EPIC Online Quantum Technology Meeting on Atomic Clocks and Network Synchronization

Speaker
Christian Schori

The Global Leader in Resilient PNT

Providing the world's most critical applications real-time, accurate, reliable positioning, navigation, and timing data.

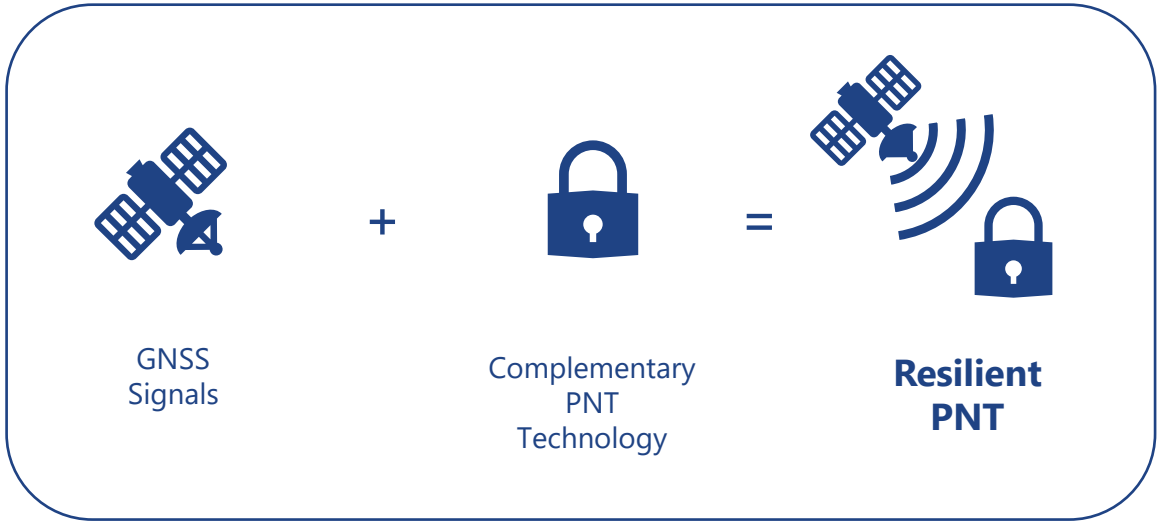
Safety, Security and Reliability

Speaker
Jacques Haesler

OROLIA, WORLD LEADER IN RESILIENT PNT

Resilient PNT

At the Core of Mission Critical Applications

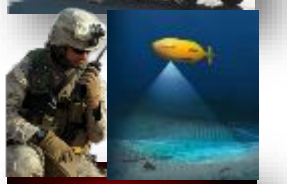


In today's world, GNSS signals are not always available or accurate. Orolia makes these signals virtually fail-safe for critical applications in defense and commercial industries worldwide.

With robust, accurate GNSS-based systems and proven technologies, Orolia is the world leader in Resilient Positioning, Navigation and Timing (PNT) solutions.

Time and Location You Can Trust™

ESSENTIAL TO ADVANCED NICHE MARKET SEGMENTS

 **TIMING & SYNC**	Disciplined and compact clocks for time servers, network synchronization, intelligent modular time & frequency systems
 **DEFENSE & AVIONICS**	Rugged MIL standard clocks with Low G and Low VIB sensitivity for various defense, resilient PNT, UAV applications
 **TELECOMMS & BROADCAST**	Ultra low noise disciplined clock sources for military, commercial ground & satellite communications
 **MOBILE SYSTEMS**	Low SWaP, low noise clock sources for mobile ground, defense, unmanned systems or tactical radios
 **SCIENCE & METROLOGY**	High stability clock sources for frequency standards, precise lab instrument for testing & science metrology (VLBI, precision monitoring & geodetic systems, timekeeping, deep space tracking & navigational systems)
 **SPACE**	Ultra stable, radiation hardened & disciplined rubidium and crystal sources for LEO Earth observation, GEO Satcom, and MEO GNSS Navigation where stability is required

