



# FOCUS TECHNOLOGY GROUP

LOAD PULL | PULSED IV | MODELLING

# WELCOME TO OUR WORLD

Focus Technology Group comprises Focus Microwaves Inc., Mesuro Ltd. and Auriga PIV Tech Inc. They are all Engineering and Manufacturing Corporations based in Montreal, Quebec (Canada), Cardiff, Wales (UK) and Merrimack, New Hampshire (USA).

Focus Microwaves is a pioneering engineering company, built around the innovations of its founder Dr. Christos Tsironis, who developed his first manual tuner in 1973, and is the inventor of most existing electro-mechanical tuner families. The success of FMW is based on the engineering and manufacturing skill of its highly motivated and experienced team of technicians and engineers, who have been trained and encouraged to develop new technologies as well as listen to and support our customers.

From humble beginnings in 1988, FMW has become the main supplier of advanced Load Pull and Noise Tuner Systems. Our mission is to provide effective, reliable and innovative solutions for non-50 Ohm testing (Noise and Load Pull) of RF and microwave transistors, thus enabling our customers to compete in the marketplace with better designs and to advance the understanding and knowledge of the field.

We offer standard and customized solutions for R&D and production testing as stand-alone hardware and fully-integrated systems:

- Passive and active load pull (CW and pulsed)
- Harmonic, scalar, vector and time domain load pull
- Wideband noise parameter measurements
- On-wafer turn-key solutions including vibration-free probe stations and pre-matching bend-lines
- DC, Pulsed IV, S-parameter measurements using 3T and TRL calibrations
- High precision and modular Pulsed-IV systems
- Active load pull, waveform engineering
- High speed wideband load pull
- Nonlinear transistor models
- Measurement services

## A WORD FROM THE CEO

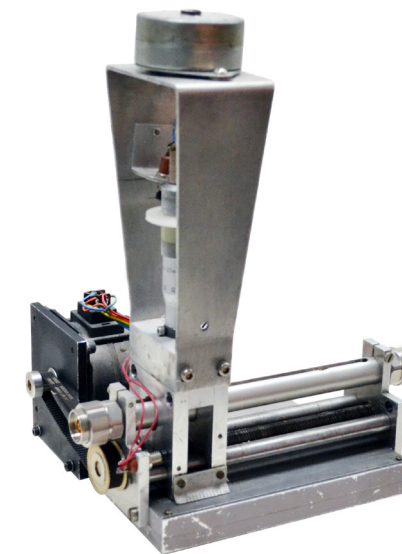
I started this company expecting to sell a dozen tuners at best. 25 years later, Focus has over 40 employees in four countries and has sold over a thousand systems worldwide. With the latest acquisitions of Mesuro and Auriga, our portfolio is stronger than ever, paving the way for a strong and growing future.

Technical innovation has fuelled our product development and has made us an industry leader in many technologies.

Our customers demands help us create most of our products and applications in this field. The result to date is over 1200 Focus systems using close to 3000 automatic and wideband harmonic tuners.

*Dr. Christos Tsironis, President and CEO*

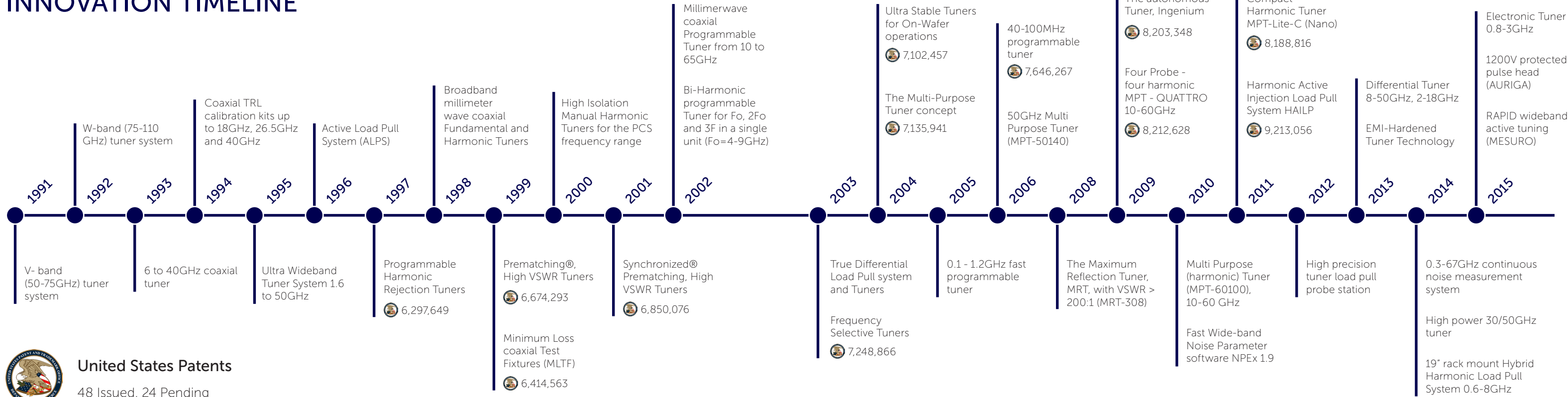
*"In Montreal it snows a lot. Perfect conditions to focus on load pull."*



