



In the right place ... with the right timeTM

First results of a
new precision
frequency source.

5 November 08_{v1}

Molecular Optical Clock

Agenda

- A new clock Why?
- OptiSynx Technology
- Technology Development
- First showing of very first results
- Where next?



A new clock ... Why?



**Cellular
phone
operator**

SAVE MONEY

**Wireless
telecom
equipment vendor**

ADD VALUE



**Backhaul,
wireline, metro
ethernet operator**

SYNC IP

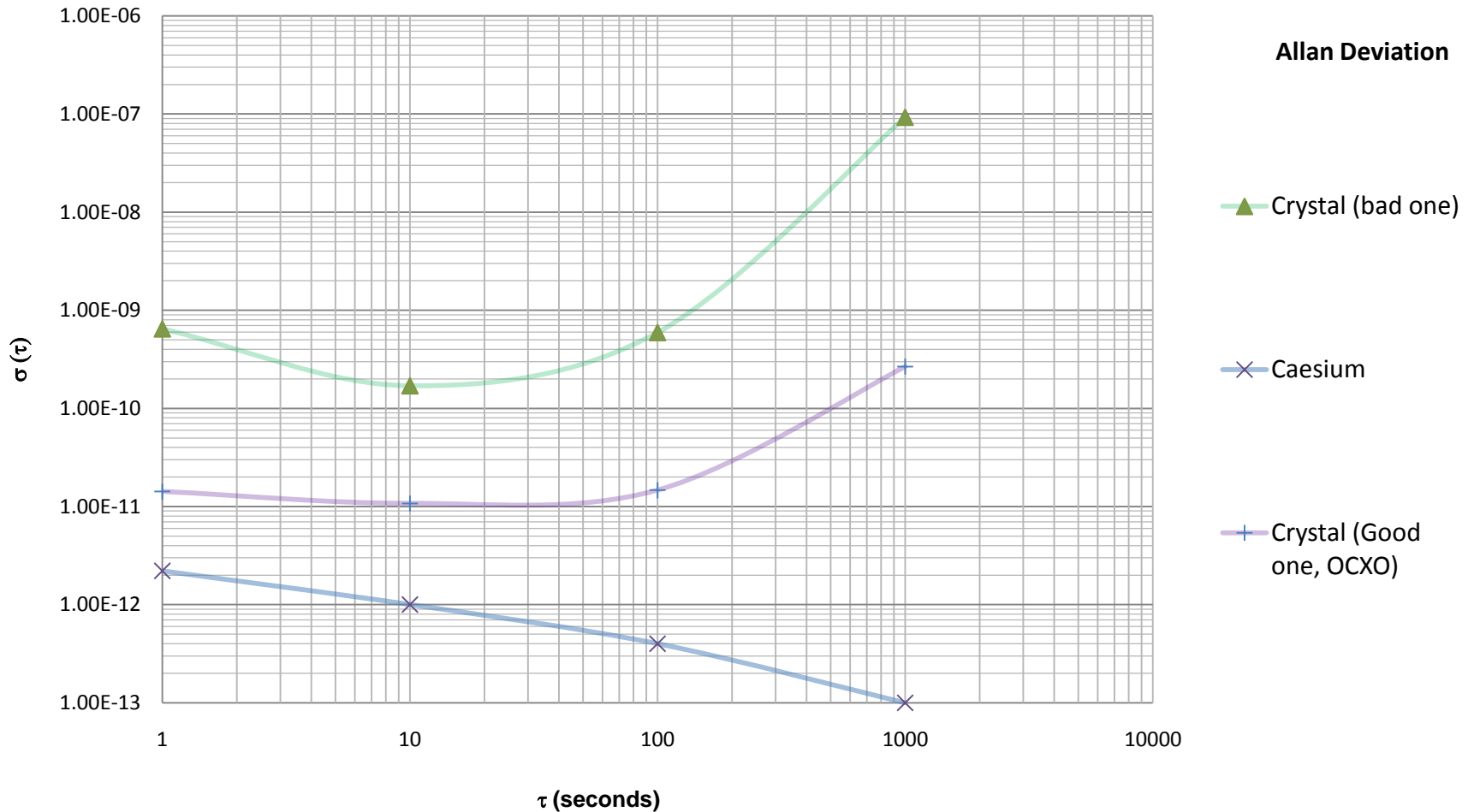
**Wireline or
ethernet
equipment vendor**

SOLVE LTE



A precision time source providing
the vital pulse of your network.

Allan Deviation Comparisons

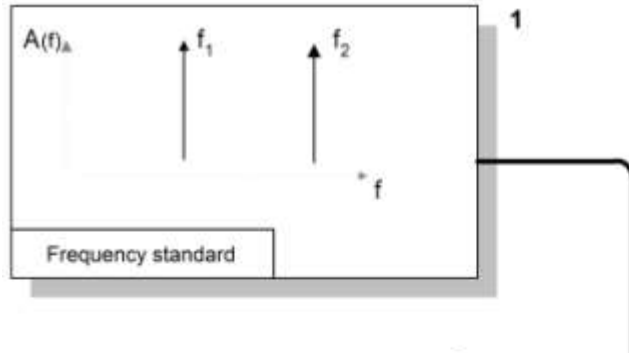


$\sigma(\tau)$ = [y-axis] = a root mean square measure of stability

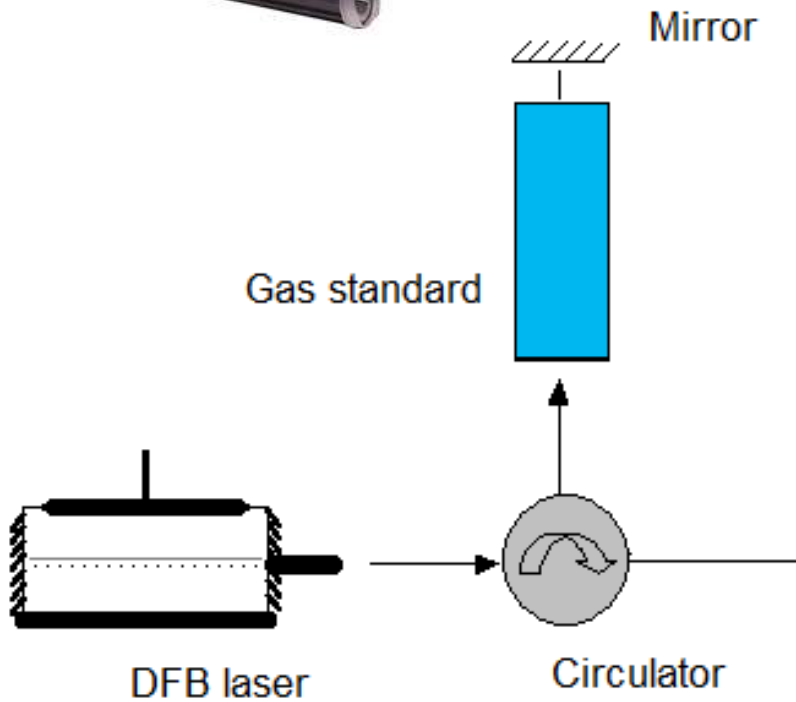
OptiSynx Molecular Optical Clock

- Cesium is based on a hyperfine atomic energy transition
 - in the tens of GHz. Atomic Line Q factor $\approx 20,000,000$
- OptiSynx MOC is based on a hyperfine molecular energy state
 - in the hundreds of THz. Molecular Q factor $\approx 200,000,000,000$
 - Also an international wavelength standard
 - Temperature effect $< 1E-15$ / $^{\circ}C$
- The problem is then to down-convert to useful frequencies
- The OptiSynx MOC teraconverter is a non-obvious combination
 - of solid state optics with the molecular oscillator
- In a single step it down-converts light to electronic frequencies

