Hprobe

MYCRONIC

Speed-Up Magnetic Test

High speed 3D magnetic field generator for semiconductor industry

Advanced Functional Materials and Methods for Neuromorphic Computing and Memory

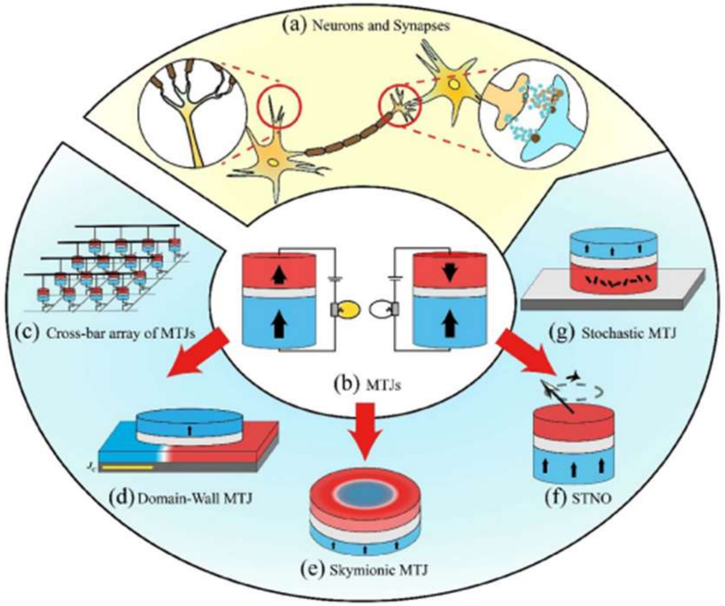
44th Chemnitz Seminar Nov 25-26, 2025

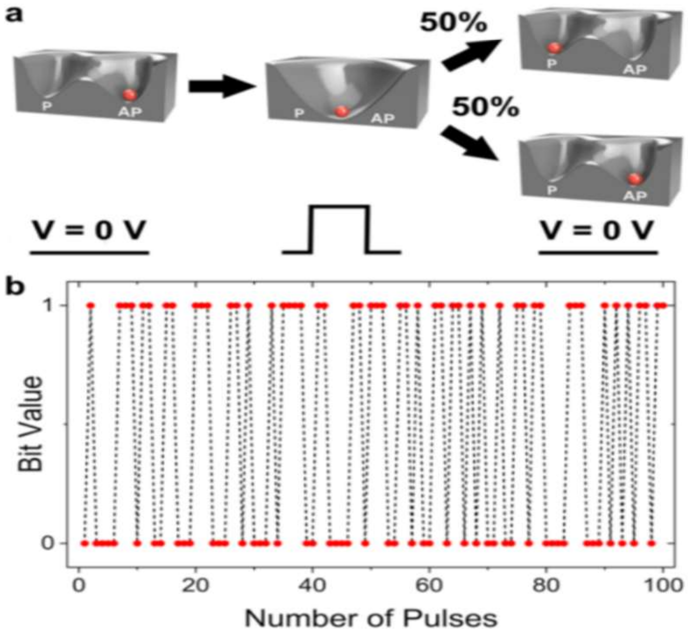
A.DELPY

MYCRONIC

MTJ* plays a strong role for unconventional computing

Remarkably endurance suitable for reprogrammable on chip neural network





MTJ simulating biological behavior of synapses and neurons for stochastic computing (e.g. TSP)

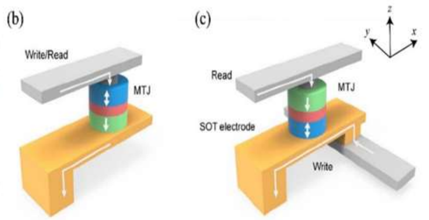
Probabilistic bit [P-bit]

*MTJ: Magnetic Tunnel Junction
Sce: https://iopscience.iop.org/article/10.1088/2752-5724/ace3af
TSP Travel Salesman Problem