VARIOUS PRODUCT CAPABILITIES

- 164 space atomic clocks FM
- 204 OCXOs FM
- more than 65000 atomic clocks

COMPONENTS

SYSTEMS

ISOURCE+®

RB OSCILLATORS

mRO-50
Rb Oscillator
Low SWaP

LPFRS
Rb Oscillator
High-Performance

LPFRS/AV1
Rb Oscillator
Rugged airborne

StarLPRO-1500
Rb Oscillator
Compatible to
Datum LPRO

iSYNC+®

GPS/GNSS SYNC
RB OCXO OSCILLATORS

SRO-100
Rb Oscillator
Disciplined

SRO-5680
Rb Oscillator
Rugged, Disciplined,
Low G

GRClock-1500
Rb Oscillator +
GNSS Rx

LNRClock-1500
Rb Oscillator
Low Noise + GNSS Rx

iSPACE+™

SPACE-QUALIFIED OSCILLATORS

LNMO
Ultra low noise
Master OCXO
Oscillator

MO
Master
OCXO
Oscillator

RAFS
Ultra low noise
Rb Frequency
standard

**Passive
Hydrogen Maser**

iREFERENCE+®

GPS/GNSS RB/MASER
STANDARDS

GNSSource-1000
Primary reference source
OCXO+GNSSRx

GNSSource-2500
Primary reference source
OCXO+Rb+GNSS Rx

RBSource-1500
Rb reference
Disciplined
Compact 1U

**Active Hydrogen
Maser**

**Passive Hydrogen
Maser**

iTEST+®

CLOCK INSTRUMENTS

FemtoStepper
High-Performance
Freq. Synthesizer

PicoTime-1U
High-performance
Clock ADEV Stability
analyzer

SPECTRATIME mRO-50

Miniaturized Rubidium Oscillator (mRO-50)

The clock design is based on the rubidium clock heritage at Orolia. It has been adapted for low power (0.36W@3.3V) and small size (51cc).

Key Features

- Aging (after 3 months) <5E-12/day
- < 0.45W @ 5V or < 0.36W @ 3.3V
- < 51cc

Frequency	10 MHz
Temperature range	-10°C to +65°C
Frequency change over Temp. range	< 4E-10
Short term stability (ADEV)	≤ 4E-11@ 1s (S option)

Size	50.8 × 50.8 × 19.5mm 2″ x 2″ x 0,77″
Weight	75 g max. 0.16 lb max.

USE CASE: OROLIA ART CARD

About the Atomic Reference Time (ART) Card

The architecture of the ART Card as well as the software architecture that will manage the card are intended to be embedded in any Open Compute server to build a PTP Grand Master.

This new timing card has been developed in the framework of the Time Appliances Project (**TAP**), a sub-project initiated by the Open Compute Project (**OCP**).

Key Features of the ART Card

- First PCie card including an atomic time reference from Orolia, the **mRO-50,** in addition to all necessary elements to create a GNSS clock (a specific GNSS timing receiver for multi-constellation and multi-frequency)
- ART Card supports PCIe standard in X4
- State-of-the-art linux driver
  Includes a software to monitor synchronization of the atomic clock reference (mRO-50) on the GNSS, while providing an API and the support of a PTP Hardware Clock (PHC)
- Detection of GNSS signals quality to switch to holdover mode, using stable atomic oscillator to provide resilient time and low time derivation

