UNIVERSITY OF TRENTO - Italy

UNIVERSITÀ DEGLI STUDI DI PADOVA

Padova-Trento group report

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on behalf of the Padova-Trento group

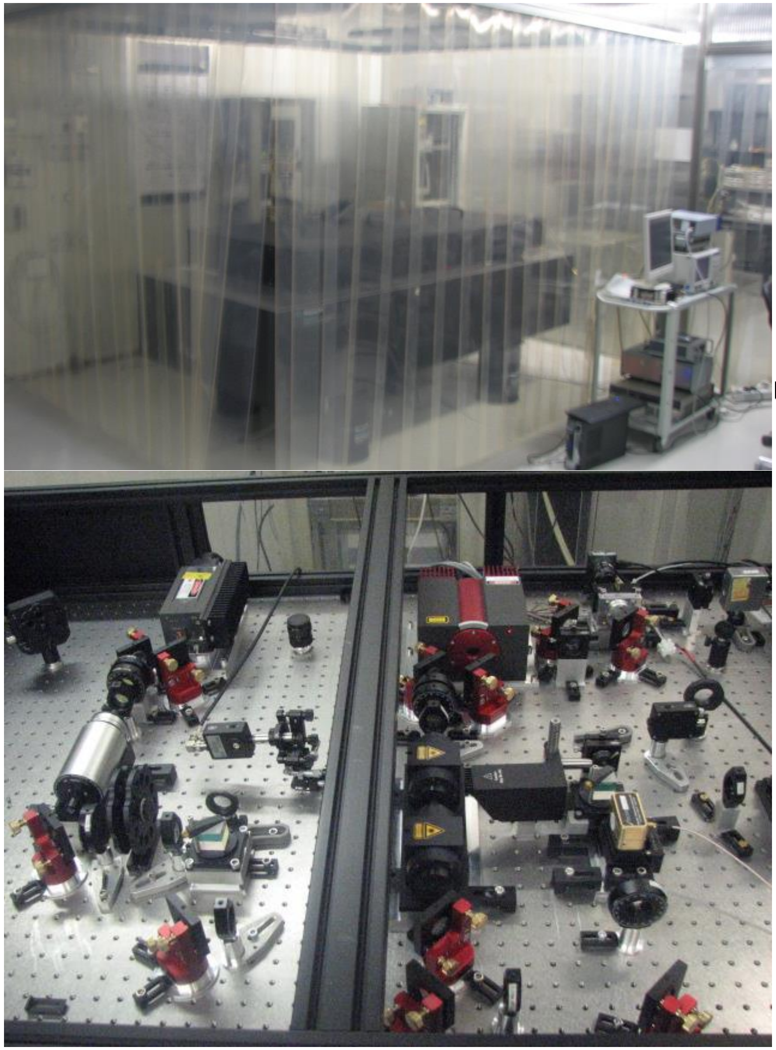
Our to do list was…

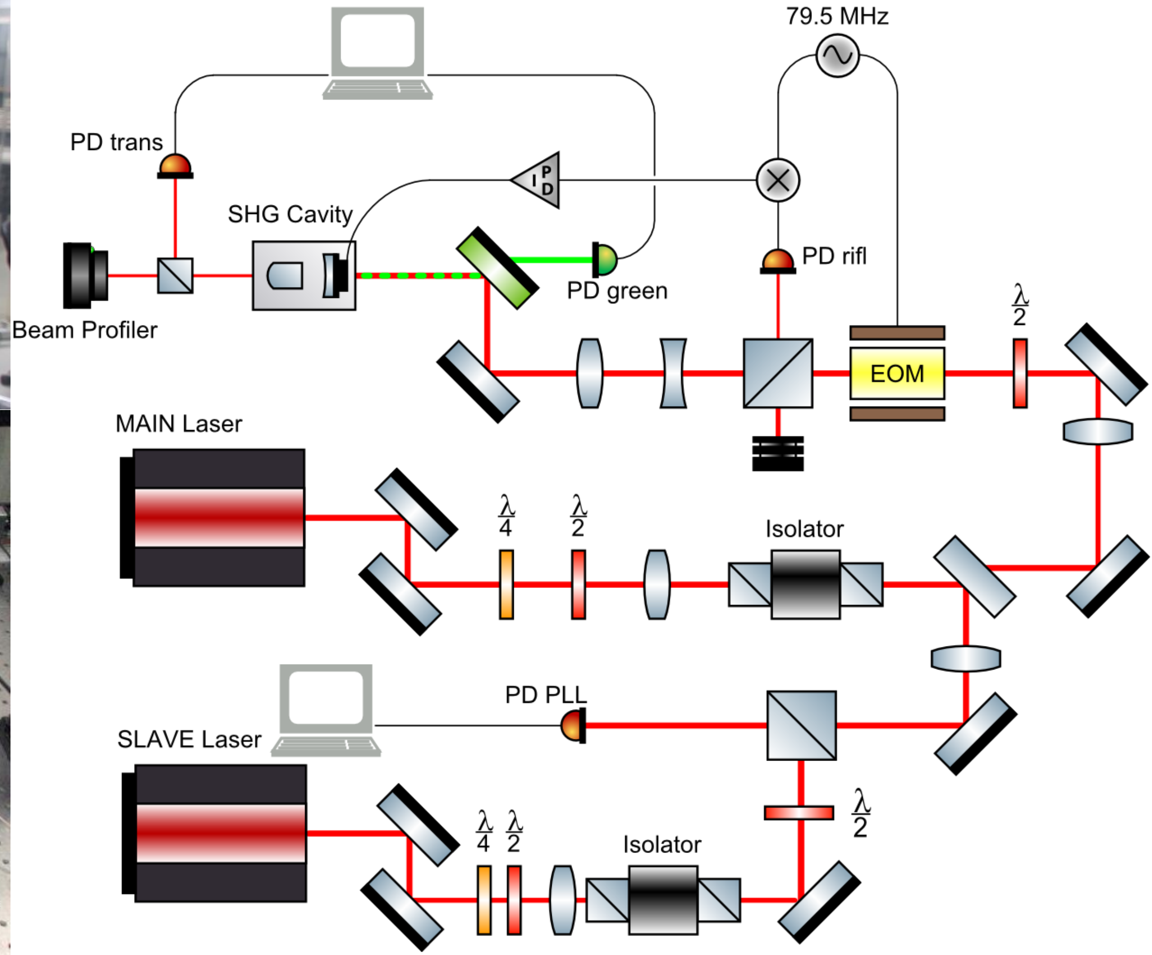
- In cavity second harmonic production
- Phase Locked Loop
- Infrared mode-cleaner
- Low loss Faraday rotator

Summary

- Bench layout @LNL
- Second Harmonic Generator (SHG)
  - Mechanics
  - Thermal control
  - Quasi Phase Matching
  - Digital locking
- Phase Locked Loop (PLL)
- Mode Cleaner (MC)
- Faraday Rotator (FR)

