

16-12-2016



Status of GP2

Umberto Giacomelli



Istituto Nazionale
Fisica Nucleare
Sezione di Pisa

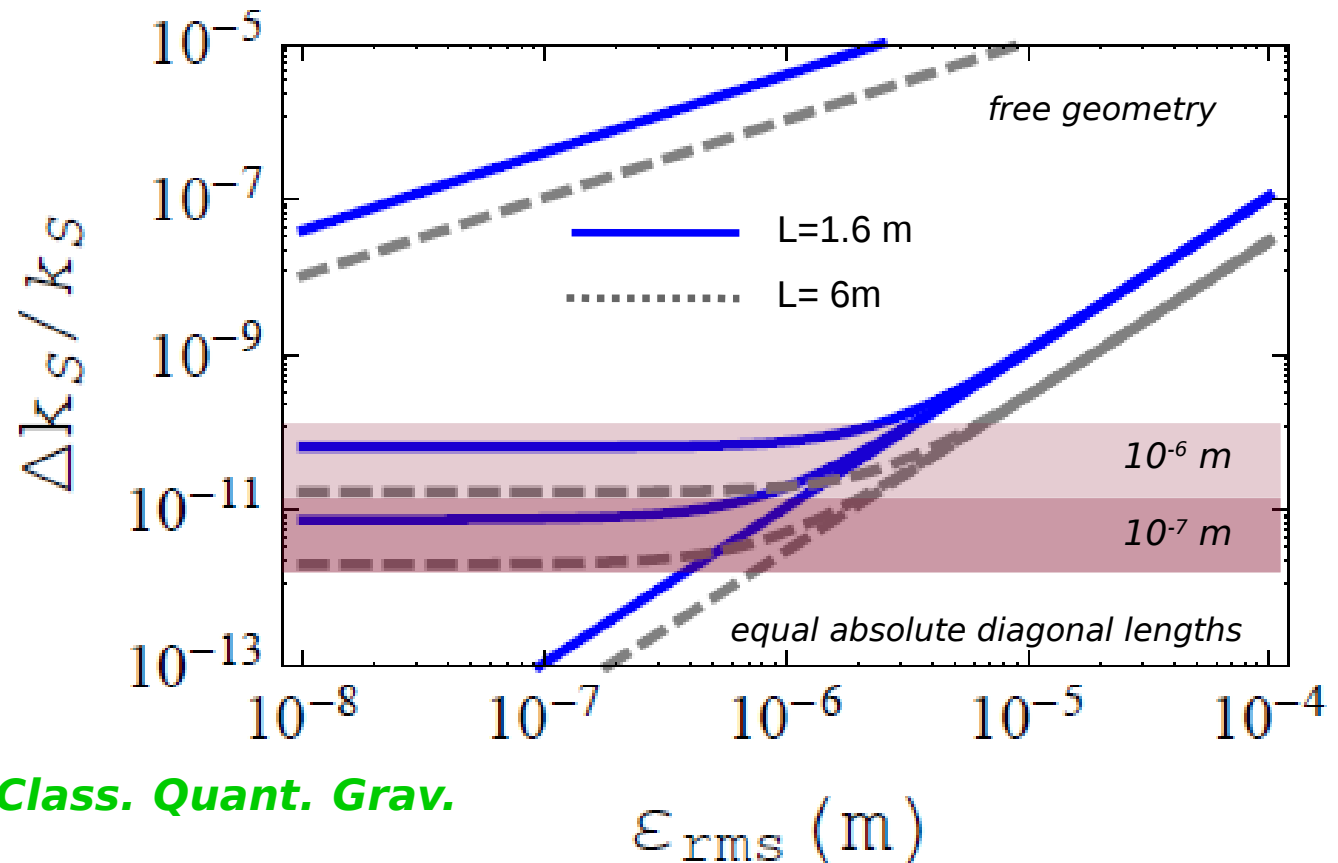
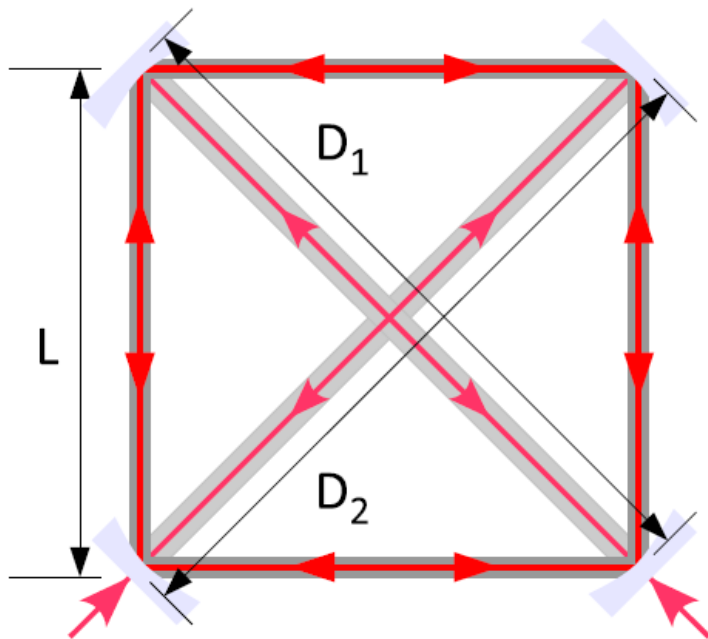
GINGER meeting @ DEI, 16-12-2016 Padova

Geometry control via interferometry

Geometry control strategy

'Perfect rigidity' can be obtained by locking internal degrees of freedom:

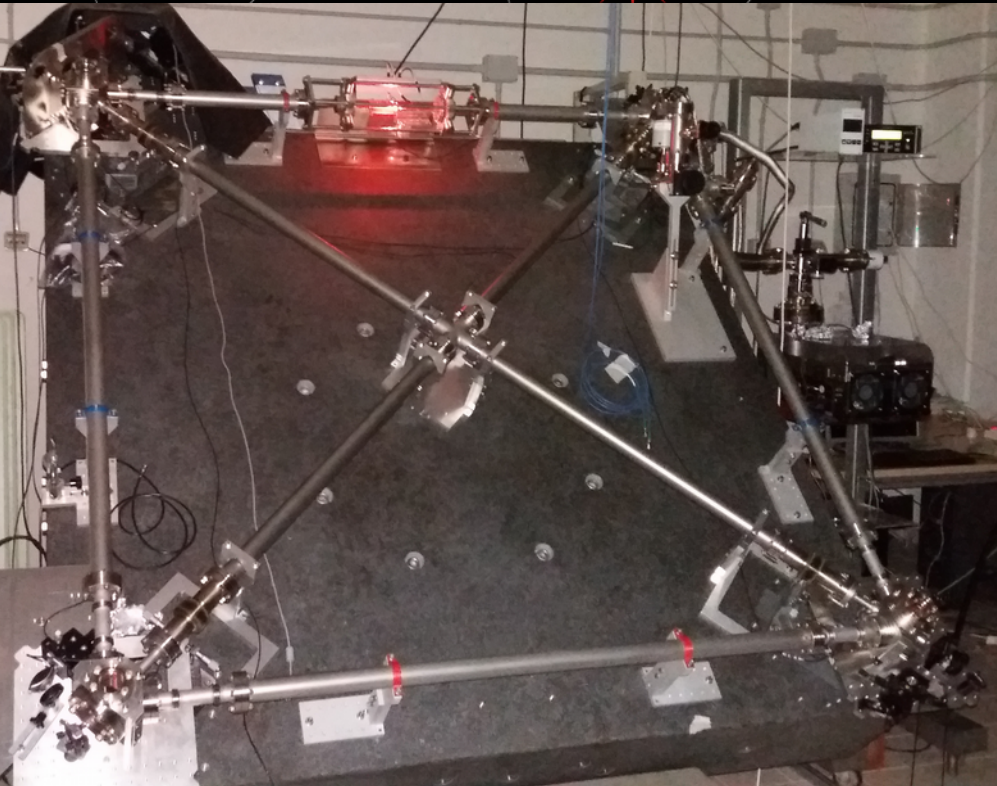
2 diagonals + cavity perimeter



R. Santagata et al. (2015), *Class. Quant. Grav.*
32, 055013

Strong improvement in the stability is expected!