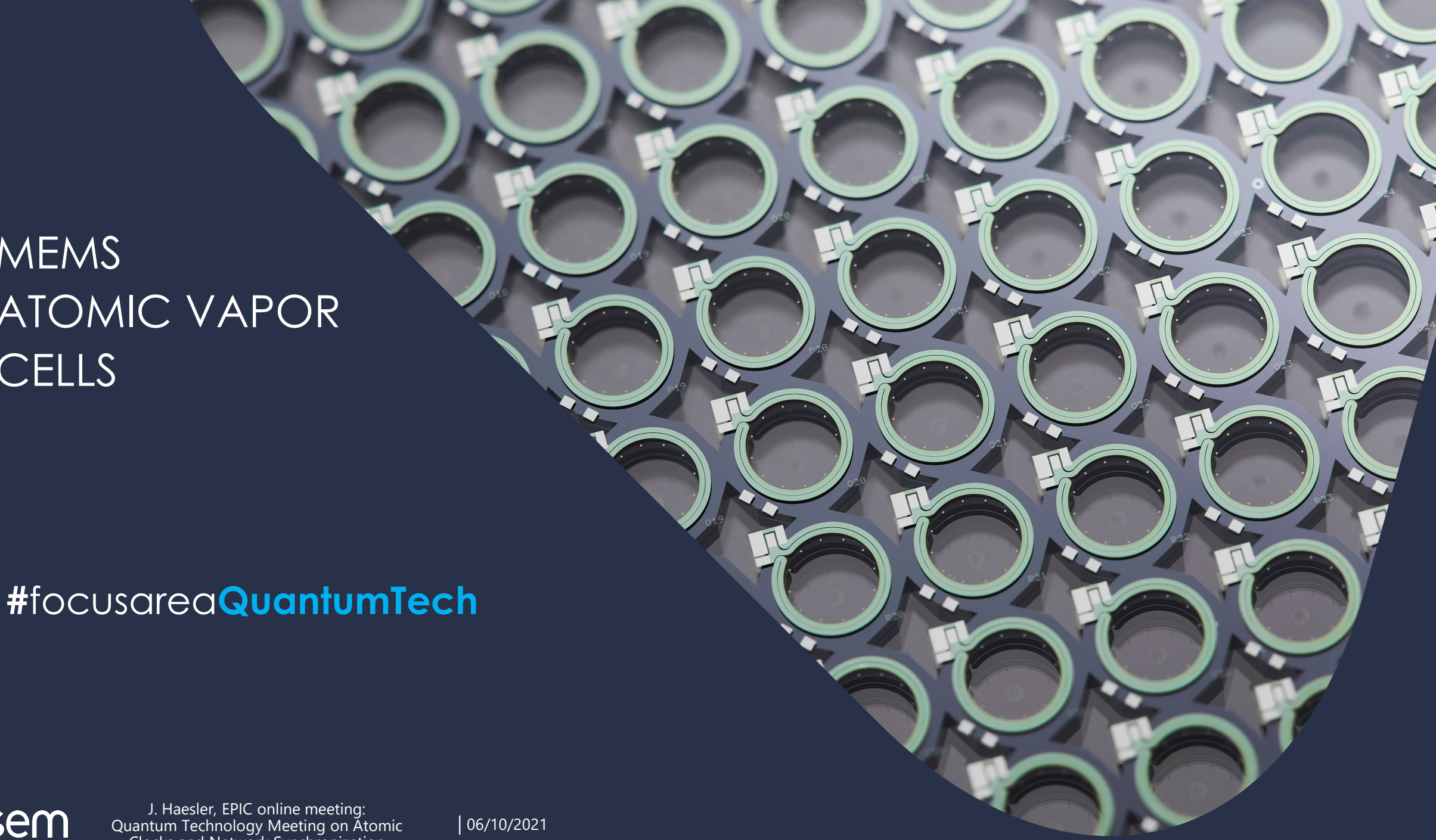
Link:
https://www.orolia.com/about-the-atomic-reference-time-card-art-card/

CSEM

Swiss Research
and Technology Organization (**RTO**)

