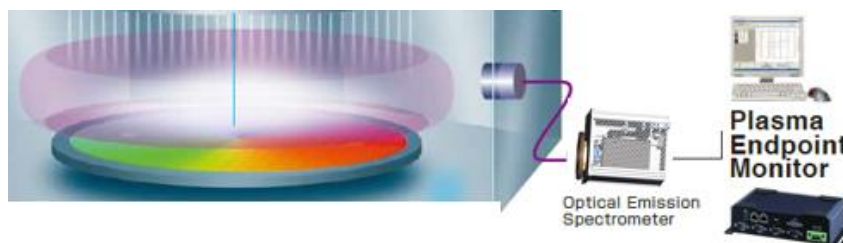# HORIBA

EV 2.0

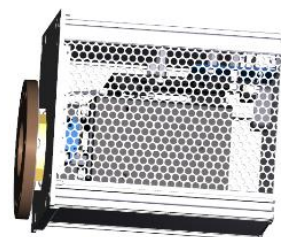## Optical Emission Spectroscopy Etching End-point Monitor

To address new requirements in Semiconductor, Compounds, MEMS… Dry Etch, Cleaning and PECVD industry, HORIBA has introduced a unique generation of Sensor dedicated to Advanced Endpoint Control, Fault detection and Chamber Health Monitoring.

EV 2.0 PC as EV 140 continuity

Plasma information is complex, **EV** 2.0 with Recipe Designer 2.0 (RD 2.0) and Sigma_P Software Highlights Process Engineering with automatic Elements Time Trend view and easy Endpoint Recipe creation.

- **EV 2.0** is a configurable, high performance spectrograph that can be customized for a variety of OEM/End-user applications in the fields of plasma chemistry, semiconductors, Compounds, PV, ALD/ALE, MEMS...: any dry etch, Plasma cleaning process and Deposition process (PECVD) needing monitoring, stability and/or drift control and ENDPOINT.
- **EV 2.0** is the continuity of our previous EV series, EV 140.
- **RD 2.0** has New engineering add-on to _create automatically Endpoint Recipe_ from a template to ease Production Recipe creation!!!
- **3 choices of spectrometer**
    - LR: Low resolution, 6.5 nm
    - STD: [200-1050] nm, 2.5 nm
    - HR: High Resolution, 1 nm

EV 2.0 belongs to EV actual family to introduce modularity

EV 2.0 is the new generation of Optical Emission Spectroscopy (O.E.S) instrument which complete **EV 140** family.

This family update gives a wider choice due its modularity: different software and spectrometers integration, different adaptation on plasma chamber: then you can optimize EV 2.0 integration choosing the more adequate model to fit with your real process needs and then gain in term of cost/footprint/integration/recipe duplication....

Segment: Semiconductor
Division: Dry Process Control
Manufacturing Company: HORIBA

EV 2.0 has 3 Software Integration

Modularity means that besides PC series, EV 2.0 will be proposed as autonomous spectrometers for OEM Mass production purpose.

- o The complete instrument, called **EV 2.0 PC**, permits to manage any engineering using all our software installed on an industrial PC (or a laptop or a compute stick). This model is also dedicated to production. This model contains full ENDPOINT software:
 - • *Sigma-P for real-time 24/24 ENDPOINT monitoring*

The Real-time software, Sigma_P, is the same whatever the sensor
  - • **Recipe designer 2.0 to ease engineering**

The Engineering Software, Recipe Designer RD 2.0, compared to RD7, contains a great NEW function:

- • **The RECIPE EXPORT** using a template recipe: a new Endpoint recipe is created in one click using all runs and RD 2.0 information
  - o From new run acquisition
  - o to engineering: Time trend, species, classification, Rupture wavelength selection...
  - o to endpoint
  - o no signal treatment, no parameters to add (except over etch if needed)
- • Software setups of RD 2.0 and Sigma_P are made so that during engineering, you never have to move data, runs, recipes...