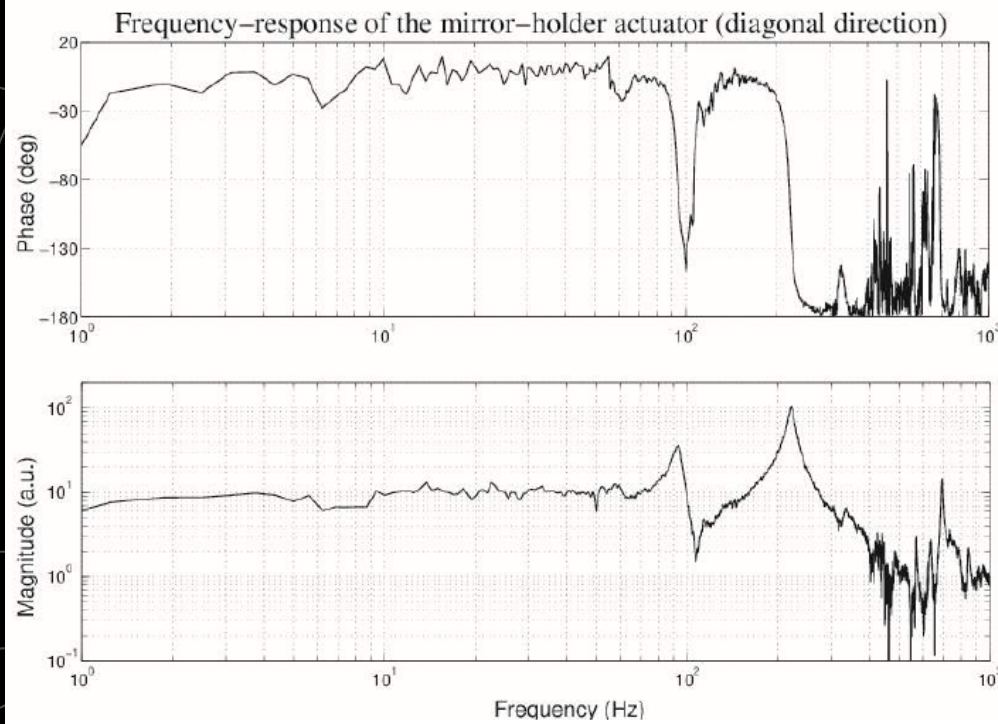
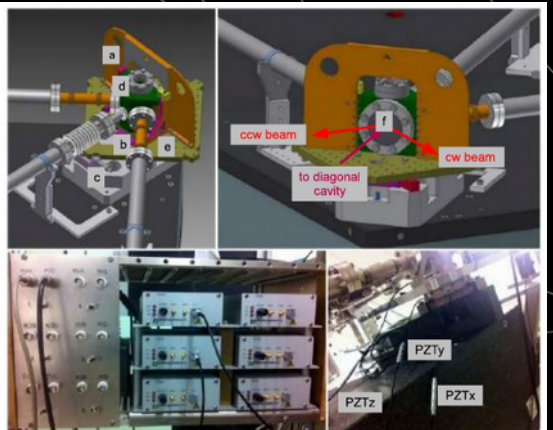
GP2 prototype [INFN Pisa]



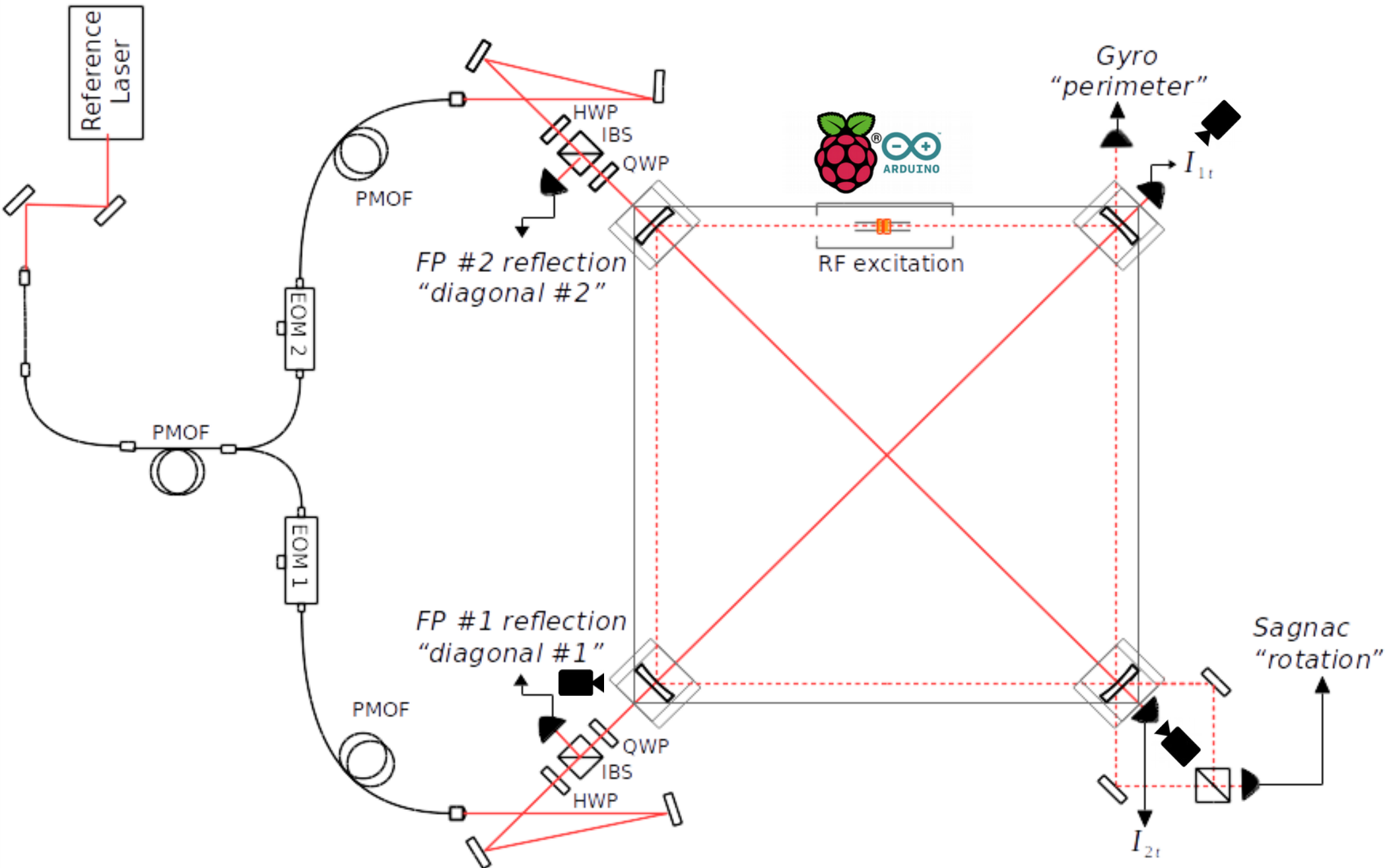
Side length	1.60 m
Ring cavity Q	5×10^{11}
Diagonal cavity Q	10^9
Orientation	Max signal
Sagnac fr. (earth)	184 Hz

Belfi J. et al. Class. Quant. Grav. 31, (2014)

