Main Oscillator with sub-fs Resolution
and
High Performance Local Oscillator Generation in MicroTCA.4

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Agenda

1. KVG Introduction
2. Quartz Crystal Products
3. Main Oscillator with high Power and sub-fs Resolution
4. High Performance Local Oscillator Generation

KVG Introduction

KVG Quartz Crystal Technology GmbH

Location / Headquarter: Neckarbischofsheim, Germany

We provide

- **state-of-the-art frequency control products for Science & Industry**
  e.g., crystals, oscillators, filters, specific quartz crystal products, etc.
- **Customized products, solution and excellent service**
- **Certification**
  EN9100 and ISO14001

Quartz Crystal Products

Ultra-low Phase Noise OCXO Series

10 MHz

- **Case:** 36.1x27.2x15 mm
- **Supply voltage:** 12.0V
- **Current consumption:**
  Warm-up ≤ 400 mA (4.8 W max.)
  Steady State ≤ 150 mA (1.8W max.)
- **Frequency stability:**
  -20˚C ~ 70°C ≤ ± 10 ppb
- **Output power:** > +8 dBm
  sine wave, 50 Ohm
- **Long-term stability** (Low aging):
  20 years ≤ ±400 ppb
- **Phase noise:**
  ≤ - 120 dBc/Hz at 1 Hz
  ≤ - 148 dBc/Hz at 10 Hz
  ≤ - 160 dBc/Hz at 100 Hz
  ≤ - 165 dBc/Hz at 1 kHz
  ≤ - 168 dBc/Hz at 10 kHz
  ≤ - 168 dBc/Hz at 100 kHz

100 MHz

- **Case:** 51 x 51 x 29 mm
- **Supply voltage:** 12.0V
- **Current consumption:**
  Warm-up ≤ 500 mA (6.0 W max.)
  Steady State ≤ 250 mA (3.0W max.)
- **Frequency stability:**
  -20˚C ~ 70°C ≤ ± 100 ppb
- **Output power:** ≥ +18 dBm,
  sine wave, 50 Ohm
- **Low aging:**
  per year ≤ ±300 ppb
- **Phase noise:**
  ≤ - 110 dBc/Hz at 10 Hz
  ≤ - 140 dBc/Hz at 100 Hz
  ≤ - 170 dBc/Hz at 1 kHz
  ≤ - 185 dBc/Hz at 10 kHz
  ≤ - 190 dBc/Hz at 100 kHz
  ≤ - 190 dBc/Hz at 1 MHz

Quartz Crystal Products

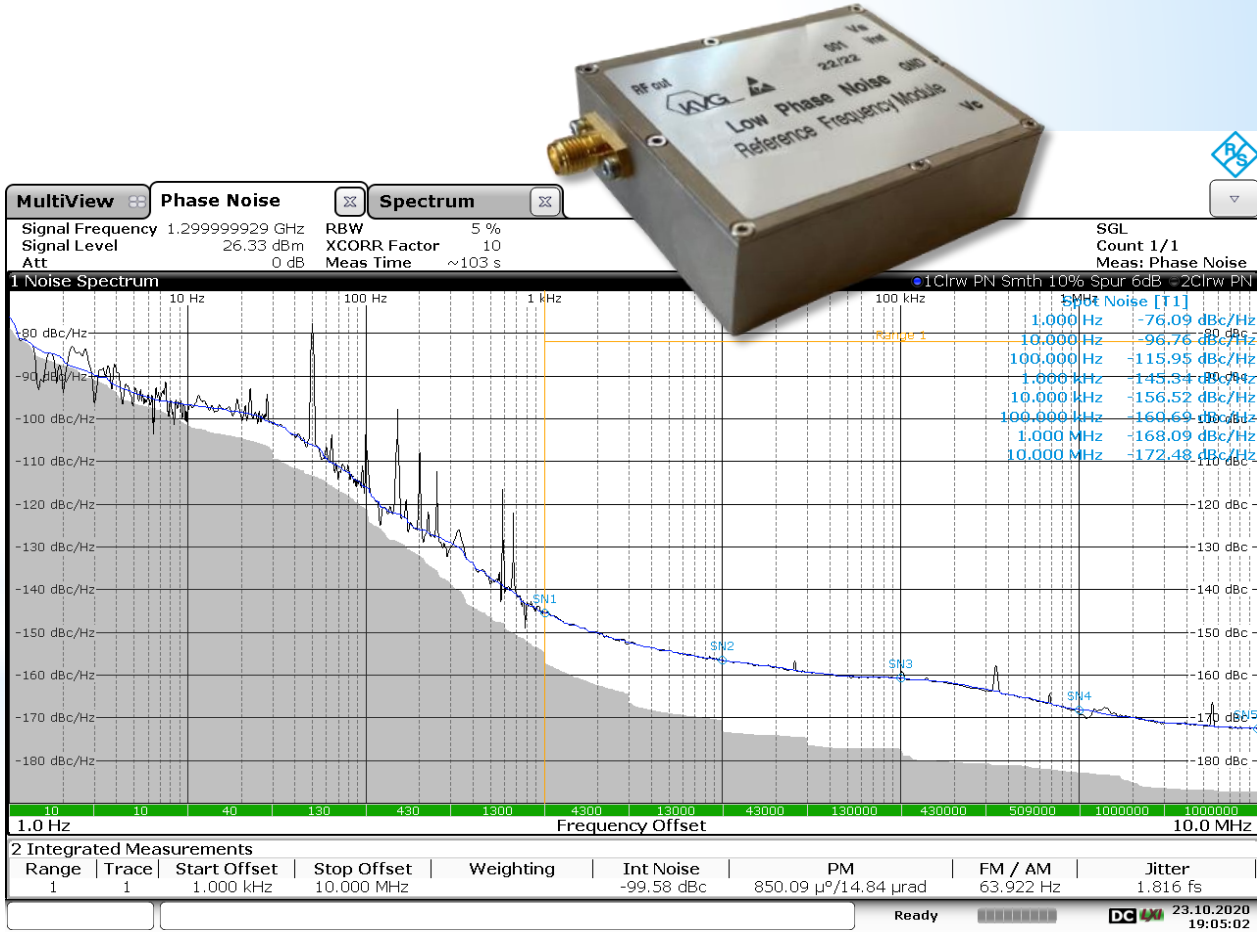
Ultra-low Phase Noise Reference Frequency Module