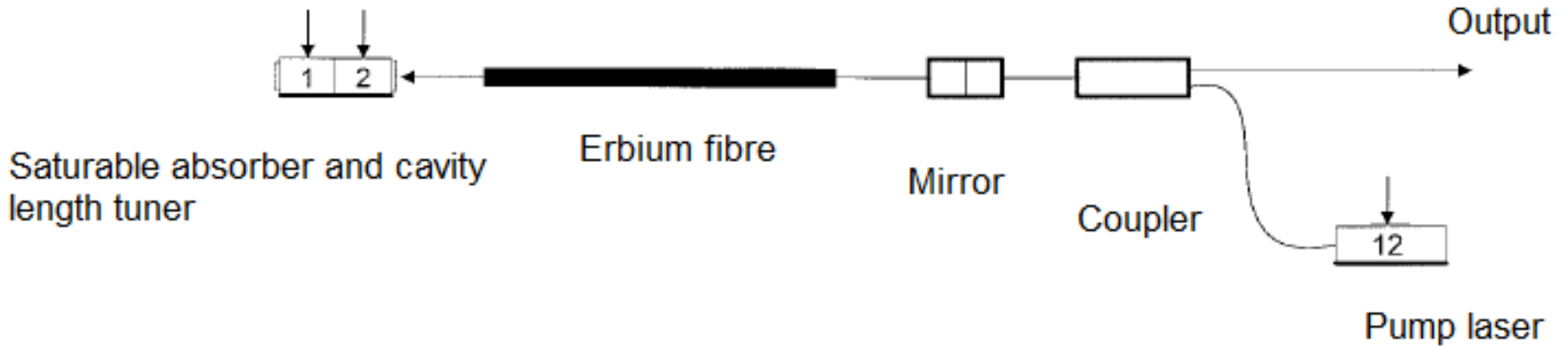
OptiSynx MOC Block Diagram



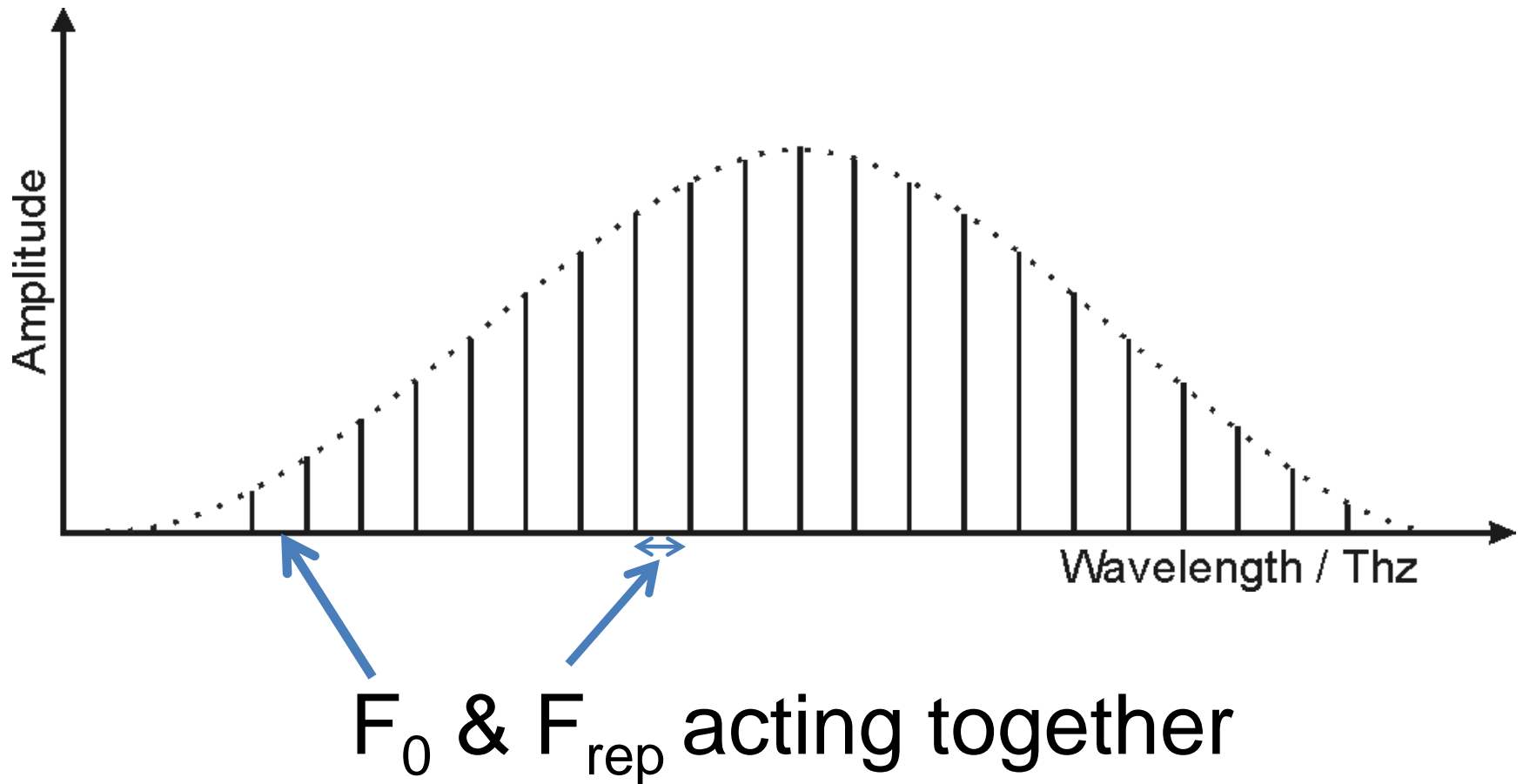
OptiSynx Gas Standard



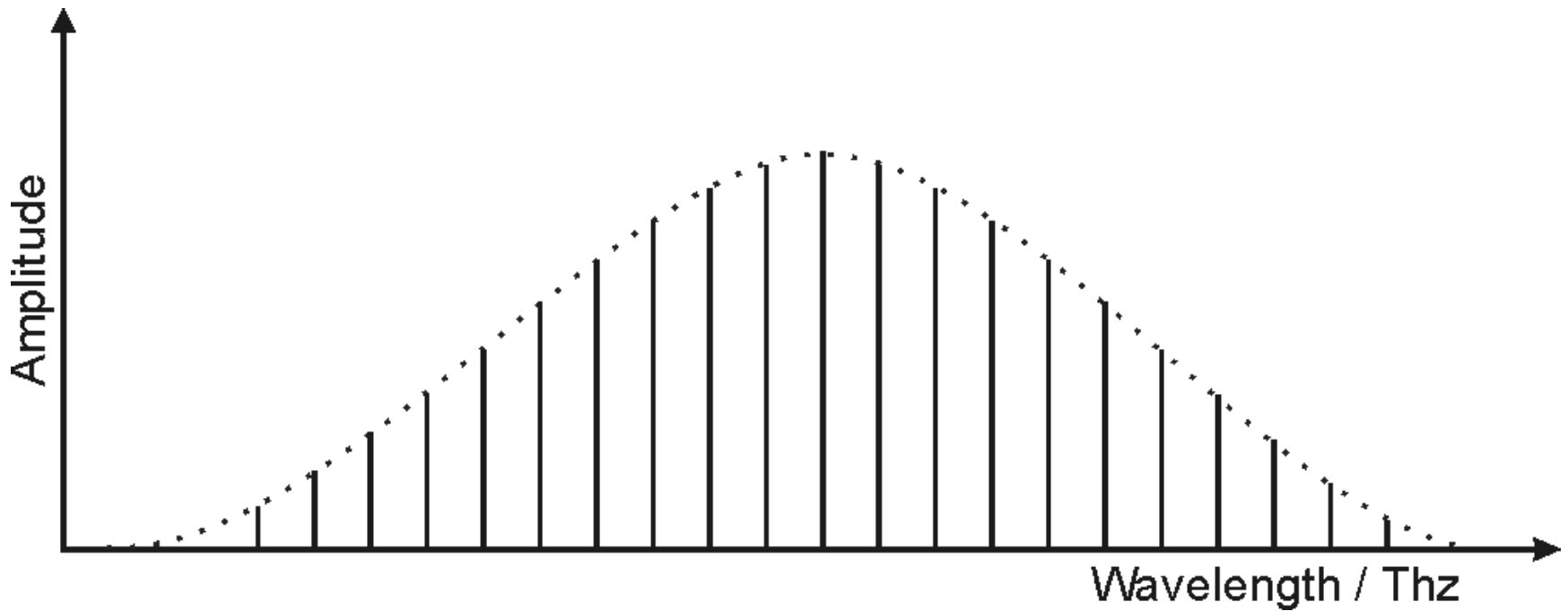
OptiSynx teraconverter



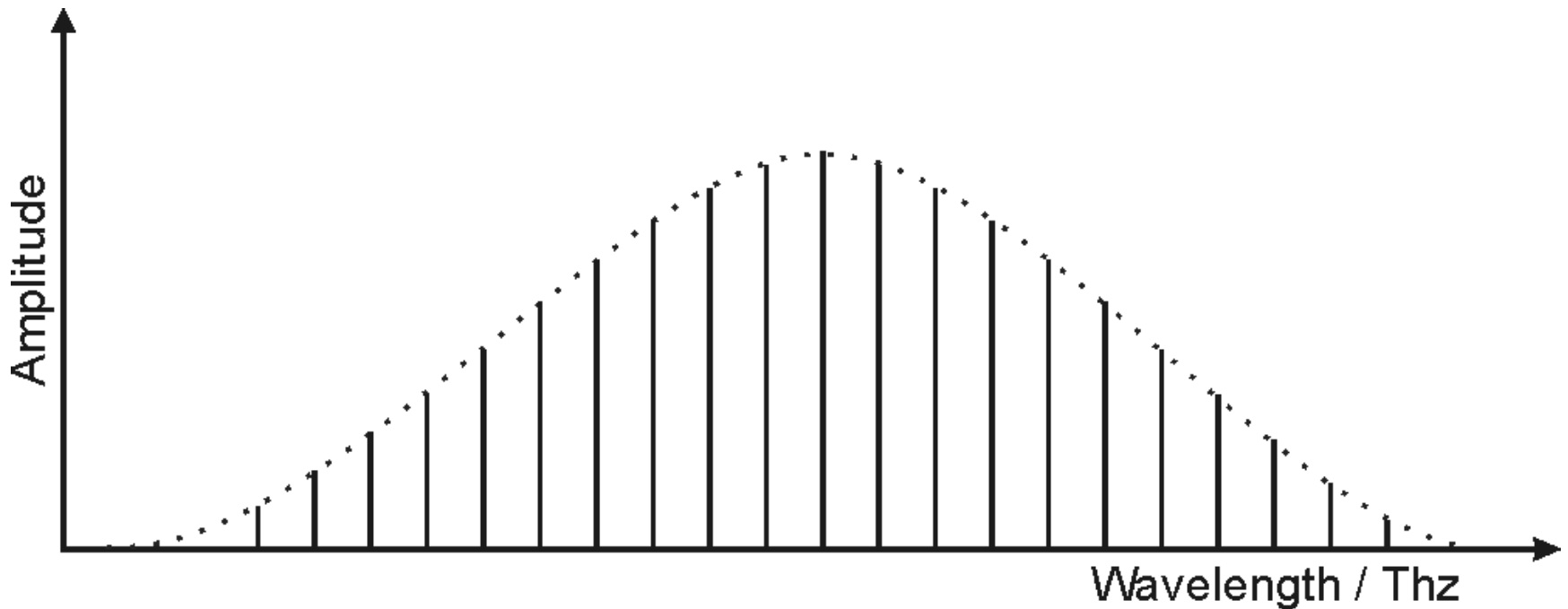
MOC Unconstrained Comb