Source: https://www.nature.com/articles/s41467-024-48152-0.pdf

MTJ* is used in many applications…

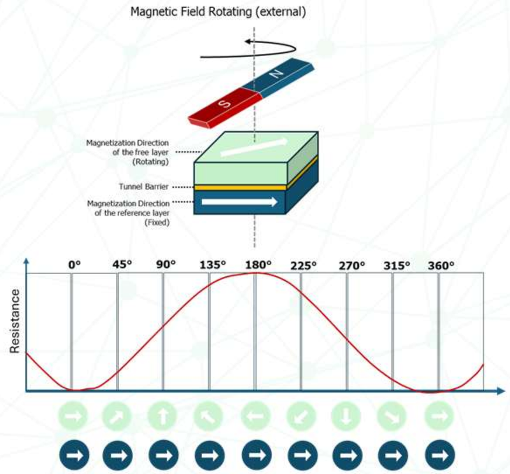
MEMORIES



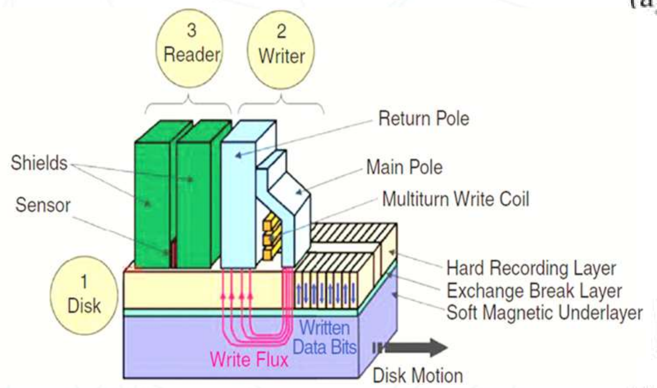
STT MRAM

SOT MRAM

xMR SENSORS

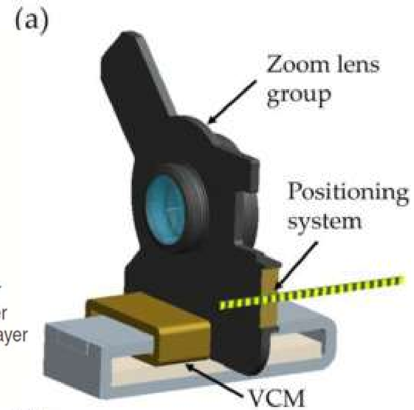


HDD



Sce: Impact of External Magnetic Fields on STT-MRAM

CAMERAS



Sce PMCID: PMC11945632

MTJ open doors in many domains with requirements from industrial, aerospace, automotive up to consumer with demanding thermal and reliable modes

MTJ: Magnetic Tunnel Junction

The ATEs addressing the specificities of Integrated Magnetic Technologies

ATE: Automatic Test Equipment

Innovative leader in high-speed device testing

MRAM and magnetic sensor markets

Technological advantage – **High-speed** 3D magnetic field generation and ultra-wide band proprietary RF instrumentation

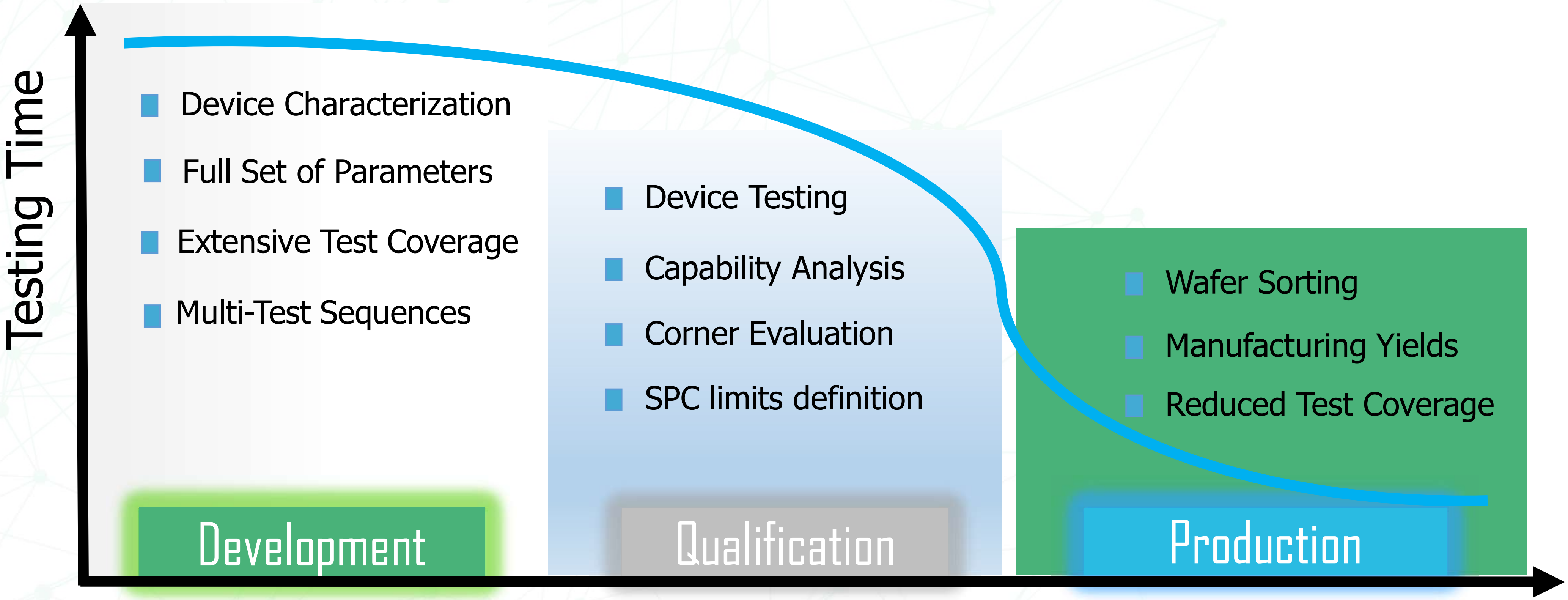
Cutting edge test equipment – For **high throughput** electrical **testing of wafers** and devices **under a magnetic field**