162.5 MHz, 325 MHz, 499.8 MHz, 1.0 GHz, 1.3 GHz, 2.6 GHz, 2.856 GHz etc.

1.3 GHz, 1.0 GHz

- **Phase noise:**
  - ≤ - 90, -88 dBc/Hz at 10 Hz
  - ≤ -120, -118 dBc/Hz at 100 Hz
  - ≤ -145, -157 dBc/Hz at 1 kHz
  - ≤ -160, -162 dBc/Hz at 10 kHz
  - ≤ -160, -162 dBc/Hz at 100 kHz
  - ≤ -160, -162 dBc/Hz at 1MHz
  - ≤ -170, -162 dBc/Hz at 10MHz

- **RMS Jitter:**
  - [1 kHz to 10 MHz] < 2 fs



Main Oscillator (MO)

Technical Overview

- Custom designed 19″ 600 mm 5U housing
- Excellent short-term phase noise and jitter <1fs
- Frequency stability better than 10^{-12} (hours-days)
- Support high power outputs ≥ +46 dBm
- Provide different frequencies (optional)
- Support remote diagnostic for maintenance
- Tight operational reliability

Under license from DESY

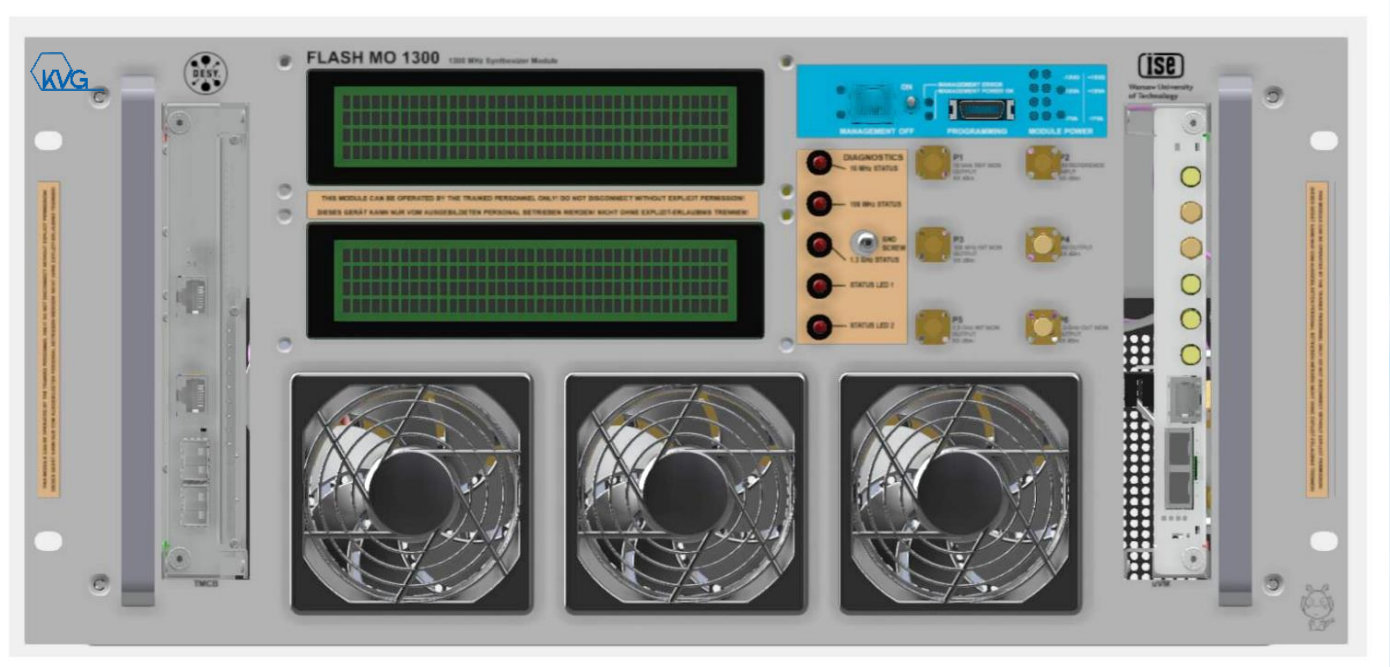
- **Typical Application:**

  Providing high-power and ultra-low phase noise RF-signals in modern accelerators

MO1300

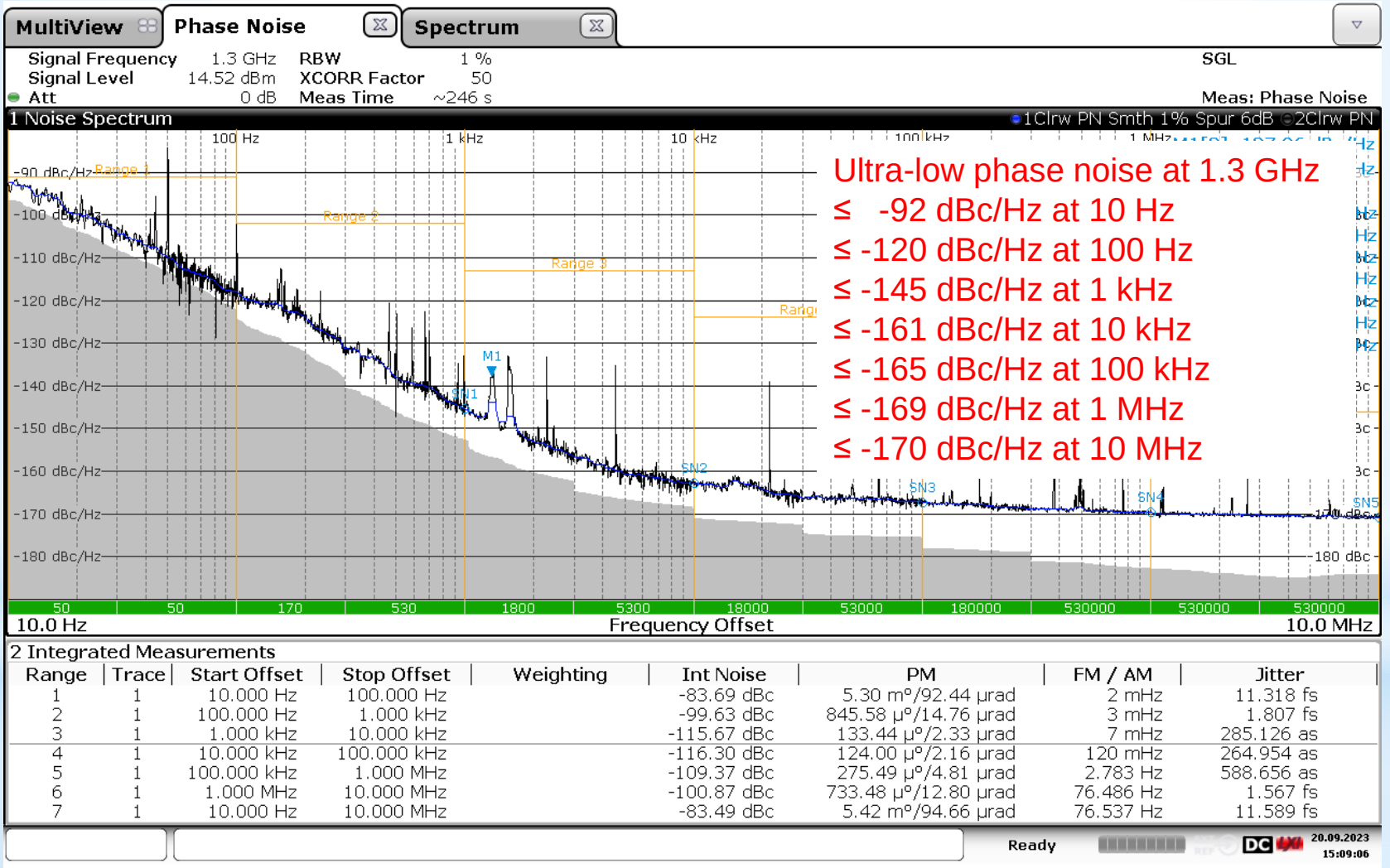
Working Principle

MO synchronizes an ultra-low phase noise DRO output signal with a 1.3 GHz signal synthesized from an ultra-stable GPSDO 10 MHz signal.