www.CSEM.ch

MEMS ATOMIC VAPOR CELLS

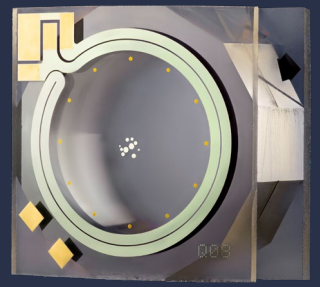


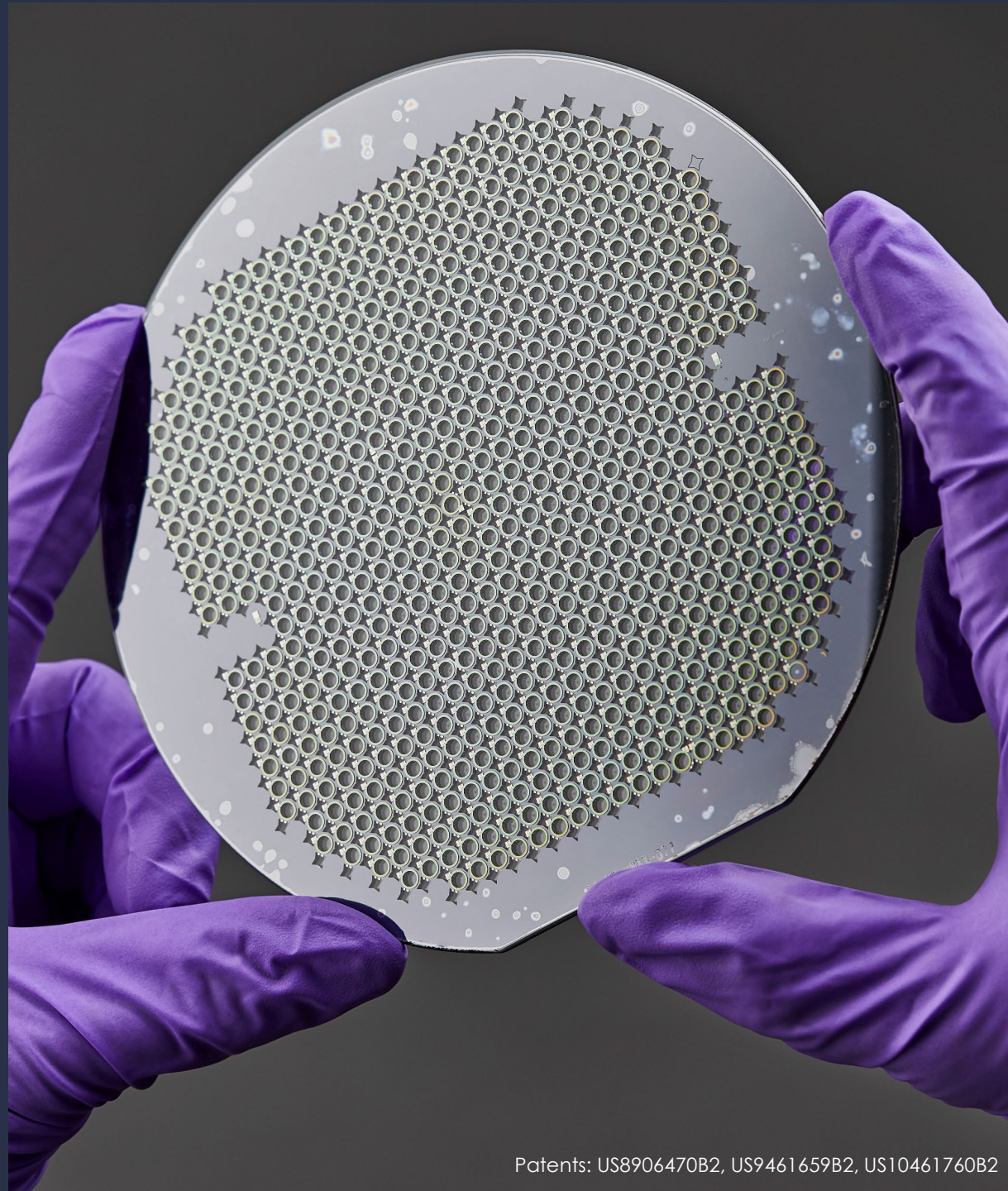
#focusareaQuantumTech

MEMS atomic vapor cells

What we **offer**:

- Patented **wafer level** fabrication
- Customized design
- Patented **RbN3** filling (^{87}Rb, nat-Rb) (N_2 buffer gas)
- Dispenser filling (natural Rb) (various buffer gases)
- Al_2O_3 **protective coatings**
- Patented **gold** microdiscs
- **Anodic bonding**
- Cu-Cu thermocompression
- Glass functionalization (heater)