We have been serious about Load Pull for over 25 years

*First Tuner: 1988*

# INNOVATION TIMELINE



## United States Patents

48 Issued, 24 Pending

# OUR PORTFOLIO

## Load Pull

Focus has the broadest portfolio of passive tuners. For frequencies from 100MHz to 110GHz (and above) we use the slide screw technique (models Multi Harmonic MPT, wideband (fundamental) CCMT, harmonic rejection PHT), in which a reflective probe (slug) is inserted into the slot of a low loss slotted transmission line (slabline or waveguide).



## Pulsed I-V

The 4th generation AU4850 Pulsed IV/RF Characterization System delivers unparalleled performance; capturing measurements with incredible speed and accuracy. Configurations include high speed mainframe with up to 6 pulser heads ranging from high accuracy  $\pm 20V$ , three different variations of 220V, two options of 600V and a 1200V head.



## Behaviour Modelling

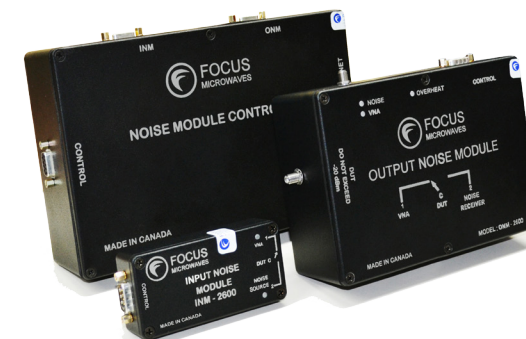
The Cardiff Model Lite is a third order formulation that allows the extension of S-Parameters under Large Signal operation. It is a Polyharmonic Distortion (PHD) based behavioural model formulation, based upon the harmonic superposition principle.

The Cardiff model+ is a generalized solution using an Nth order 'mixing' parameter formulation and can be applied as a fundamental only mode or using the harmonic content and then easily extracted using the model generation tool and used within the EDA simulation environment.



## Accessories

RF design engineers need to fully characterize their low noise transistors and MMIC's over a very large frequency bandwidth. The result of the characterization is a set of four noise parameters (Fmin, Rn, Gamma-opt), that allow the design of the highest sensitivity (lowest noise) amplifiers and receivers. This is accomplished by controlling the source impedance presented to the transistor using highly precise automatic tuners and retrieving the data from a noise receiver. Traditional noise receivers and VNA's can be used.

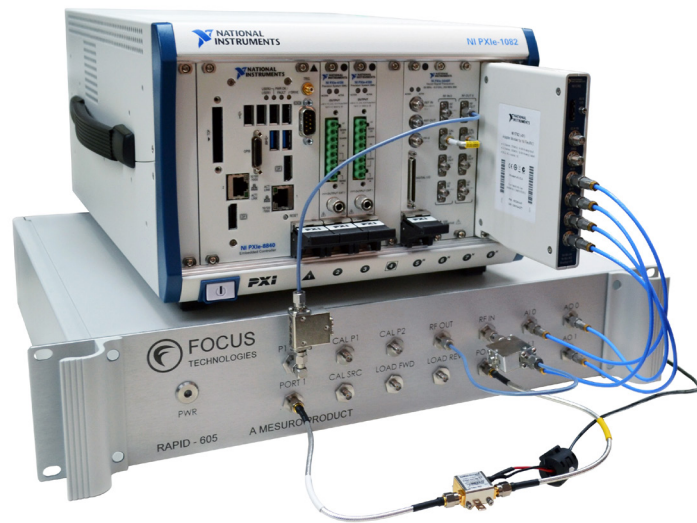




# RAPID

Focus Microwaves' RAPID digital tuner is the heart of a precision, high-speed, load pull device characterization system. The RAPID has been developed by Focus' UK subsidiary MESURO and is suitable for every phase of the design and production test cycle. This series of new digital tuner products provide performance, reliability, and cutting edge features for a reasonable cost. The RAPID series is compatible with the hardware and software of existing labs, thereby allowing users to easily upgrade their existing systems.

