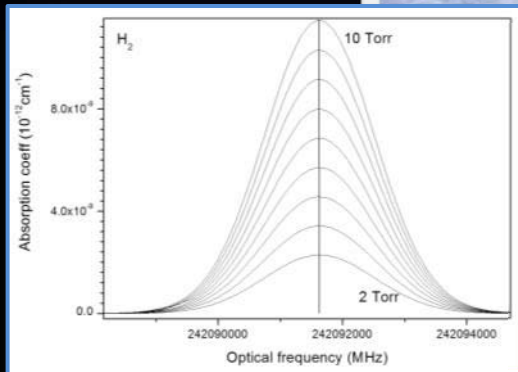
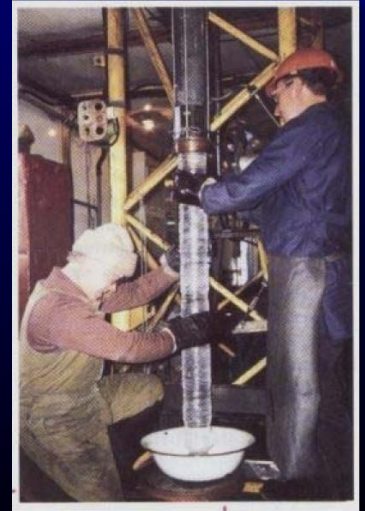
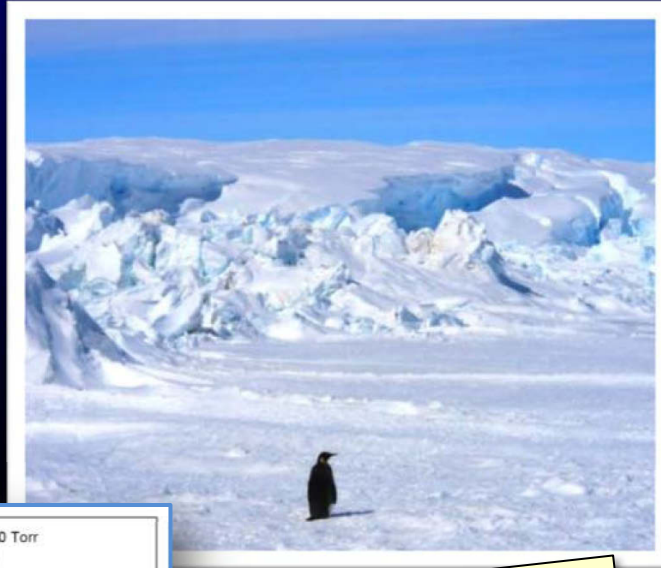


Motivations

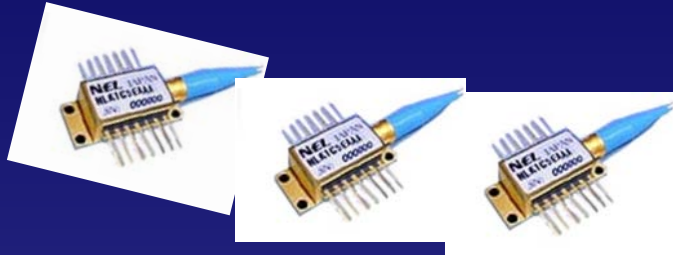


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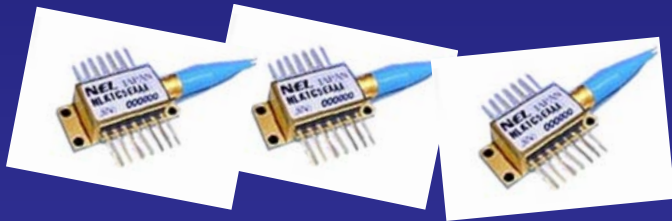


*Today spectroscopy, frequency metrology, fiber communications...
need ultra-stable laser sources*

