DC

QD1_Sum	1.02e-02	QD2_Sum	1.65e-02
QD1_H	1.11e-02	QD2_H	1.79e-02
QD1_V	1.83e-02	QD2_V	1.60e-02

6MHz

QD1_6MHz_ph0	0.179	QD1_6MHz_Q	4.09e-06
QD2_6MHz_ph0	0.179	QD2_6MHz_Q	1.11e-05

ASC 6MHz

QD1_H_6MHz	0	QD1_V_6MHz	0
QD2_H_6MHz	0	QD2_V_6MHz	0

8MHz

QD1_H_8MHz	1.59e-06	QD1_V_8MHz	5.05e-06
QD2_H_8MHz	0.306	QD2_V_8MHz	4.89e-05

DCPHI

DC

QD1_H_DPHI	1.59e-06	QD1_V_DPHI	6.85e-05
QD2_H_DPHI	0	QD2_V_DPHI	3.18e-05

### SDB2 B5

DC

QD1_Sum	2.85e-02	QD2_Sum	1.39e-02
QD1_H	1.66e-02	QD2_H	2.02e-02
QD1_V	3.17e-02	QD2_V	1.83e-02

6MHz

QD1_6MHz_ph0	0.179	QD1_6MHz_Q	9.44e-05
QD2_6MHz_ph0	0.421	QD2_6MHz_Q	2.28e-04

ASC 6MHz

QD1_H_6MHz	0	QD1_V_6MHz	0
QD2_H_6MHz	0	QD2_V_6MHz	0

56MHz

QD1_56MHz_ph0	0.017	QD1_56MHz_Q	-3.42e-05
QD2_56MHz_ph0	0.017	QD2_56MHz_Q	-6.26e-06

ASC 56MHz

QD1_H_56MHz	2.61e-05	QD1_V_56MHz	6.12e-06
QD2_H_56MHz	0.330	QD2_V_56MHz	7.16e-06

### SDB2 B1p

DC

QD1_Sum	-8.05e-04	QD2_Sum	-1.08e-03
QD1_H	-1.99e-02	QD2_H	1.43e-04
QD1_V	-1.17e-05	QD2_V	2.47e-05

6MHz

QD1_6MHz_ph0	0.521	QD1_6MHz_Q	-1.42e-07
QD2_6MHz_ph0	1.551	QD2_6MHz_Q	3.67e-08

ASC 6MHz

QD1_H_6MHz	0	QD1_V_6MHz	0
QD2_H_6MHz	0	QD2_V_6MHz	0

56MHz

QD1_56MHz_ph0	0.017	QD1_56MHz_Q	-1.73e-09
QD2_56MHz_ph0	0.017	QD2_56MHz_Q	-3.46e-08

ASC 56MHz

QD1_H_56MHz	1.92e-09	QD1_V_56MHz	6.37e-07
QD2_H_56MHz	5.740	QD2_V_56MHz	0.32e-07

# Violin Damping

Violin Damping

GPS time: 1217929606.36 (now)  
GPS time: 1217929603 (frame) server OK

Ramp time  Restore Defaults

DARM  VIOLIN\_SW

### NE violin damper

NE TX  NE\_LOCK\_FLAG  NE\_TX\_NOISE\_OUT

NE TY   NE\_TY\_NOISE\_OUT

NE TY

### NI violin damper

NI TX  NI\_LOCK\_FLAG  NI\_TX\_NOISE\_OUT

NI TY   NI\_TY\_NOISE\_OUT

NI TY

### WE violin damper

WE TX  WE\_LOCK\_FLAG  WE\_TX\_NOISE\_OUT

WE TY   WE\_TY\_NOISE\_OUT

WE TY

### WI violin damper

WI TX  WI\_LOCK\_FLAG  WI\_TX\_NOISE\_OUT

WI TY   WI\_TY\_NOISE\_OUT

WI TY

### NE violin damper

ERR	ERR_RMS	(445.84 Hz)
LSC_NE_VIOLIN1_fit1	0.00e+00	0.00e+00
LSC_NE_VIOLIN1_fit2	0.00e+00	0.00e+00
NE_VIOLIN1_AMPL	6.31e-09	0.0

### NI violin damper

ERR	ERR_RMS	(447.34 Hz)
LSC_NI_VIOLIN1_fit1	0.00e+00	0.00e+00
LSC_NI_VIOLIN1_fit2	0.00e+00	0.00e+00
NI_VIOLIN1_AMPL	1.04e-08	0.0

### WE violin damper

ERR	ERR_RMS	(443.67 Hz)
LSC_WE_VIOLIN1_fit1	0.00e+00	0.00e+00
LSC_WE_VIOLIN1_fit2	0.00e+00	0.00e+00
WE_VIOLIN1_AMPL	4.67e-09	0.0

### WI violin damper

ERR	ERR_RMS	(444.73 Hz)
LSC_WI_VIOLIN1_fit1	0.00e+00	0.00e+00
LSC_WI_VIOLIN1_fit2	0.00e+00	0.00e+00
WI_VIOLIN1_AMPL	7.32e-09	0.0

### NE violin damper

ERR	ERR_RMS	(446.27 Hz)
LSC_NE_VIOLIN2_fit1	0.00e+00	0.00e+00
LSC_NE_VIOLIN2_fit2	0.00e+00	0.00e+00
NE_VIOLIN2_AMPL	6.76e-09	0.0

### NI violin damper

ERR	ERR_RMS	(447.81 Hz)
LSC_NI_VIOLIN2_fit1	0.00e+00	0.00e+00
LSC_NI_VIOLIN2_fit2	0.00e+00	0.00e+00
NI_VIOLIN2_AMPL	7.36e-09	0.0

### WE violin damper

ERR	ERR_RMS	(444.06 Hz)
LSC_WE_VIOLIN2_fit1	0.00e+00	0.00e+00
LSC_WE_VIOLIN2_fit2	0.00e+00	0.00e+00
WE_VIOLIN2_AMPL	8.55e-09	0.0

### WI violin damper

ERR	ERR_RMS	(445.11 Hz)
LSC_WI_VIOLIN2_fit1	0.00e+00	0.00e+00
LSC_WI_VIOLIN2_fit2	0.00e+00	0.00e+00
WI_VIOLIN2_AMPL	4.42e-09	0.0

### NE violin damper

ERR	ERR_RMS	(448.90 Hz)
LSC_NE_VIOLIN3_fit1	0.00e+00	0.00e+00
LSC_NE_VIOLIN3_fit2	0.00e+00	0.00e+00
NE_VIOLIN3_AMPL	8.10e-09	0.0

### NI violin damper

ERR	ERR_RMS	(449.36 Hz)
LSC_NI_VIOLIN3_fit1	0.00e+00	0.00e+00
LSC_NI_VIOLIN3_fit2	0.00e+00	0.00e+00
NI_VIOLIN3_AMPL	5.20e-09	0.0

### WE violin damper

ERR	ERR_RMS	(445.15 Hz)
LSC_WE_VIOLIN3_fit1	0.00e+00	0.00e+00
LSC_WE_VIOLIN3_fit2	0.00e+00	0.00e+00
WE_VIOLIN3_AMPL	3.24e-09	0.0