Bench layout



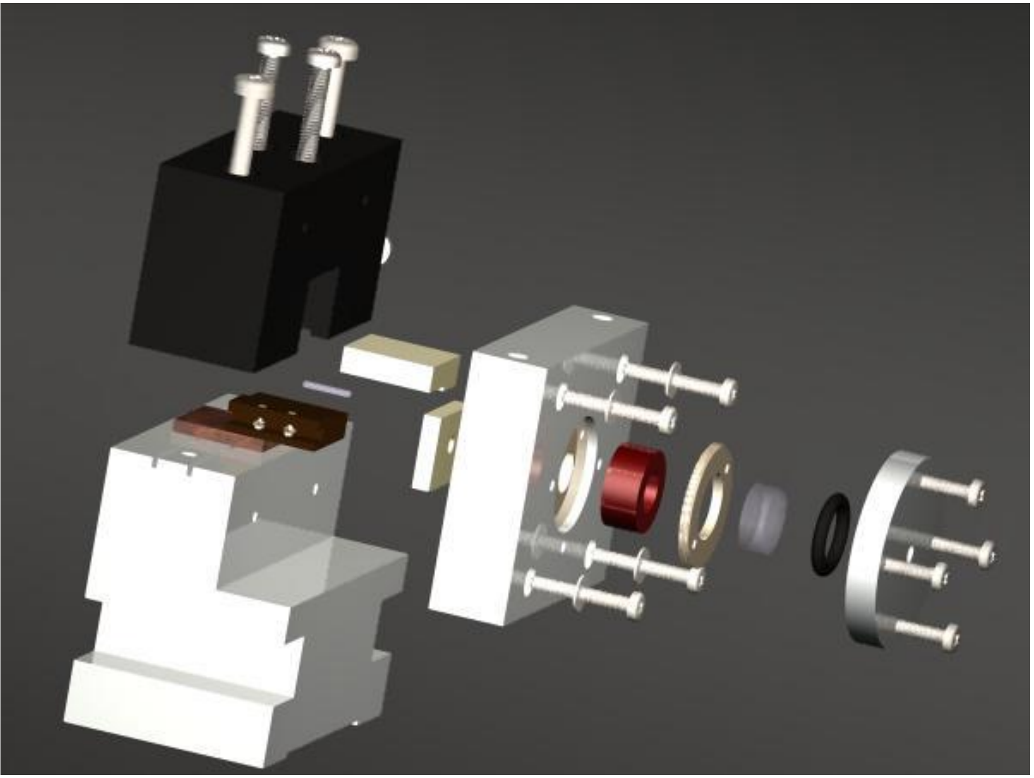


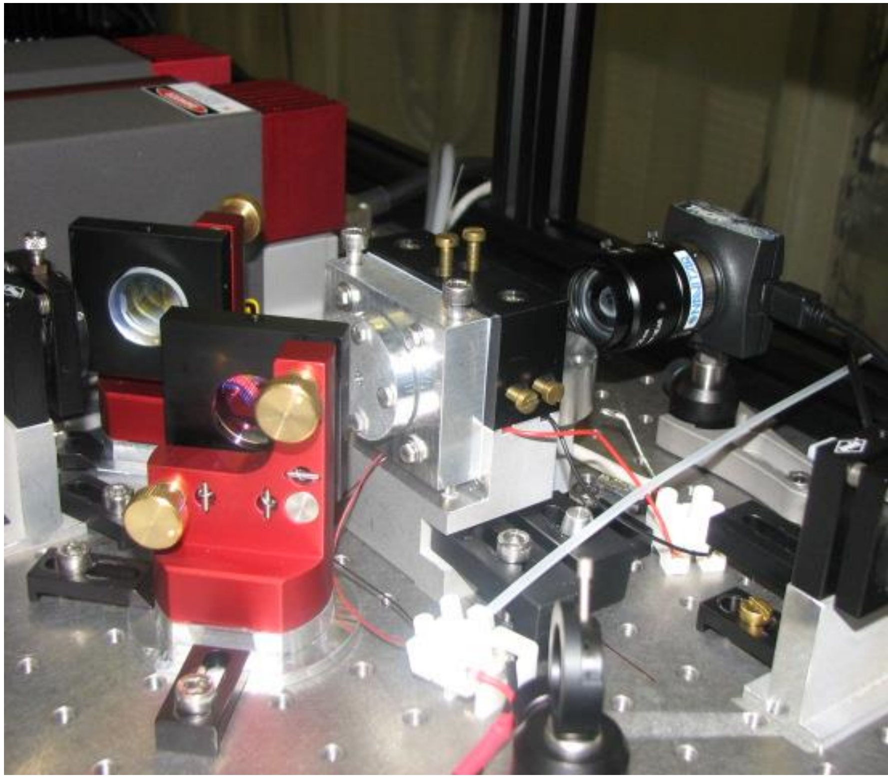
Second Harmonic Generator

Requirements:

- 50-100mW of green (TDR will specify the number)
- low IR contamination
- long term continuous operation

SHG mechanics



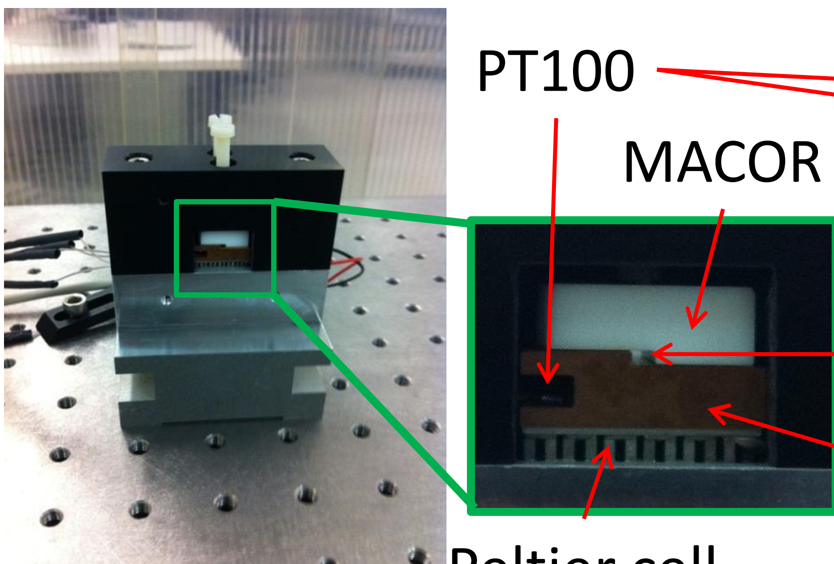


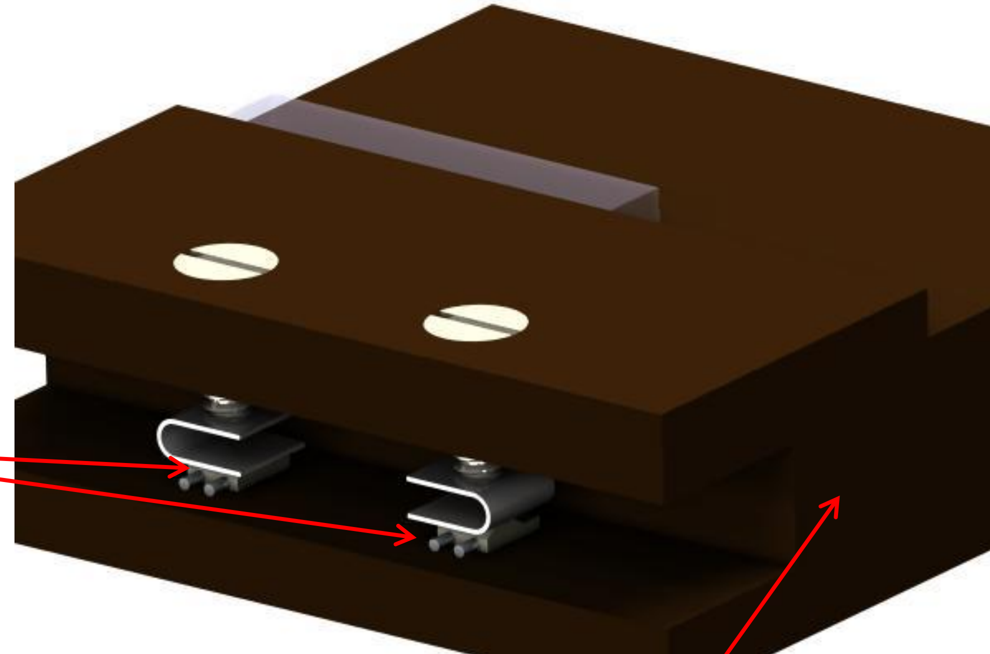
Key features: *compact* and *robust*

SHG thermal control (I)