Our approach



Standard laser
diode library



2 MHz linewidth



narrow linewidth
Laser comb



*Tunable
narrow
laser*



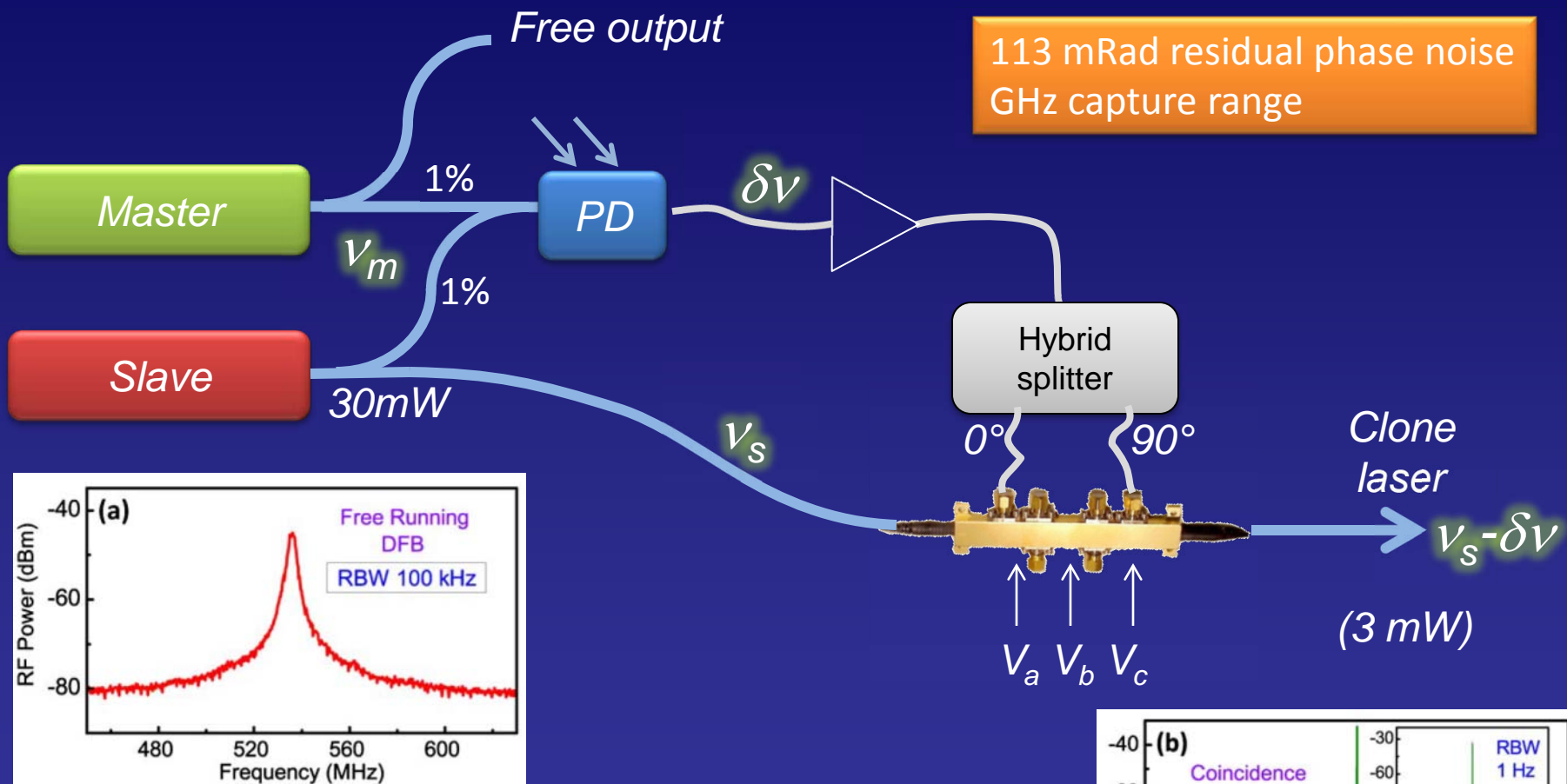
Radio frequency



Electronics

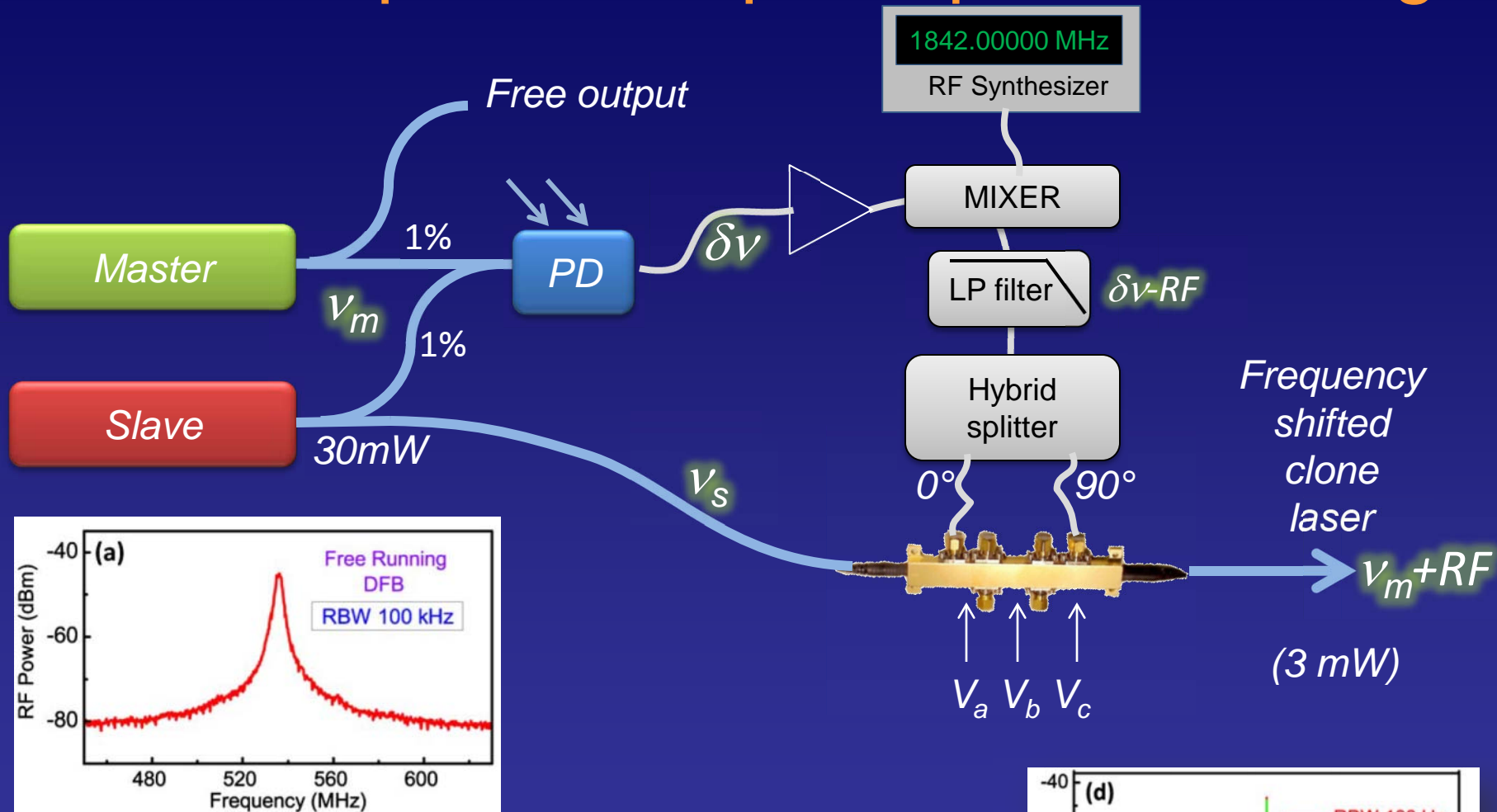
Transfer single tooth comb quality to your standard laser