MO1300

RF Performance



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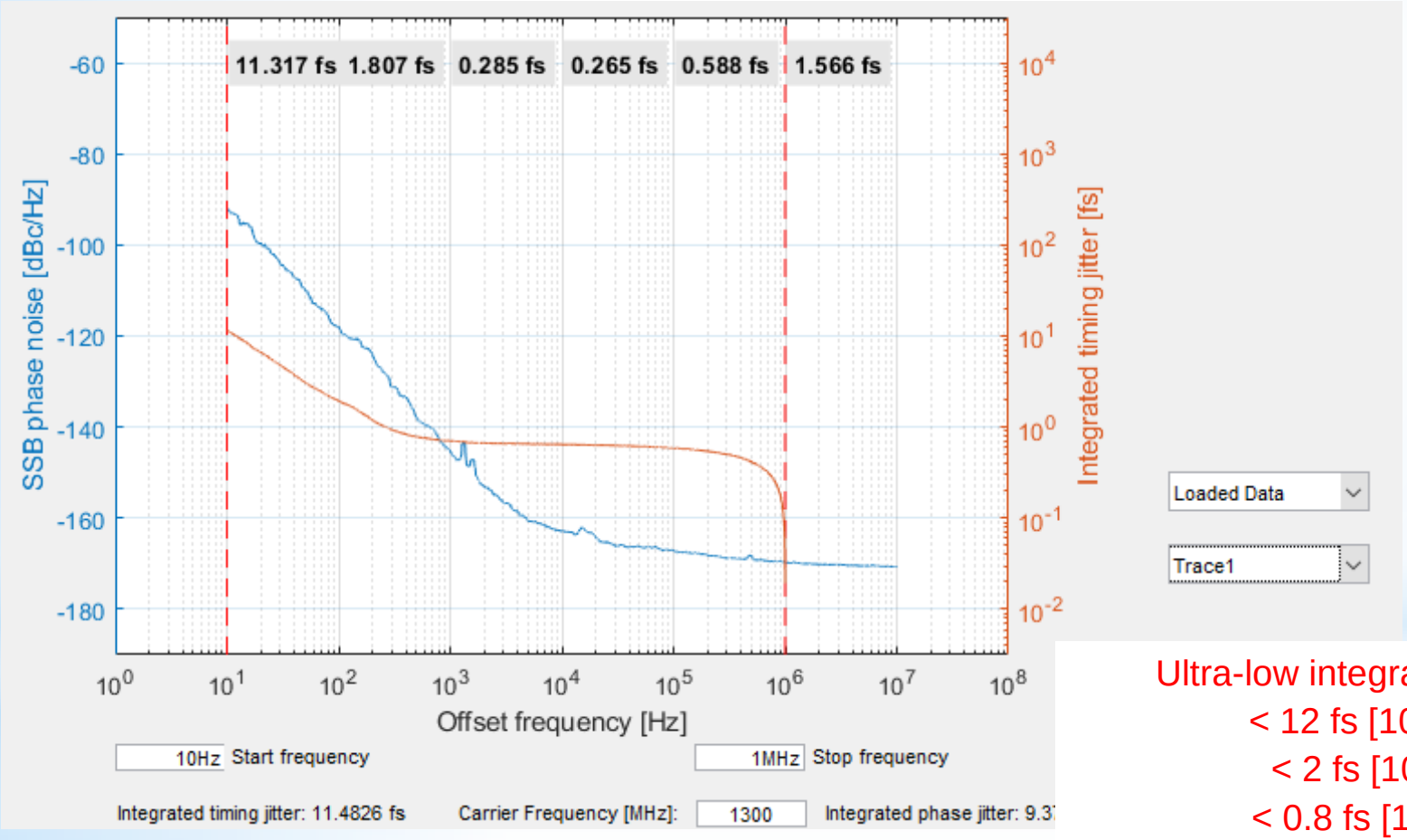
Measurement result provided by F.Ludwig and H.Pryschelski (MSK, DESY)

MO1300

RF Performance



Ultra-low integrated jitter at 1.3 GHz

< 12 fs [10 Hz to 100 Hz]

< 2 fs [100 Hz to 1 kHz]

< 0.8 fs [1 kHz to 1 MHz]

Measurement result provided by F.Ludwig and H.Pryschelski (MSK, DESY)

Local Oscillator Generation (DeRTM-LOG)