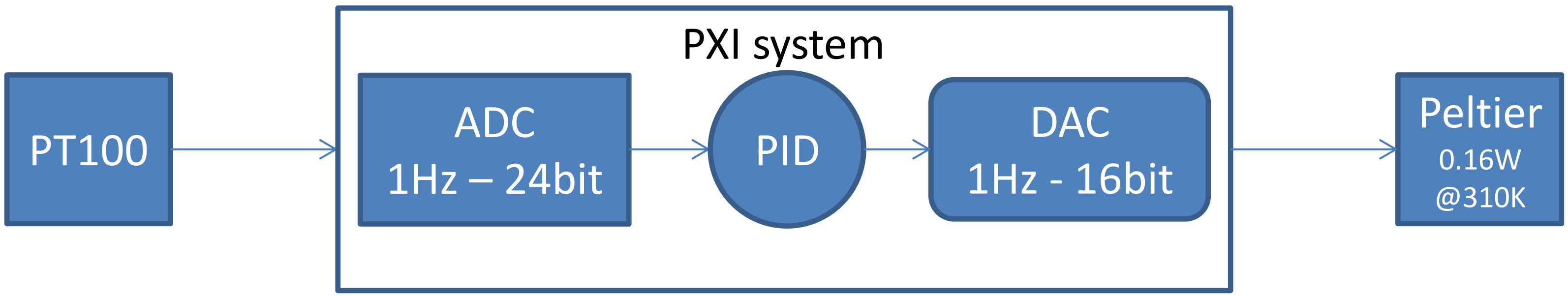
Conductive paste could be a problem

Completely DRY assembly

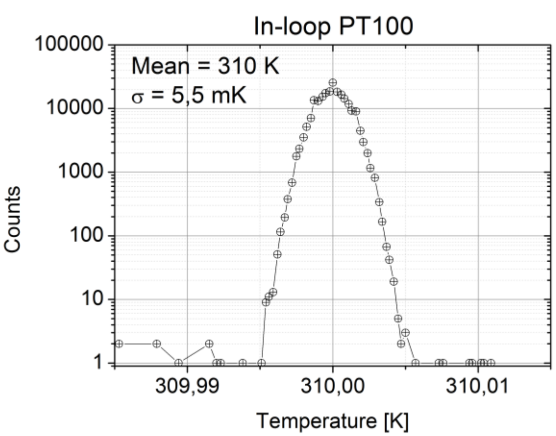




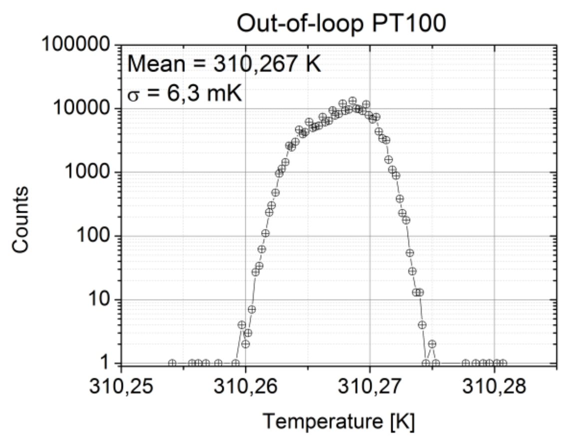
SHG thermal control (II)



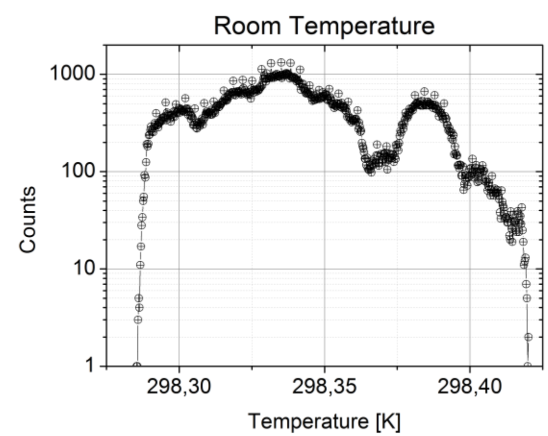
~60h acquisition (215950 points)