### WI violin damper

ERR	ERR_RMS	(446.89 Hz)
LSC_WI_VIOLIN3_fit1	0.00e+00	0.00e+00
LSC_WI_VIOLIN3_fit2	0.00e+00	0.00e+00
WI_VIOLIN3_AMPL	6.68e-09	0.0

### NE violin damper

ERR	ERR_RMS	(449.30 Hz)
LSC_NE_VIOLIN4_fit1	0.00e+00	0.00e+00
LSC_NE_VIOLIN4_fit2	0.00e+00	0.00e+00
NE_VIOLIN4_AMPL	2.27e-09	0.0

### NI violin damper

ERR	ERR_RMS	(449.72 Hz)
LSC_NI_VIOLIN4_fit1	0.00e+00	0.00e+00
LSC_NI_VIOLIN4_fit2	0.00e+00	0.00e+00
NI_VIOLIN4_AMPL	5.64e-09	0.0

### WE violin damper

ERR	ERR_RMS	(445.54 Hz)
LSC_WE_VIOLIN4_fit1	0.00e+00	0.00e+00
LSC_WE_VIOLIN4_fit2	0.00e+00	0.00e+00
WE_VIOLIN4_AMPL	4.39e-09	0.0

### WI violin damper

ERR	ERR_RMS	(447.29 Hz)
LSC_WI_VIOLIN4_fit1	0.00e+00	0.00e+00
LSC_WI_VIOLIN4_fit2	0.00e+00	0.00e+00
WI_VIOLIN4_AMPL	5.09e-09	0.0

### NE violin damper

ERR	ERR_RMS	(449.33 Hz)
LSC_NE_VIOLIN5_fit1	0.00e+00	0.00e+00
LSC_NE_VIOLIN5_fit2	0.00e+00	0.00e+00
NE_VIOLIN5_AMPL	1.30e-09	0.0

### NI violin damper

ERR	ERR_RMS	(451.78 Hz)
LSC_NI_VIOLIN5_fit1	0.00e+00	0.00e+00
LSC_NI_VIOLIN5_fit2	0.00e+00	0.00e+00
NI_VIOLIN5_AMPL	2.84e-09	0.0

### WE violin damper

ERR	ERR_RMS	(449.23 Hz)
LSC_WE_VIOLIN5_fit1	0.00e+00	0.00e+00
LSC_WE_VIOLIN5_fit2	0.00e+00	0.00e+00
WE_VIOLIN5_AMPL	8.73e-09	0.0

### WI violin damper

ERR	ERR_RMS	(449.15 Hz)
LSC_WI_VIOLIN5_fit1	0.00e+00	0.00e+00
LSC_WI_VIOLIN5_fit2	0.00e+00	0.00e+00
WI_VIOLIN5_AMPL	4.04e-09	0.0

### NE violin damper

ERR	ERR_RMS	(449.71 Hz)
LSC_NE_VIOLIN6_fit1	0.00e+00	0.00e+00
LSC_NE_VIOLIN6_fit2	0.00e+00	0.00e+00
NE_VIOLIN6_AMPL	1.96e-09	0.0

### NI violin damper

ERR	ERR_RMS	(452.30 Hz)
LSC_NI_VIOLIN6_fit1	0.00e+00	0.00e+00
LSC_NI_VIOLIN6_fit2	0.00e+00	0.00e+00
NI_VIOLIN6_AMPL	2.90e-09	0.0

### WE violin damper

ERR	ERR_RMS	(449.61 Hz)
LSC_WE_VIOLIN6_fit1	0.00e+00	0.00e+00
LSC_WE_VIOLIN6_fit2	0.00e+00	0.00e+00
WE_VIOLIN6_AMPL	4.14e-09	0.0

### WI violin damper

ERR	ERR_RMS	(449.56 Hz)
LSC_WI_VIOLIN6_fit1	0.00e+00	0.00e+00
LSC_WI_VIOLIN6_fit2	0.00e+00	0.00e+00
WI_VIOLIN6_AMPL	3.65e-09	0.0

### NE violin damper

ERR	ERR_RMS	(452.10 Hz)
LSC_NE_VIOLIN7_fit1	0.00e+00	0.00e+00
LSC_NE_VIOLIN7_fit2	0.00e+00	0.00e+00
NE_VIOLIN7_AMPL	4.79e-09	0.0

### NI violin damper

ERR	ERR_RMS	(452.81 Hz)
LSC_NI_VIOLIN7_fit1	0.00e+00	0.00e+00
LSC_NI_VIOLIN7_fit2	0.00e+00	0.00e+00
NI_VIOLIN7_AMPL	6.95e-09	0.0

### WE violin damper

ERR	ERR_RMS	(450.18 Hz)
LSC_WE_VIOLIN7_fit1	0.00e+00	0.00e+00
LSC_WE_VIOLIN7_fit2	0.00e+00	0.00e+00
WE_VIOLIN7_AMPL	5.91e-09	0.0

### WI violin damper

ERR	ERR_RMS	(453.36 Hz)
LSC_WI_VIOLIN7_fit1	0.00e+00	0.00e+00
LSC_WI_VIOLIN7_fit2	0.00e+00	0.00e+00
WI_VIOLIN7_AMPL	5.58e-09	0.0

### NE violin damper

ERR	ERR_RMS	(452.50 Hz)
LSC_NE_VIOLIN8_fit1	0.00e+00	0.00e+00
LSC_NE_VIOLIN8_fit2	0.00e+00	0.00e+00
NE_VIOLIN8_AMPL	5.09e-09	0.0

### NI violin damper

ERR	ERR_RMS	(453.14 Hz)
LSC_NI_VIOLIN8_fit1	0.00e+00	0.00e+00
LSC_NI_VIOLIN8_fit2	0.00e+00	0.00e+00
NI_VIOLIN8_AMPL	8.48e-09	0.0