From R&D to volume manufacturing – Dedicated to **support** all **phases of device technology and IC deployment**, from R&D through qualification to mass production

Experts in challenging tests – Hprobe's **expert engineering team** delivers dedicated support to **empower customers** throughout their development and deployment processes

From R&D to Mass Production

The specificity of Magnetic Device Technologies require testing under magnetic field in all phases



Hprobe MYCRONIC

Multiple Configurations for Different Applications

Extensive test capabilities with unmatched precision and speed — all at a fraction of the cost

Non-Volatile Memory: STT MRAM / SOT MRAM

IBEX – WAT Parametric Test

- Testing of magnetic **tunnel junction** and **bitcell**
- End of Line testing under magnetic field in 200/300mm wafer fab
- **R&D**, Medium & High-volume **production**

IBEX – WS Functional Test

- **Characterization** and **testing** of **SoC** under magnetic field
- Chip **functional testing** under magnetic field in 300mm wafer fab
- System design verification and **immunity tests**

Magnetic Sensors Hall / xMR

LINX – Wafer Sort

- Enabling both **characterization** and **high-throughput** production testing under 3D magnetic field
- Fully integrated with **commercial ATE**

Hprobe MYCRONIC

Highly-configurable Automated Test Equipment

One configuration for every testing need

Magnetic Test Head	Electrical Test Module	Non-Volatile Memory
3Dgen	RF BOX	• STT and SOT MRAM characterization • Sub-nanosecond pulse width
H3DM	RF SPIN	• Fast Bit Error Rate Test • Time Resolved Measurement • Switching Dynamics Analysis
H3DM-XL	MC16X	• Multi-channels sub-ns pulse system • Multi-terminal devices pulse test (N>4) • Test of crossbar arrays

Sub ns pulsewidth

Hprobe MYCRONIC

Hprobe Magnetic Instruments for Wafer Level Tests

The test heads are inserted with direct docking on wafer prober and integrate all functions to:

- Calibrate and control the field applied at DUT position
- Auto-align magnetic generator to probes and wafer
- Interface with prober and electrical tester
- Compensate prober chamber and chuck influence
- Operates with probe cards or manual probes
- Interface with Fab Automation

The magnetic field is calibrated using **Hmap®** software graphical User Interface and the field is controlled and generated directly from the electrical tester through TCP:IP commands