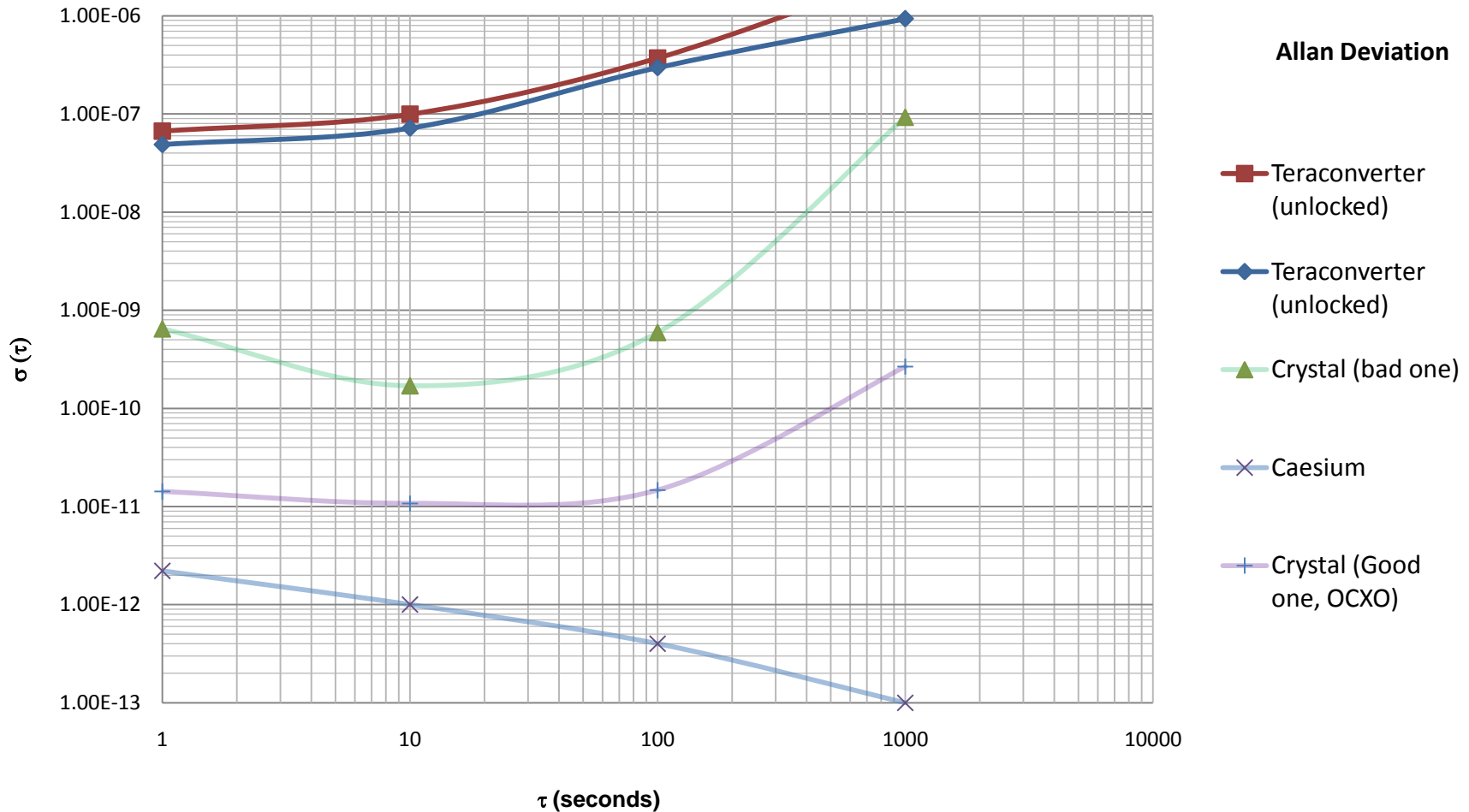
MOC Comb: F_0 degree of freedom



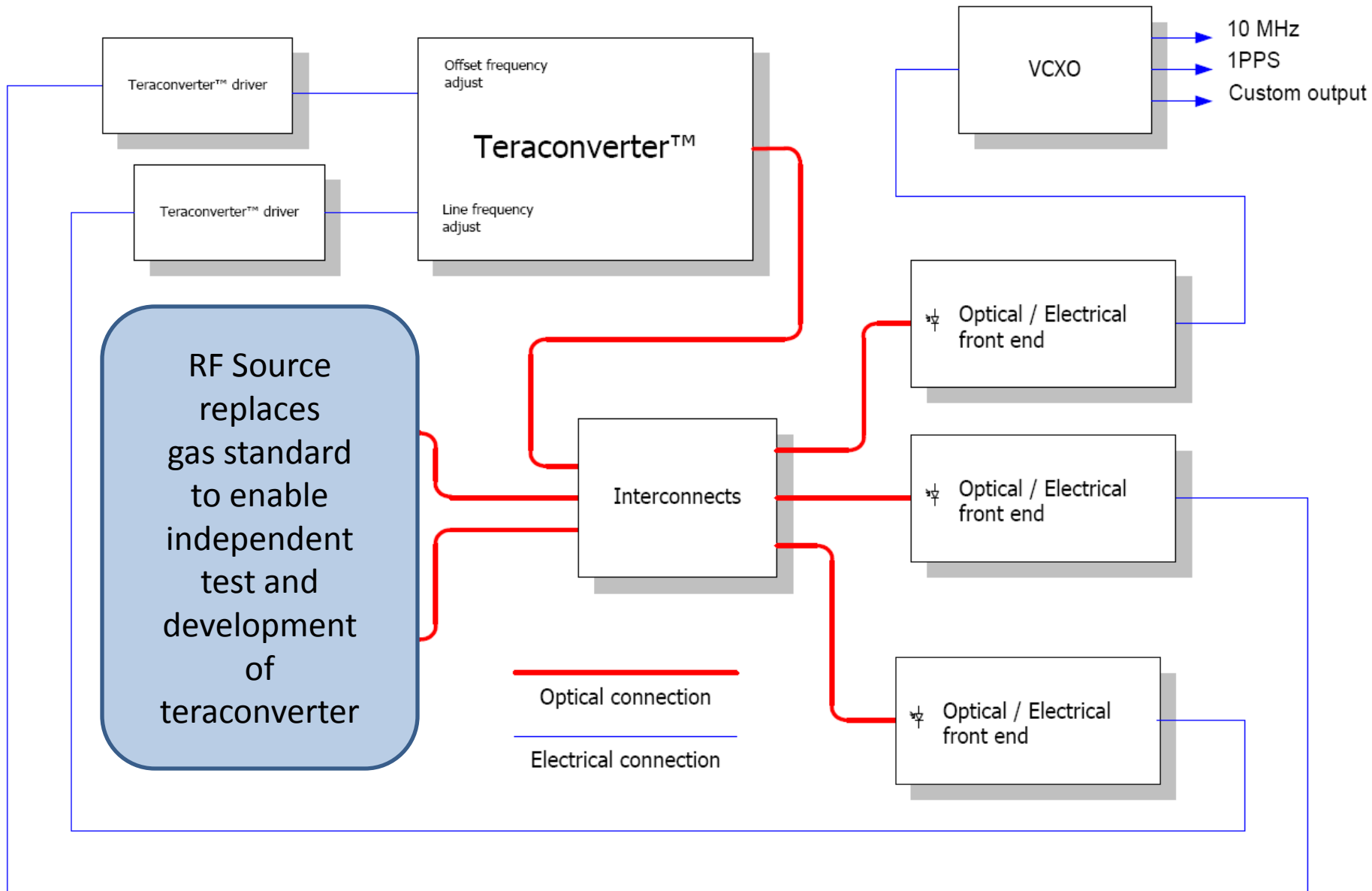
MOC Comb: F_{rep} degree of freedom



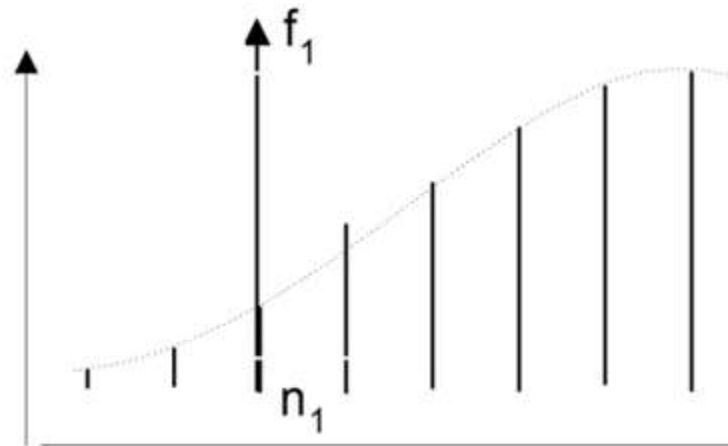
MOC Integration Stage 0: No Lock