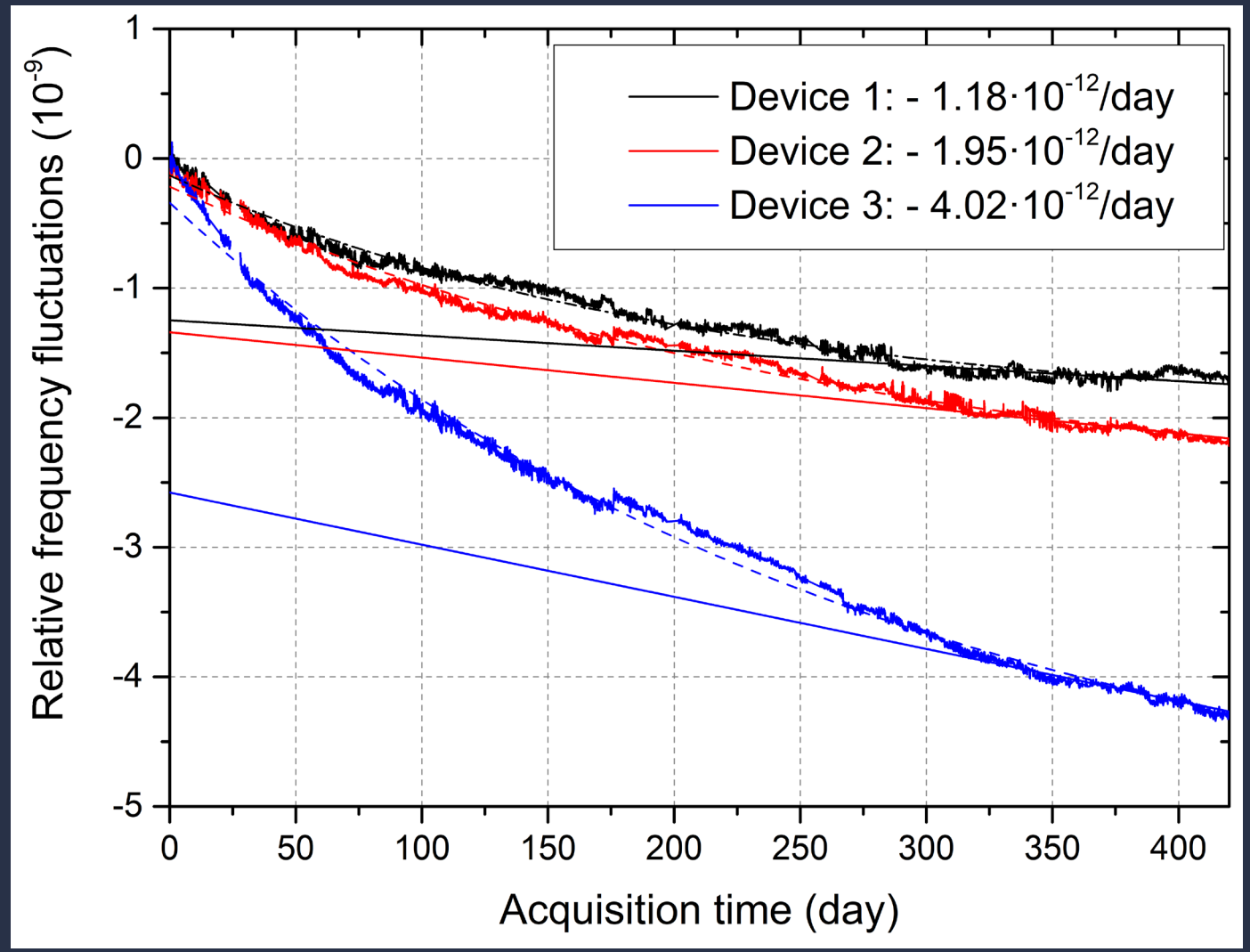
Patents: US8906470B2, US9461659B2, US10461760B2

MEMS atomic vapor cells **performances**

- MEMS cells with Au discs tested together with

spectratime
iPrecision Timing Solutions®

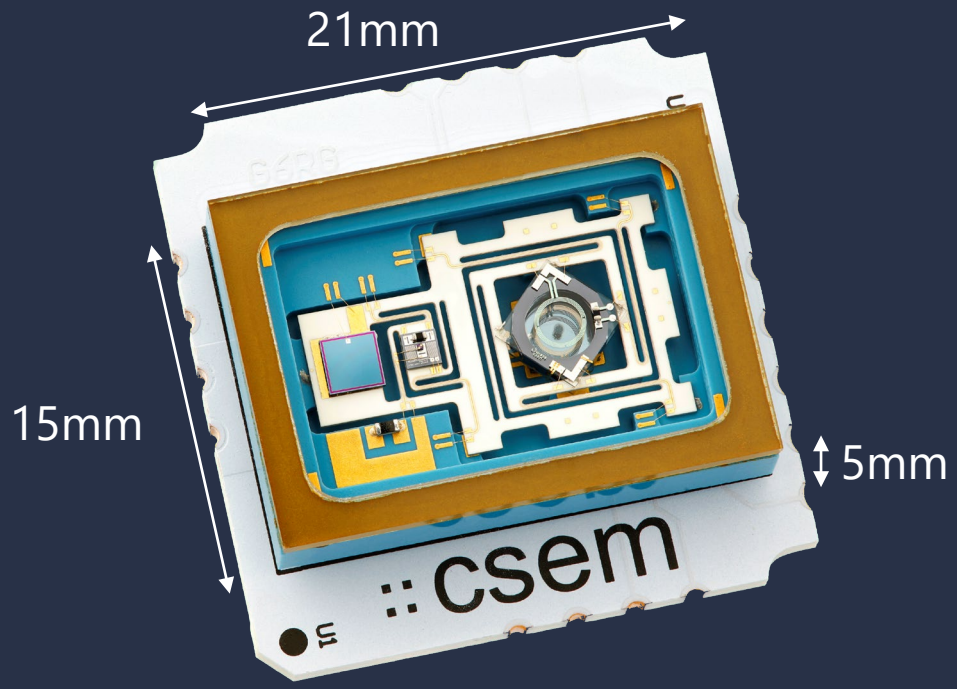
- Low drift: < 5E-12 / day
- Results equaling world best performances in a miniature clocks with MEMS cells