First step: Direct optical phase cloning

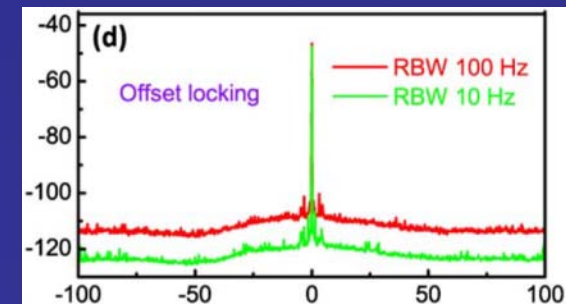


A photodiode, a hybrid splitter and an MZM allow for phase cloning

Second step: Offset optical phase cloning



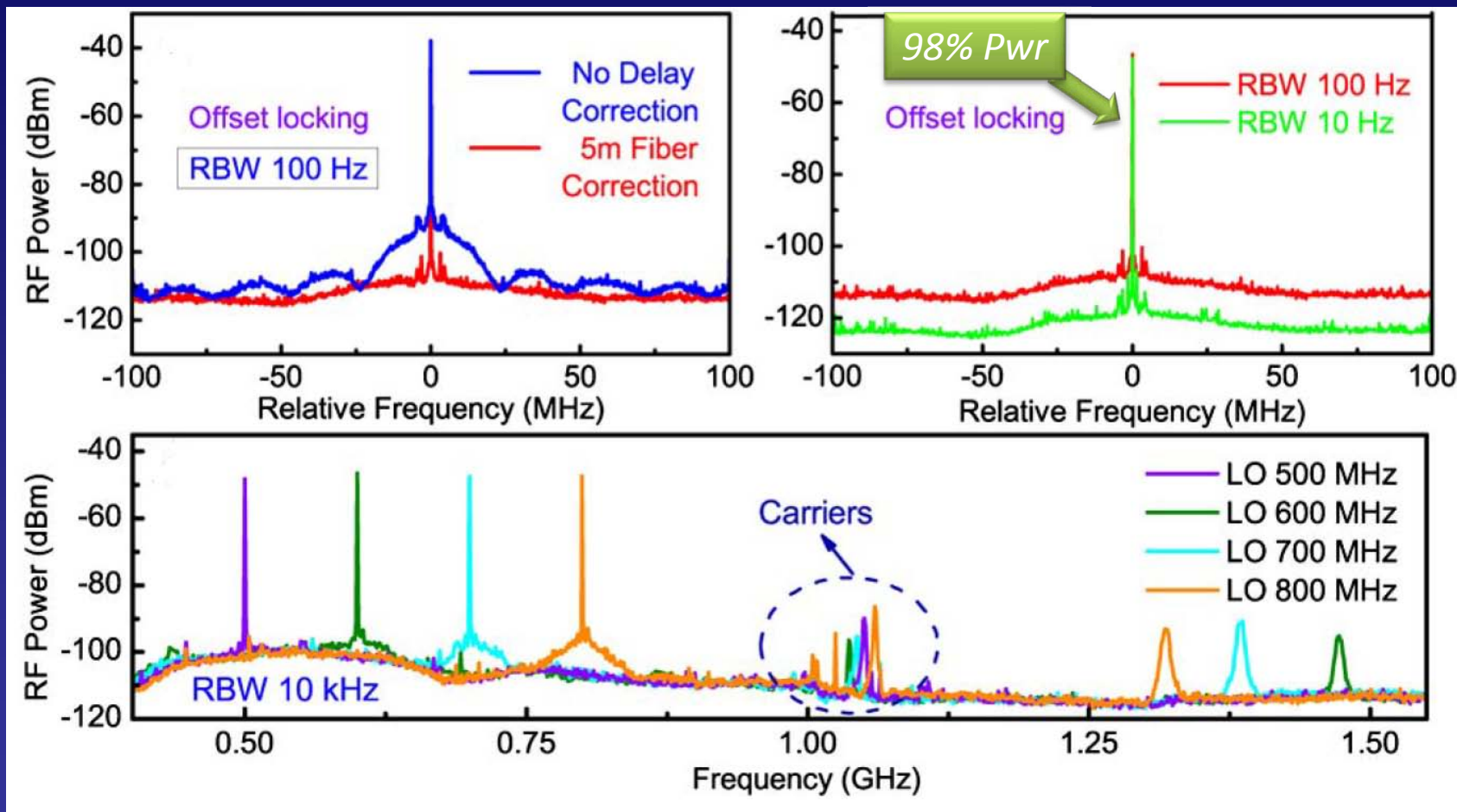
Let's mix it with an RF : tunability



Phase cloning performance

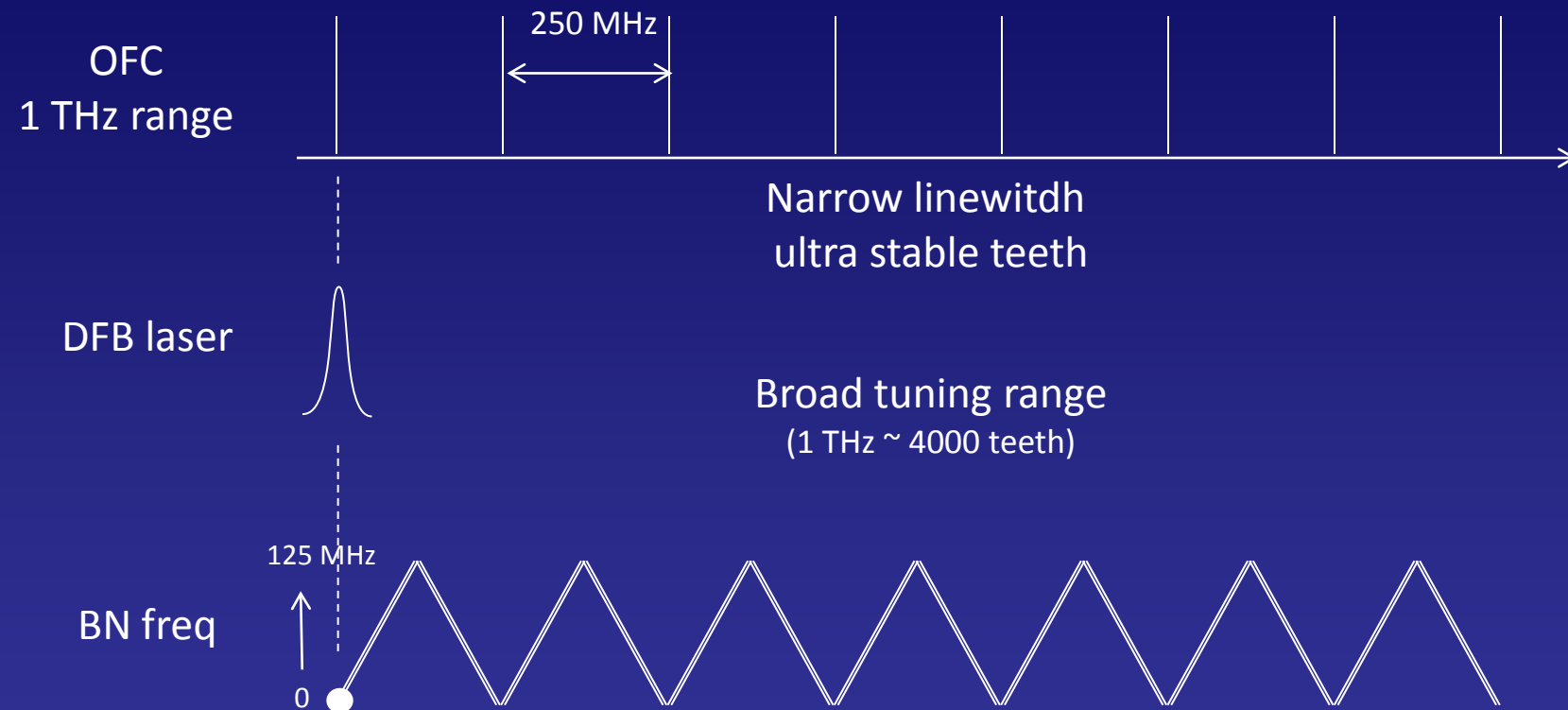
Propagation delay is of importance

Up to 80 dB noise suppression



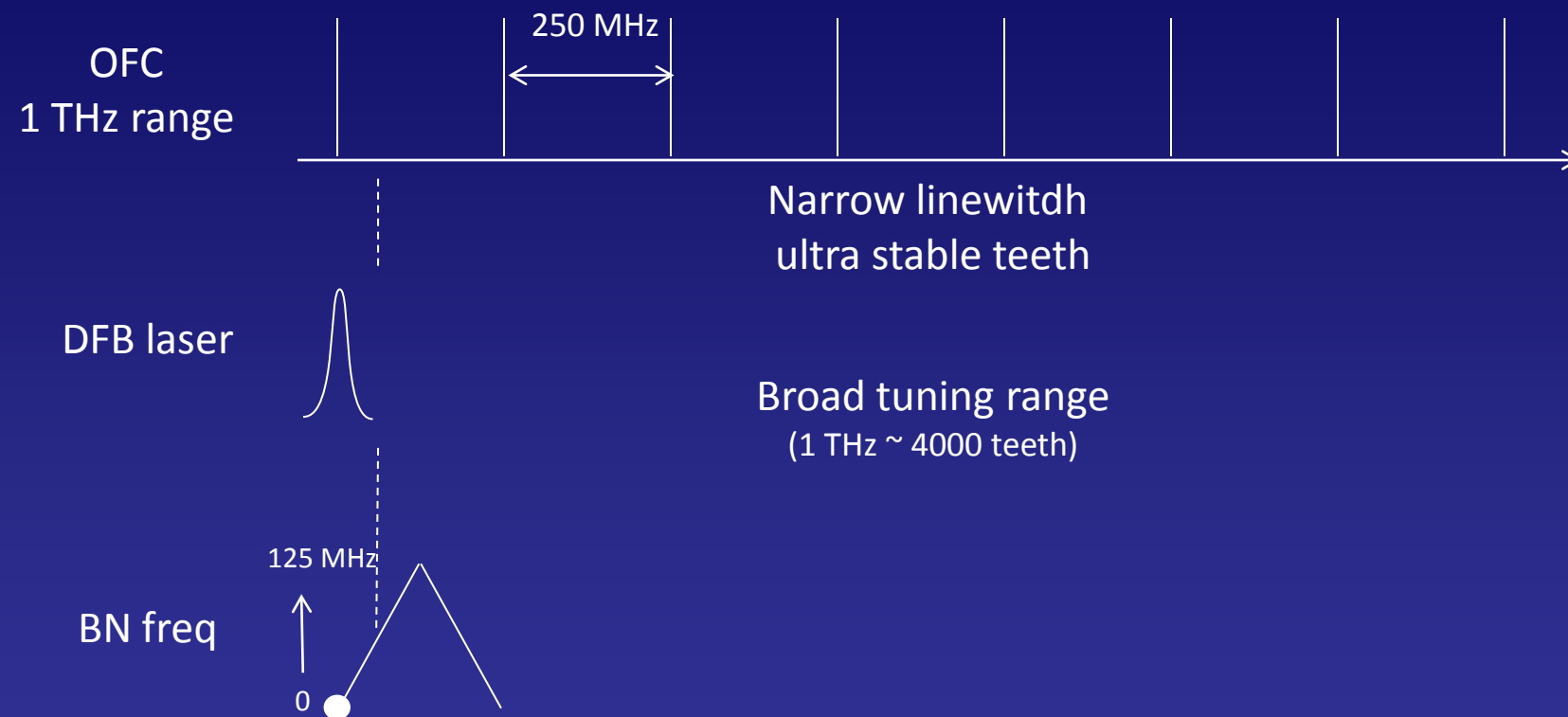
With an unbalanced MZM one illustrates the mechanism (pedagogic purpose!)

Now, with a comb : broad tuning



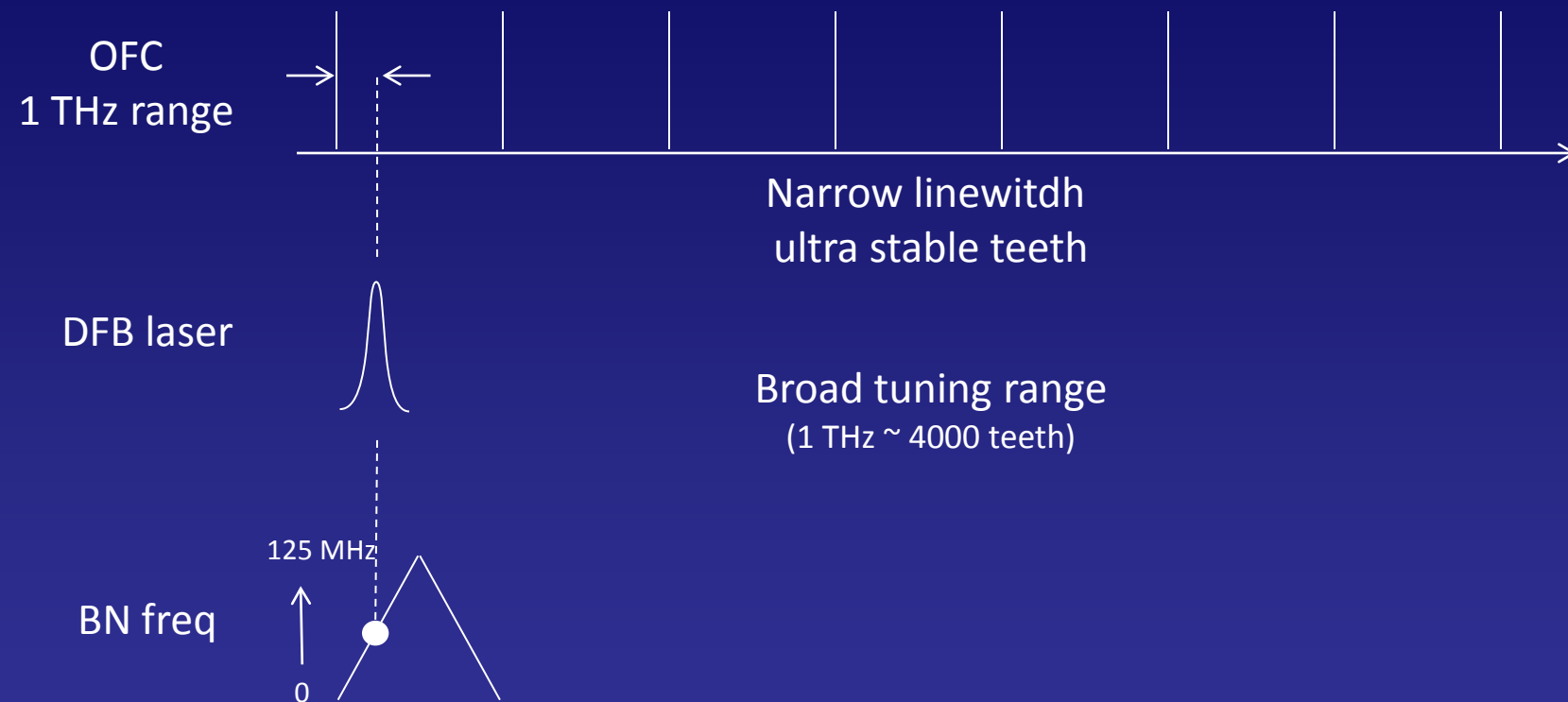
Different strategies to discipline the DFB laser