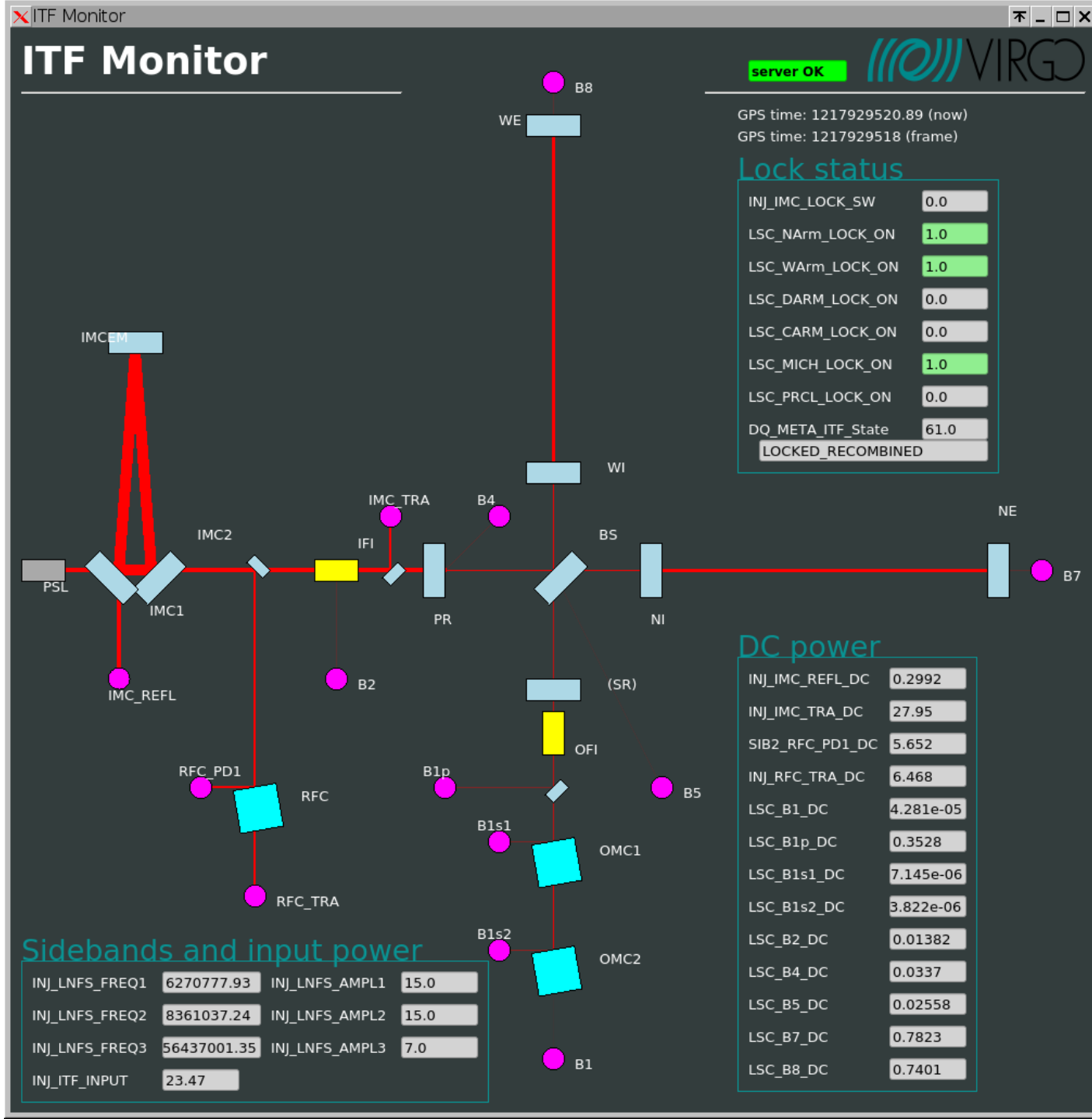
### WE violin damper

ERR	ERR_RMS	(450.56 Hz)
LSC_WE_VIOLIN8_fit1	0.00e+00	0.00e+00
LSC_WE_VIOLIN8_fit2	0.00e+00	0.00e+00
WE_VIOLIN8_AMPL	5.51e-09	0.0

### WI violin damper

ERR	ERR_RMS	(453.76 Hz)
LSC_WI_VIOLIN8_fit1	0.00e+00	0.00e+00
LSC_WI_VIOLIN8_fit2	0.00e+00	0.00e+00
WI_VIOLIN8_AMPL	1.09e-08	0.0

# ITF Monitor



# PyQt and Qt Designer



- GUIs are made by Python package PyQt4
- GUI design made with Qt Designer (easier to design than MEDM editor)

The screenshot displays the Qt Designer interface for a GUI titled "LSC Overview - LSCOverview.ui". The main workspace shows a complex control panel with five sections: NArm, WArm, DARM, CARM, and MICH. Each section contains a flow diagram with input fields (channel, TRIG, GAIN, LOCK\_ON, UGFS) and output filters, along with "Apply" buttons. A "DRIVING" table is present in each section, listing parameters like NI, NE, WI, WE, PR, BS with numerical values and "Apply" buttons. A "Ramp time" slider is visible at the top right. The left sidebar shows the "Widget Box" with various UI elements like layouts, spacers, buttons, and containers. The right sidebar contains the "Object Inspector" and "Property Editor". The "Object Inspector" lists objects like "LSC\_NArm\_INPUT\_channel\_request" with their classes (e.g., QComboBox). The "Property Editor" shows the properties for the selected "LSC\_NArm\_INPUT\_channel\_request" object, such as "enabled", "geometry", and "sizePolicy". The "Resource Browser" at the bottom right shows the resource root.

Qt Designer

File Edit Form View Settings Window Help

Widget Box

LSC Overview - LSCOverview.ui

LSC Overview

GPS time: (now)  
GPS time: (frame)

Server ON

Ramp time 0.0

NArm

NArm\_INPUT channel 0.0 NArm\_TRIG 0.0 NArm\_GAIN 0.0 NArm\_OUT filters none NArm\_CORR 0.0

channel 0.0 channel 0.0 channels 0.0 Apply

NArm\_LOCK\_ON 0.0 NArm\_SET 0.0 Apply

DRIVING

NI	0.0	0.0	Apply
NE	0.0	0.0	Apply
WI	0.0	0.0	Apply
WE	0.0	0.0	Apply
PR	0.0	0.0	Apply
BS	0.0	0.0	Apply

WArm

WArm\_INPUT channel 0.0 WArm\_TRIG 0.0 WArm\_GAIN 0.0 WArm\_OUT filters none WArm\_CORR 0.0

channel 0.0 channel 0.0 channels 0.0 Apply

WArm\_LOCK\_ON 0.0 WArm\_SET 0.0 Apply

DRIVING

NI	0.0	0.0	Apply
NE	0.0	0.0	Apply
WI	0.0	0.0	Apply
WE	0.0	0.0	Apply
PR	0.0	0.0	Apply
BS	0.0	0.0	Apply

DARM

DARM\_INPUT channel 0.0 DARM\_TRIG 0.0 DARM\_GAIN 0.0 DARM\_OUT filters none DARM\_CORR 0.0

channel 0.0 channel 0.0 channels 0.0 Apply

DARM\_LOCK\_ON 0.0 DARM\_UGF 0.0 Apply

DRIVING

NI	0.0	0.0	Apply
NE	0.0	0.0	Apply
WI	0.0	0.0	Apply
WE	0.0	0.0	Apply
PR	0.0	0.0	Apply
BS	0.0	0.0	Apply

CARM

CARM\_INPUT channel 0.0 CARM\_TRIG 0.0 CARM\_GAIN 0.0 CARM\_OUT filters none CARM\_CORR 0.0

channel 0.0 channel 0.0 channels 0.0 Apply

CARM\_LOCK\_ON 0.0 CARM\_SET 0.0 Apply

INJ\_JMC\_LOCK\_SW 0.0 SSFS\_UGF 0.0 Apply

DRIVING

NI	0.0	0.0	Apply
NE	0.0	0.0	Apply
WI	0.0	0.0	Apply
WE	0.0	0.0	Apply
PR	0.0	0.0	Apply
BS	0.0	0.0	Apply