OptiSynx MOC Block Diagram

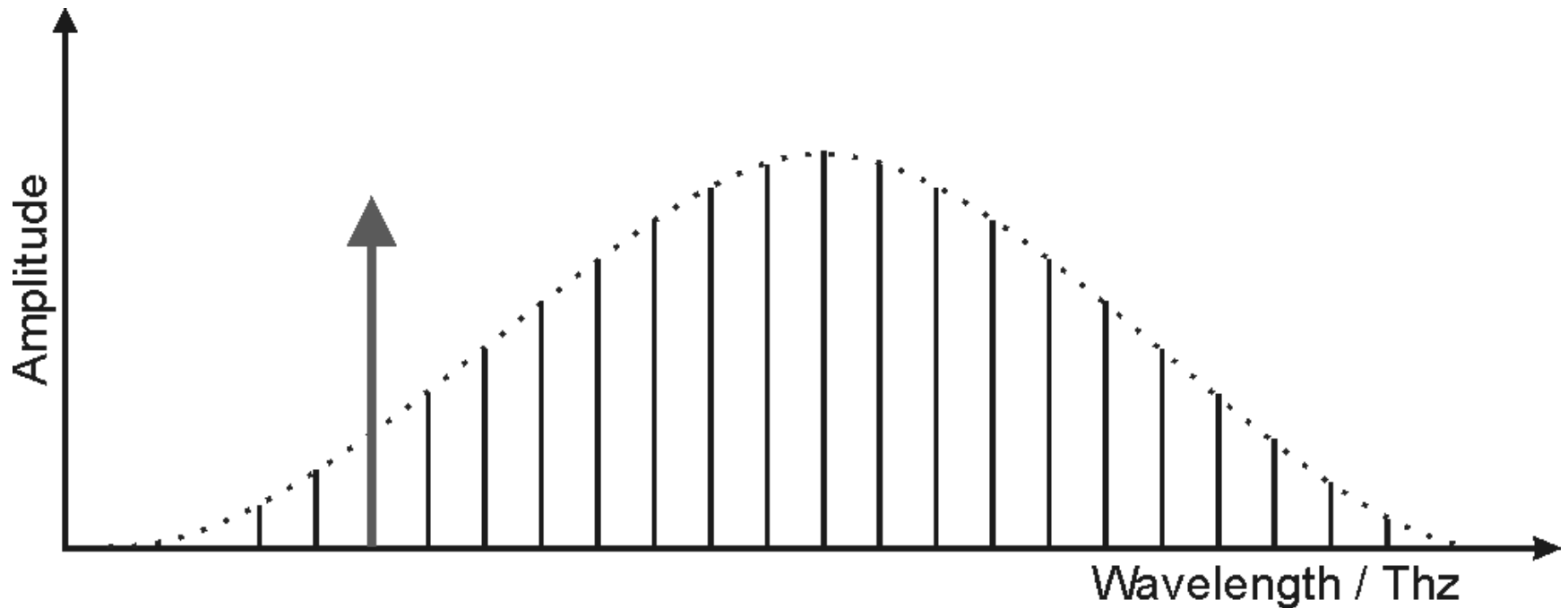


MOC Integration Stage 1: RF Lock



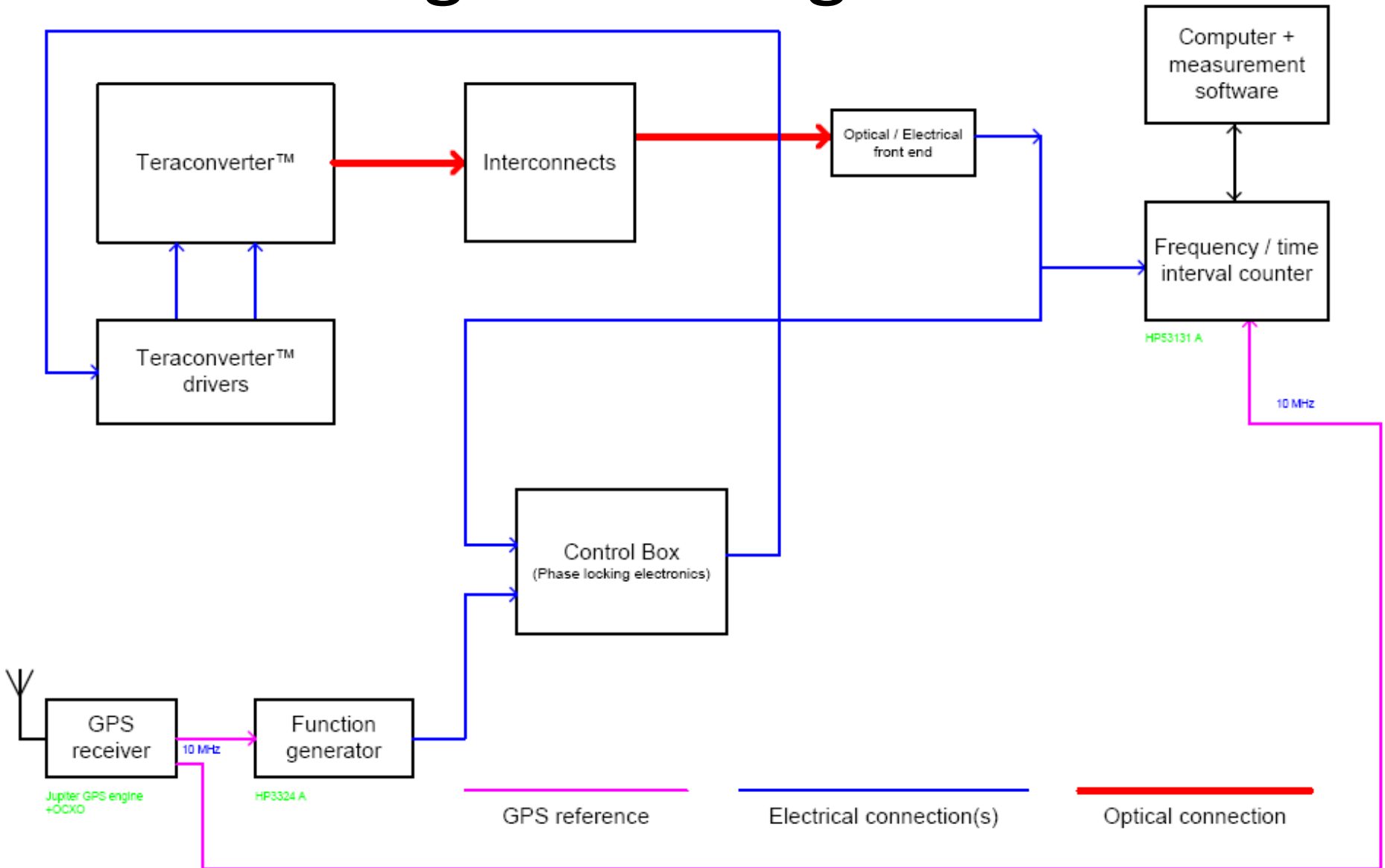
A comb line is locked onto a single fixed frequency generated by an RF signal source (locked to GPS to provide a high quality signal)