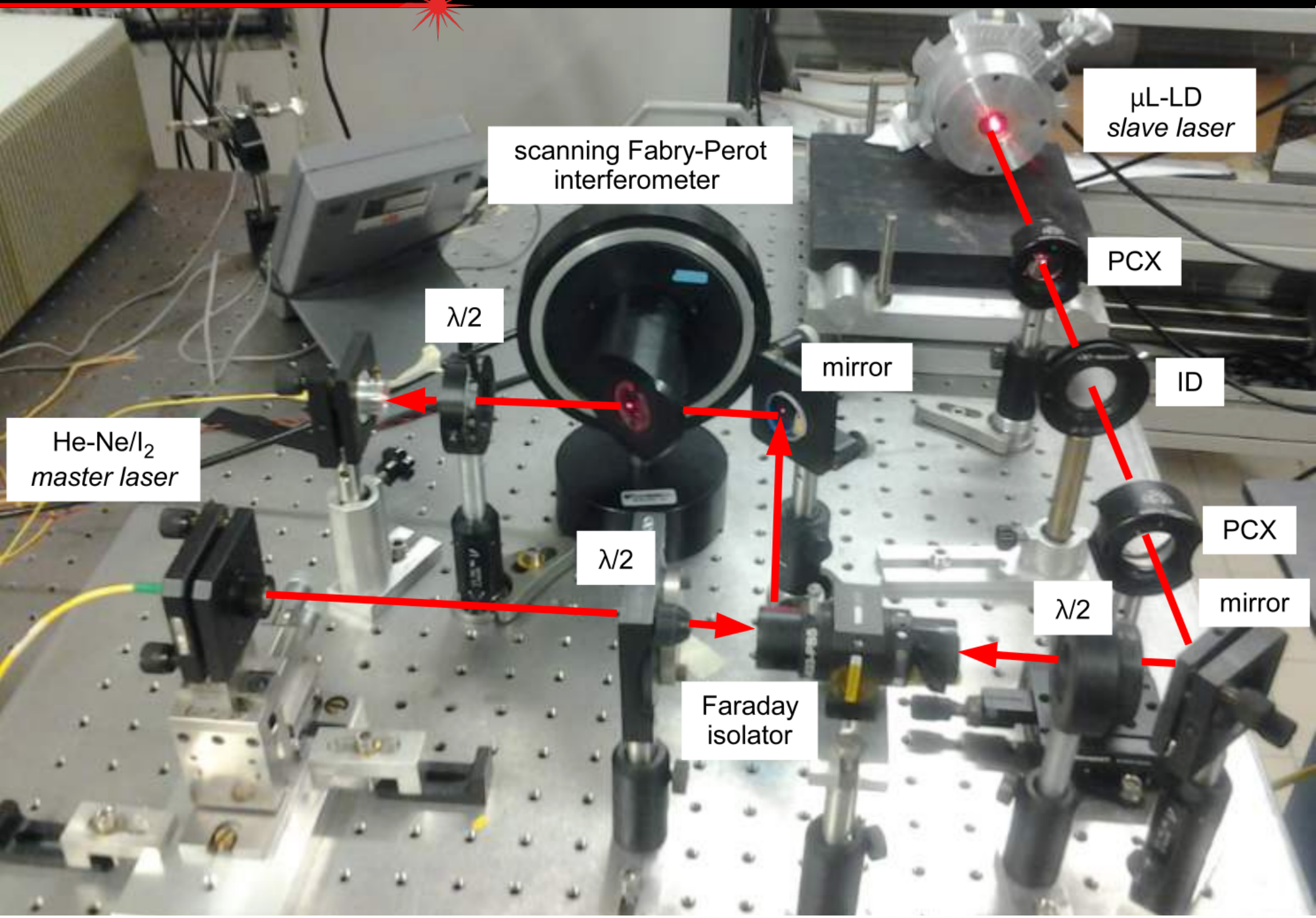
- ▶ #3 1-axial PZT; #1 3-axial PZT
- ▶ dynamic range (measured): 80 μm
- ▶ control bandwidth (measured): few tens of Hz



GP2: Optical



Reference Laser setup



He-Ne/I₂
master laser

scanning Fabry-Perot
interferometer

μL-LD
slave laser

$\lambda/2$

mirror

PCX

ID

$\lambda/2$

PCX

Faraday
isolator

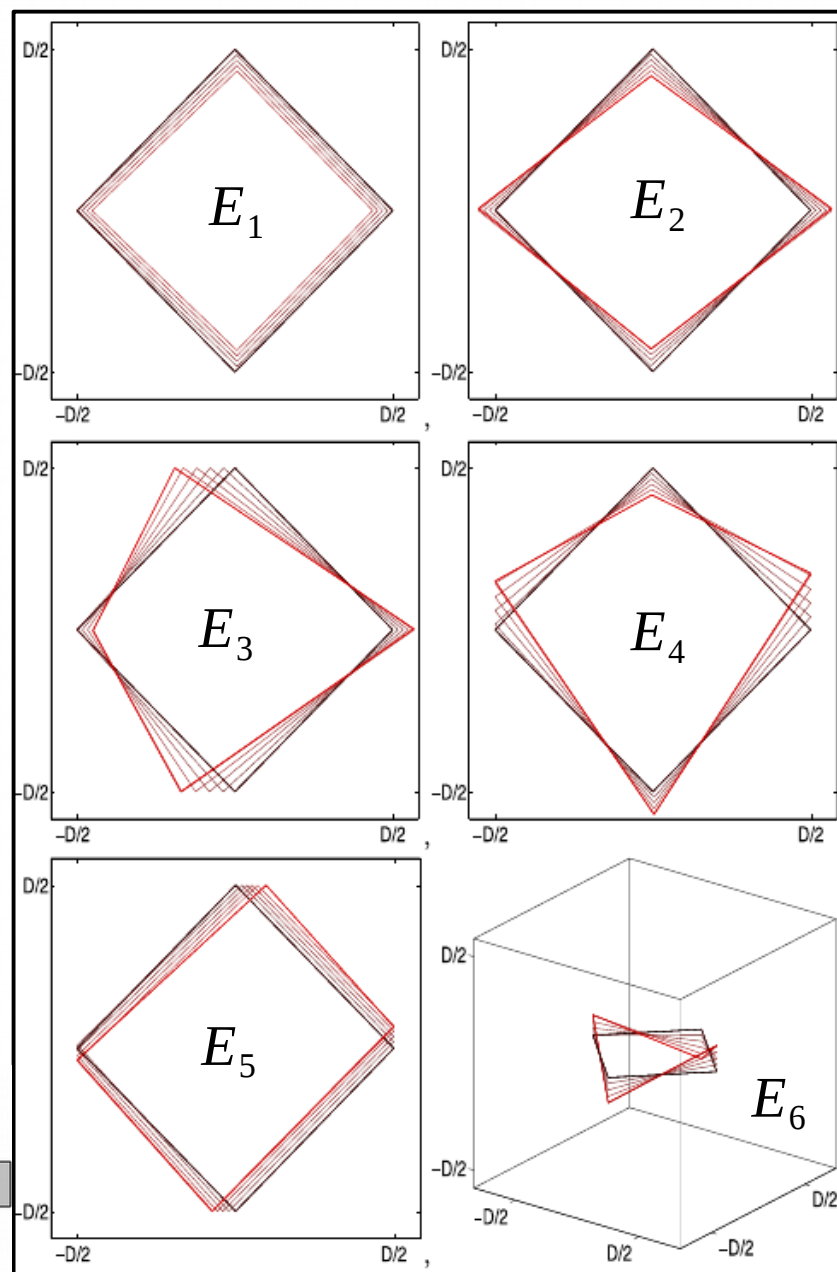
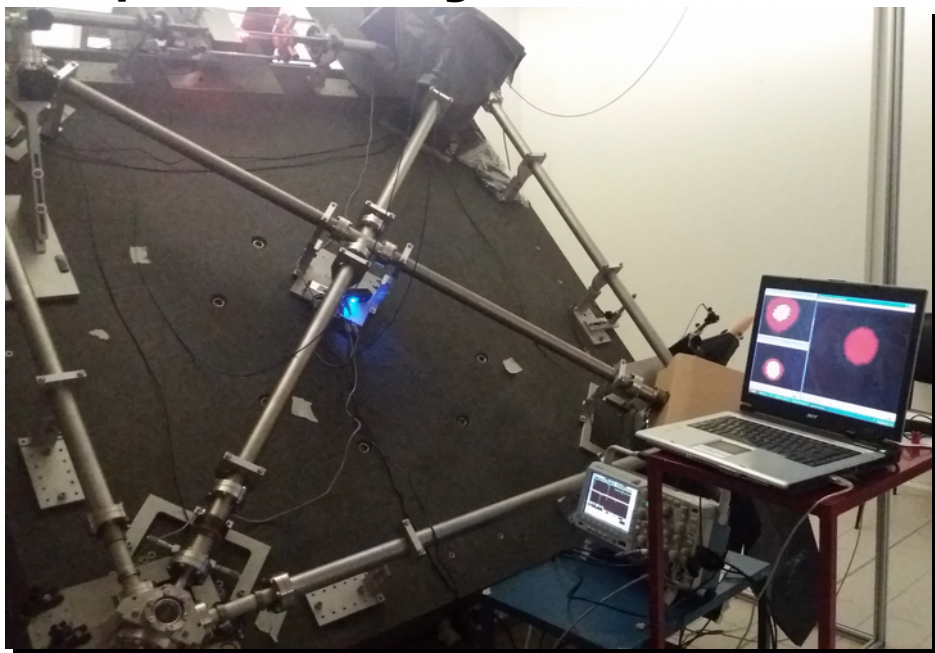
$\lambda/2$

mirror

Multi-resonator stabilization

Control IDEA

- Lock **opposite mirrors distances** (diagonal Fabry-Pérot ITFs) $[(E_1, E_5), E_2]$
- Optimize the **residual 4 quadratic d.o.f.** $[E_3(-), E_4(-), E_5(+), E_6(+)]$ the looking at the **perimeter length**