MICH

MICH\_INPUT channel 0.0 MICH\_TRIG 0.0 MICH\_GAIN 0.0 MICH\_OUT filters none MICH\_CORR 0.0

channel 0.0

DRIVING

NI	0.0	0.0	Apply
----	-----	-----	-------

Object Inspector

Object	Class
LSC_NArm_INPUT_channel_1	QLineEdit
LSC_NArm_INPUT_channel_2	QLineEdit
LSC_NArm_INPUT_channel_request	QComboBox
LSC_NArm_INPUT_value	QLineEdit
LSC_NArm_INPUT_weight_1	QLineEdit
LSC_NArm_INPUT_weight_2	QLineEdit
LSC_NArm_INPUT_weight_apply	QPushButton
LSC_NArm_INPUT_weight_request	QLineEdit
LSC_NArm_LOCK_ON_value	QLineEdit
LSC_NArm_OUT_filter	QTextEdit

Property Editor

LSC\_NArm\_INPUT\_channel\_request : QComboBox

Property	Value
objectName	LSC_NArm_INPUT_channel_request
enabled	checked
geometry	[[10, 160], 141 x 23]
X	10
Y	160
Width	141
Height	23
sizePolicy	[Preferred, Fixed, 0, 0]
Horizontal Policy	Preferred
Vertical Policy	Fixed
Horizontal Stre...	0
Vertical Stretch	0
minimumSize	0 x 0
Width	0
Height	0
maximumSize	16777215 x 16777215
Width	16777215
Height	16777215

Resource Browser

<resource root>

Signal/Slot Editor Action Editor Resource Browser



# Some Headaches

- In Virgo, getting current value of a parameter is more difficult than pushing a new value
  - You have to access to frames to get it (~3 sec latency)
  - Not all channels (even 1Hz ones) are saved unless configured so
  - Frames store data in multiple ways, and how to access to frames depends on how it is stored. You cannot tell how to access from the channel name
- Pushing is also tricky since the command depends on what kind of parameter you want to push (constant value, matrix element, weight of sum channel or filter name)
- So, making GUIs also needs some expertize...
- Maintaining existing GUIs would be tough

# For 3G

- Virgo system is better in the sense, for example, that
  - it recompiles fast  
(new DAQ channel immediately available)
  - number of filters can be arbitrarily set, and you can use same filters to different loops
- I think something like  
Simulink + Foton + (auto generated) PyQt + dataDisplay  
is the best

The image shows two overlapping software windows. The top window, titled 'mainbrowser', is a channel management interface. It features a list of channels on the left, a central panel with various processing options (TIME, FFT, ID-DISTRIB, TR. FCT, COHERENCE, 2D-DISTRIB, RAW-IMAGE, FFTIME, TRFCTIME, COHETIME, IDTIME, RAWTIME, AUDIO), and a right-hand panel with plot-related actions (Edit Plots, Superpose, Unsuperpose, Copy, Transform, Permute Var, Move Up, Move Down, Hide, Show, Get Channels). The channel list includes entries like 'V1:LSC\_B8\_DC:10000.00Hz' and 'V1:SPRB\_B4\_PD2\_sample\_\_FFT'. The bottom window, titled 'dy\_michimura\_25228', is a 'DataDisplay v10r9p1' interface. It has a menu bar (Inputs, Config, Data/Plots, Clear, Ref Plots, Tools, Quit) and a control panel with buttons for Start, Pause, Continue, Next Refresh, Stop, and HELP. It also includes a 'Wait for data' checkbox and a status bar at the bottom showing '10\_Aug\_2018\_11:52:52 : ===== STOP READING DATA'. The status bar also contains a '57' indicator.

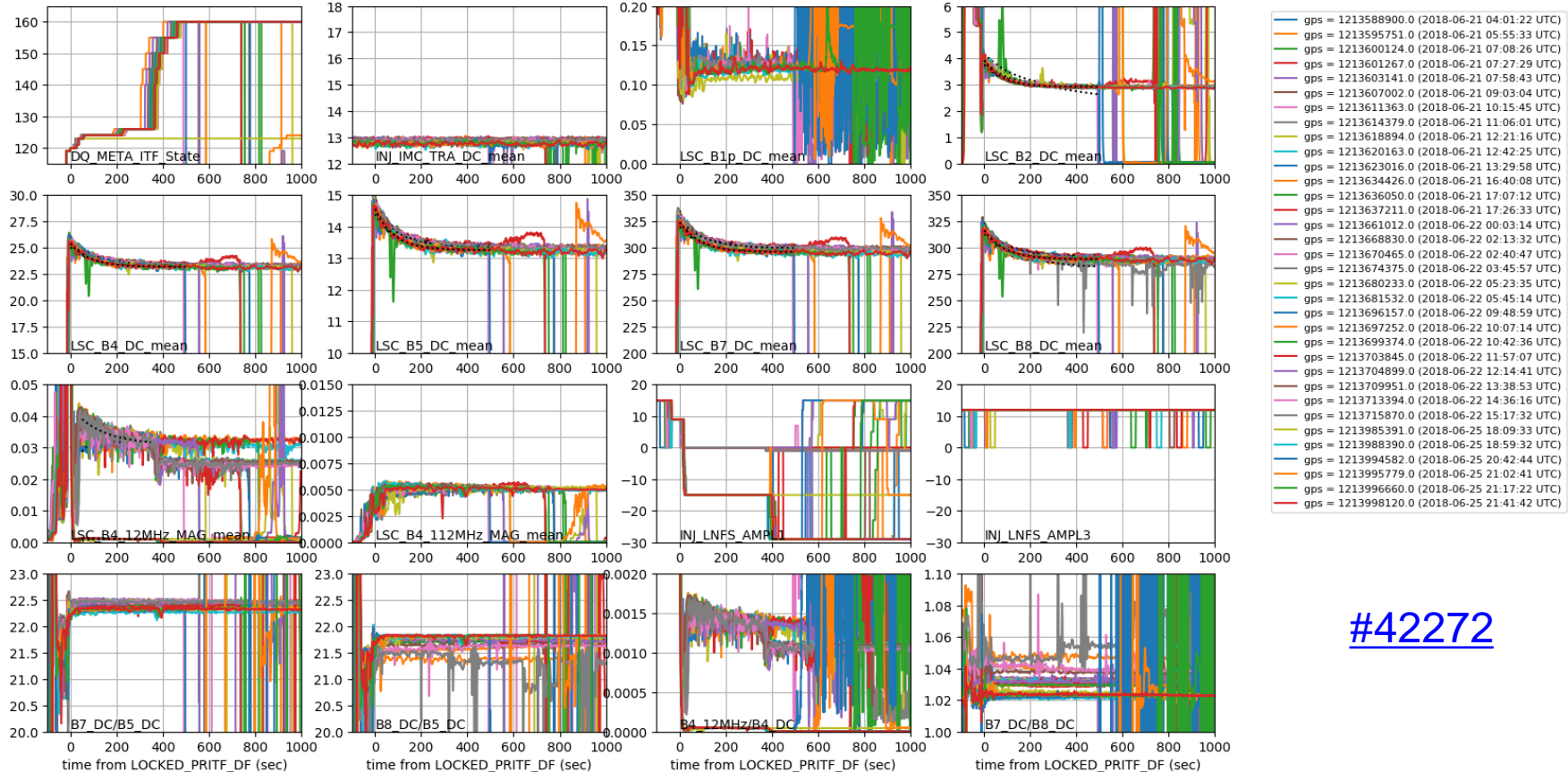
# Contents

- **Advanced Virgo status**
- **Selected commissioning topics**
  - thermal compensation (TCS)
  - line noises and line tracking
  - violin mode damping
  - graphical user interfaces
  - **power drop issue**
- **Working environment**
- **Summary**