Now, with a comb : broad tuning



“Classical” offset frequency locking

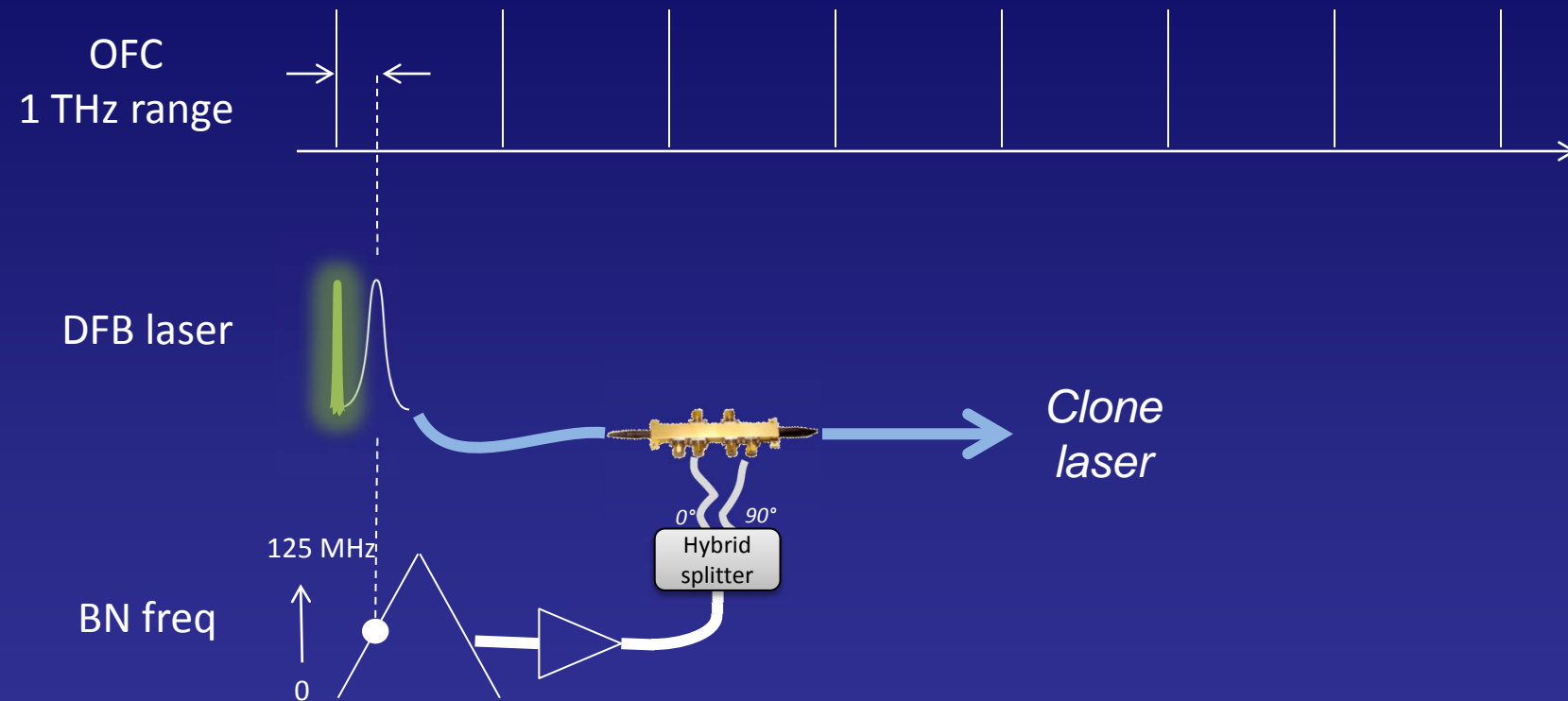
Now, with a comb : broad tuning



Changing OFC repetition rate for slight tunability

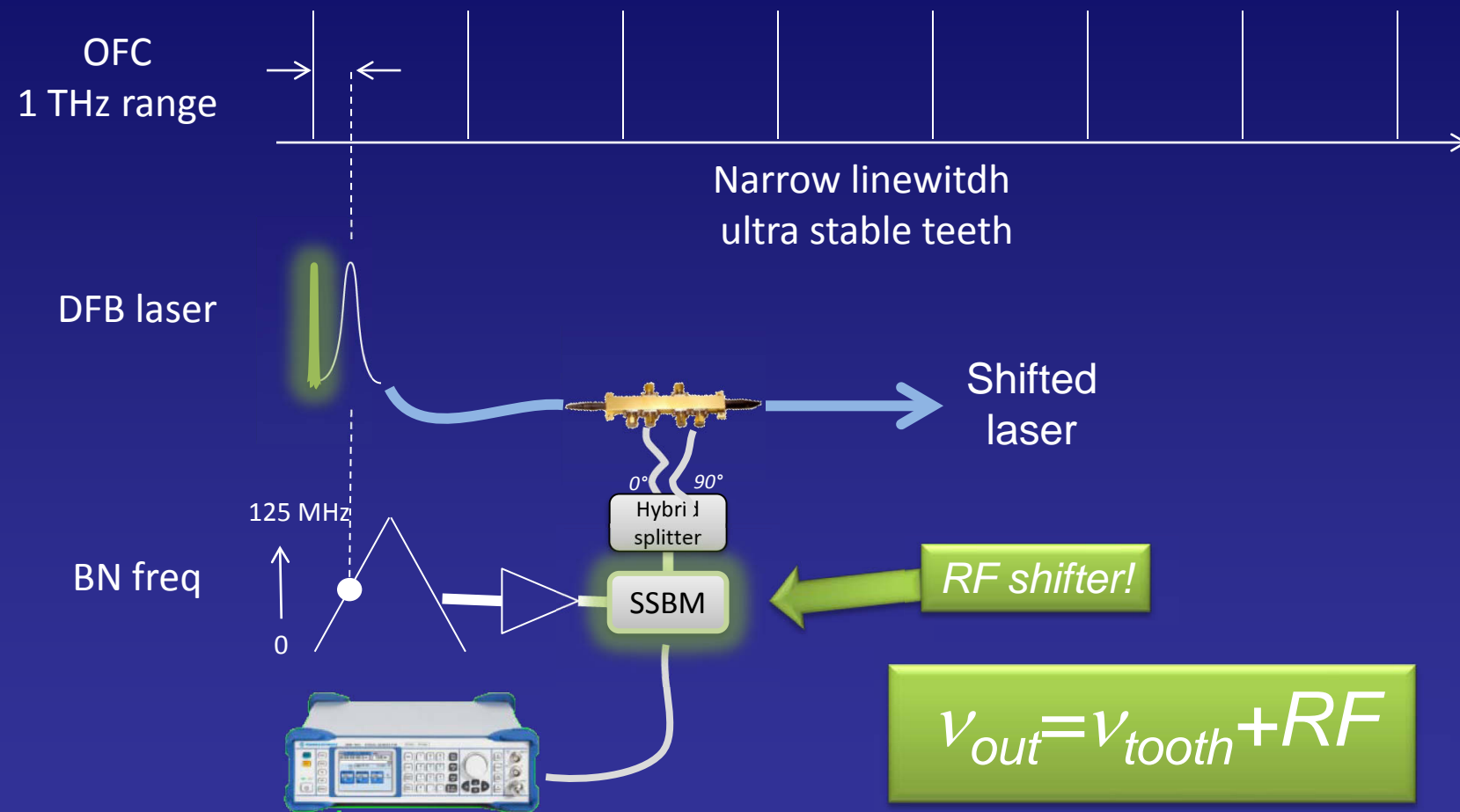
(involving fast phase detector, PLL, PID...)