Reference laser

He-Ne/I₂ laser
primary frequency standard

μ-lens coupled cw diode laser
probe laser

iodine spectral purity

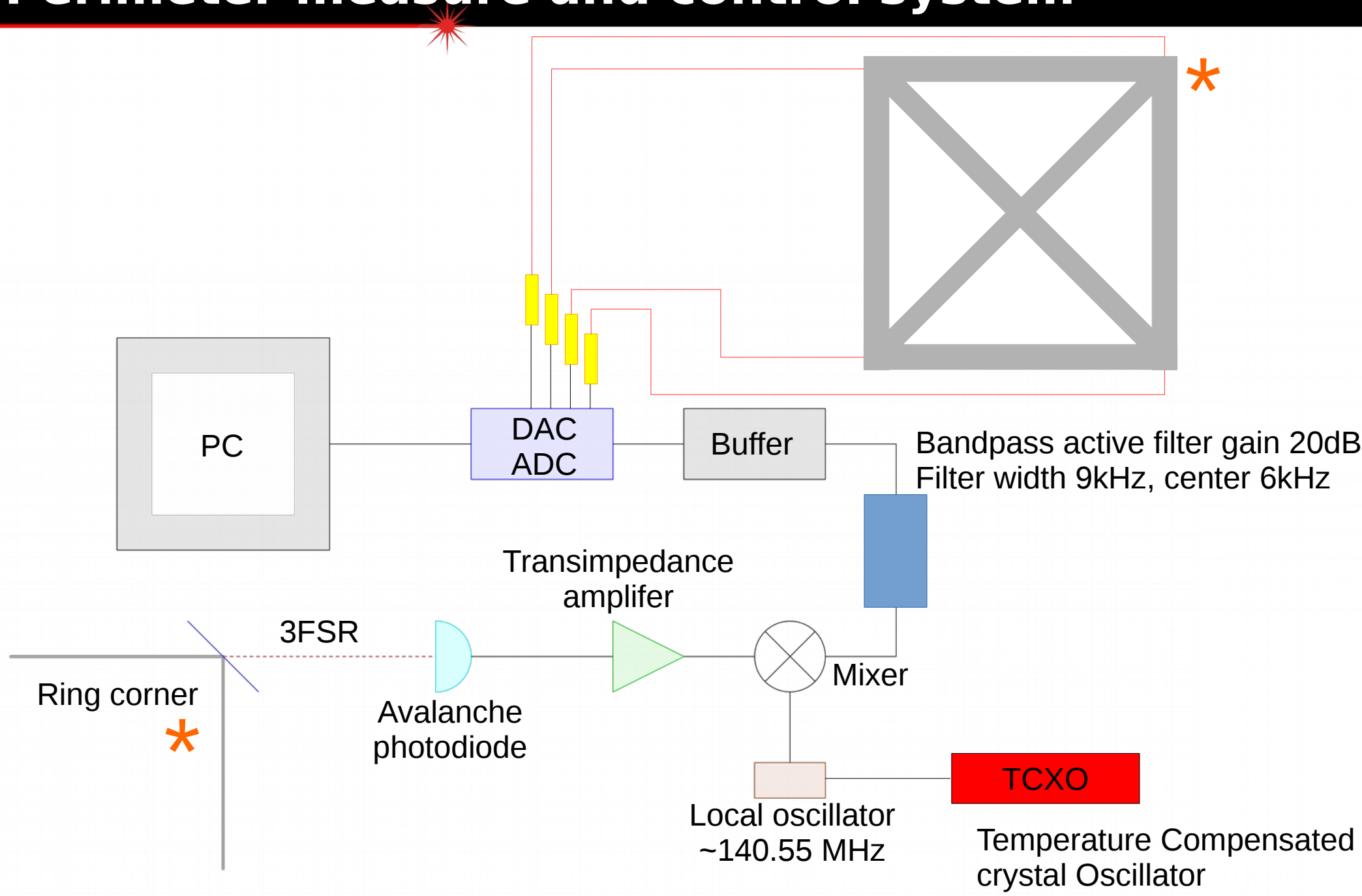


Master laser

Slave laser

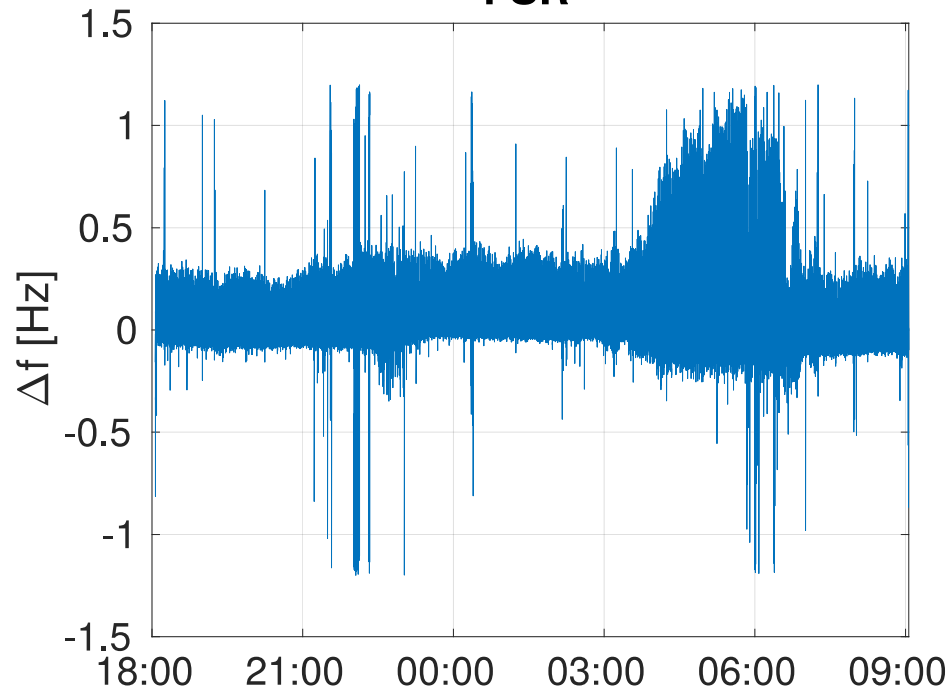
Deformation quasi-normal modes