# Power Drops at Dark Fringe

- After reaching dark fringe, **arm transmission drops quickly** @ ~100 sec, and B1p increases quickly ([#42058](#))
- Can be explained by **power recycling gain decay**, but the reason is **unclear**

from gps = 1213574418.0 (2018-06-21 00:00:00 UTC) for 432000 sec



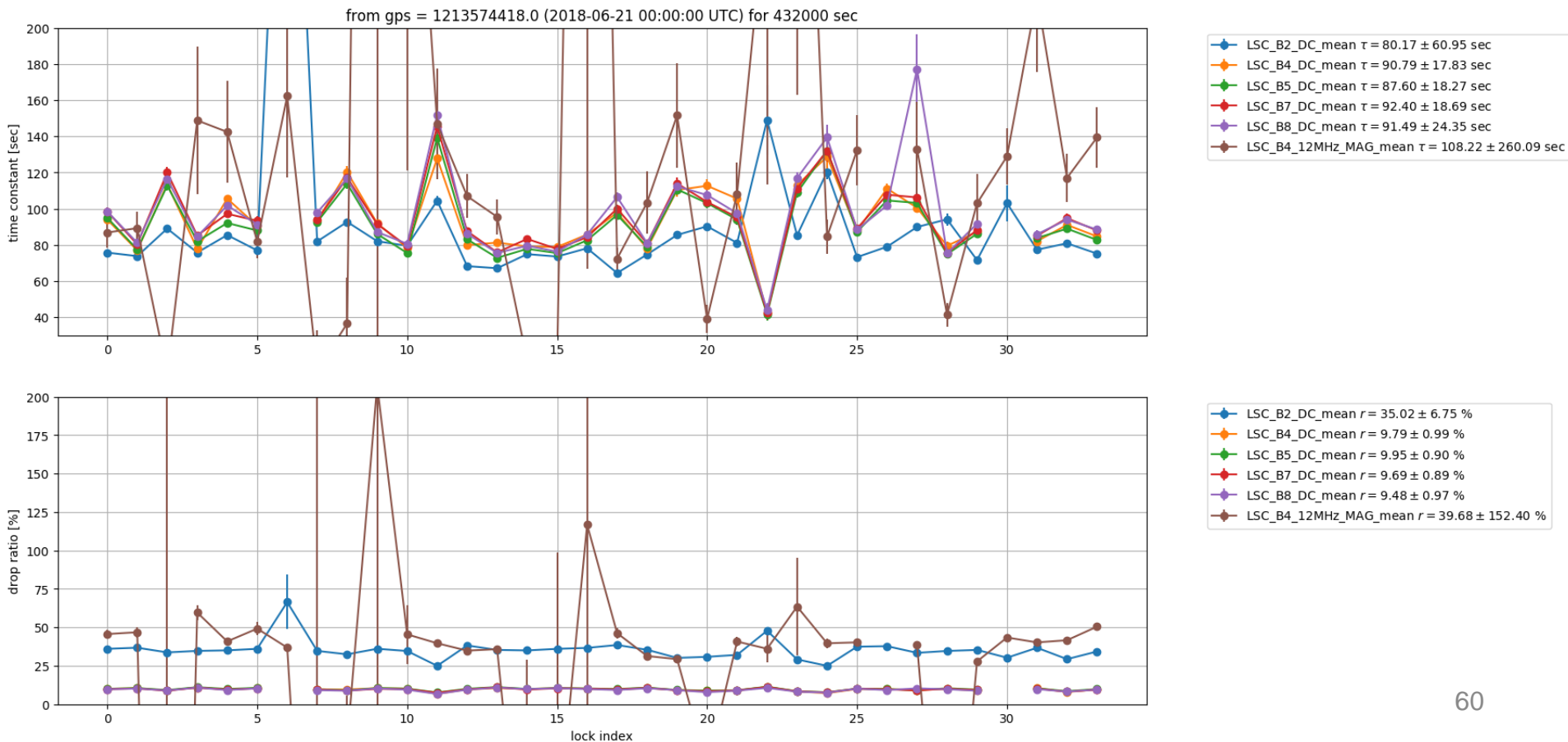
[#42272](#)



# Time Constant

- Time constant of the decay changed after power increase
  - ~90 sec in June 21 @ 13W
  - ~50 sec in July 23 @ 25W