within $\pm 1.7mK$
for 90% of time



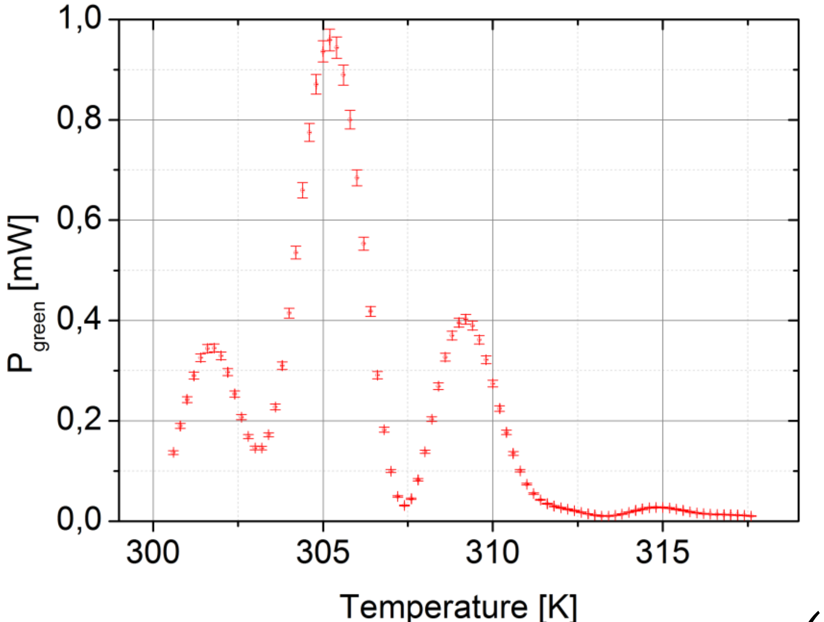
within $\pm 2.55mK$
for 90% of time

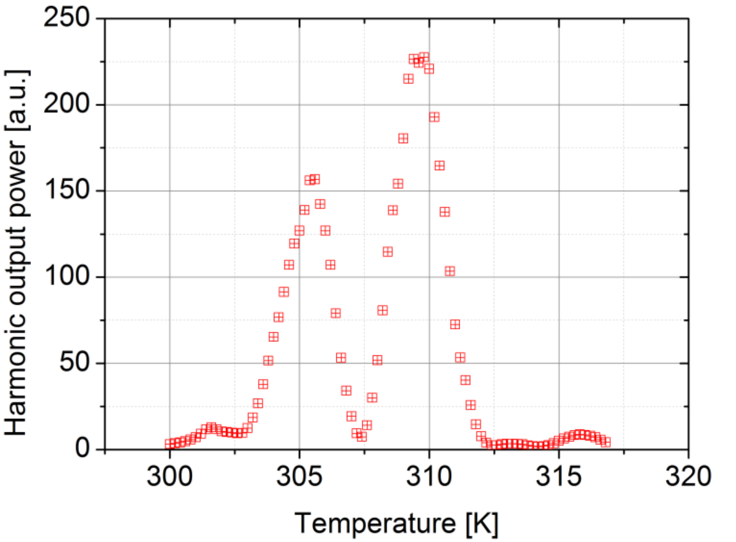


within $\pm 51.25mK$
for 90% of time

SHG double pass QPM

We were expecting a sinc^2 but…

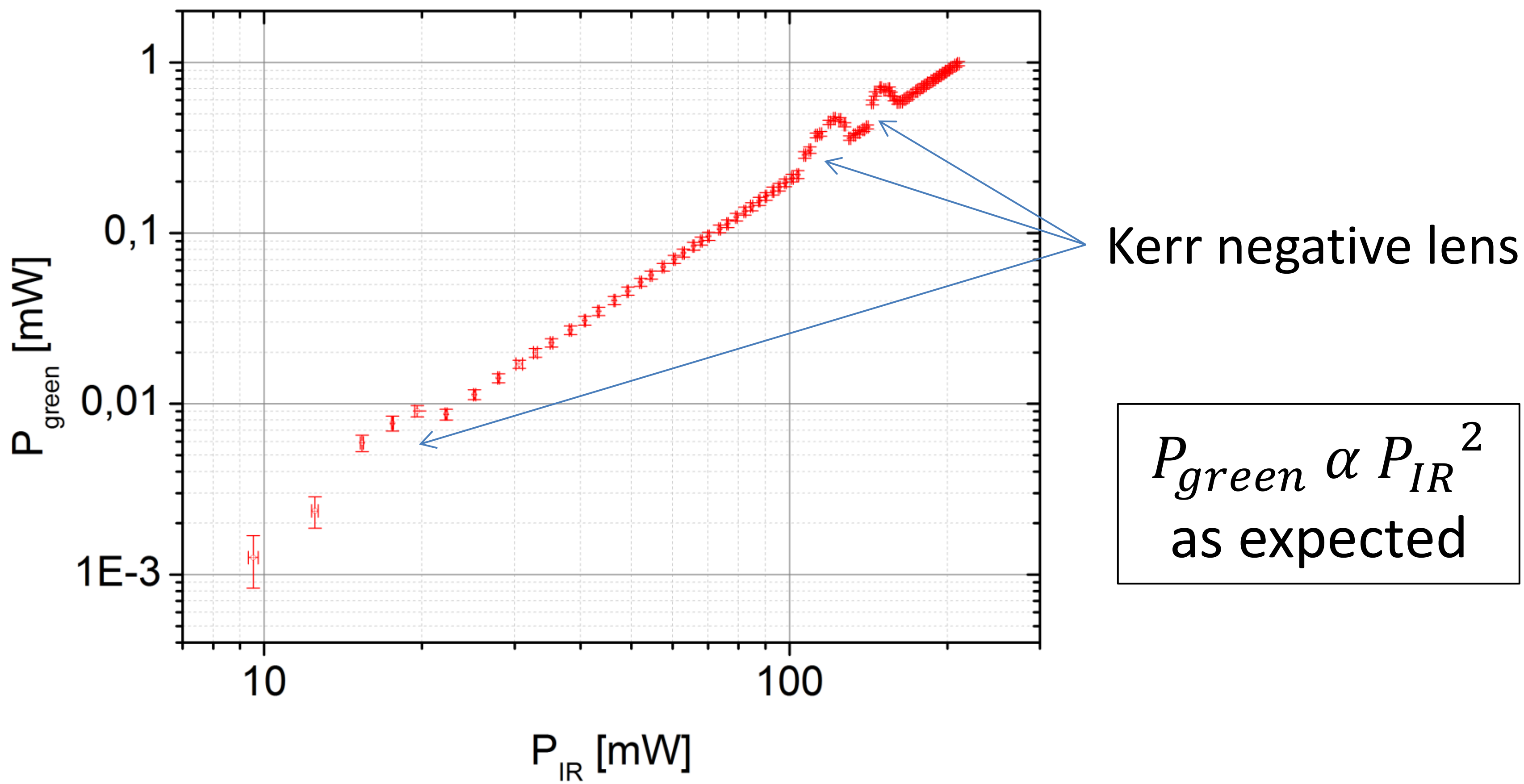




$$P_{green}\ \alpha\ {P_{IR}}^2\ \text{sinc}^2\left(\frac{\Delta k \ell_c}{2}\right)\cos^2\left(\frac{\Delta k \ell_c}{2}+\phi\right)$$