MOC Single Constrained Comb



Single RF lock

MOC Integration Stage 1: RF Lock



RF lock results (March 2008)



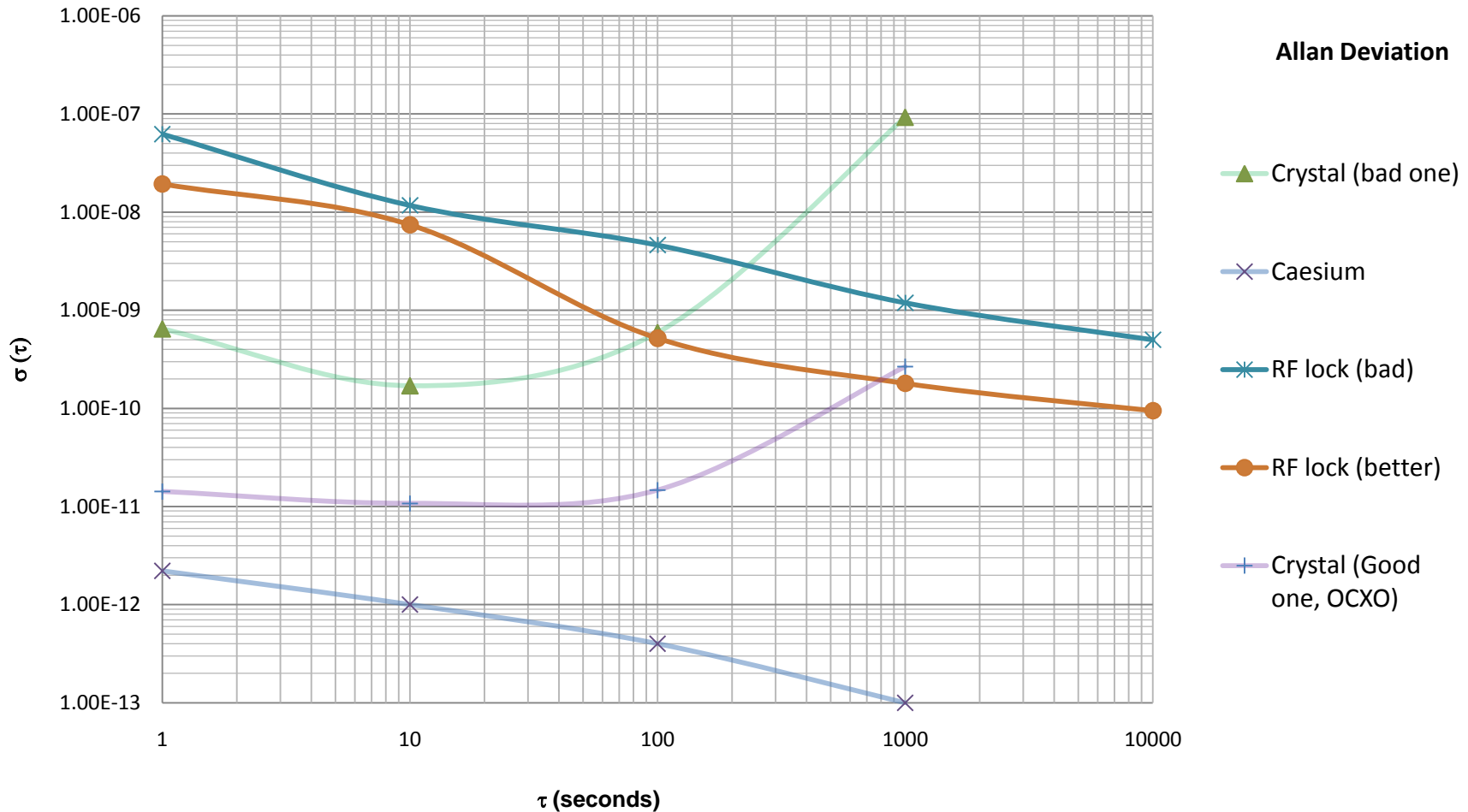
- First attempt at “closing the loop”. Brief periods of locking like behaviour observed.