Technical Overview

- A multi-channel local oscillator, RF signal and clock generator
  - 9 REF, 9 LO and 9 CAL signals [400 MHz to 6 GHz]
  - 22 low-jitter, differential CLK signals up to 160 Msps
- Two double-width, full-height, MicroTCA.4 compliant extended Rear Transition Module (eRTM)
- LO residual phase noise < 5 fs (rms) [10 Hz to 1 MHz] at 1.354 GHz
- On/Off switching of output clocks and RF signals
- Temperature regulation for long-term stability of RF signals
- Diagnostic for RF power, DC voltage, temperature, humidity

Under license from DESY

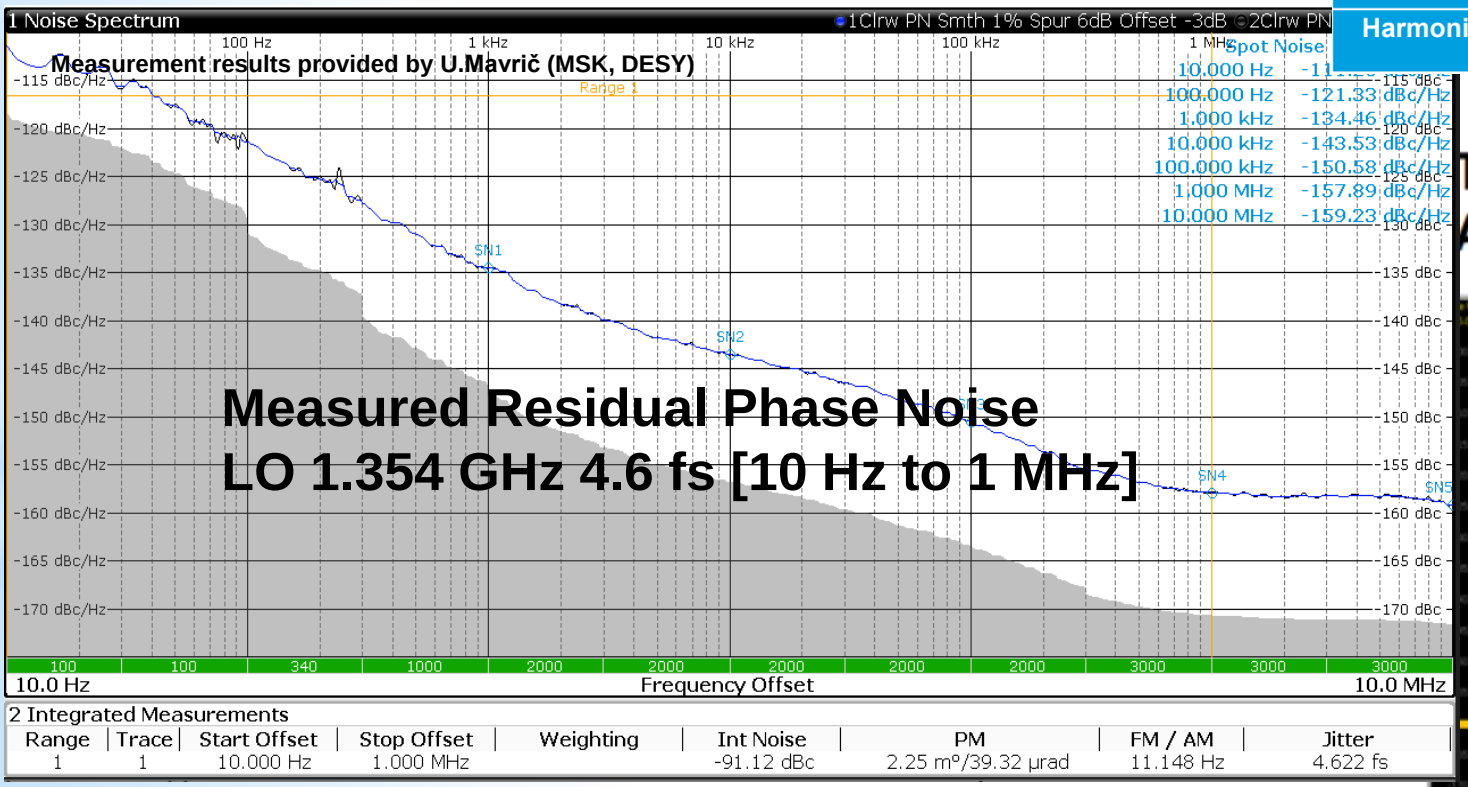
DeRTM-LOG

RF Performance

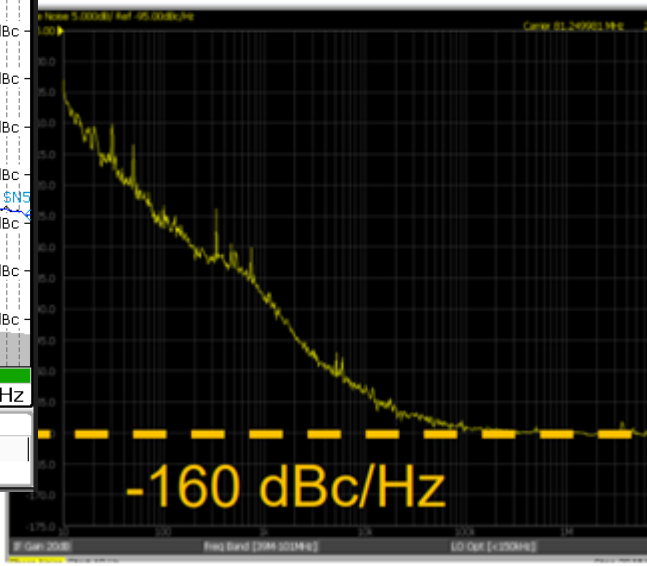
DeRTM-LOG 1.3 GHz:

- REF 1.300 GHz
- LO 1.354 GHz
- CLK 81.25 MHz

RF Parameter	Measured Value (Worst Case)
Return Loss	>20 dB
LO Out Power	>29 dBm
Isolation	>80 dBc
Harmonics (2nd, 3rd)	<-80 dBc