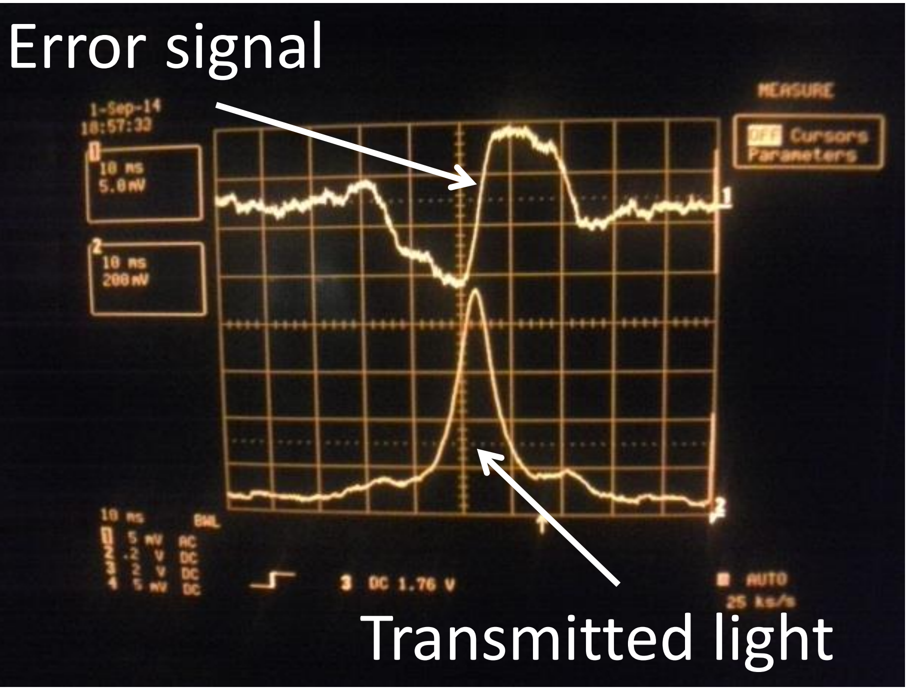
SHG DP conversion

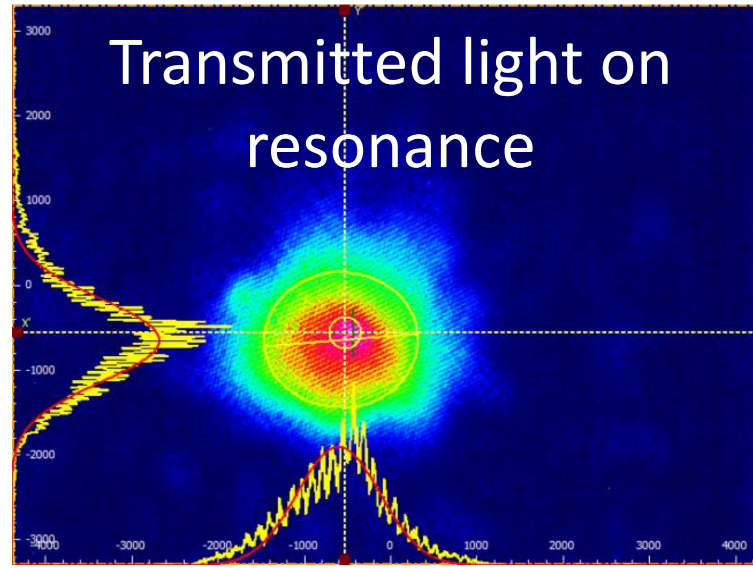
For each P_{IR} the maximum of the QPM curve is plotted.

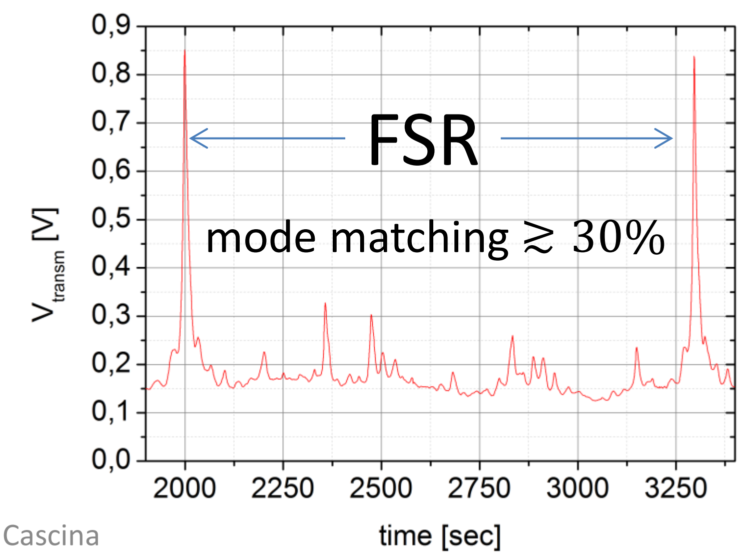


$P_{green}\ \alpha\ {P_{IR}}^2$
as expected

SHG cavity







Fitted finesse

$$\mathcal{F} = 136 \pm 2$$

Expected one was $\mathcal{F} = 142$ (computed with FINESSE)

SHG cavity locking loop (I)

First step → ANALOG locking loop

Done

Second step → DIGITAL locking loop

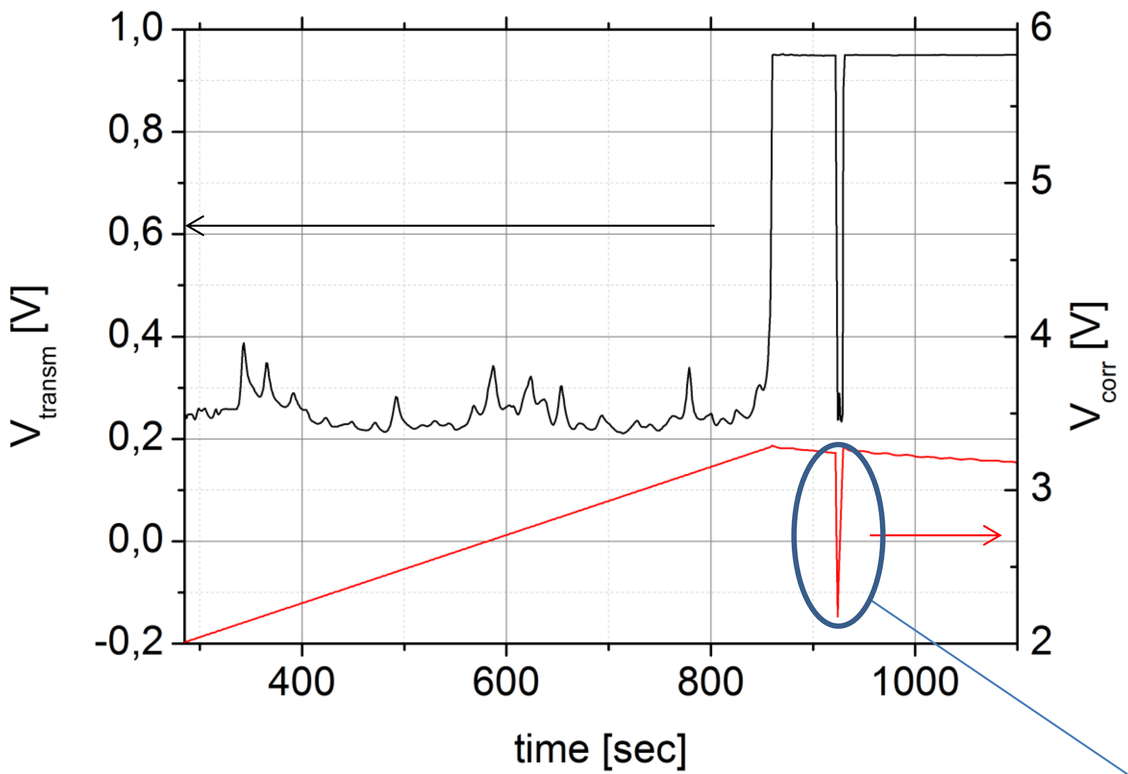
Done

Third step → DIGITAL locking loop with auto-relock

Done

(see next slide)

SHG cavity locking loop (II)