RF lock results (October 2008)

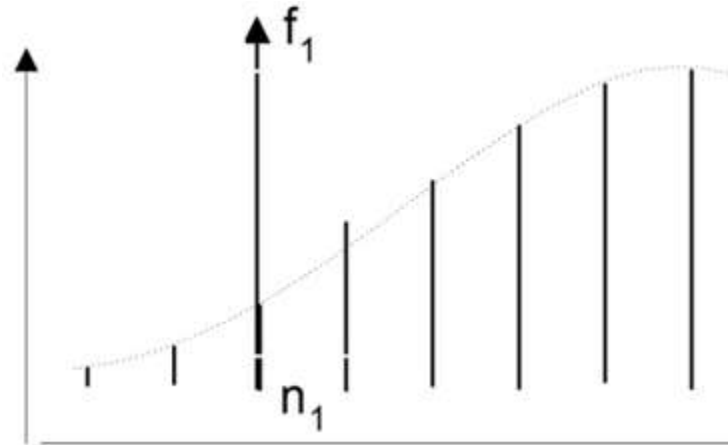


- Initially unlocked, then locking circuit switched on to produce stable lock

RF lock results (October 2008)

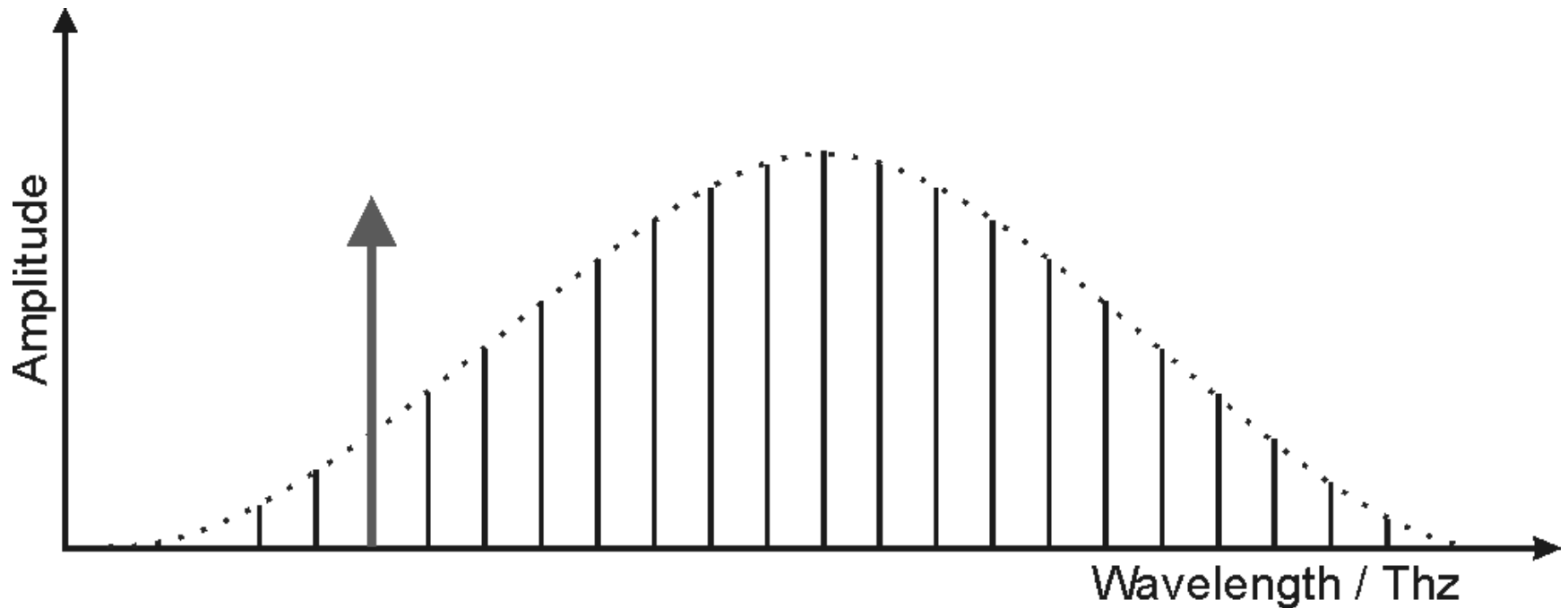


MOC Integration Stage 2: SOL (Single Optical Lock)



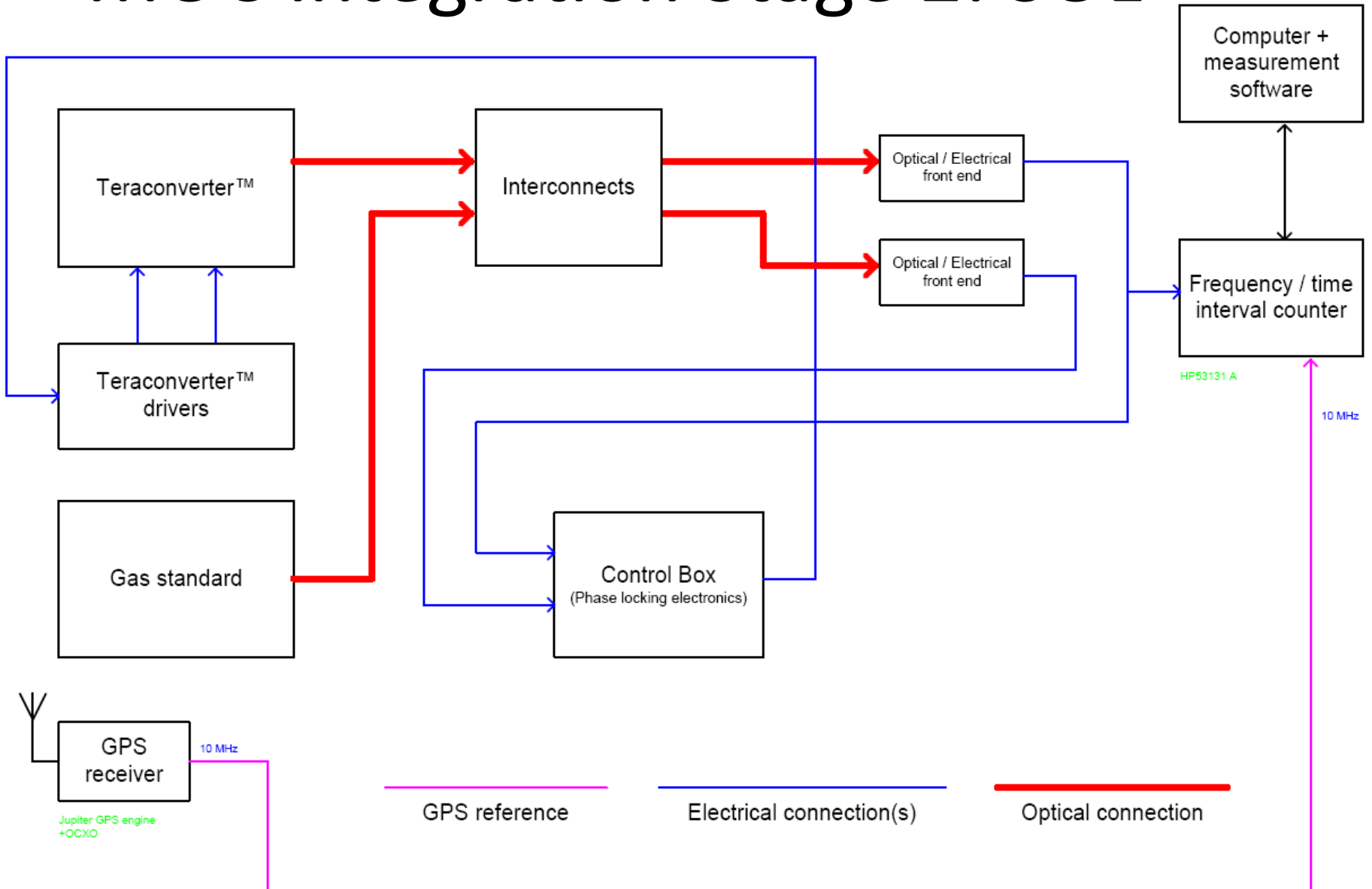
A comb line is locked onto a single fixed frequency generated by our own frequency standard source