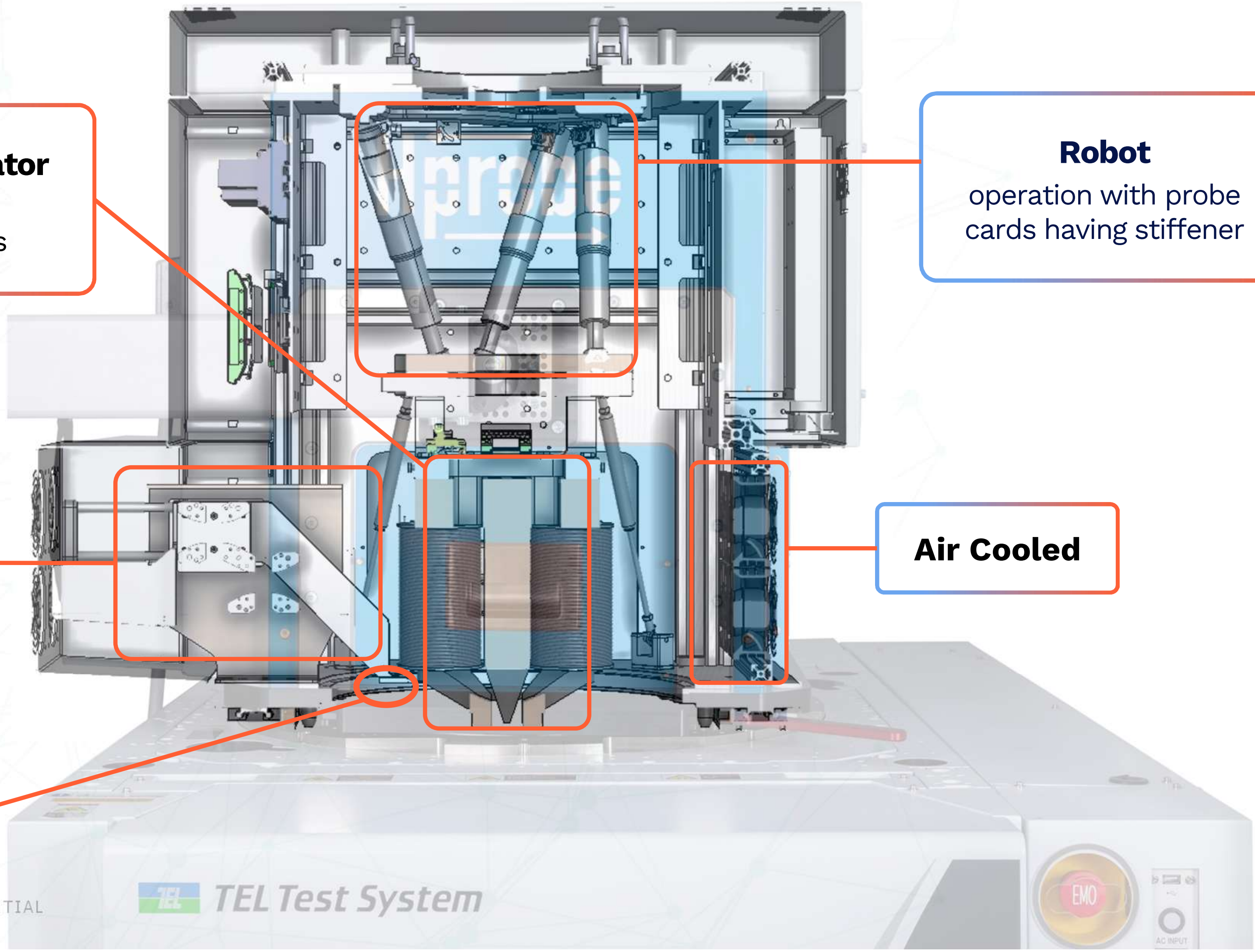
The system can be driven from programming with any language

LabVIEW python

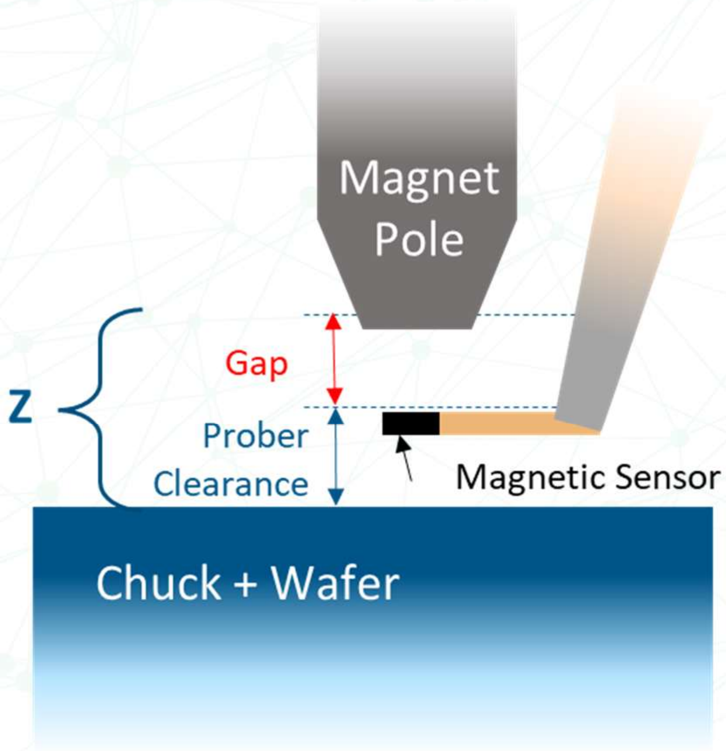
Inside the Automated Magnetic Test Head

Hprobe
MYCRONIC

Inside the Automated Magnetic Test Head



Magnetic Field Calibration Unit (FCU)



Test Head FCU

3D sensor on **robot in test head**

➔ Designed for High accuracy

The Field Calibration (FCU) is automatically control by the software and enables to:

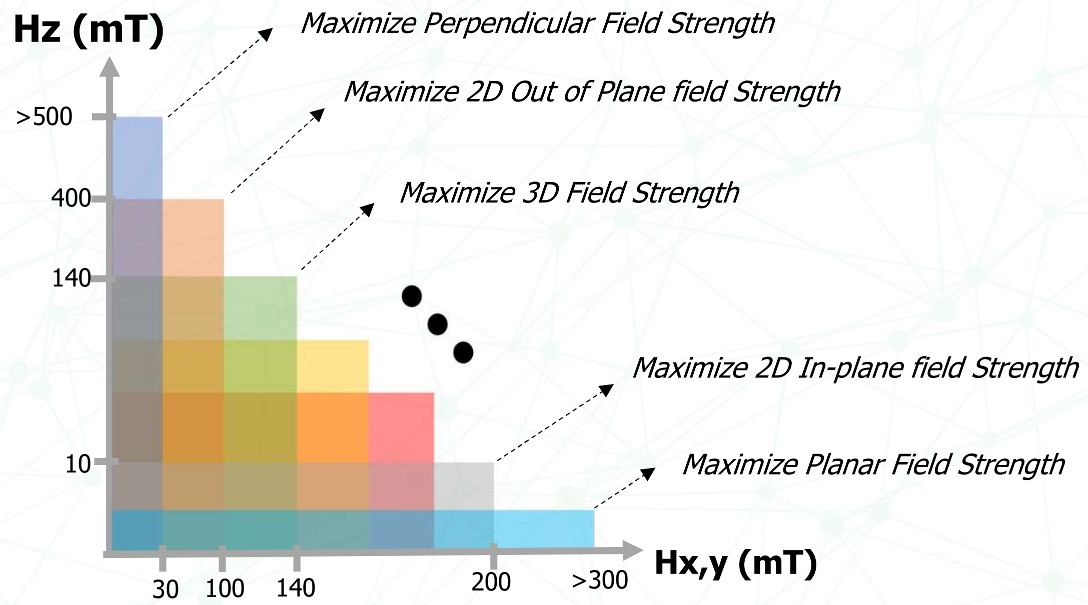
- Calibrate magnetic fields to apply during electrical probing of the wafer
- Compensate at DUT position environmental effect leading to parasitic stray fields during test (Earth field, influence of eddy current in the chuck ...)
- Monitor and control the magnetic field applied on DUT

Magnetic Generator Configurations

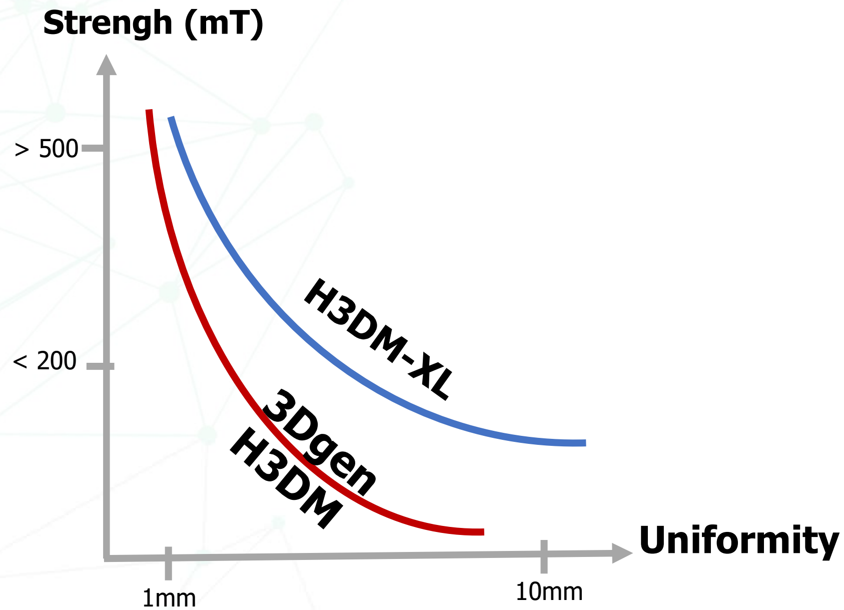
All configurations enable 3D field projection on wafer

More than 12 different configurations of magnetic generator are available to address various test requirements.
Specific configurations are, for example, selected to maximize field strength or projected area at specific vectorial direction