Perimeter measure and control system

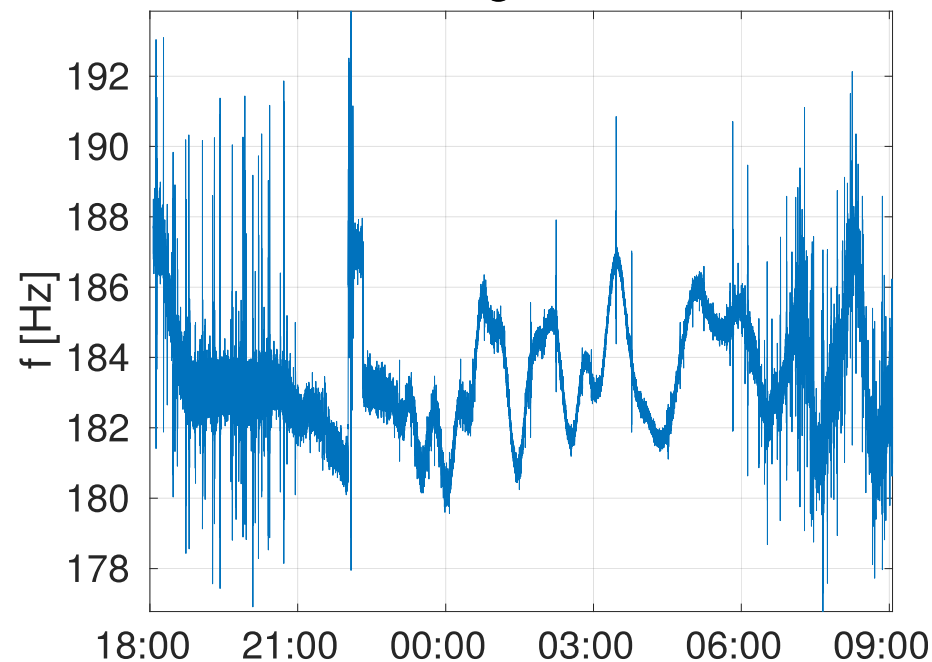


Perimeter stabilization

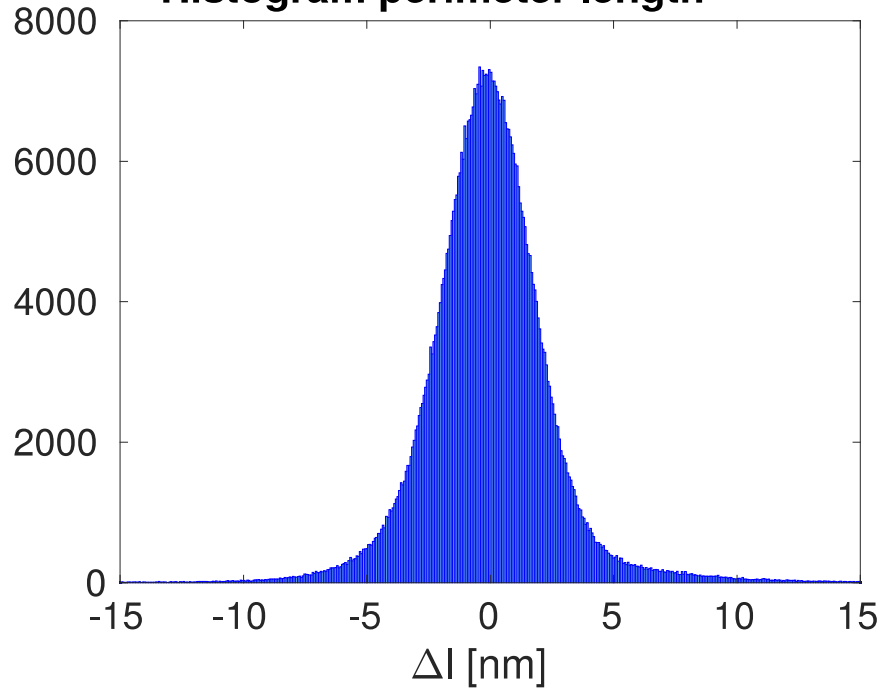
FSR



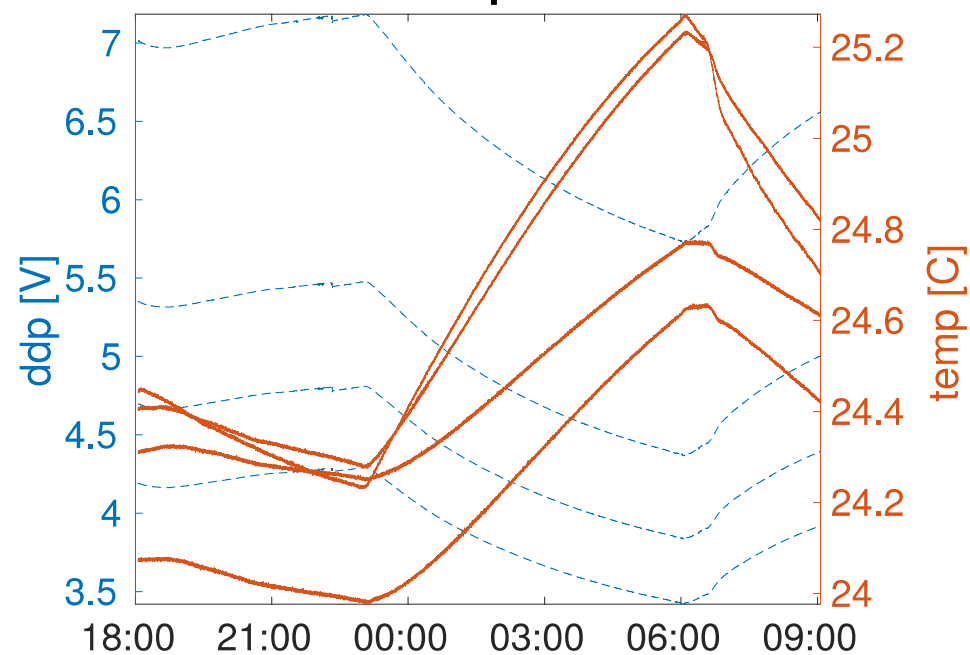
Sagnac



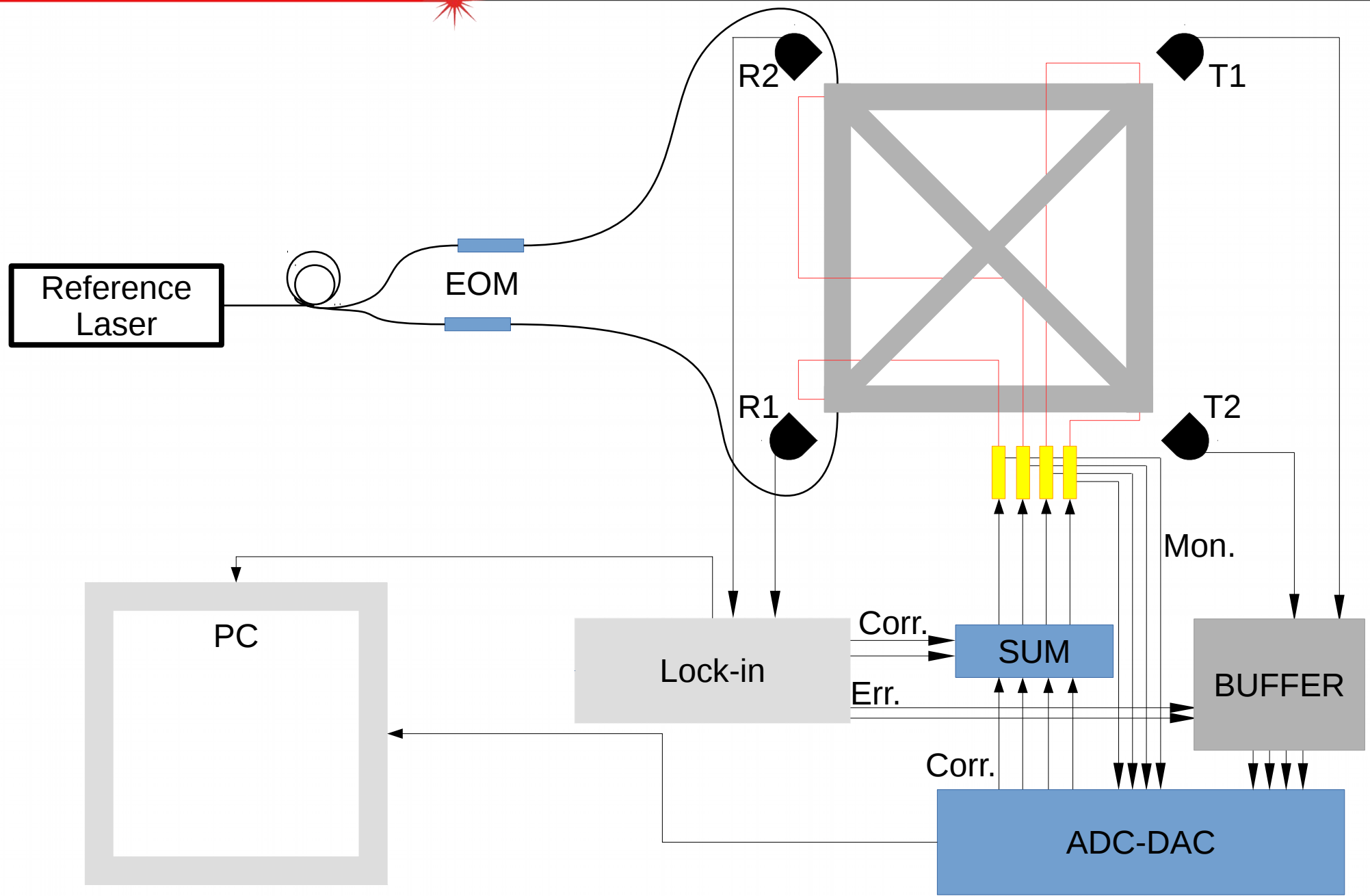
Histogram perimeter length