Now, with a comb : broad tuning



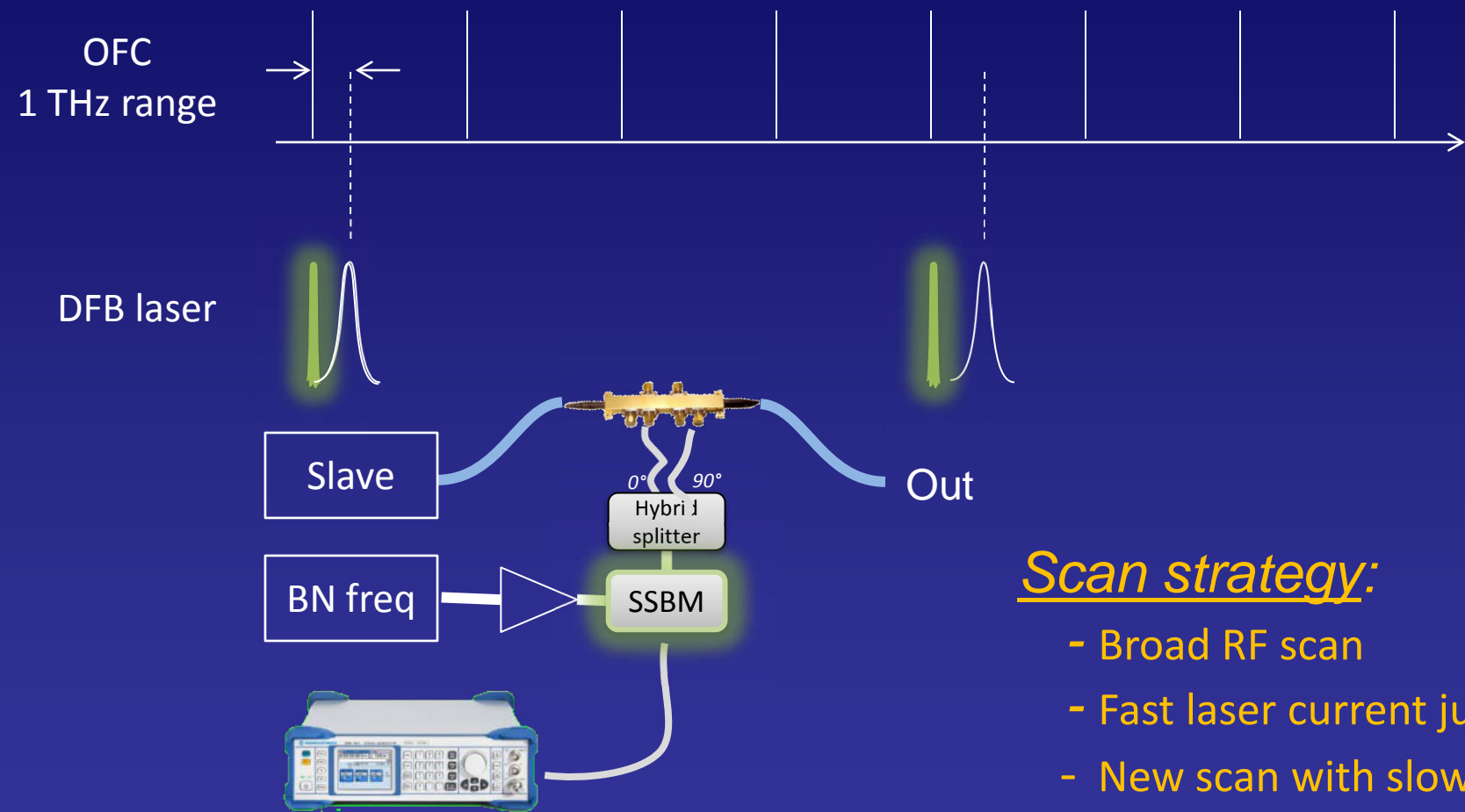
*Or applying phase cloning!
Narrow laser at tooth frequency*

Now, with a comb : broad tuning



Narrow and widely tunable laser

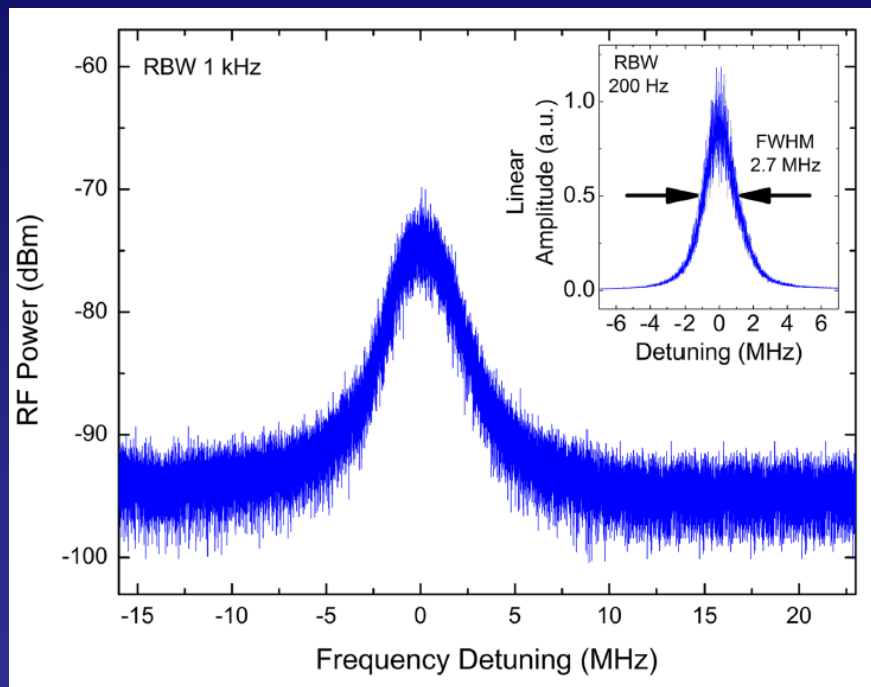
Now, with a comb : broad tuning



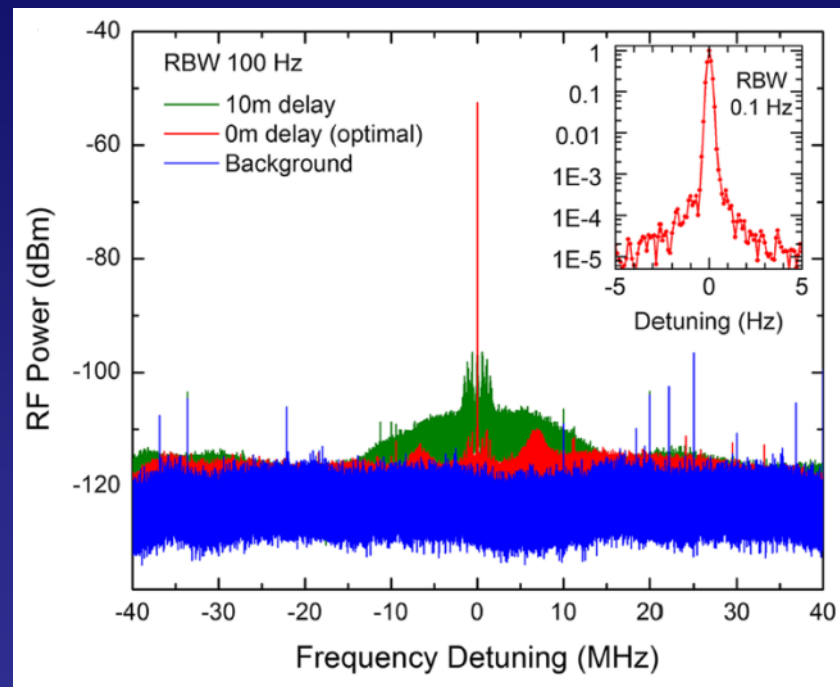
Scan strategy:

- Broad RF scan
- Fast laser current jump
- New scan with slow T° adj for BN recovery (while applying RF scan!)

What about the noise?