Typical CLK (81.25 MHz) Absolute Phase Noise

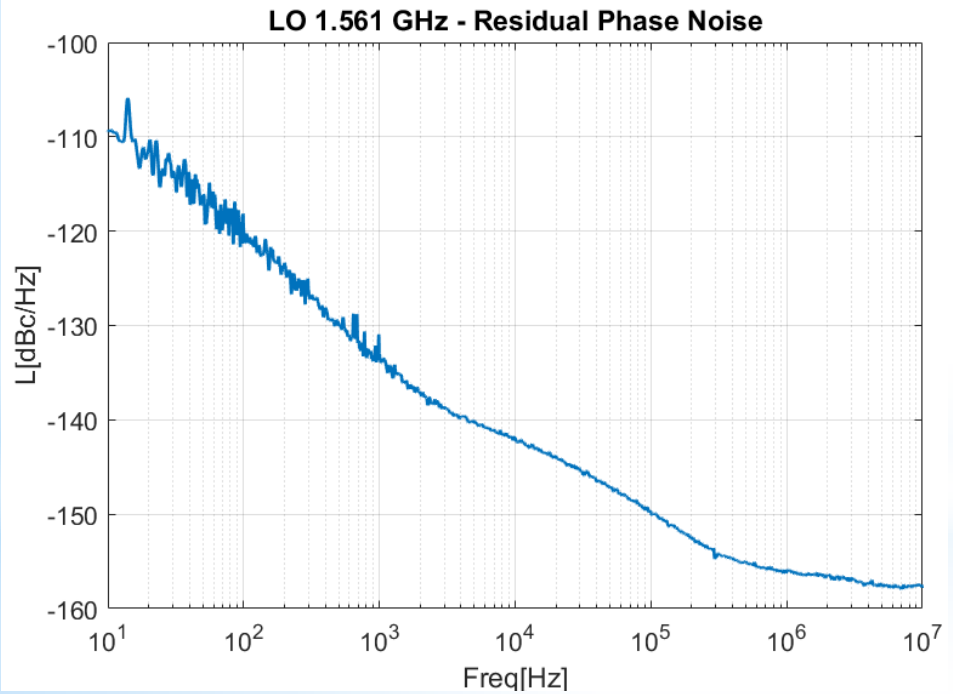


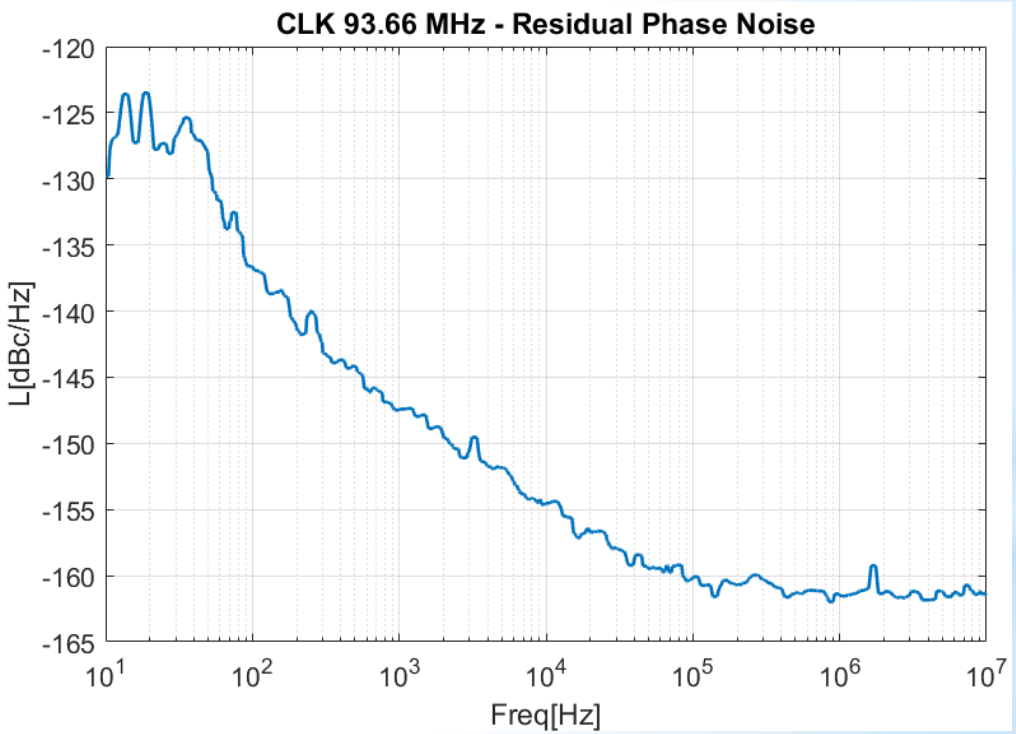
DeRTM-LOG

RF Performance

DeRTM-LOG 1.5 GHz:

- REF 1.500 GHz
- LO 1.561 GHz
- CLK 93.66 MHz