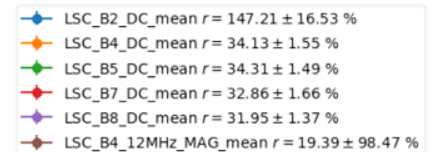
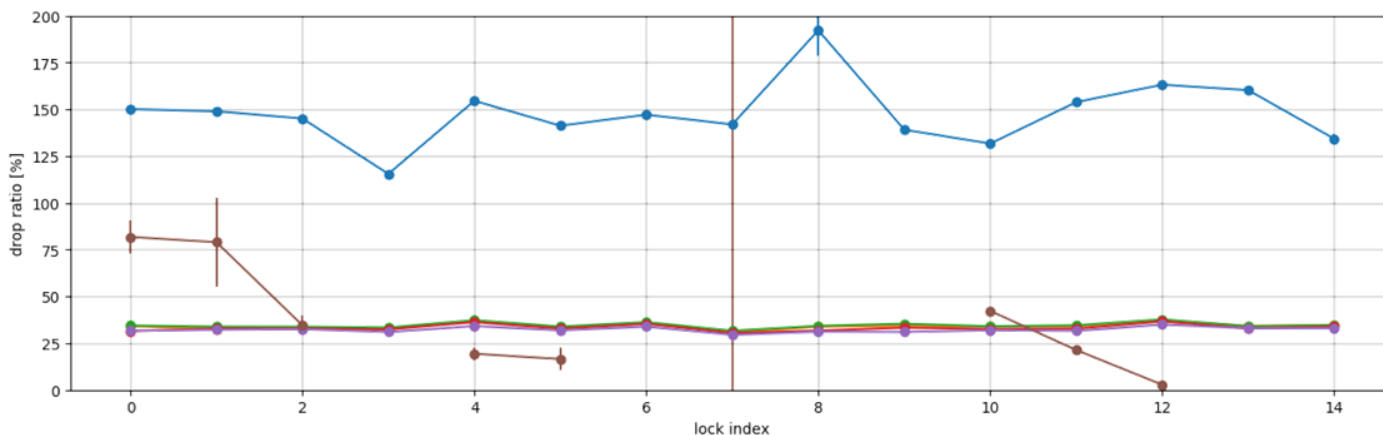
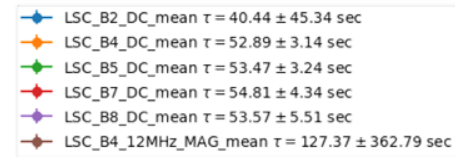
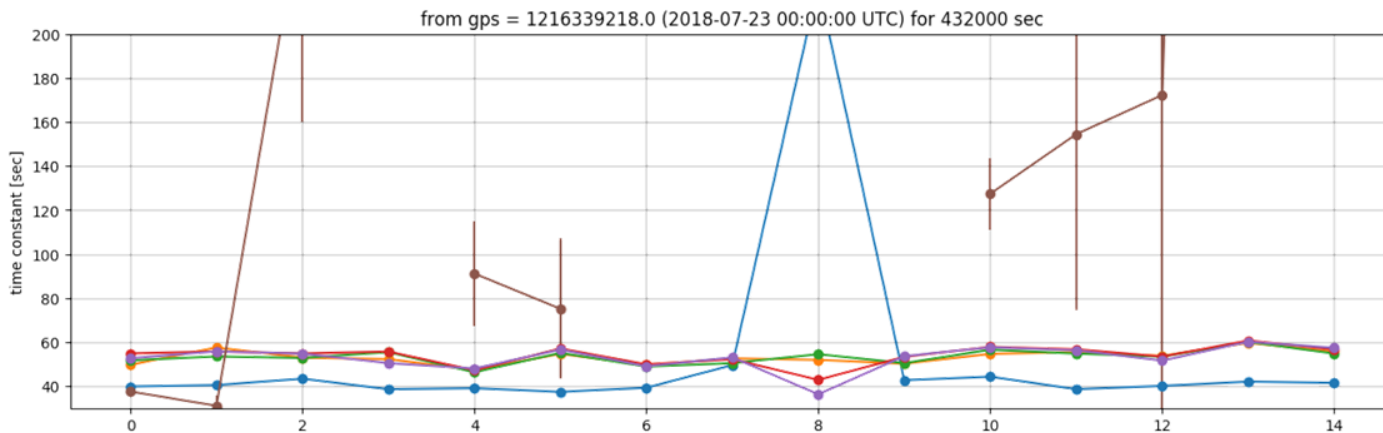
[#42272](#)



# Time Constant

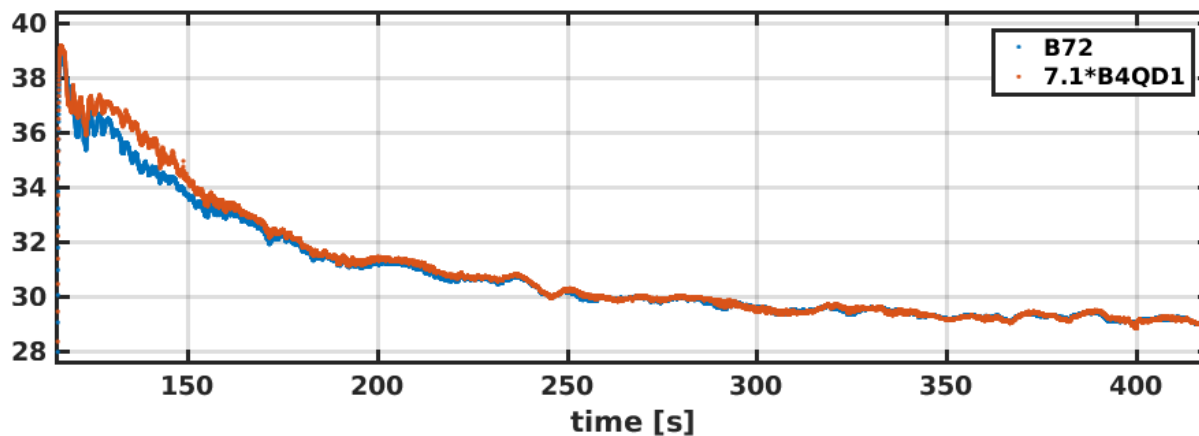
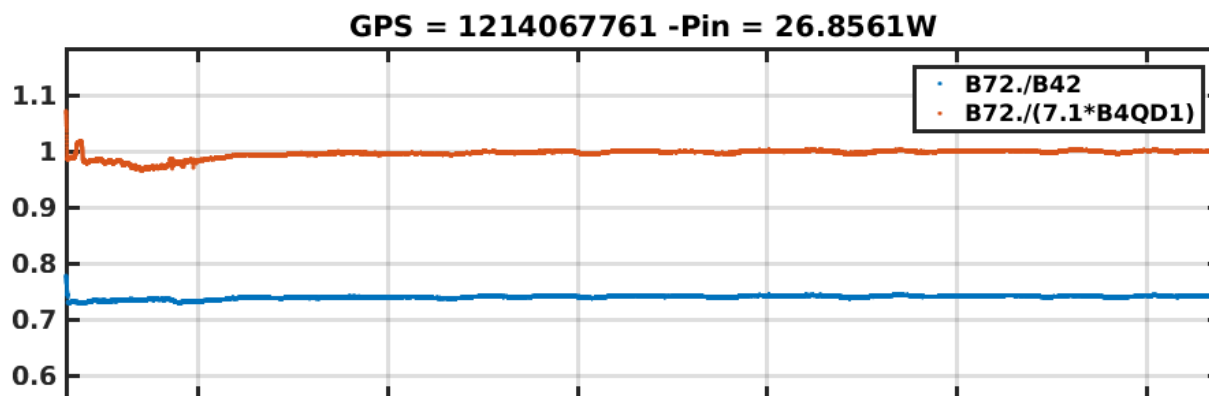
- Time constant of the decay changed after power increase
  - ~90 sec in June 21 @ 13W
  - ~50 sec in July 23 @ 25W

[#42272](#)



# Comparison between PD & QPD

- Photodiodes and quadrants have similar time constants
- Probably not due to photodiode heating



[#42240](#)