To select field vector strength and angle control range*



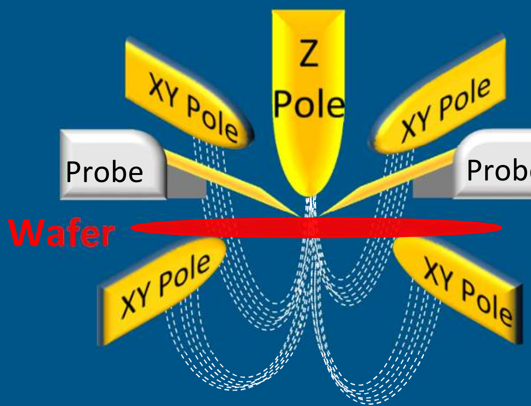
To select field uniformity area



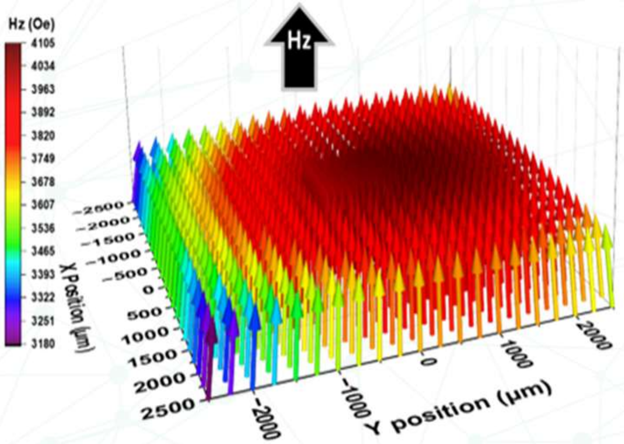
(*) Each color square is a specific Hardware configuration
All hardware configuration have 3D vectorial field capability

3D Magnetic Generator Configuration

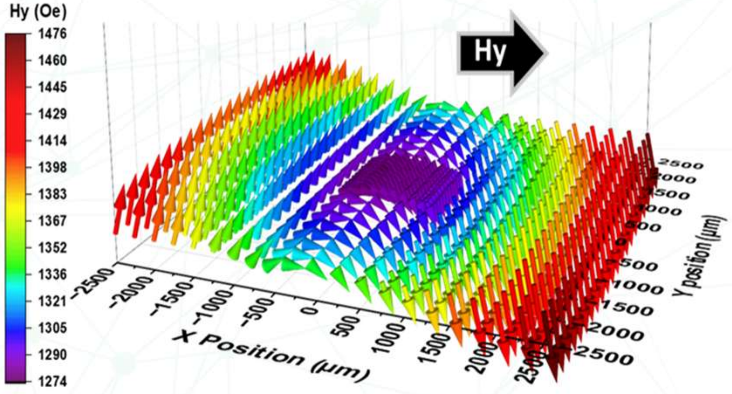
Core Proprietary Technology to generate 3D vectorial field projected on the wafer surface