MOC Single Constrained Comb



Single Optical lock

MOC Integration Stage 2: SOL



SOL results (October 2008)



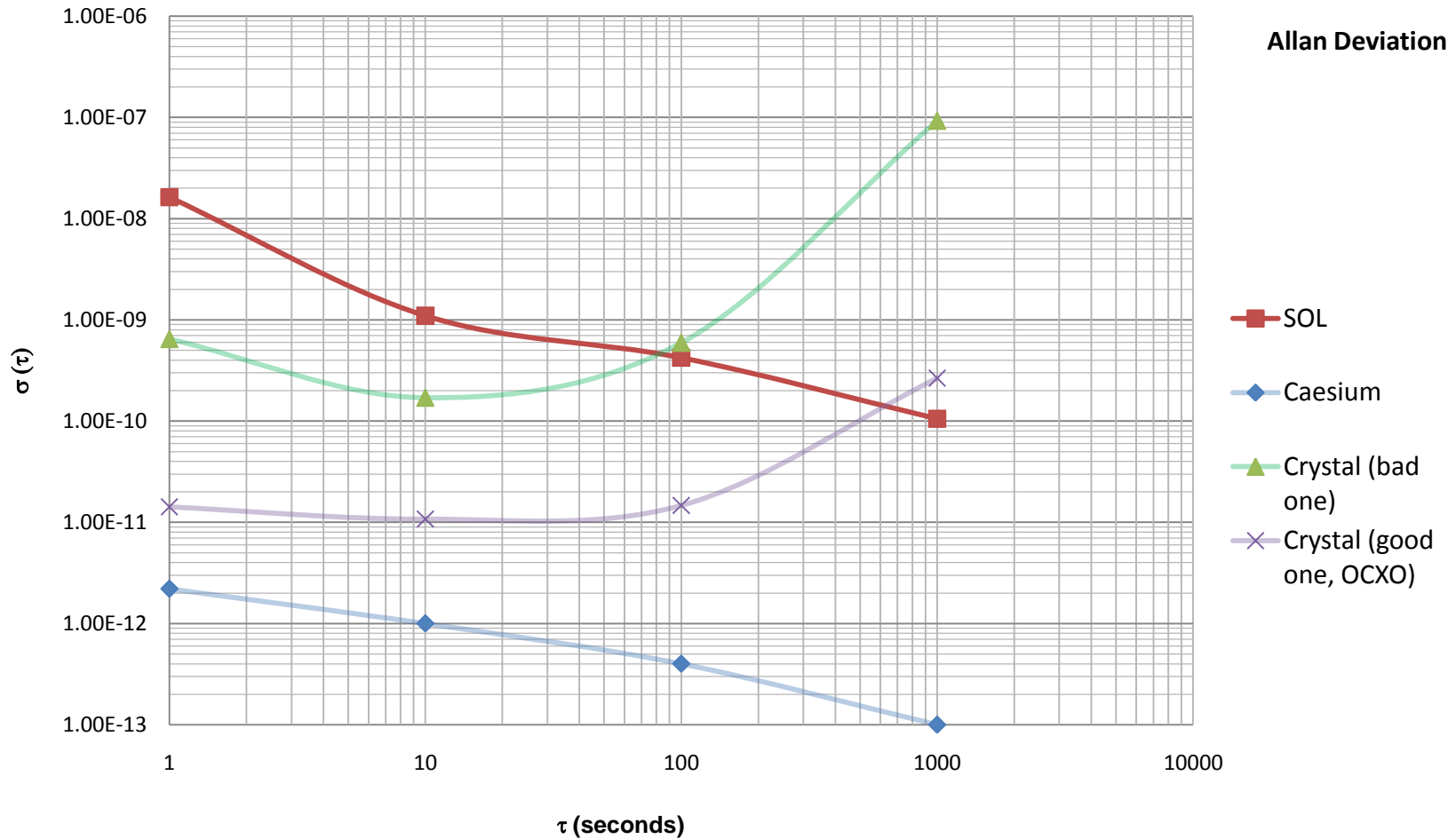
- Very noisy, regularly jumping out of lock, but with a brief period in lock

SOL results (November 2008)



- Initially unlocked then locking circuit turned on and it snaps into a nice stable long term lock

SOL results (November 2008)

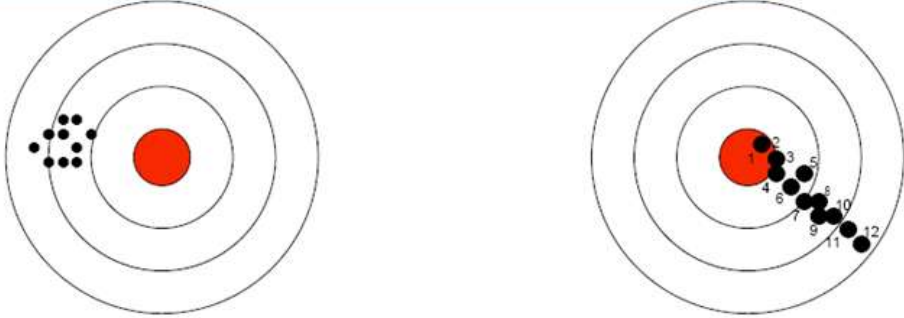


OptiSynx MOC as an accurate source

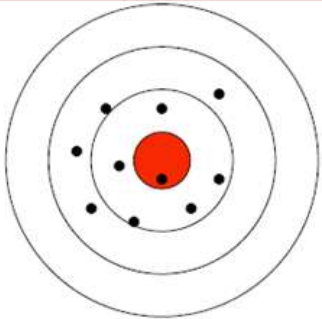
002 - Mike Garvey.pdf - Adobe Reader
File Edit View Document Tools Window Help

Accuracy vs Stability

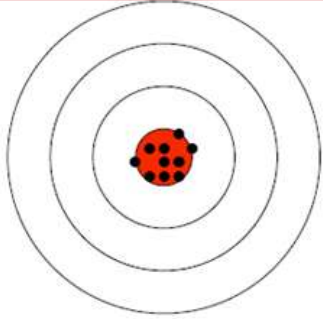
Symmetricom



St-11 ... St-11 ...