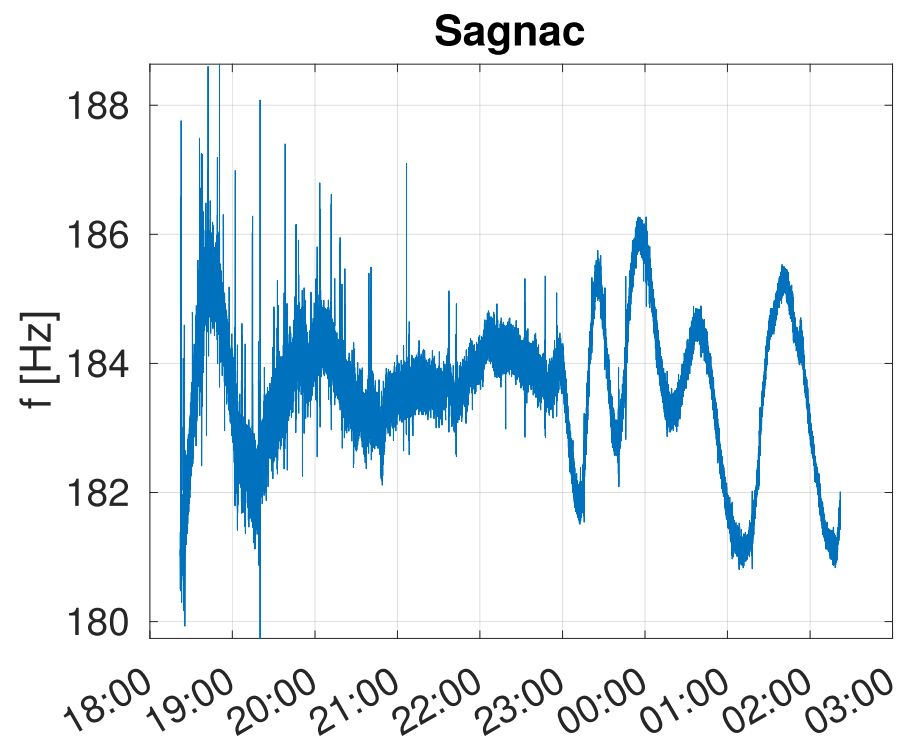
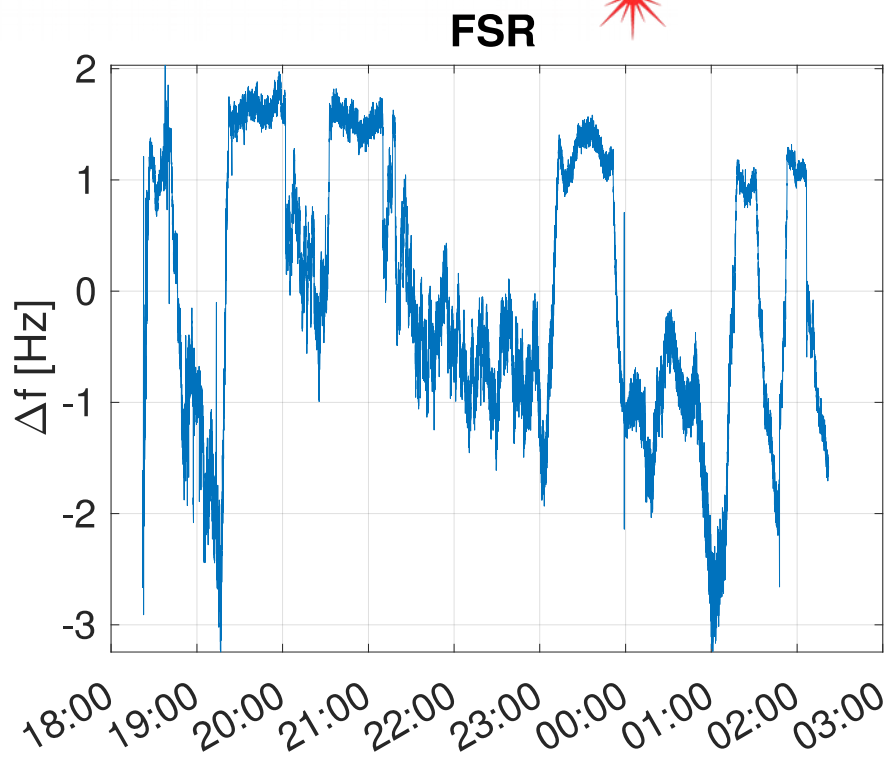
PZT correction and Temperature values



Diagonals measure and control system



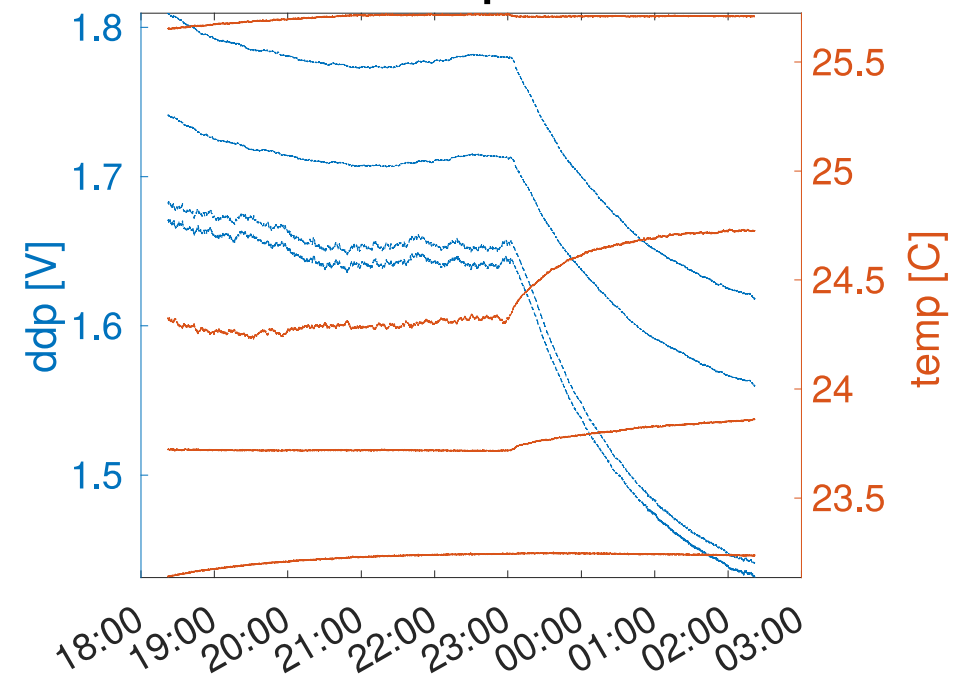
Perimeter and Sagnac while diagonal stabilization