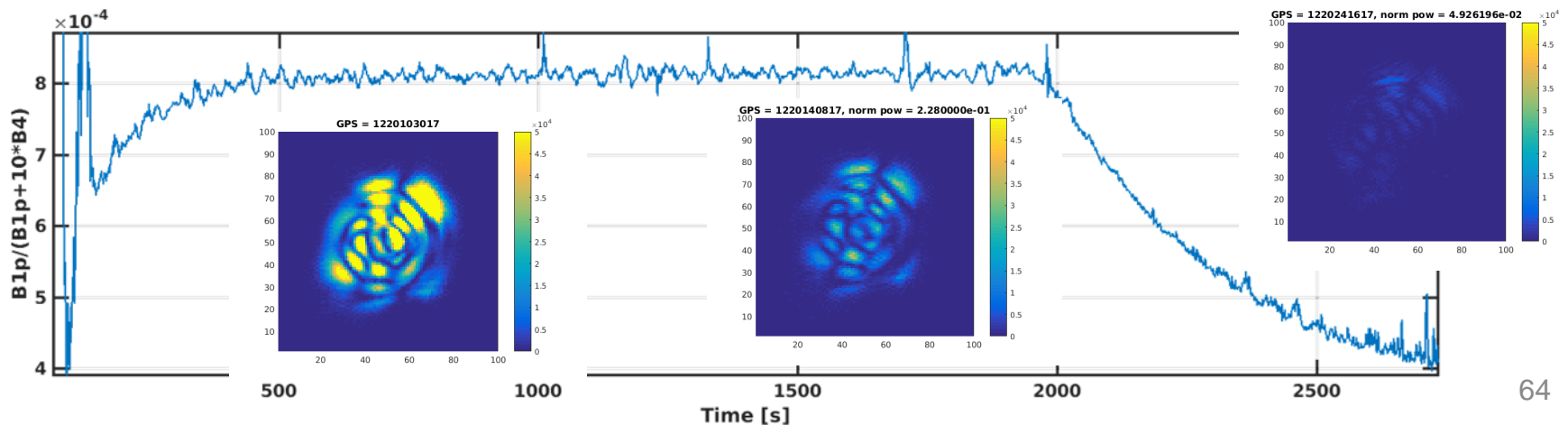
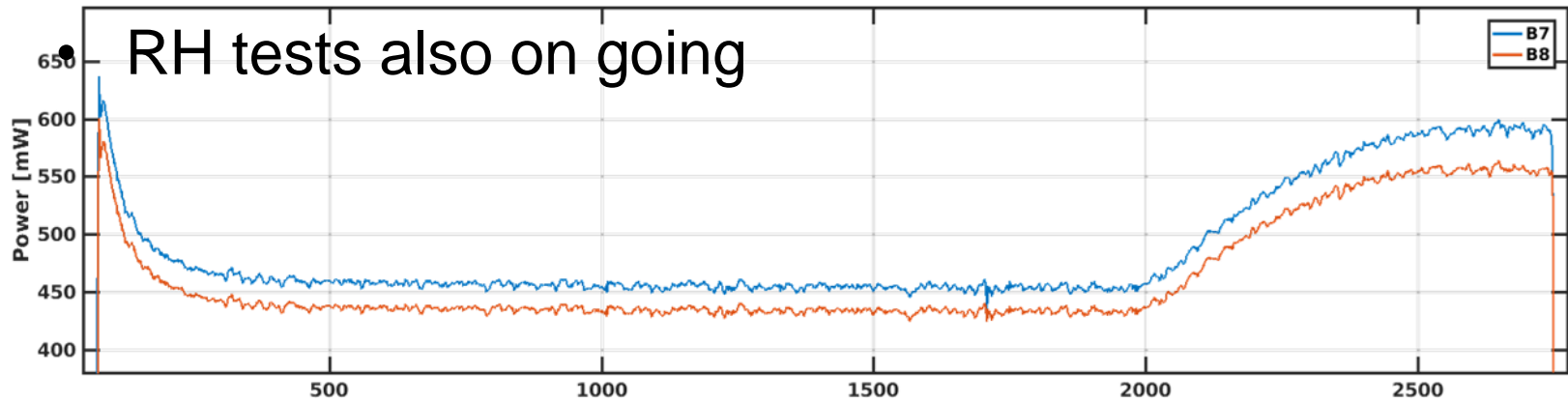
# Mystery

- Too quick compared with
  - thermal lensing of input mirrors ( $\sim 1000$  sec)
  - bulk heating of input mirrors ( $\sim$  few days)
- Point absorber??
- Power recycling gain comparison between 6 MHz and 56 MHz might indicate something
  - 6 MHz is more sensitive to alignment and aberration



# Recent News from This Week

- **Changing beam spot on ETM recovers** the power drop of arm transmission and increase of B1p, but B1p mode content stays the same ([#42639](#))



# Contents

- **Advanced Virgo status**
- **Selected commissioning topics**
- **Working environment**
  - **commissioning coordination**
  - **control room**
  - **random impressions**
- **Summary**

# Commissioning Coordination

- **Shift** based (08:00-16:00, 15:00-23:00, 23:00-07:00)  
also shift for remote
- **Wiki** for coordinating the shift
- **Daily meeting** 15:30- (~0.5 h)  
between morning and afternoon shifts  
active remote participation (~15 at site, ~8 from remote)
- **Weekly commissioning meeting** on Tue 11:00- (~1.5 h)  
during maintenance
- **Weekly coordinator** (from remote)  
(assigned based on the number of authors in the institute)
- Well organized, very subsystem-oriented.
  - You have to coordinate before you work (e.g. You cannot just turn on XXX yourself. You have to convince XXX team to turn it on by themselves).

# Shift Table Example

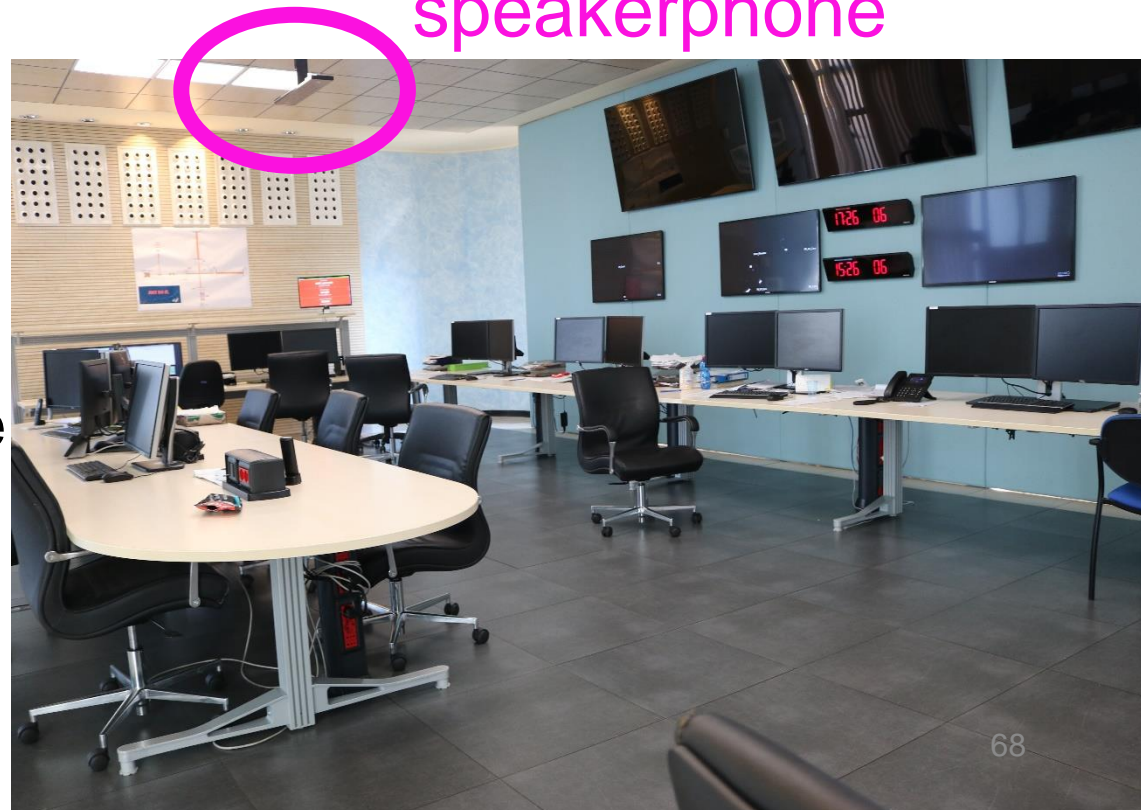
- You have to propose ahead to get a shift
- I think it is good that you can plan ahead and prepare for it