The RAPID can be used as a standalone impedance synthesis and measurement system, or combined into a hybrid solution when paired with Focus' MPT series harmonic tuners. The passive tuners can be used to synthesize fixed harmonic impedances in a high speed fundamental active setup. With this modular configuration the user benefits from speed, increased tuning range for F0, CW, pulsed and modulated signals while reducing cost and simplifying the system.



# WIDEBAND FUNDAMENTAL TUNERS

Focus Microwaves manufactures, since 1989, coaxial programmable (slide screw) impedance tuners from 100MHz up to 67GHz. All tuners are LAN control and have an on-board processor, memory and firmware with interpolation and tuning capability. The iCCMT series is optimized for large bandwidth, high VSWR and RF power. Each tuner contains one, two or three wideband probes, so-called slugs, which cover different parts of the bandwidth and can be inserted simultaneously or separately in the slabline, a slotted airline, to create high reflection.



## WIDEBAND HARMONIC TUNERS

Focus' MPT series of wideband harmonic tuners simplifies and reduces the cost of highly complicated harmonic load-pull setups. Multi-purpose tuners (MPT) use three independent wideband probes, allowing independent control of the amplitude and phase of the reflection factor at all three harmonic frequencies. The MPT can be used to pre-match impedances at the fundamental and the harmonic frequencies



## LOW FREQUENCY TUNERS

The patented Low Frequency Tuners (LFT) are a fraction of the size large of equivalent CCMT slide screw tuners that would use transmission lines and capacitive probes (slugs). LFT use three or more tuning sections connected in cascade. Each section includes a transmission line (cable) and a parallel plate (rotary) air capacitor connected to ground. Proprietary software allows optimizing the size of the capacitors, the length of the cables and the number of tuning sections in order to best cover the Smith chart over a given bandwidth.



## PULSED IV

Auriga's 4th generation pulsed IV/RF characterization system delivers unparalleled performance, capturing measurements with incredible speed and accuracy. Pulsed IV (current-voltage) measurements have emerged as the preferred method of capturing current-voltage characteristics of active devices such as field effect (FETs) and bipolar junction (BJTs) transistors. With the growing popularity of high-power devices, like GaN HEMTs, LDMOS, SiC, and graphene, current and voltage requirements are constantly being pushed higher and higher.

With these requirements in mind, Auriga Microwave has developed its next-generation Pulsed IV/RF Characterization System, the AU4850. The AU4850 is designed to meet the ever-changing requirements of the device modeling community. With its modular hardware design and powerful application programming interface (API), the AU4850 is poised to handle present and future pulsed IV requirements.

The Pulsed IV System is also available as a Modular (MPIV) or as an Integrated (IPIV) solution. If you already have DC power supplies, computers and digital oscilloscopes MPIV is the most economic solution for you. The Focus Pulsed IV capability (PIV) is also configurable to a Pulsed Load Pull (PLP) setup when a pulsed RF source and Peak power meter are included.



## BIAS-TEES

Auriga Bias Tees balance impressive RF performance with heavy-duty power handling across multiple frequency bands ranging from 100MHz to 40GHz. They are designed for rigorous usage without sacrificing RF performance. Only the highest-quality materials are used to minimize signal loss and enable efficient heat removal.

The highest-power bias tees include a fast-acting fuse to protect DUTs against current spikes. A DC sense port is provided for accurately measuring the incident DC voltage. Bias tees requiring external heat sinking include pre-tapped holes for easy mounting.



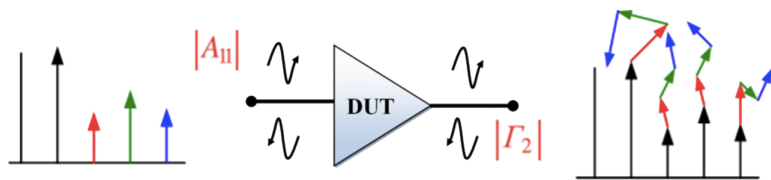


# CARDIFF MODEL LITE

Non-linear measurement data has been exploited in various ways to create behavioral models for high frequency transistors. Formulations of these models have been developed in the travelling wave domain with a desire to represent nonlinear behavior of high frequency transistors. Work demonstrated using the Cardiff Model, based on PHD models, has shown that by considering higher order mixing terms in the PHD formulation, a model can be developed that does not require the simulator to interpolate between datasets for different fundamental and harmonic source and load pull impedance measurements.