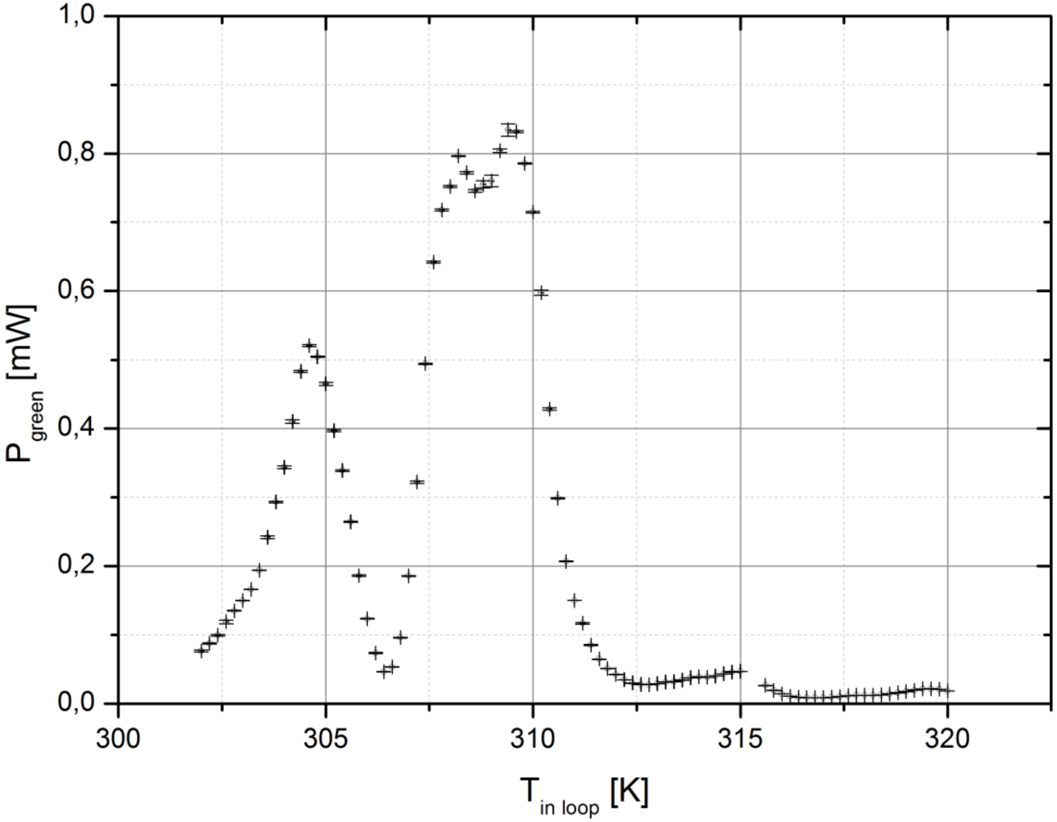
relock system 'searching' the TEM00, slow ramp in this plot only

relock acquired at working speed

$$t_{relock} < 10sec$$

Lock was never lost even during the longest run (72h).

SHG cavity QPM (I)

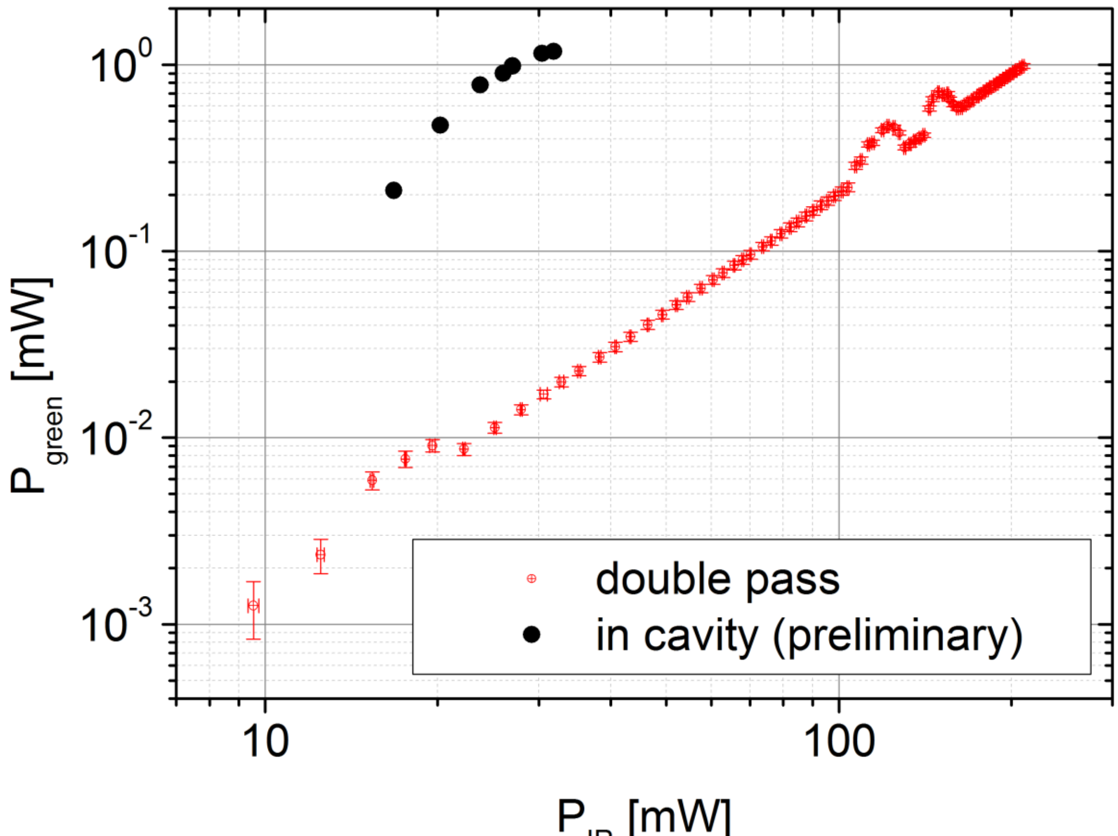


QPM curve with the SHG cavity.