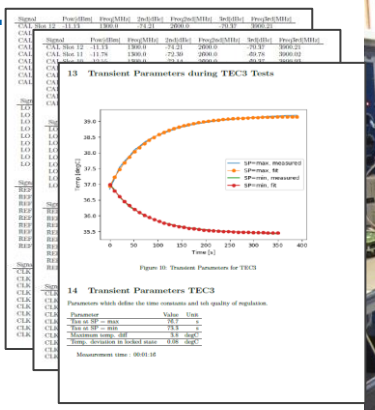
Measurement results provided by U.Mavrič (MSK, DESY)

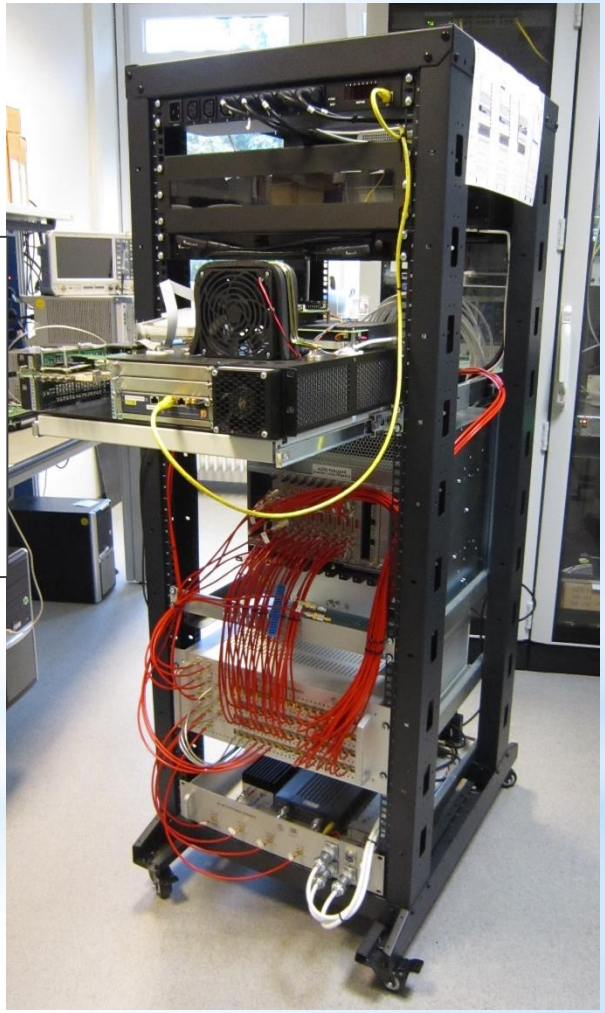
DeRTM-LOG

Test-Stand

A fully automated test stand developed and provided by DESY to check possible production errors.