2.7 MHz



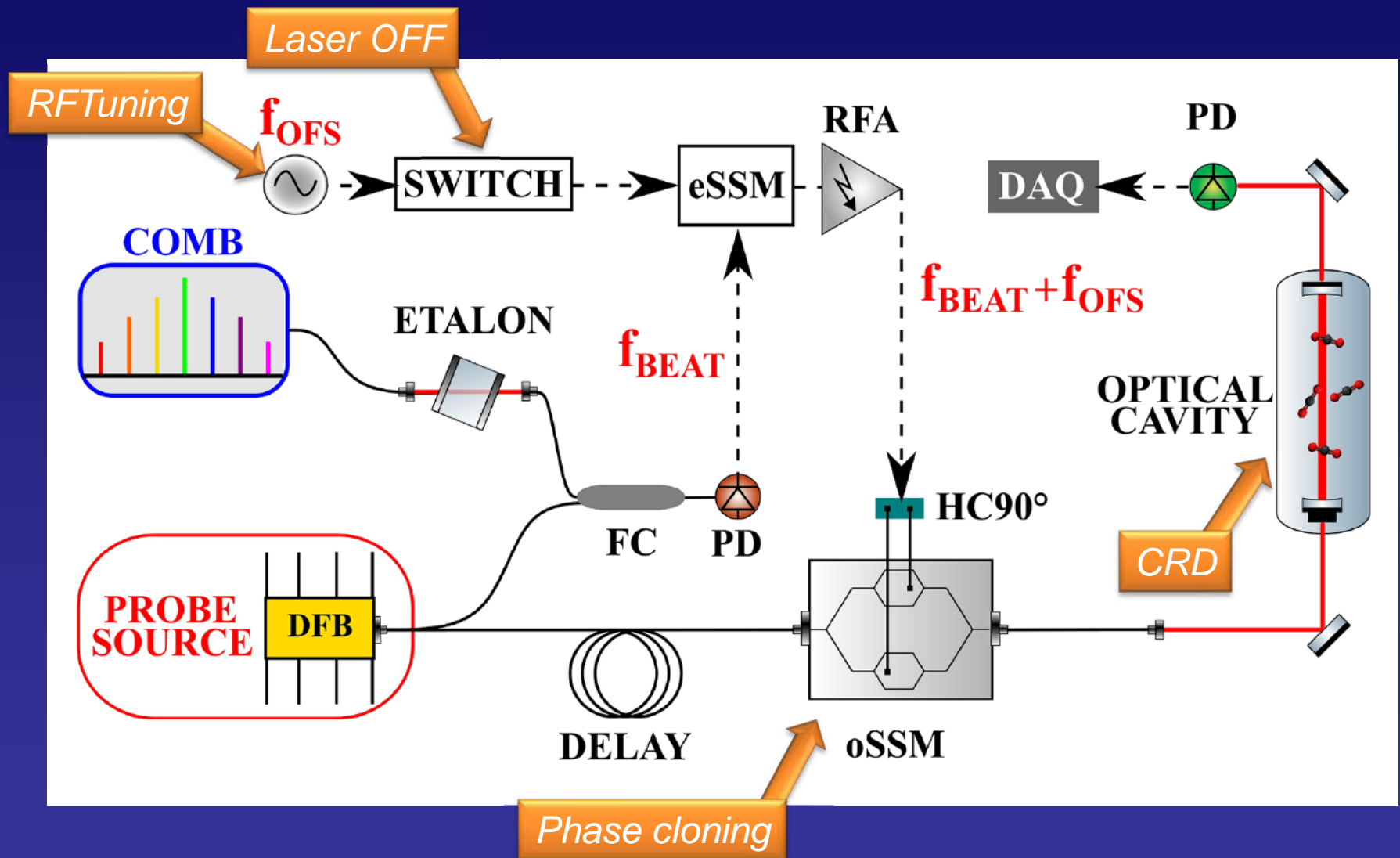
0.1 Hz resolution limited

One checked noise by direct beating with another OFC tooth

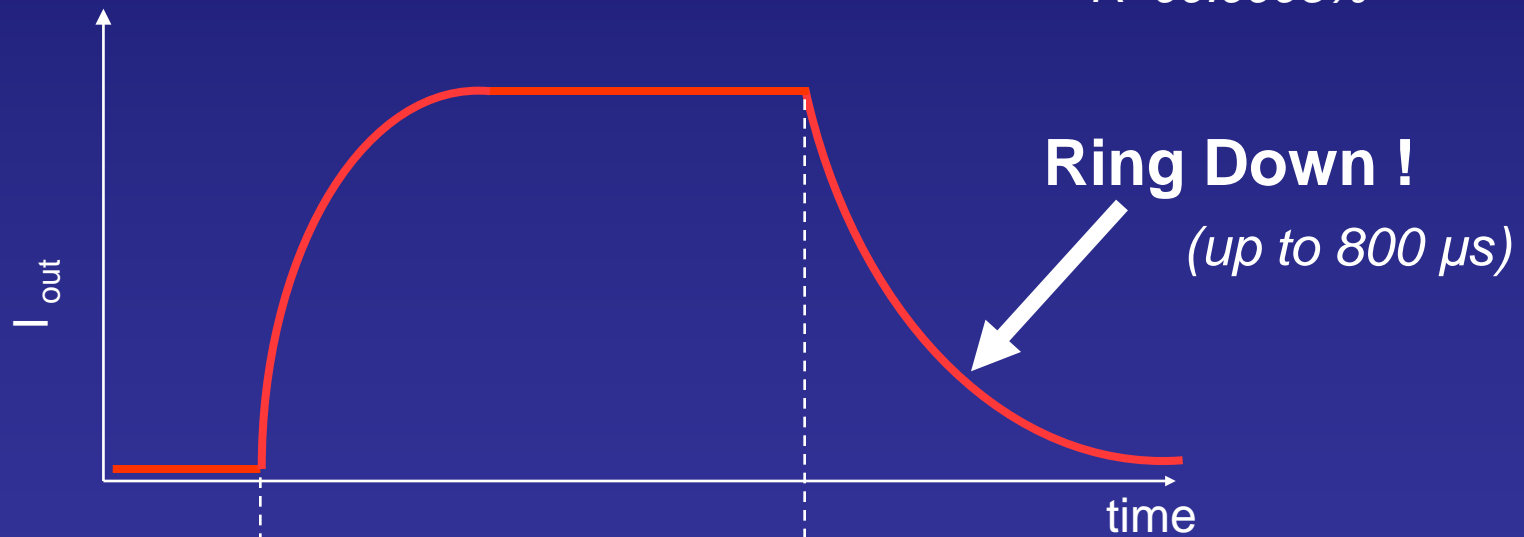
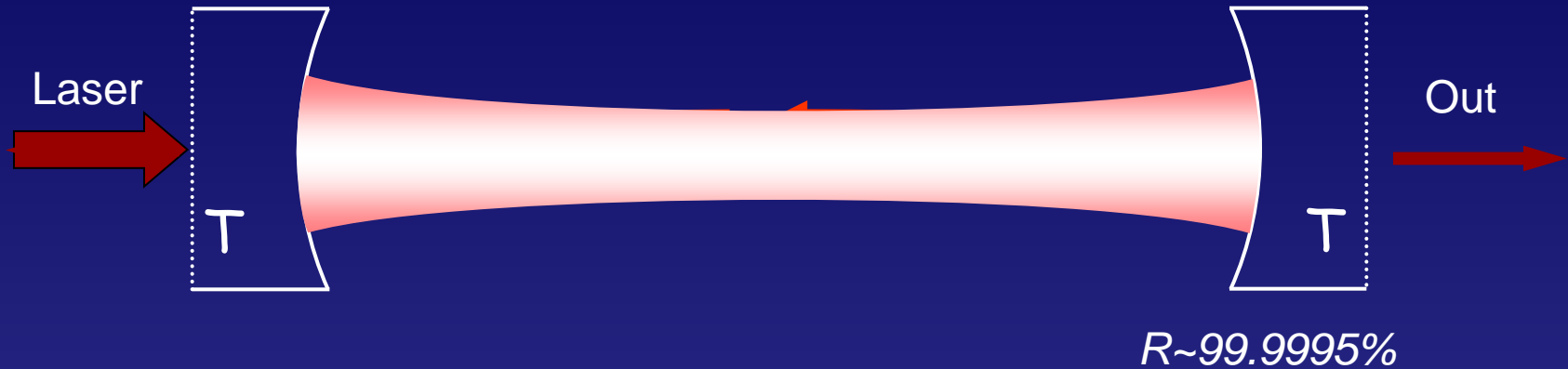
Application: Feeding a CRDS

(filled with traces of methane)