By carrying out fundamental-interpolation and harmonic-extrapolation on measurement data, the system can take advantage of the intelligence of behavioral modeling. Interpolation carried out on measurement data can reduce the density of impedance grids hence reducing utilization time. Measurement systems that cannot achieve a high enough impedance termination at higher harmonics can take advantage of harmonic extrapolation to achieve these values.

The Cardiff Model Lite is a third order formulation that allows the extension of S-Parameters under Large Signal operation. It is a Polyharmonic Distortion (PHD) based behavioural model formulation, based upon the harmonic superposition principle.



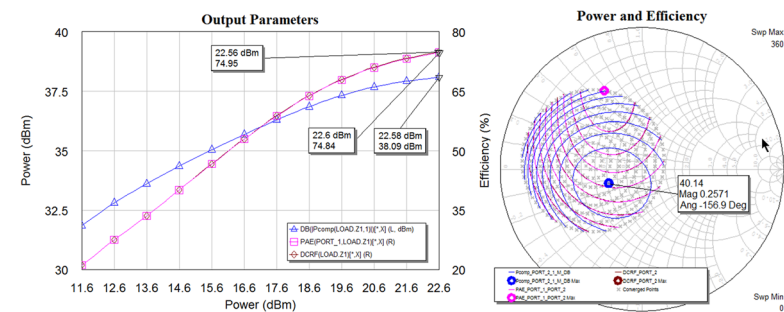
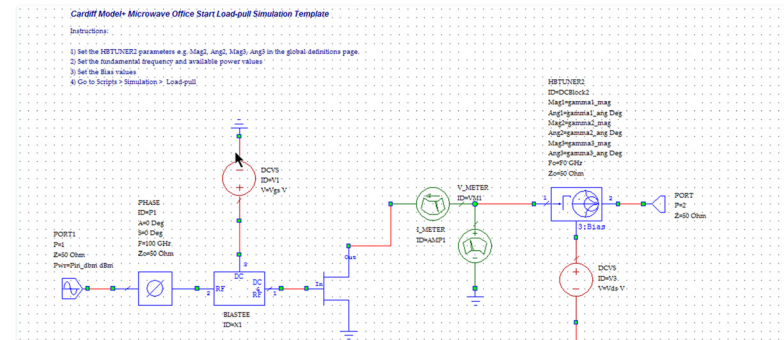
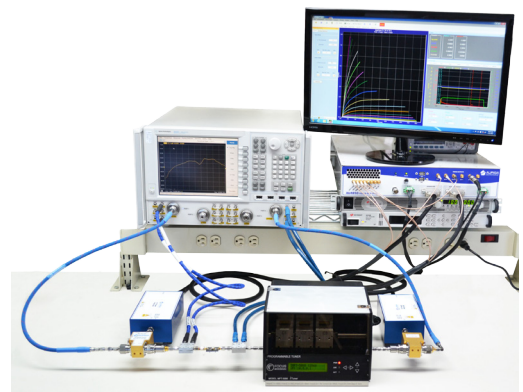
$$B_{pm} = S_{p1,m1}(DC, |A_{11}|)P^m \cdot |A_{11}| + \sum_{qn} S_{pq,mn}(DC, |A_{11}|)P^{m-n} \cdot A_{qn} + \sum_{qn} T_{pq,mn}(DC, |A_{11}|)P^{m+n} \cdot A_{qn}^*$$



# CARDIFF MODEL PLUS

The Cardiff model+ is a generalized solution using an Nth order 'mixing' parameter formulation and can be applied as a fundamental only mode or using the harmonic content and then easily extracted using the model generation tool and used within the EDA simulation environment.

The Cardiff model + is a poly-harmonic distortion (PHD) model. The ideal analyzing set is generated by varying one parameter at a time and analyzing the effect on the frequency components. Using a MPT tuner simplifies the control of three independent impedances at the given frequencies and greatly enriches the model generated.