- Measure:
  - individual mezzanines (DC/DC mezz., RF mezz., ...)
  - A fully assembled module
- Test:
  - CLK frequency [1 MHz to 500 MHz]
  - LO, REF and calibration signals [1 MHz to 6 GHz]

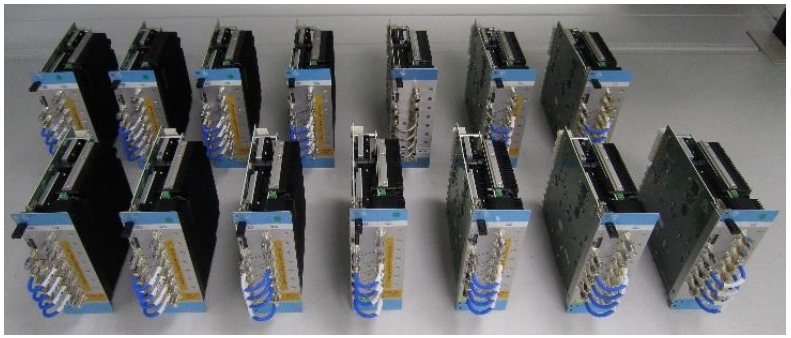




DeRTM-LOG

Production and Future Development

Available Options: DeRTM-LOG 1.3 GHz and 1.5 GHz



Further developments by DESY with new architecture

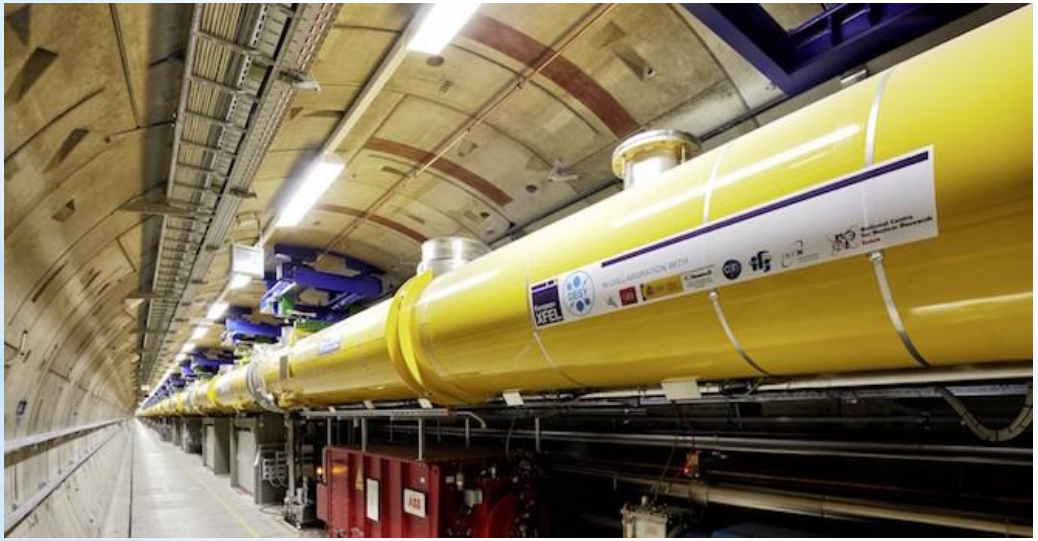
- Cover various LO and CLK generation scenarios
- Cover more REF frequencies applications
- Residual phase noise of the LO and CLK generation

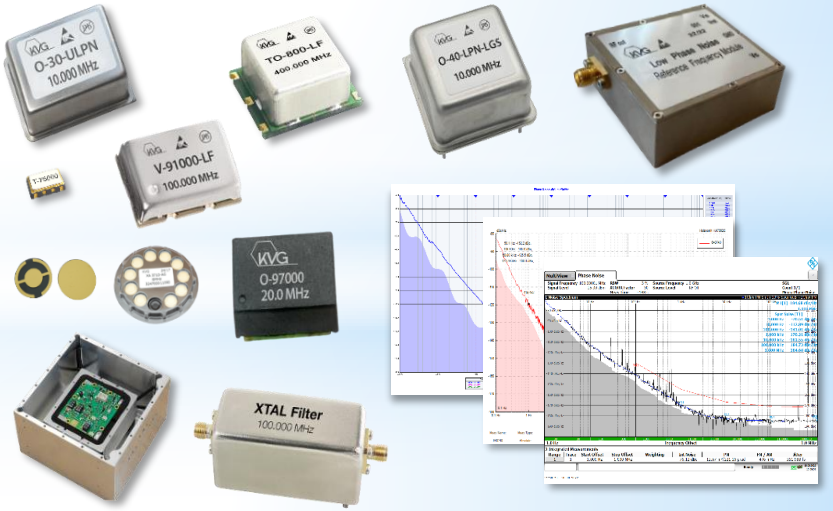
  ≤ -165 dBc/Hz white noise

We provide DeRTM-LOG for your frequency application.

Welcome to our booth

- Standard products
- Local Oscillator Generation (DeRTM-LOG) test stand
- Join us for visits at FLASH Main Oscillator MO1300





Thank you for your attention!

Thanks to DESY colleagues for their support.

Further questions, please contact us.

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