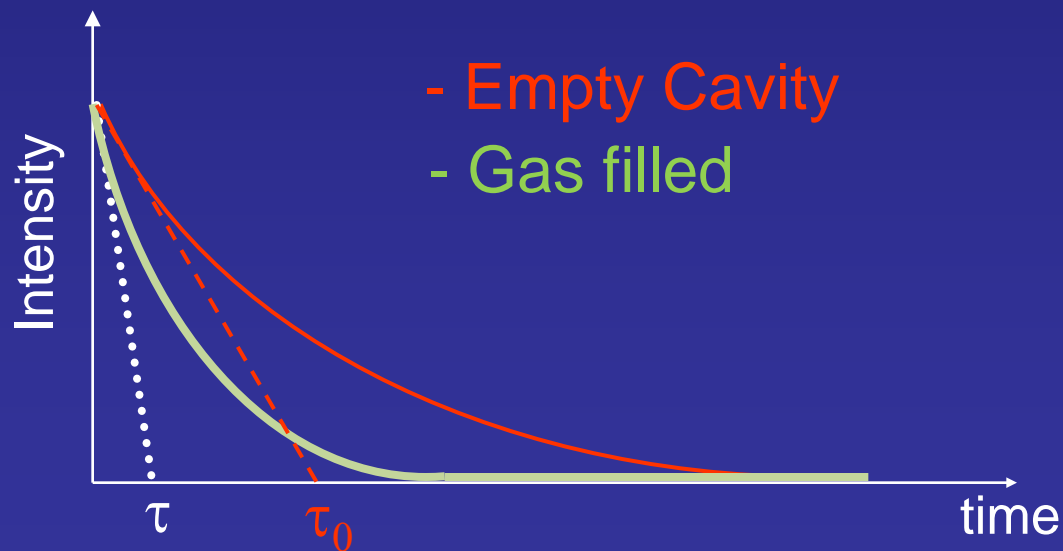
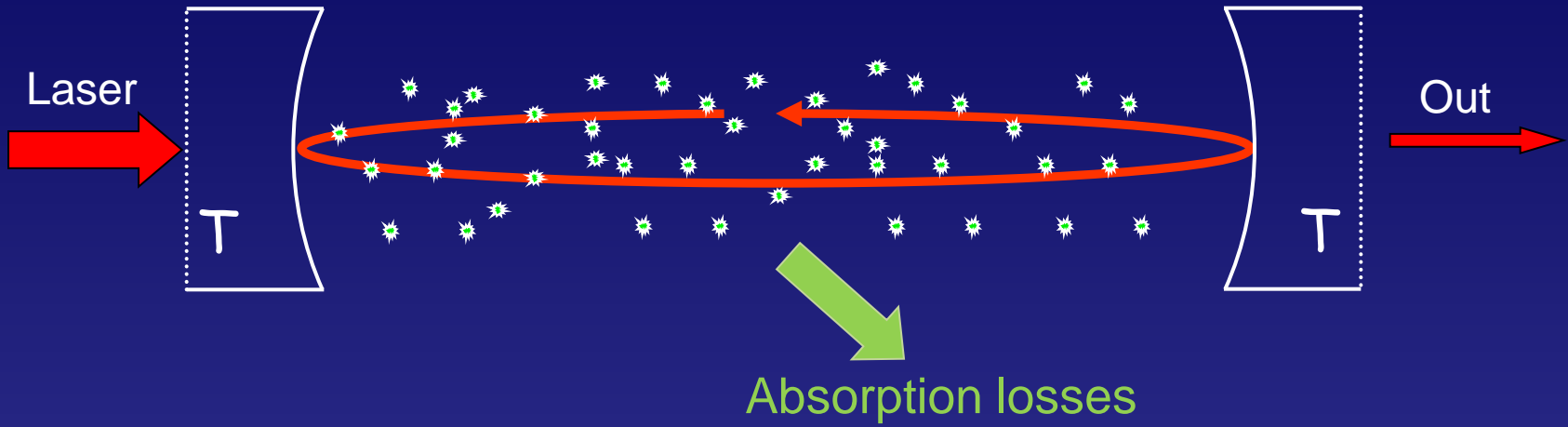
Offset Phase Cloning - CRDS



Cavity Ring Down



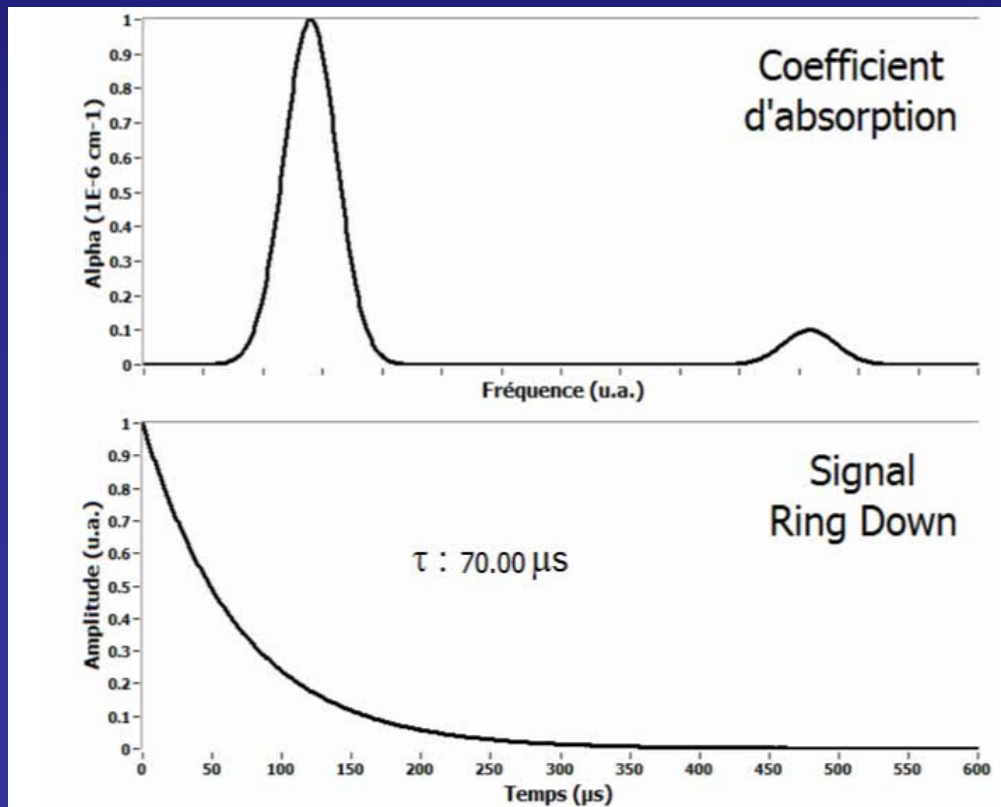
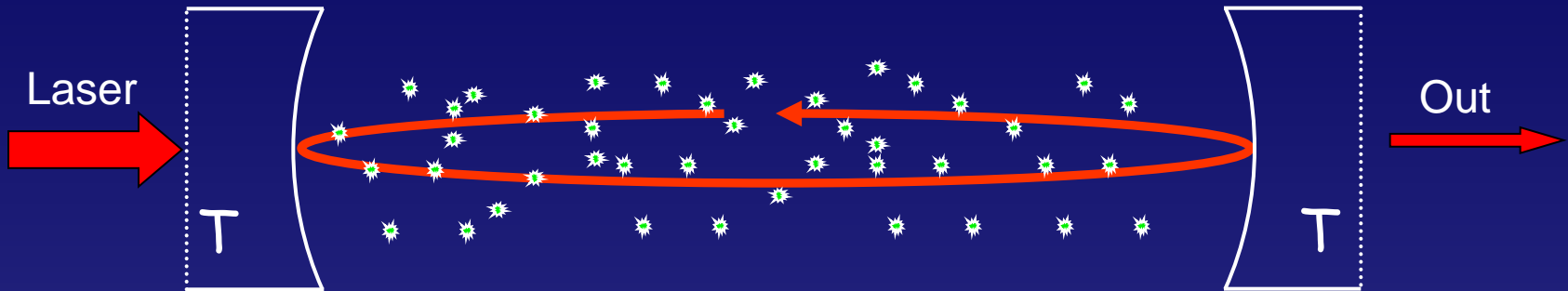
Cavity Ring Down