## OUR CORE TEAM OF EXPERTS



**Dr. Christos Tsironis**

President & CEO  
Director of Engineering



**Vince Mallette**

Director of Sales &  
Business Development



**Bryan Hosein**

Director of Software &  
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General Manager  
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**Dr. Tudor Williams**

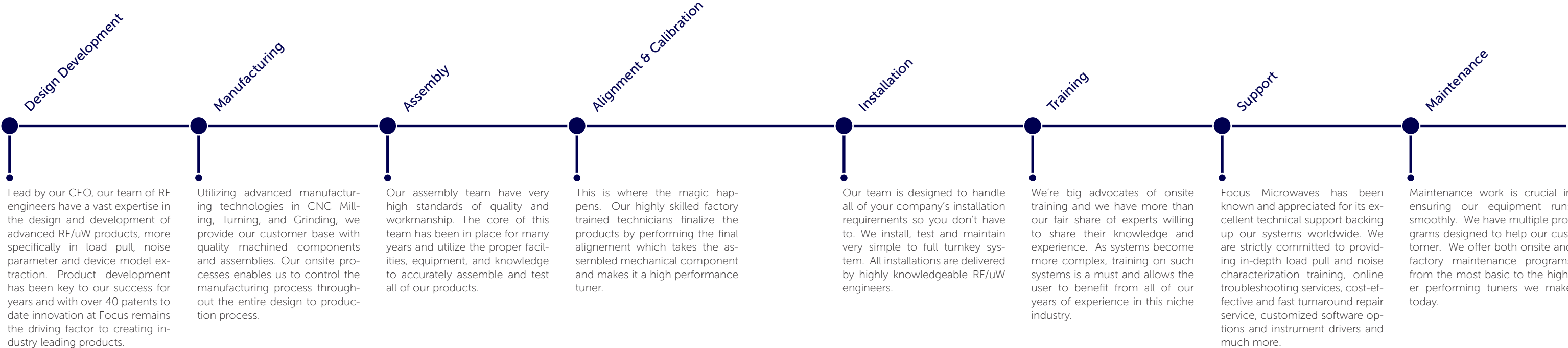
Engineering Manager  
Mesuro Ltd.



**Linda Pajari**

Operations Manager  
Auriga PIV Tech

# FROM START TO FINISH



# OUR OFFICES AROUND THE WORLD

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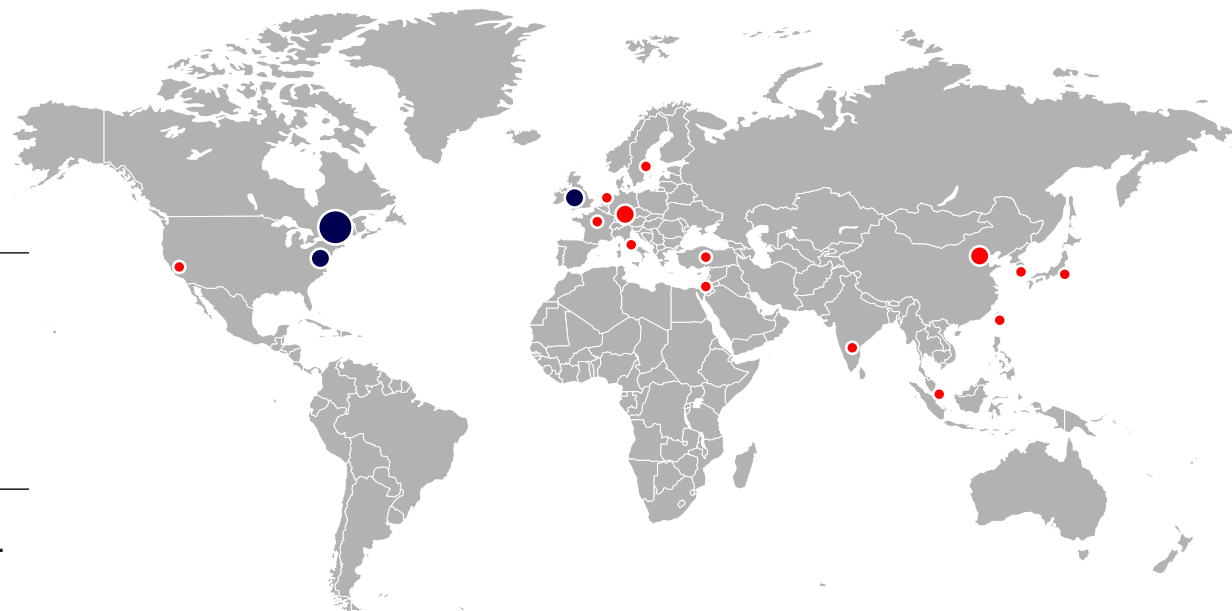
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