Miniature
atomic clocks

#focusarea**QuantumTech**

CSEM **C-MAC** physics package



Flat-form factor physics package (C-MAC)

The physics package design is based on a patented waveguide architecture. Under vacuum, the power consumption is less than 50mW at room temperature. The volume is as low as 1.6cc.

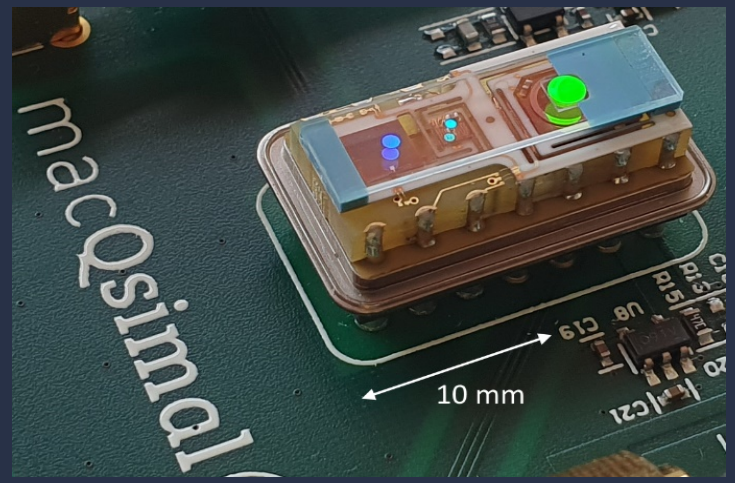
Key Features

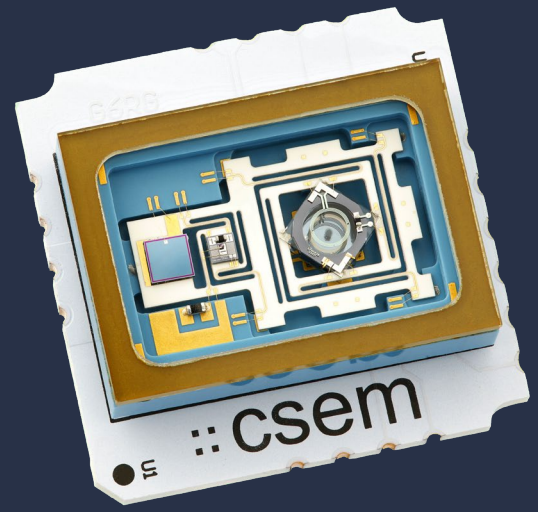
- Aging (after 3 months) <5E-12/day
- < 0.05 W @ 5V
- < 1.6cc

Frequency	n/a (10 MHz)
Temperature range	-10°C to +65°C
Frequency change over Temp. range	tbc
Short term stability (ADEV)	≤ 8E-11@ 1s

Size	21 × 15 × 5mm 0.8″ x 0.6″ x 0.2″
Weight	5 g max. 0.011 lb max.
Power consumption	< 0.05 W @ 5V