June 18 – 24

MON	TUE	WED	THU	FRI	SAT	SUN
ISC – LSC 7Hz damping - tuning BS alignment loop in full bandwidth (Ruggi, ...)	Maintenance Relocking (Casanueva late morning?, Chiummo)	ISC - tuning ITF alignment loops in full bandwidth (Ruggi, Chiummo, Mantovani)	ISC – Casanueva, Mantovani, Cohen: CMRF and related	ENV - tapping tests B1 pipe, 50Hz magnetic noise in sensitive locations around TMs and TMs electronics (Fiori, Paoletti, Boschi, Hardwick, Michimura) (until lunch-time)		
ISC – Casanueva, Masserot: SSFS hand-off to B2	ISC – Bersanetti, Michimura, Hardwick, Ruggi: violin modes active damping	ISC – Bersanetti Carbognani, Swinkels: FmodErr	ISC – tuning ITF alignment loops in full bandwidth: (Ruggi, Allocca, Chiummo)	DET - noise injections on benches and/or OMC (half shift after lunch time to 17h00)  ISC – Carbognani Casanueva: tuning phases automation		
			Automation – Carbognani: cleaning metatron			

# Control Room

- Nice system to talk to people off-site and people working at experiment area
- Many measurements done off-site (NoiseBudget, cavity scan, transfer functions etc.)
  - people in the control room help (and vice versa)
- Remote desktop (ThinLink) to control machines to work
  - same working condition for on-site and off-site



speakerphone



# Random Impressions

- Many people are at the site, but basically only two who can take care of ISC
- Many site people also do not understand what's happening in the control room now
  - Maybe partially because some work is done with people remote
- Many people responsible for the hardware is not at the site
- Sectionalism
  - Pros: clear who is responsible  
(and people actually take responsibility)
  - Cons: we cannot touch their system on our own  
sometimes their data is not open  
mixed-up system (e.g. Acl and DSP)
- We can learn many things from Virgo

# Contents

- **Advanced Virgo status**
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  - **Lessons Learned**
  - **Visiting Around**
  - **Summary**



# Lessons Learned

- Understand the current configuration as much as possible before changing the configuration (but do not waste too much time on intermediate configurations)
  - May be do not take intermediate steps unless necessary
  - Recovering the interferometer after some changes is always time consuming
- Take your time to increase the number of people who can do what you do
  - It's not good if you are the only person who can do some specific work (e.g. locking, suspension tuning etc.)
- You can detect gravitational waves even if you don't follow LIGO designs
  - Be creative and be brave to design your own scheme
- DetChar tools (VIM, line tracker etc.) are extremely useful



Cinque Terre



Portovenere



Lucca



Livorno



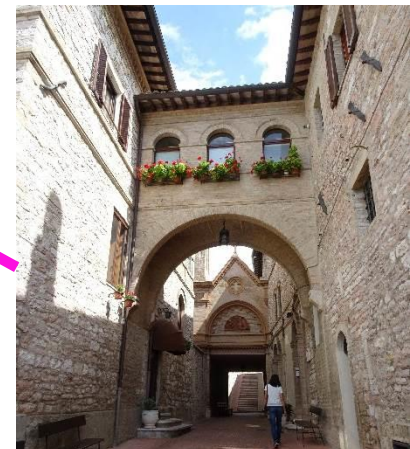
# Visiting Around



Venezia



Firenze



Assisi



Rome



# Summary

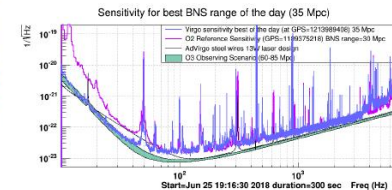
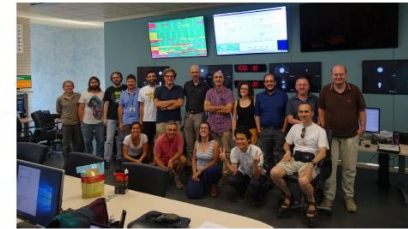
- Commissioning is fun

Site Report

## Advanced Virgo: the best summer destination for commissioners

Yuta Michimura

I am now visiting Virgo site for 2 months from June 5. Advanced Virgo commissioning is now in a critical phase to reach the O3 sensitivity goal of 60-85 Mpc in the binary neutron star (BNS) range. The installation of a full monolithic suspension was done in March, and on June 25 we reached the best best BNS range up to now of 35 Mpc. The sensitivity improvement is mainly due to frequency noise subtraction at high frequencies and a tuning of the suspension controls. Amazingly, the sensitivity below 40 Hz is already compliant with the O3 goal! On June 26, we doubled the input power from 13 W to 25 W, to reduce shot noise at high frequencies. After the power increase, we were suffering from new issues. On July 23, we finally recovered the full lock of the interferometer, but the sensitivity is still at around 15 Mpc. Work towards more stable locking and investigations on some new noise sources is ongoing with great efforts.



The best sensitivity was achieved on June 25 (plot from Virgo Interferometer Monitor, VIM).



Virgo site has a superb canteen, which offers a different menu every day.

Buonissimo!



Beautiful sunflowers along the west arm.

I have been to LIGO for several times, but this is my first visit to Virgo. The working environment at Virgo is very nice: friendly people, beautiful weather, excellent facilities, and delicious food. I realized that working environment is crucial for physics research. Interferometer commissioning is fun, but it can be even more fun with a better environment.

From my perspective, the KAGRA collaboration resembles more to Virgo than LIGO in which subgroups are led by different institutes. Virgo is suffering from the lack of manpower especially for the interferometer commissioning at the site, and therefore participation of remote people is very active compared with KAGRA and LIGO. I think many issues Virgo is now facing will be our own issues in the near future. I hope my experience from the Virgo visit will be useful not only for KAGRA commissioning, but also for a better collaboration in KAGRA.

This visit is supported by the Young Researchers International Deployment Program at the University of Tokyo. Visiting abroad for this long period not be possible without this program and the support from my colleagues in the Ando group and KAGRA. Thank you very much.