$$\frac{1}{\tau(v)} = \frac{1}{\tau_0} + \alpha(v)c$$

$\alpha(v)$ is L and I_0
independent

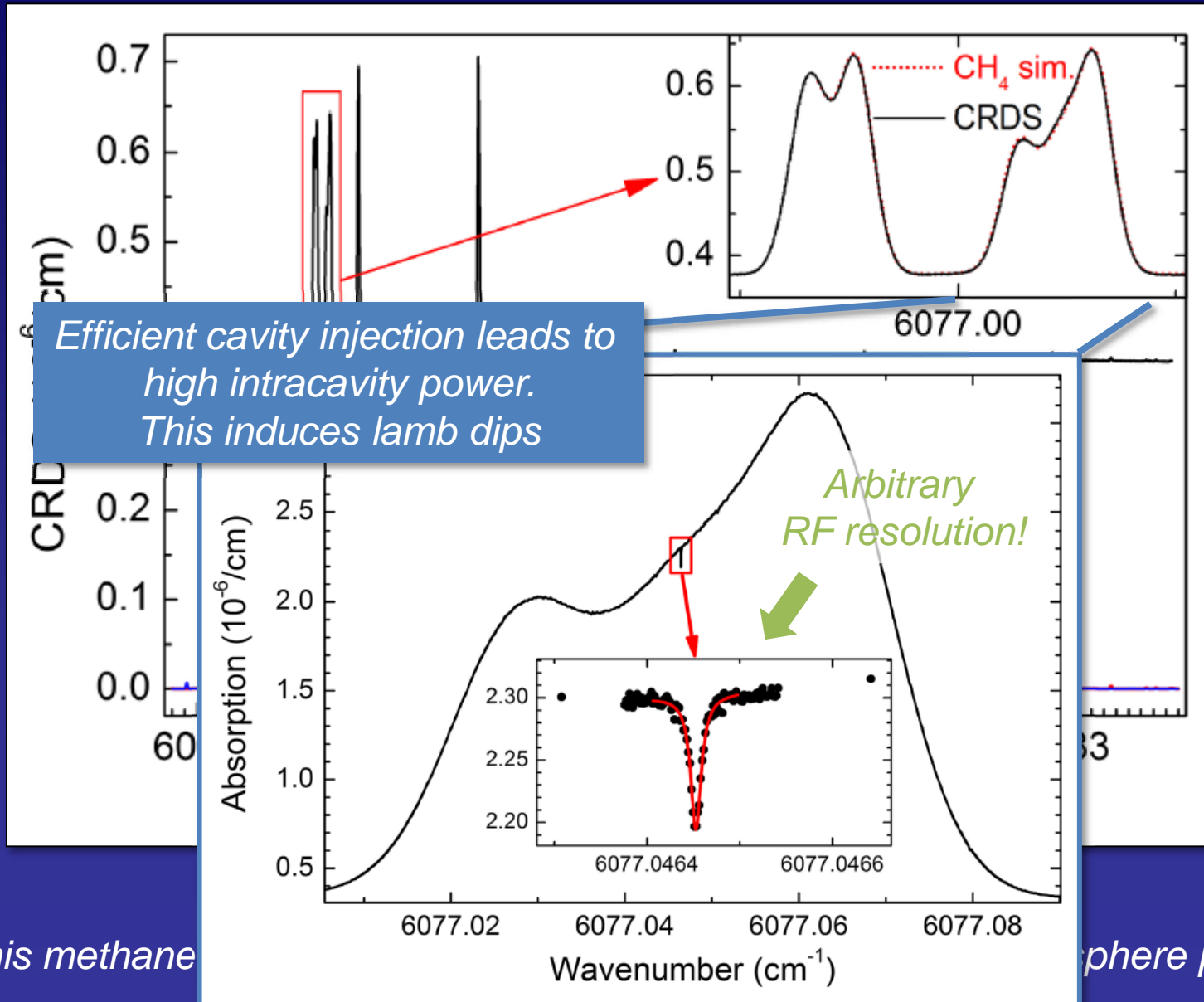
Cavity Ring Down



$$\frac{1}{\tau(\nu)} = \frac{1}{\tau_0} + \alpha(\nu) c$$

*$\alpha(\nu)$ is L and I_0
independent*

Cavity Ring Down

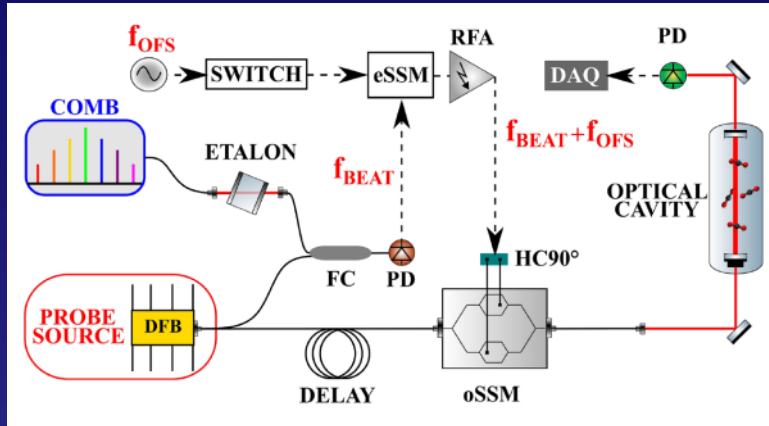


Cavity Ring Down

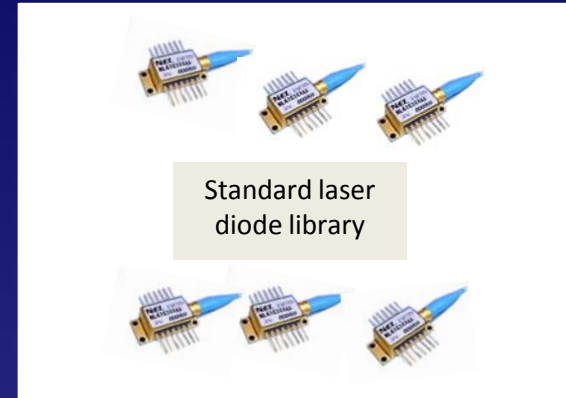
R(6) transition	Dip position (cm ⁻¹)	From Ref. 21 (cm ⁻¹)
7E ← 6E 1	6 076.927 593 39(9)	6 076.927 16(9)
7F1 ← 6F2 1	6 076.934 108 45(16)	6 076.934 11(9)
7A1 ← 6A2 1	6 076.953 099 31(5)	6 076.953 16(1)
7F1 ← 6F2 2	6 077.027 987 94(12)	6 077.027 85(1)
7F2 ← 6F1 1	6 077.046 452 60(6)	6 077.046 39(2)
7A2 ← 6A1 1	6 077.062 939 79(6)	6 077.062 96(1)

Ready for everyday spectroscopy!

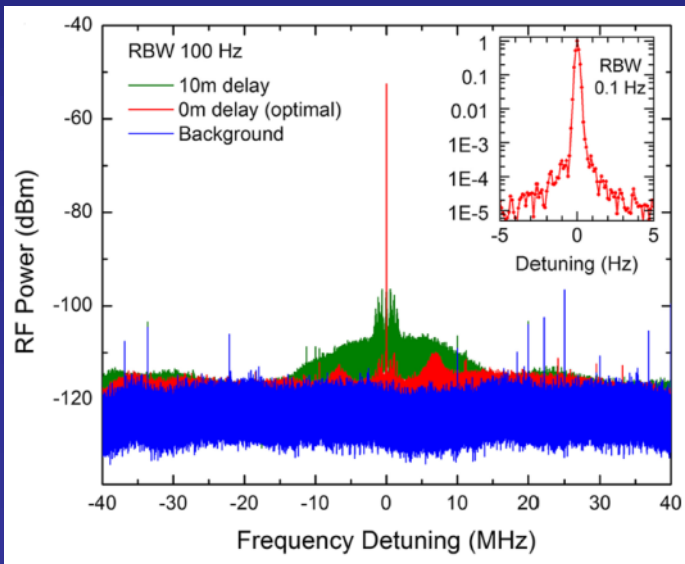
A new kind of broadband tunable source!



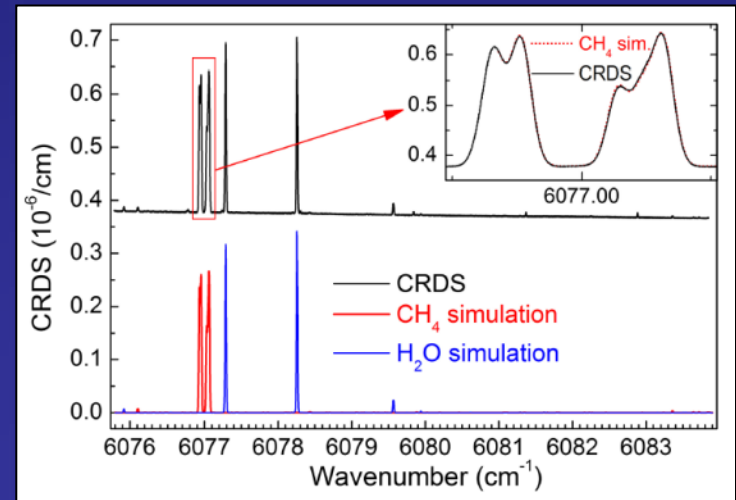
A pretty simple scheme



May transfigure your laser sources



High fidelity cloning



Suitable for spectroscopy

Thank you for your attention!