Merging **Orolia's** and **CSEM's** expertises



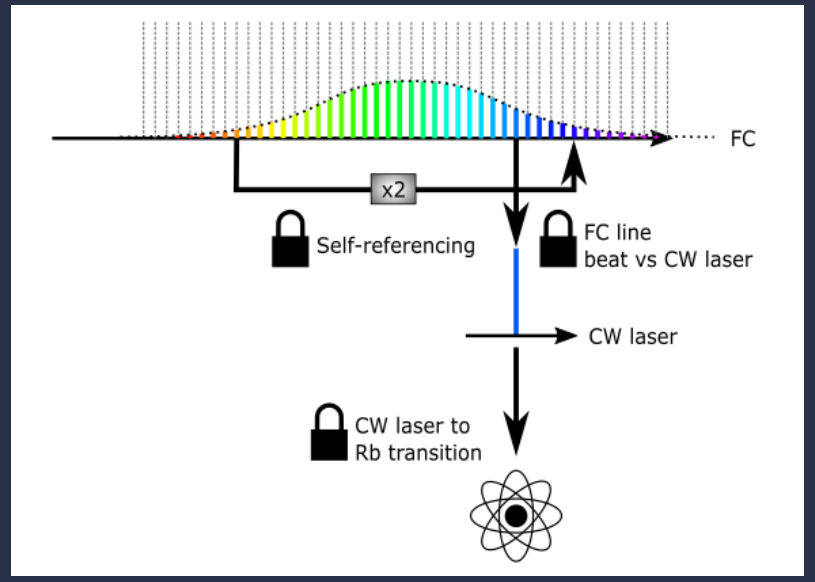


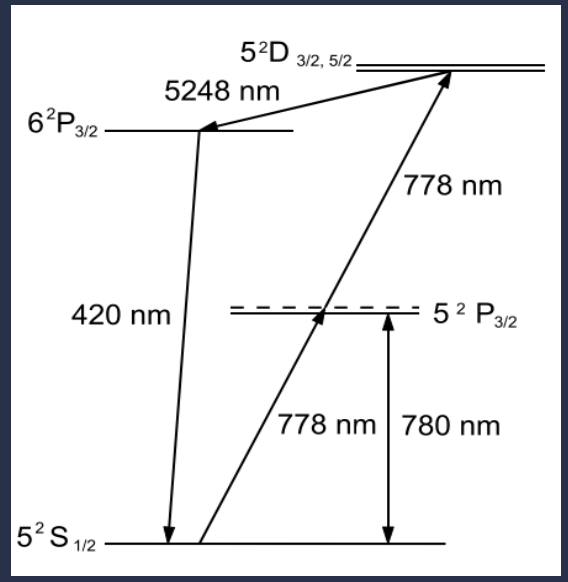
Expected performances

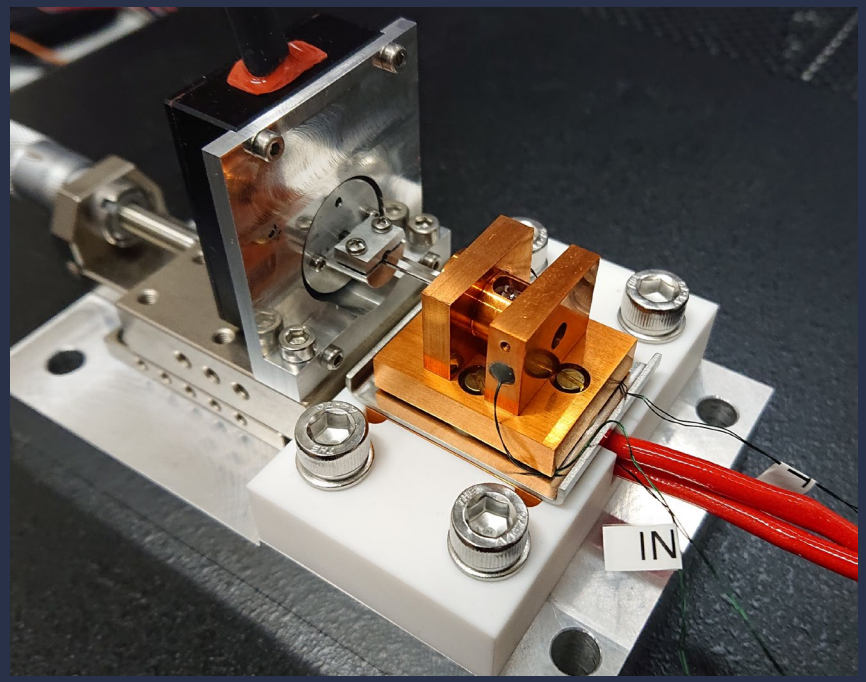
Frequency	10 MHz
Temperature range	-10°C to +65°C
Frequency change over Temp. range	tbc
Short term stability (ADEV)	≤ 8E-11@ 1s