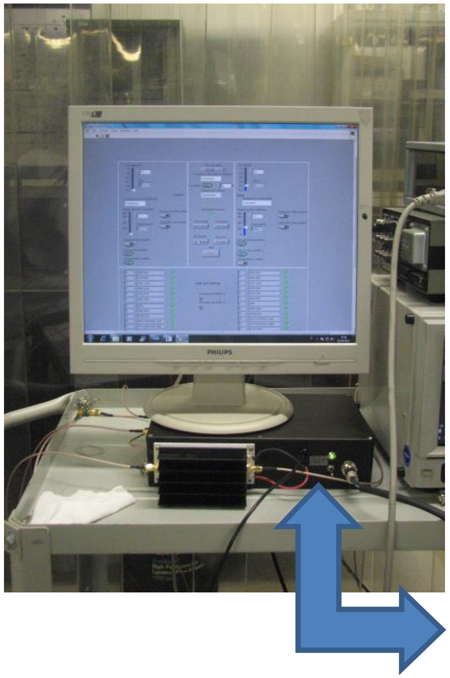
Further investigation is required…

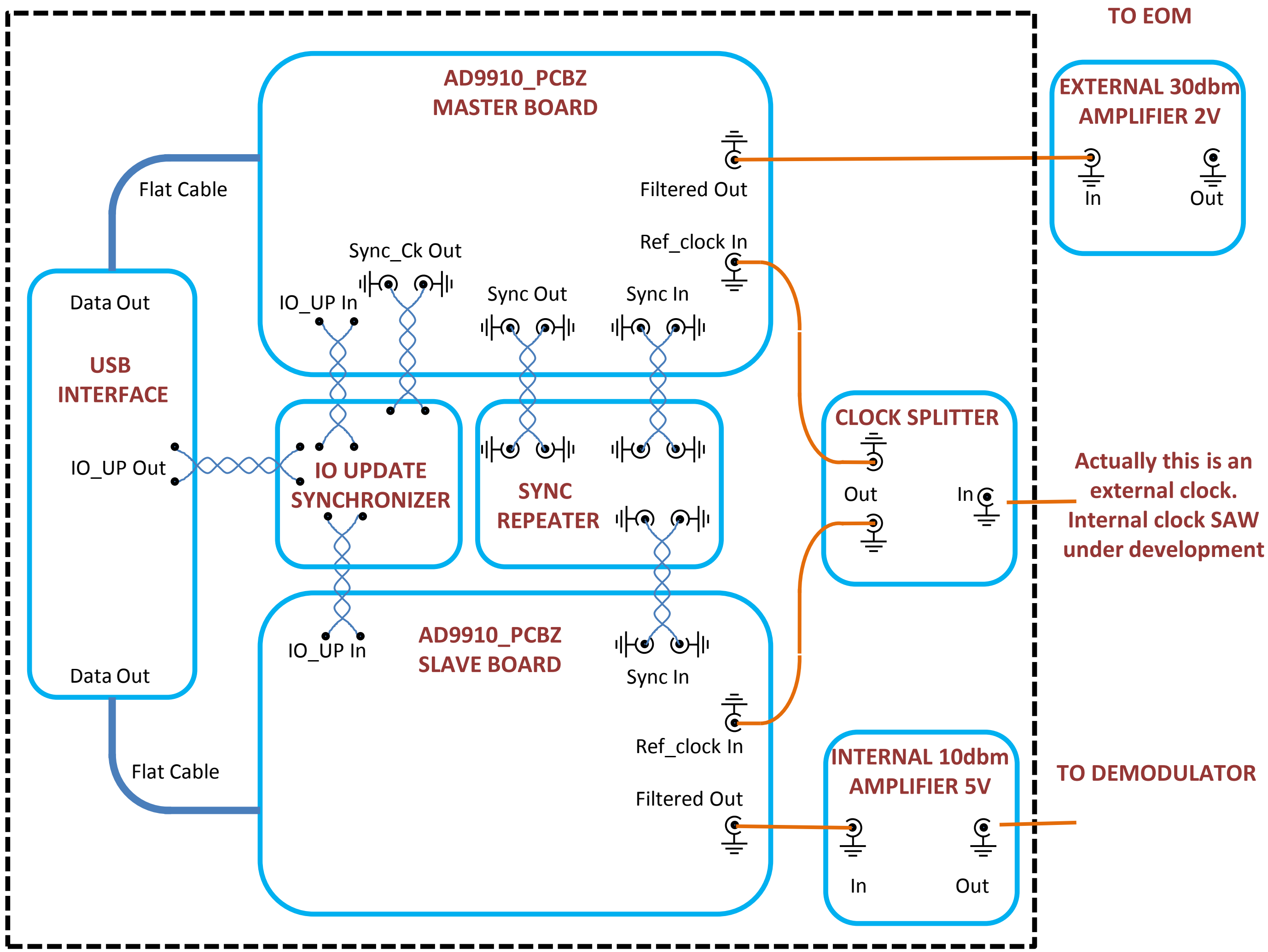
SHG cavity QPM (II)

Comparison between the cavity and the double pass conversion (preliminary)



SHG: RF generator





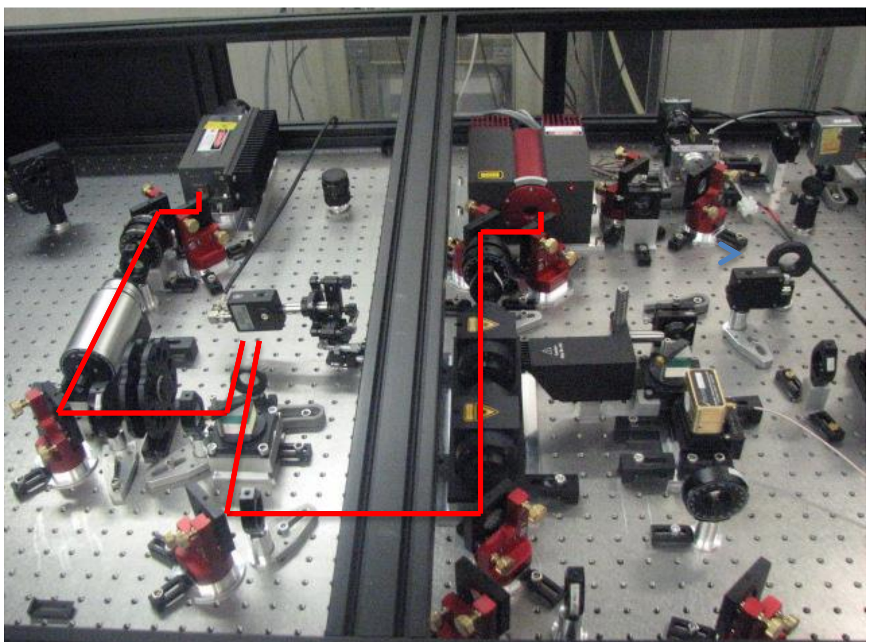
Based on AD9910
14 Bit 1GS/s

PLL

Requirement: phase noise $< 10mrad$

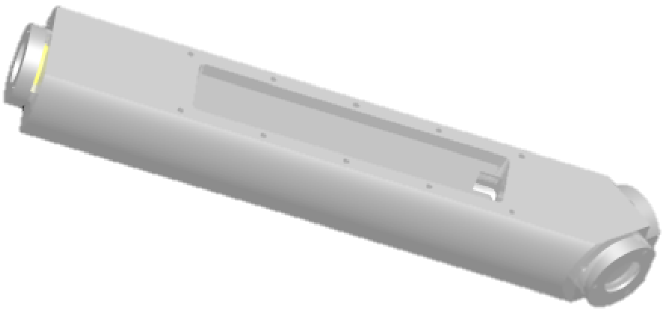
$$\phi^2{}_{noise} = \frac{f_{FWHM}(master) + f_{FWHM}(slave)}{2 * unitary\ gain\ BW}$$

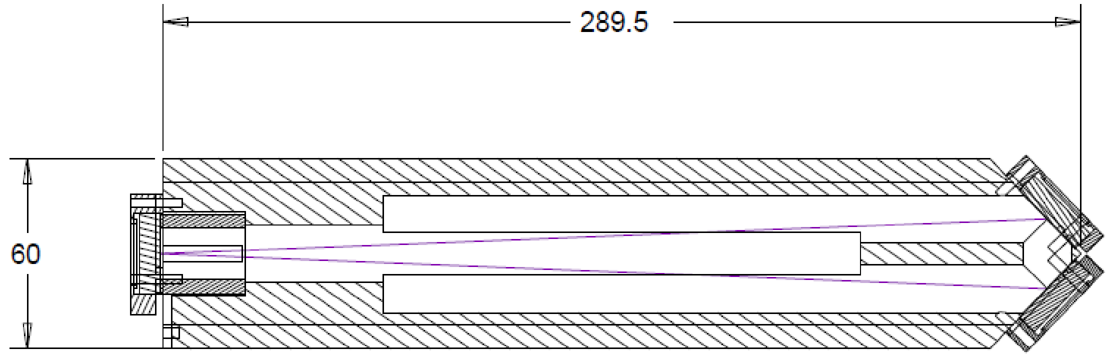
→ unitary gain BW $\sim 1MHz$



Optical part completed.

