

# Broadband FMR

NanOsc Instruments AB

The NanOsc Instruments AB line of broadband ferromagnetic resonance (FMR) spectrometers and coplanar waveguides (CPWs) offer a simple turn-key solution to the burgeoning field of magnetodynamics research. Broadband FMR spectroscopy allows for measurements continuously spanning several 10's of GHz. Measurements over a wide frequency range allow for significant improvements in accurately extracting a variety of material parameters not accessible by static measurement techniques.



Broadband FMR is particularly well-suited for studying magnetic thin films, which not only form the backbone of fundamental spintronics and magnonics research but are also constituents of current and future technologies focused on magnetic memories, sensors, logic, and microwave signal processing.

## Key features

- Turn-key FMR spectrometer with easy to use software interface
- Broadband FMR using a coplanar waveguide
- Calculates the Effective magnetization ( $M_{\text{eff}}$ ), anisotropy ( $K$ ), gyromagnetic ratio ( $\gamma$ ), damping ( $\alpha$ ), inhomogeneous broadening ( $\Delta H^{\circ}$ ),
- Enables the user to extract the exchange stiffness ( $A$ ) and inverse spin Hall effect ISHE
- ST-FMR adds the extraction of the spin Hall angle (SHA) as well as the damping-like and field-like
- torque efficiencies (DLTE and FLTE).

## Specifications

| Instrument  | Bandwidth                | Temperature Range                           | Magnetic Field                                                      |
|-------------|--------------------------|---------------------------------------------|---------------------------------------------------------------------|
| PhaseFMR    | 2–8, –20, –40, –60 GHz   | Room Temperature                            | User Supplied Voltage<br>Controllable Power<br>Supply/Electromagnet |
| ST-FMR      | 2–20, –40 GHz            | Room Temperature                            | User Supplied Voltage<br>Controllable Power<br>Supply/Electromagnet |
| CryoFMR     | 2–8, –20, –40, –60** GHz | 5*–400 K: DynaCool®<br>55*–400 K: VersaLab® | ±9, 12, 14 T:<br>±3 T                                               |
| Cryo ST-FMR | 2–20, –40 GHz            | 5*–400 K: DynaCool®<br>55*–400 K: VersaLab® | ±9, 12, 14 T:<br>±3 T                                               |

\*Minimum temperature dependent on modulation amplitude and RF frequency.

\*\*60 GHz only available for the PPMS®DynaCool®.



Quantum Design

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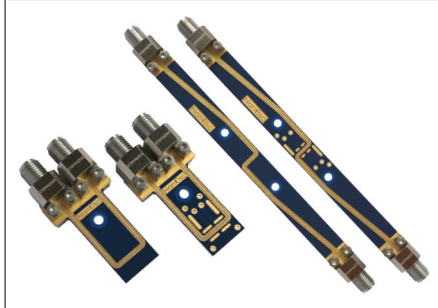
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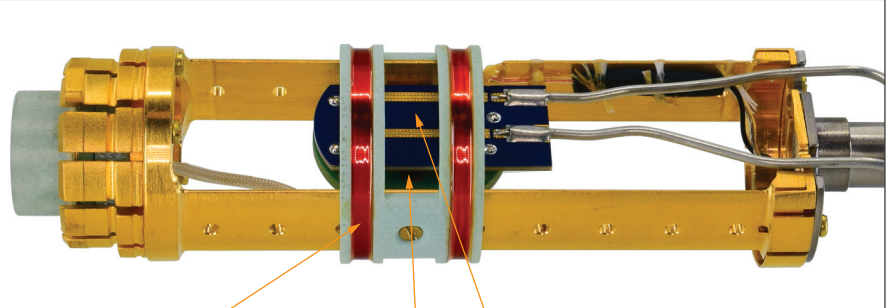
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## NanOsc Instruments AB

CryoFMR Probe Insert for PPMS®/DynaCool™/VersaLab™



Coplanar Waveguides (CPWs) for room temperature PhaseFMR.  
<http://www.nanosc.se/wave-guides-cpw.html>

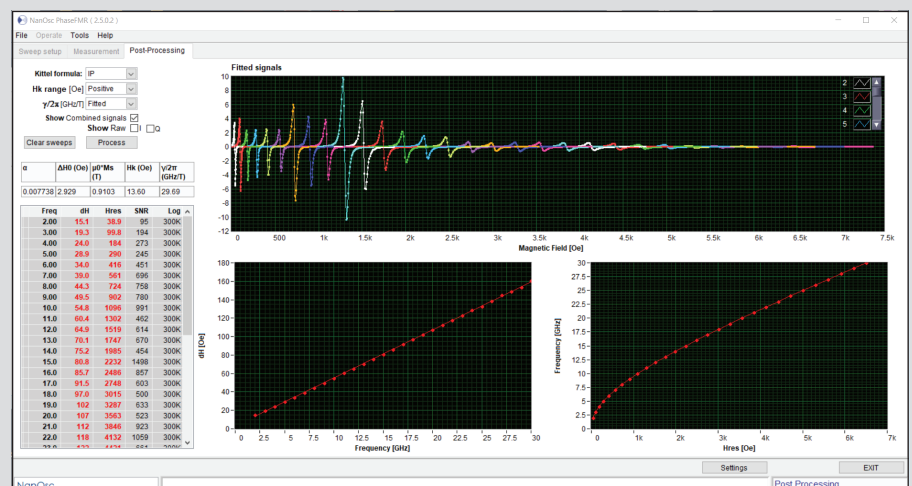


Helmholtz coils for field modulation  
 Temperature sensor  
 CPW for in-plane analysis\*\*  
 \*\*out-of-plane CPW also included

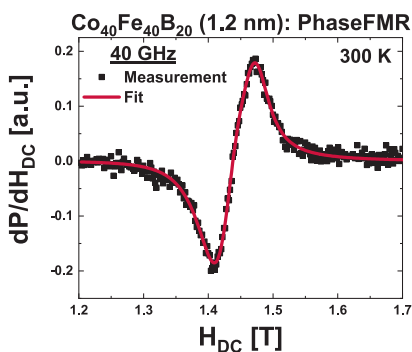
### Software Makes FMR Easy:

The software user interface is divided into three tabs:

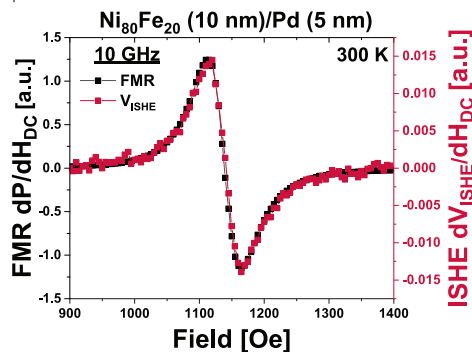
1. Setting up the measurement sweeps
2. Monitoring the running measurements
3. Post-processing and parameter extraction



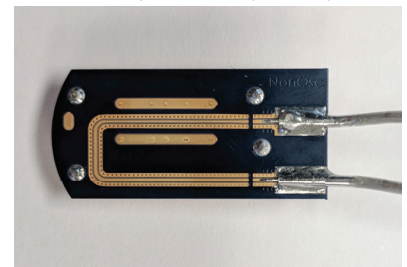
### Example Data:



### Inverse Spin Hall Effect



### ISHE-CPW (4087-608\*) for CryoFMR



\*Not included with CryoFMR Probe