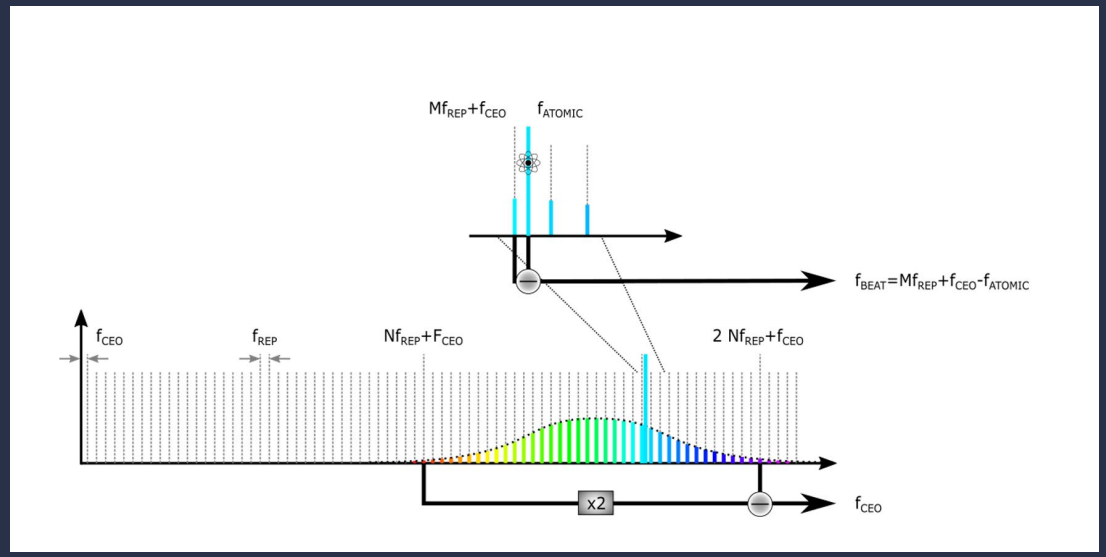
Size	50.8 × 50.8 × 19.5mm 2″ x 2″ x 0,77″
Weight	75 g max. 0.16 lb max.
Power consumption	< 0.15 W @ 5V

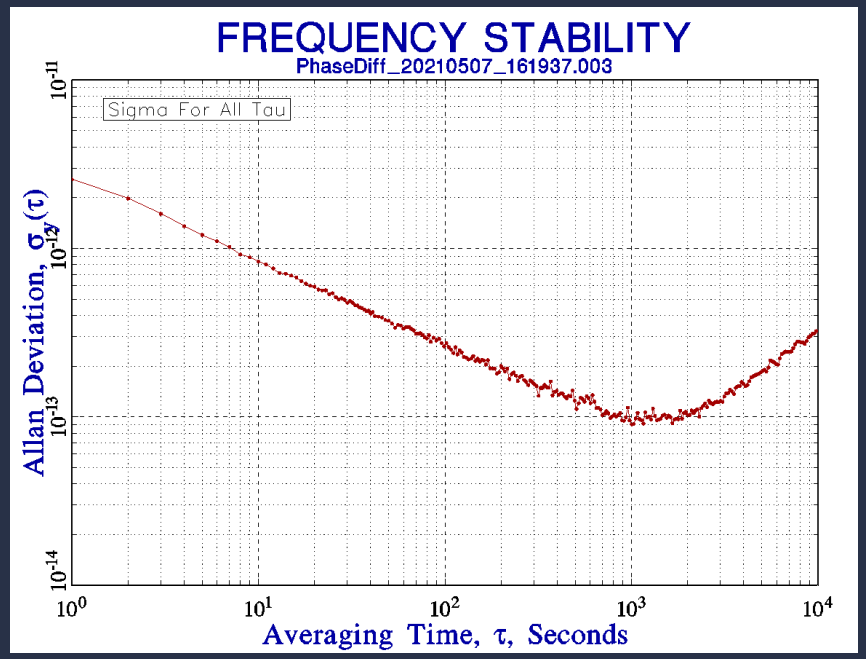
Next generation atomic clocks









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