Sample rate acquisition signals 5Hz

Sample rate acquisition temperature 1Hz

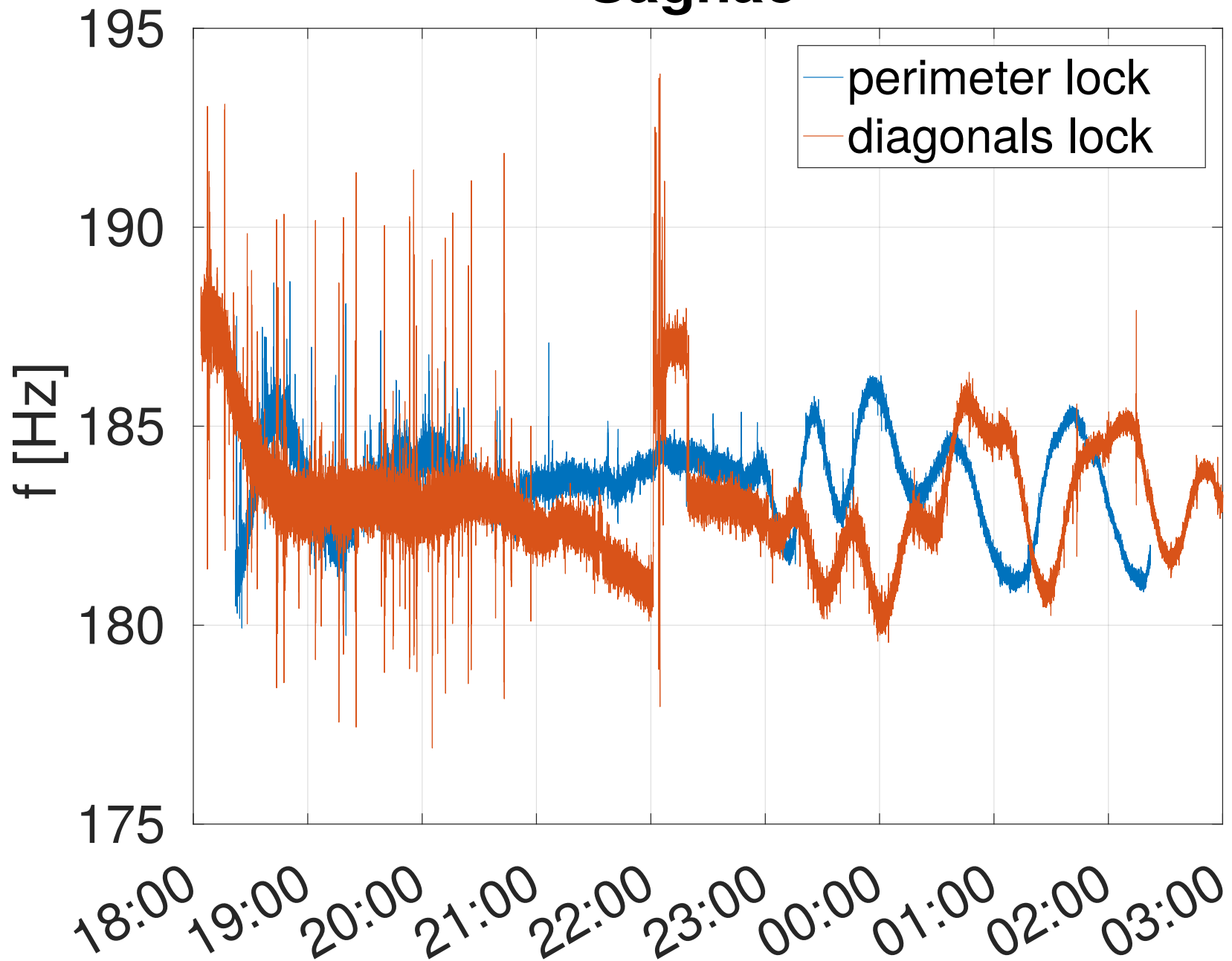
PZT correction and Temperature values



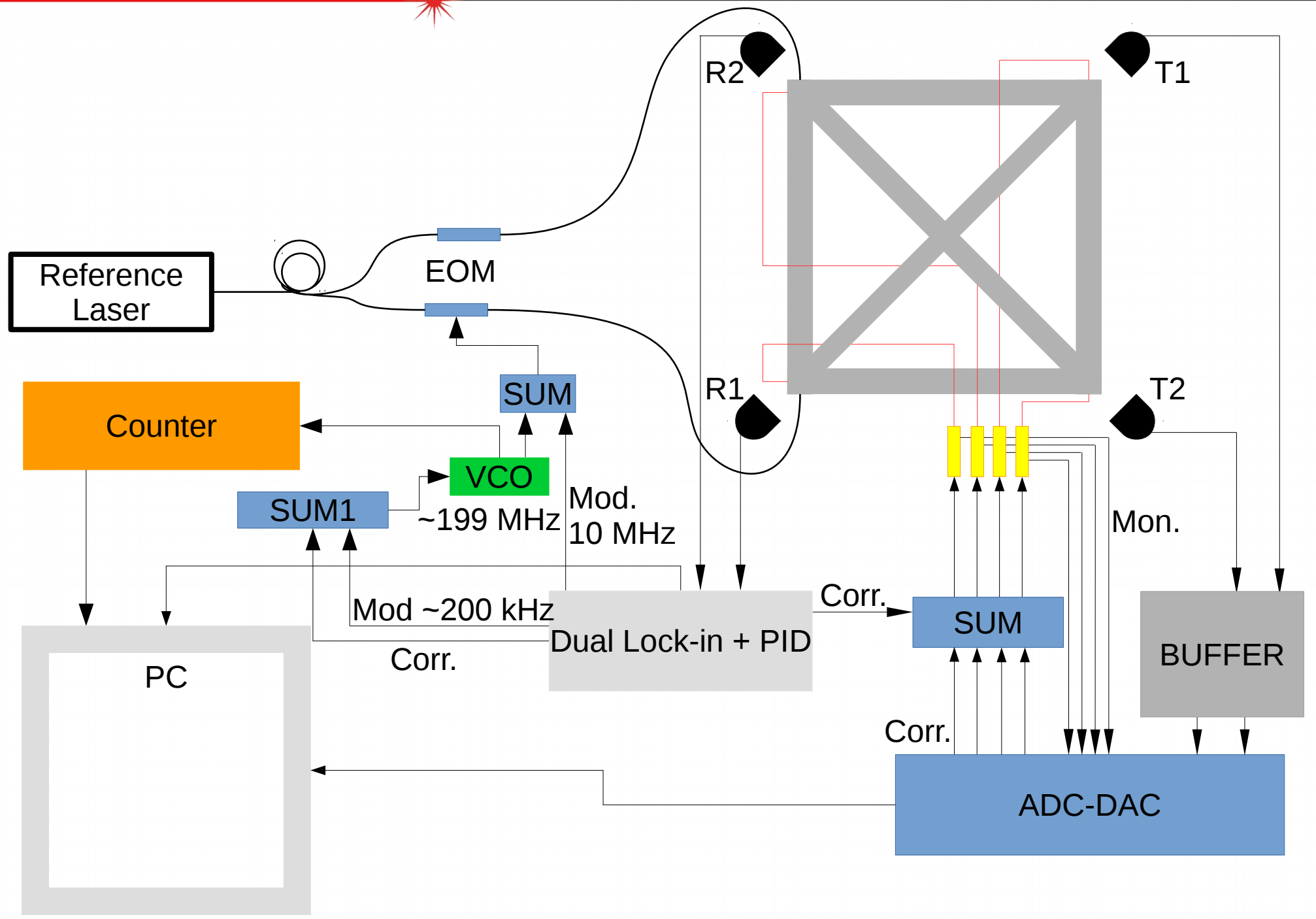
Coparison Sagnac signals with different lock