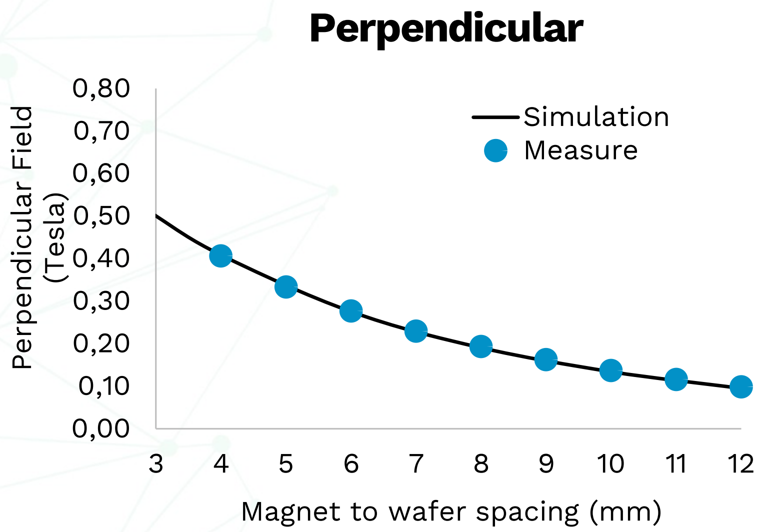


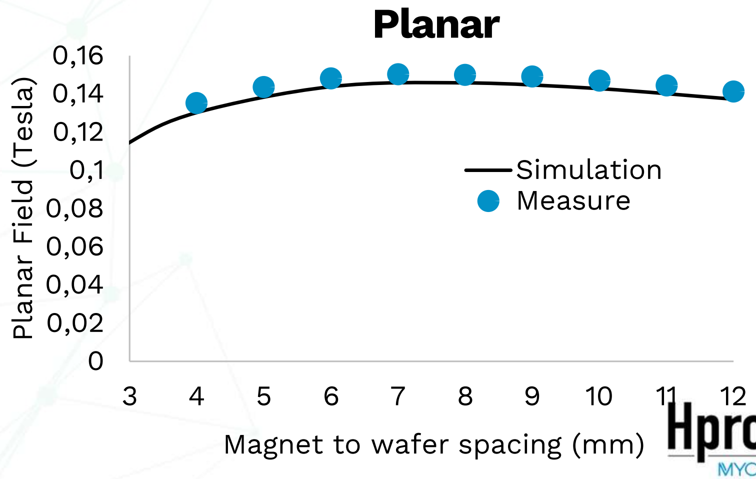
Magnetic field lines



Measurments





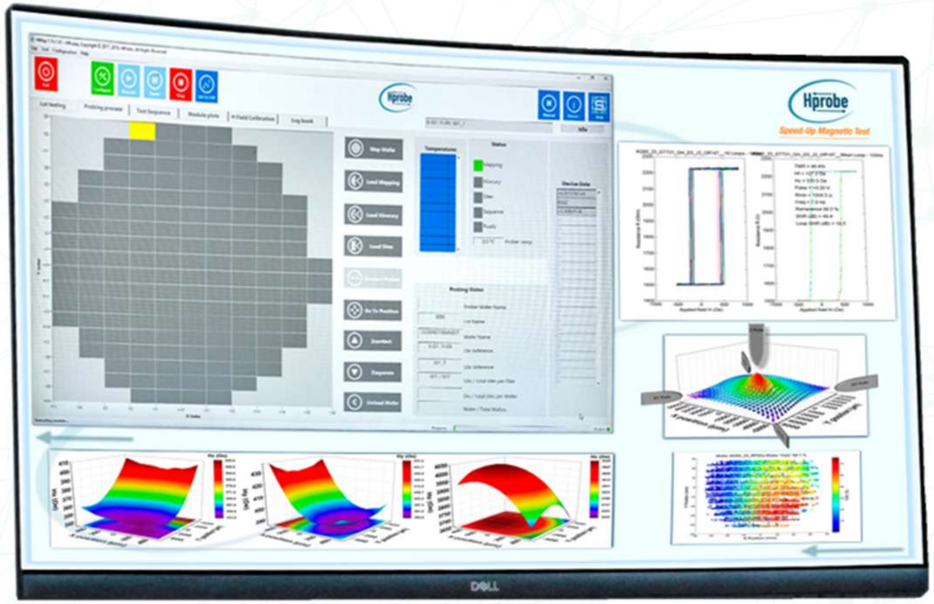


Hprobe MYCRONIC

Turnkey solution for Engineers

Fast and Easy adoption

- MRAM modules available to build test sequences without programming
- User can develop his own module and use in the application



Development

Sequence.1	Sequence.2
RH-Sweep	RH-Sweep1
RV-Pulsed	RH-Sweep2
BER	IV-Pulsed
Endurance	P-bit