Accurate-not stable (noisy)



Stable and Accurate

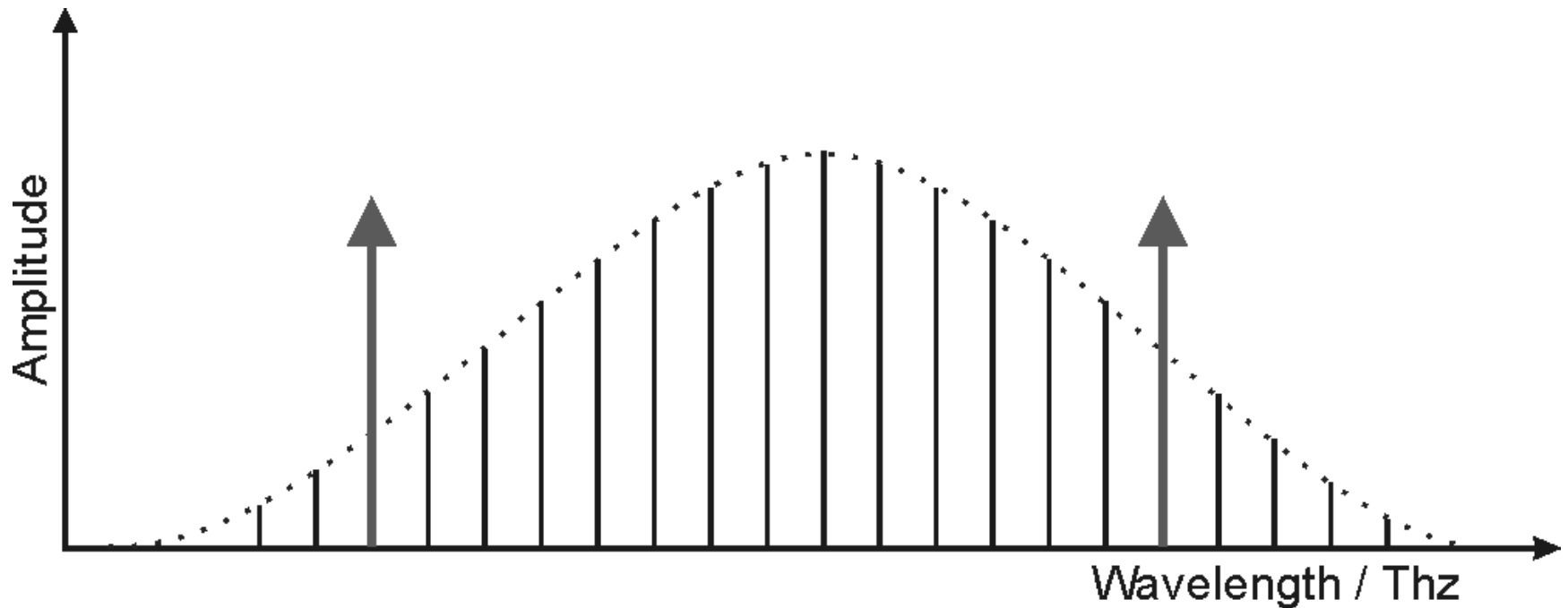
2008

2009

OptiSynx MOC Next Integration Stages

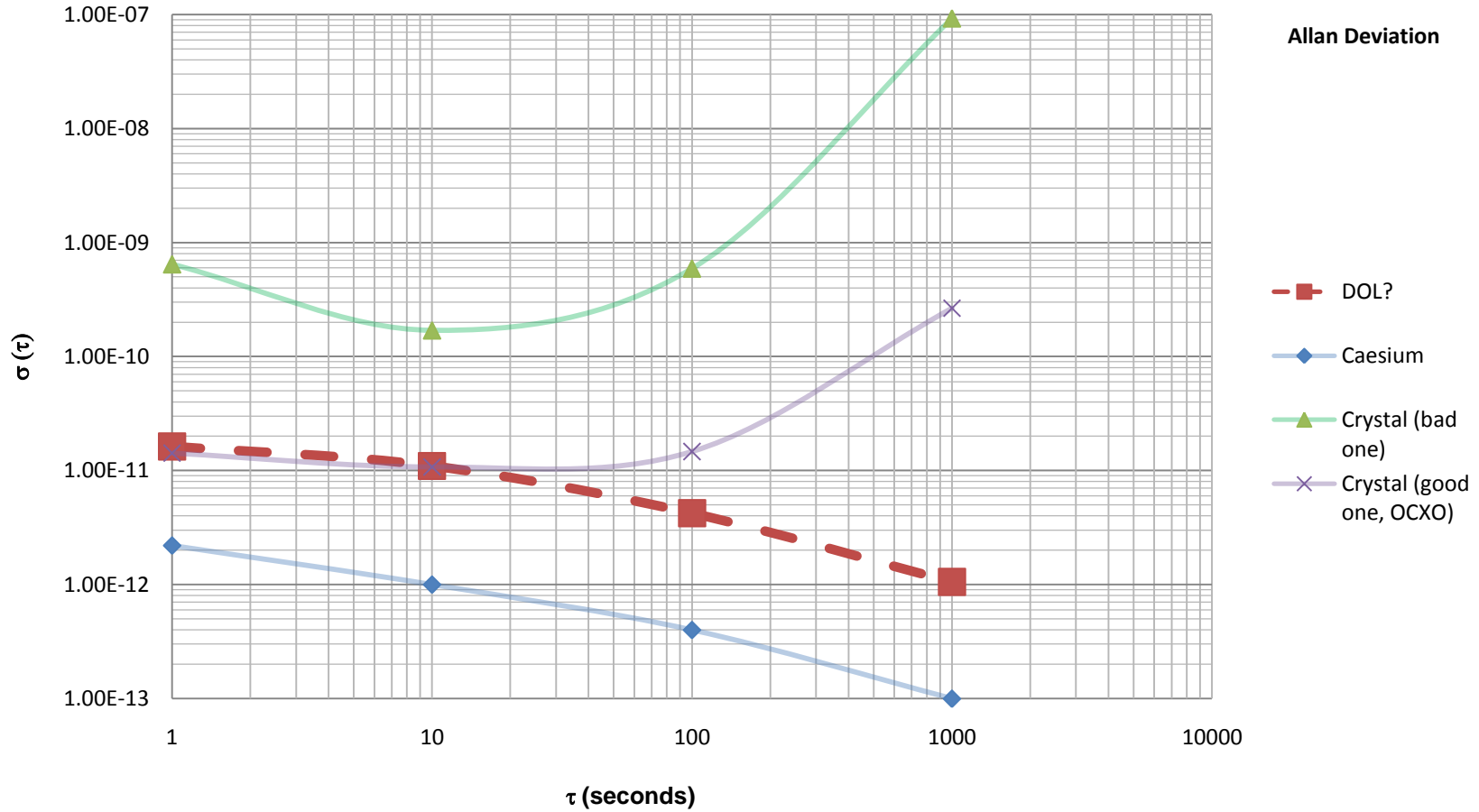
- Double Optical Lock (DOL) to remove noise
- Iterative improvement of locking circuits
- Output conditioning
- Evaluation prototypes
- Field trials
- Production

MOC Fully Constrained Comb



Double optical lock

Anticipated Initial DOL Results



OptiSynx Product Development



OptiCloc
xU Rack mount box

OptiModule
for mounting on blade or card



OptiChip
a PCB component



Product	x months	y years	z years
Cost	\$a0,000	\$b00	\$c0
Deployment	Core	Edge	Home

Currently OptiSynx envisage the above roadmap for product release with each successive product smaller, lower cost and lower power. Exact product features will be dependent on customer feedback.

Summary

- New primary source
 - Based on molecular reference standard
 - Teraconverter
- New performance/price regime
 - Offers new options in synchronisation
 - Offers solutions to precision timing over IP networks
- Stand-alone or network synchronised
 - Can be used stand-alone for some applications
 - Can be used as UTC time source with long hold-over



network
for the time of your/life™

optisynx08@optisynx.com

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