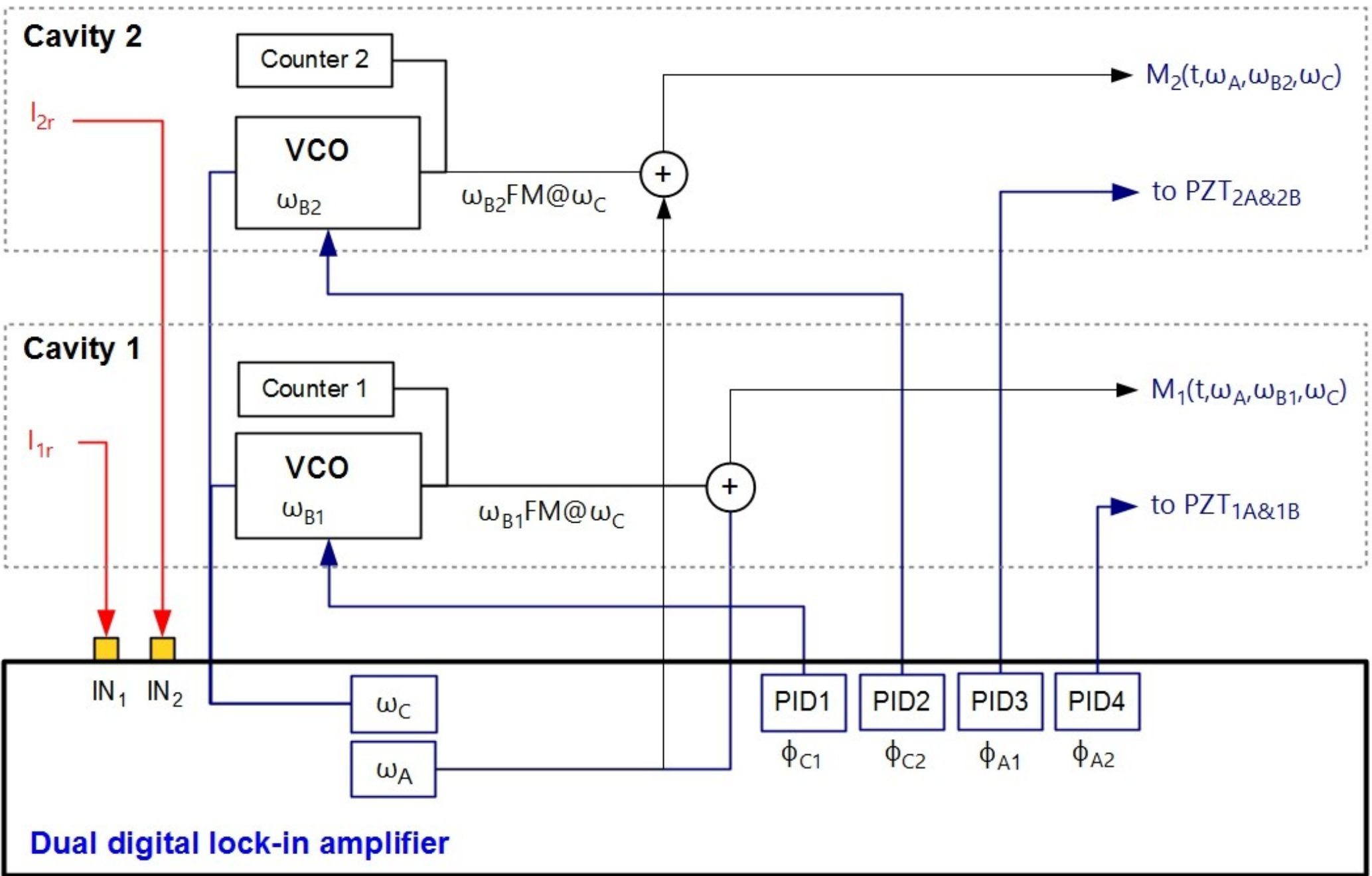
Sagnac



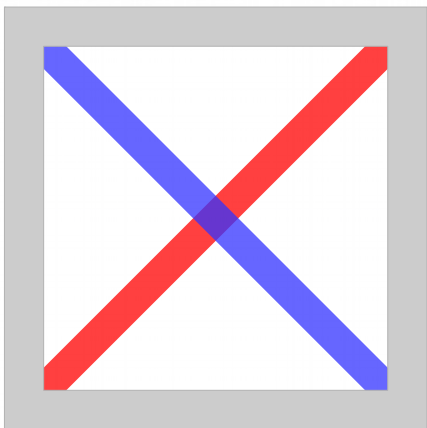
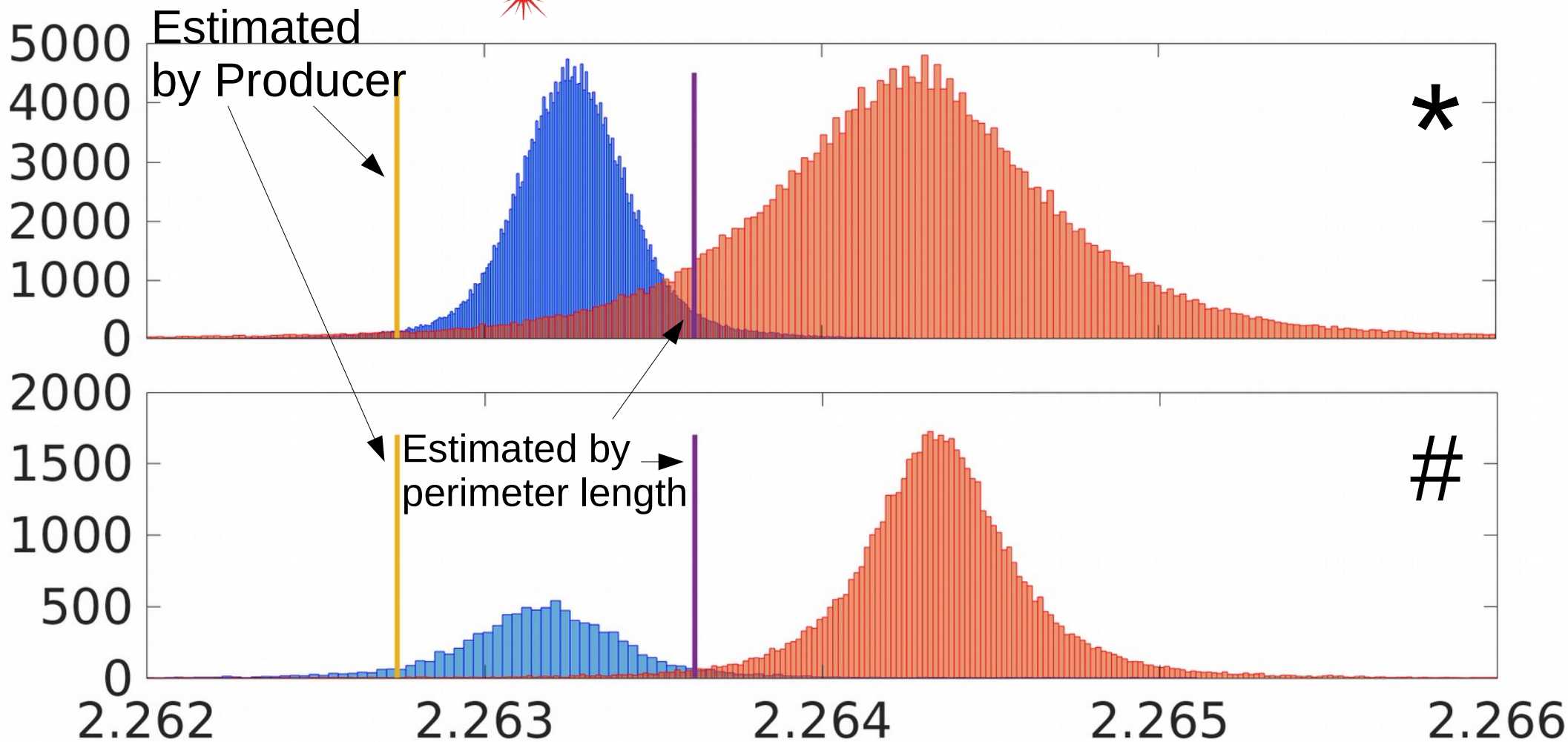
Diagonals absolute length measurement system



Double dual-frequency Lock-in detection



Diagonals absolute measurements



* 2 days of acquisition 1Hz sampling

~3 hours of acquisition 1Hz sampling

Diagonals absolute measurements



	Center	error
*	2.264263	0.000002
#	2.264335	0.000002
*	2.2632585	0.0000007
#	2.263176	0.000004
Diff *	0.0010041	0.000002
Diff #	0.001158	0.000006
displacement	-0.000072	0.000004
displacement	0.000082	0.000005