IR mode cleaner



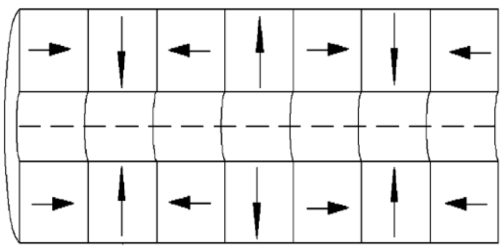


Polarization	Finesse	TEM_{00} transmittivity
s	4187	0,933
p	259	0,996

- the invar bar is being machined
- the PZT and the digital locking loop are ready
- the mirrors will arrive soon (~October)

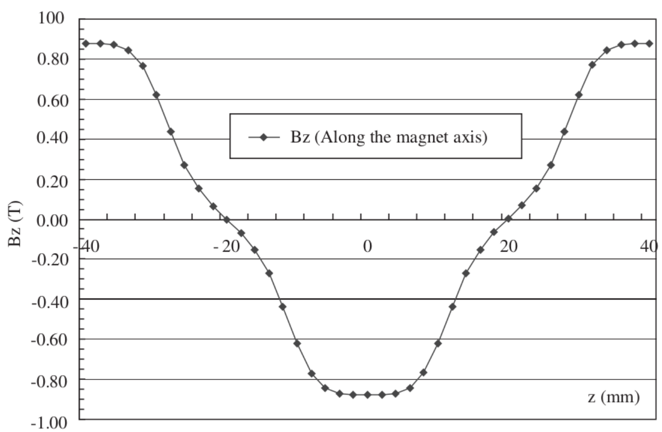
Faraday rotator (I)

We have a code to calculate numerically the magnetic field of realistic magnets geometries.

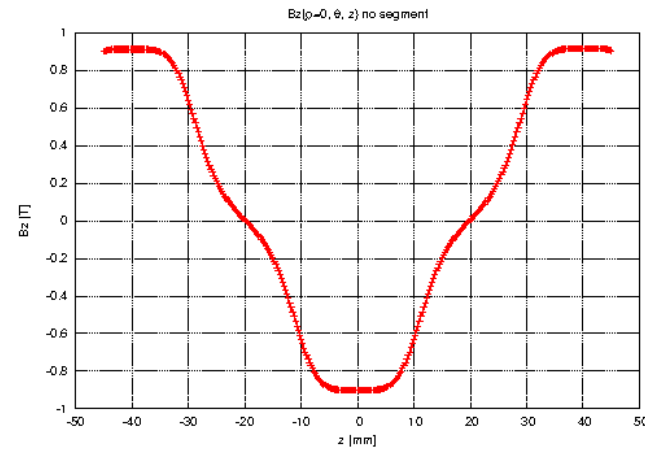


B_r	1.35 T
R_{int}	6 mm
R_{ext}	20 mm
h	20 mm

Published result

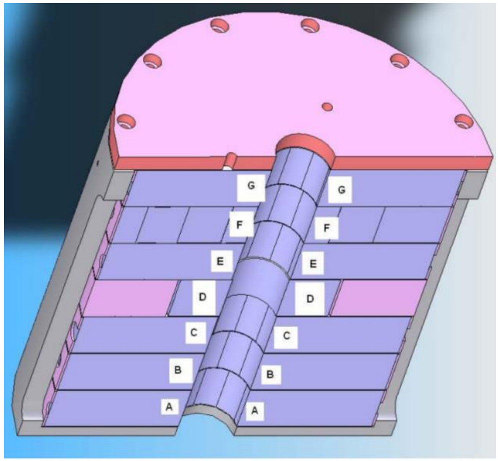


Our result



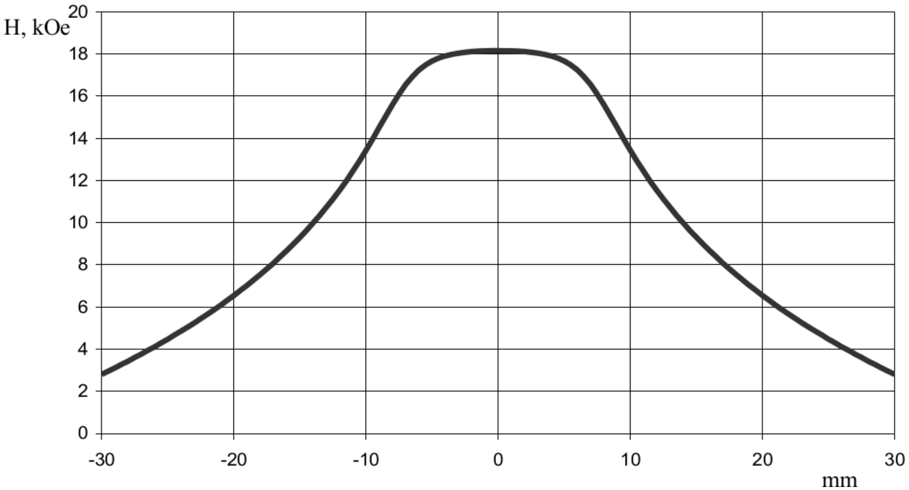
Q.L. Peng, S.M. McMurry, J.M.D. - Coey Journal of Magnetism and Magnetic Materials 268 (2004) 165–169

Faraday rotator (II)

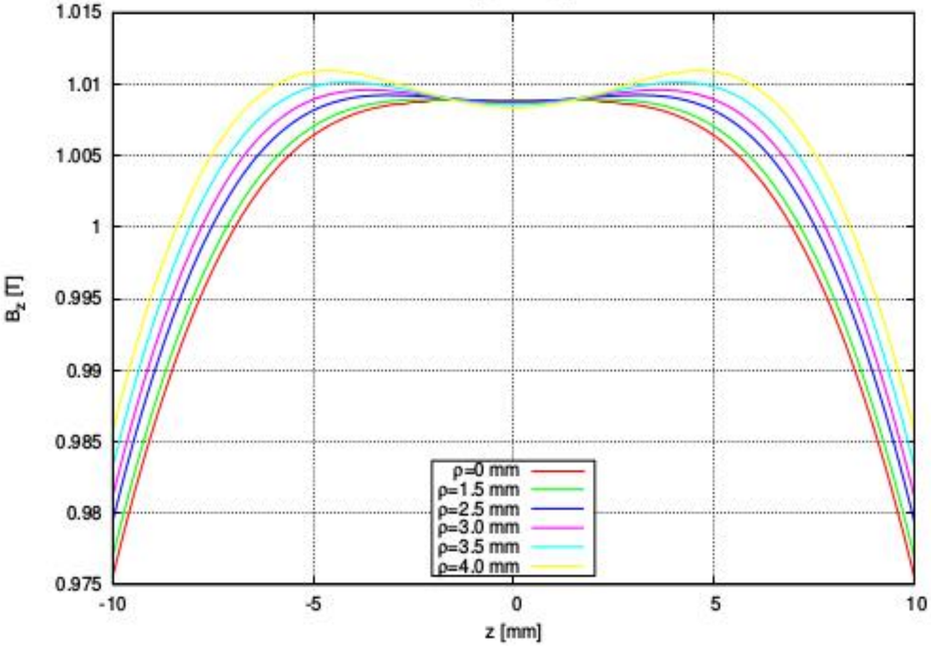


The code was applied to the AdV INJ Faraday.

$B_z(z, 0)$ on axis



$B_z(z, \rho)$ off axis



Near Future

SHG:

1. mode matching needs to be improved
2. green beam needs to be characterized (polarization, collimation, IR contamination, …)
3. temperature and PDH digital loops can be further optimized

PLL:

- Real Time OS will be tested

IR MC:

- needs to be constructed and tested

FR:

- our TGG will be tested by us inside faraday rotator similar to the AdV INJ one (no manpower theft)

Thank you