Full Flexibility

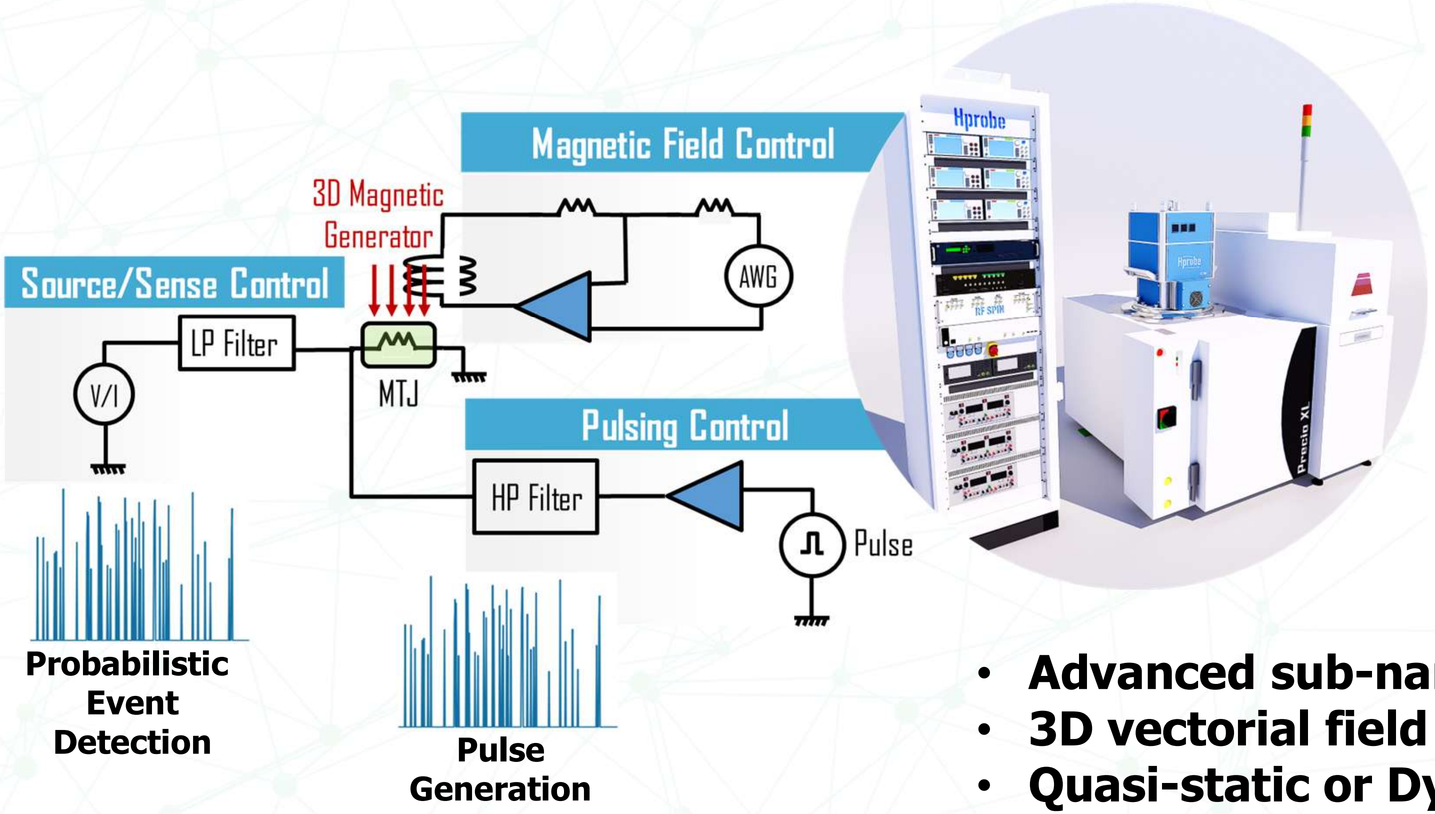
Production

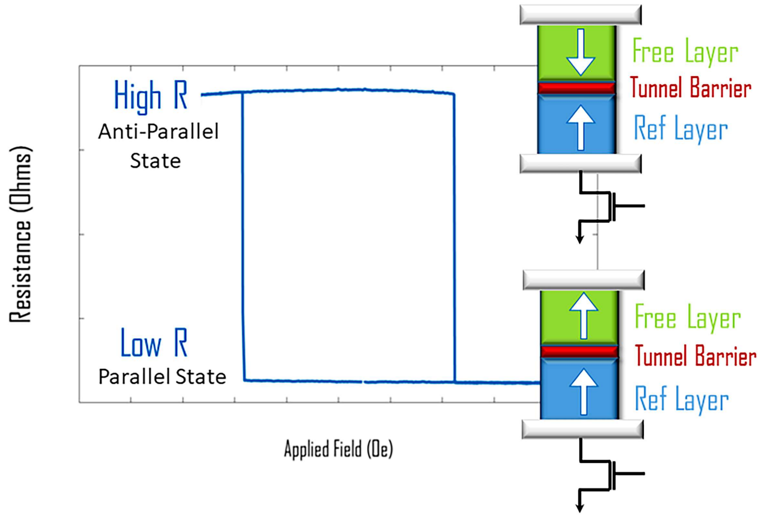
Channel.1	Channel.2
RH-Sweep	RH-Sweep
RV-Pulsed	RV-Pulsed
Breakdown	Breakdown

Performances

Typical set up for MTJ Parametric measurement

IBEX tester with H3DM Automated Test Equipment for R&D





- **Advanced sub-nanosecond pulsing capability**
- **3D vectorial field projection**
- **Quasi-static or Dynamic acquisition**

Hprobe MYCRONIC

Take away

3D magnetic test ready for multiple applications

- Turnkey system for spintronic providing a comprehensive solution for **magnetic junction characterization for neuromorphic computing** and other applications such as MRAM or magnetic sensors

- **Future Directions**:
    - Multi-terminal advanced spintronic devices and Cross-points arrays
    - Potential for new test protocols implementation,
    - Adaptation to emerging needs with higher 3D fields,
    - Easy way to demonstrate immunity in applications
    - New applications requiring 3D magnetic fields

IBEX300 Parametric ATE

LINX Magnetic Instrument

Hprobe
MYCRONIC

Bringing tomorrow’s electronics to life

THANK YOU