- • The rest is equivalent: **Example of Recipe Designer setting**

  - o STEP1: Automatic extraction of the pattern of wavelength changes
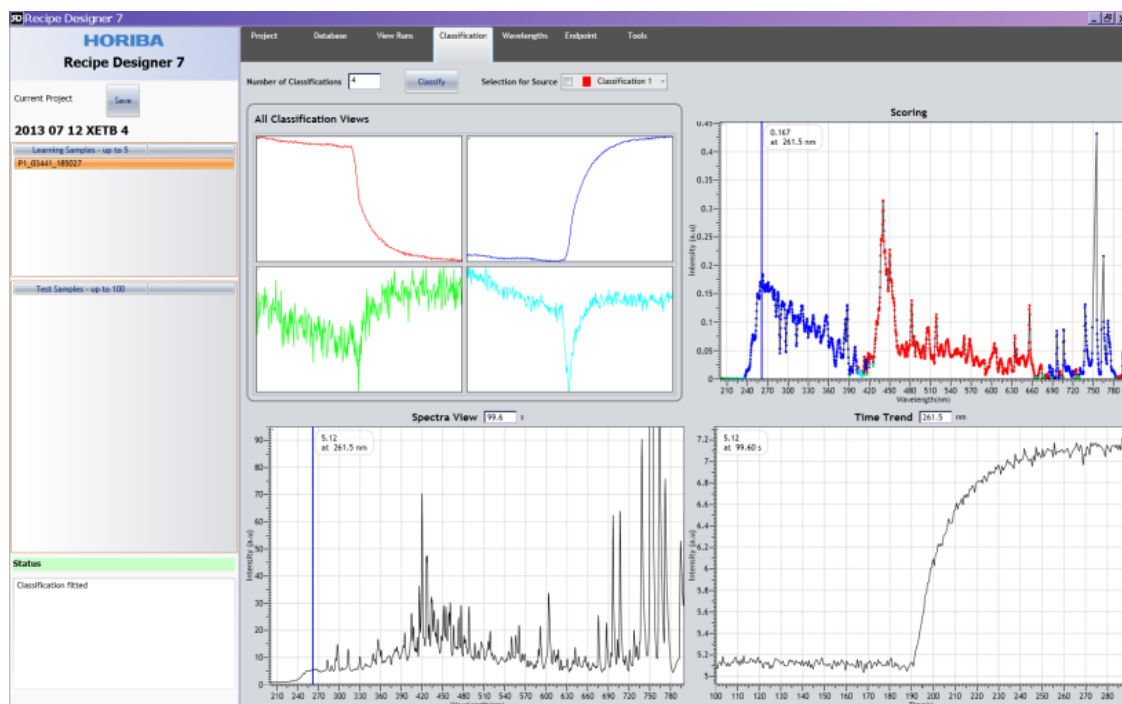
- • STEP2: Identification of the point of change using the approximation of two straight lines
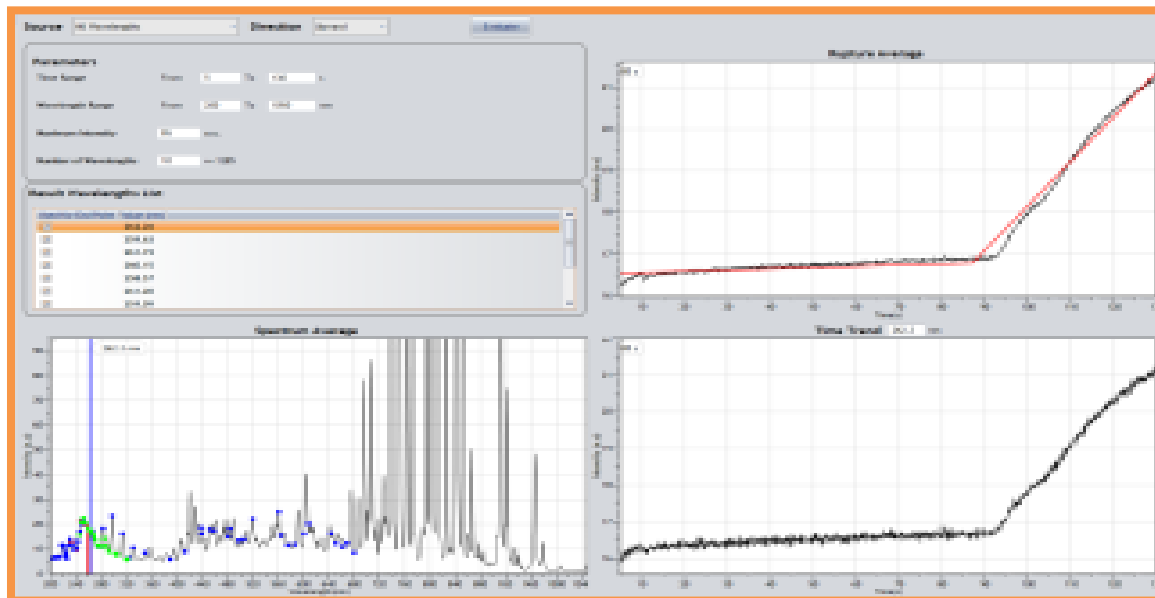
- • STEP3: The Endpoint simulation conducted by Rupture Intensity and the completed algorithm can be exported and built into Sigma-P. Endpoint is set on blue line when rupture intensity is the greatest, then over etch is applied.
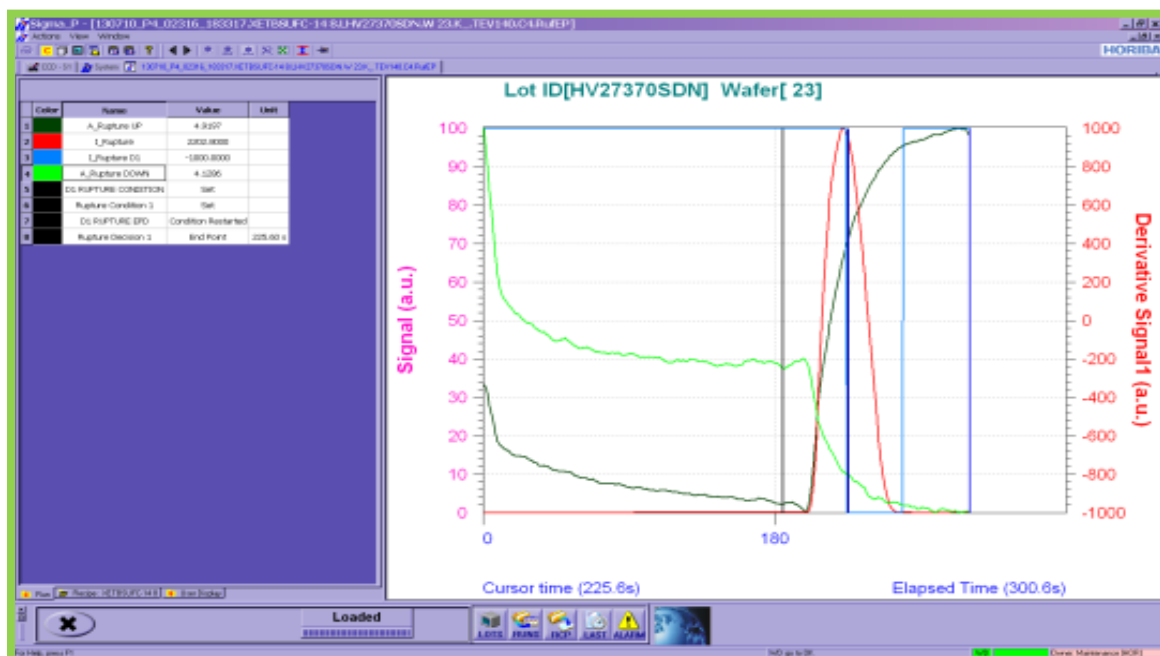
o Later, an autonomous version, called **EV 2.0 SMART**, can be integrated for Mass production, for OEM who needs to duplicate ENDPOINT and/or Control recipes on many Tools/chambers.

- This model contains full ENDPOINT algorithms/remote integration.

- At any time, connecting our engineering PC may permit to develop new ENDPOINT recipe if needed

o Then, an OEM version, called **EV 2.0 API,** dedicated to OEM who want to manage Software integration by itself using the Software Development Kit (SDK) provided

EV 2.0 has 3 Spectrometers Integration

This new OEM Optical module consists of a compact Versatile Spectrograph coupled with a multi-channel array detector and an HORIBA PCB board (JY70 ARM).

The optical design has been optimized to minimize stray light and maximize optical performance (S/N, high Dynamics, UV to NIR flat response…), high sensitivity, wide dynamic range and low noise to provide very high performance in terms of accuracy and reliability, making it the ideal in situ monitoring solution for today's shrinking geometries and complex multi-step processes.

Depending on process, it may need Low, standard or high resolution

- **EV 2.0 LR**, LR for Low resolution, down to 6.5 nm

- **EV 2.0 STD**, STD for Standard with a resolution down to 2.5 nm

- **EV 2.0 HR**, HR for High resolution down to 1 nm

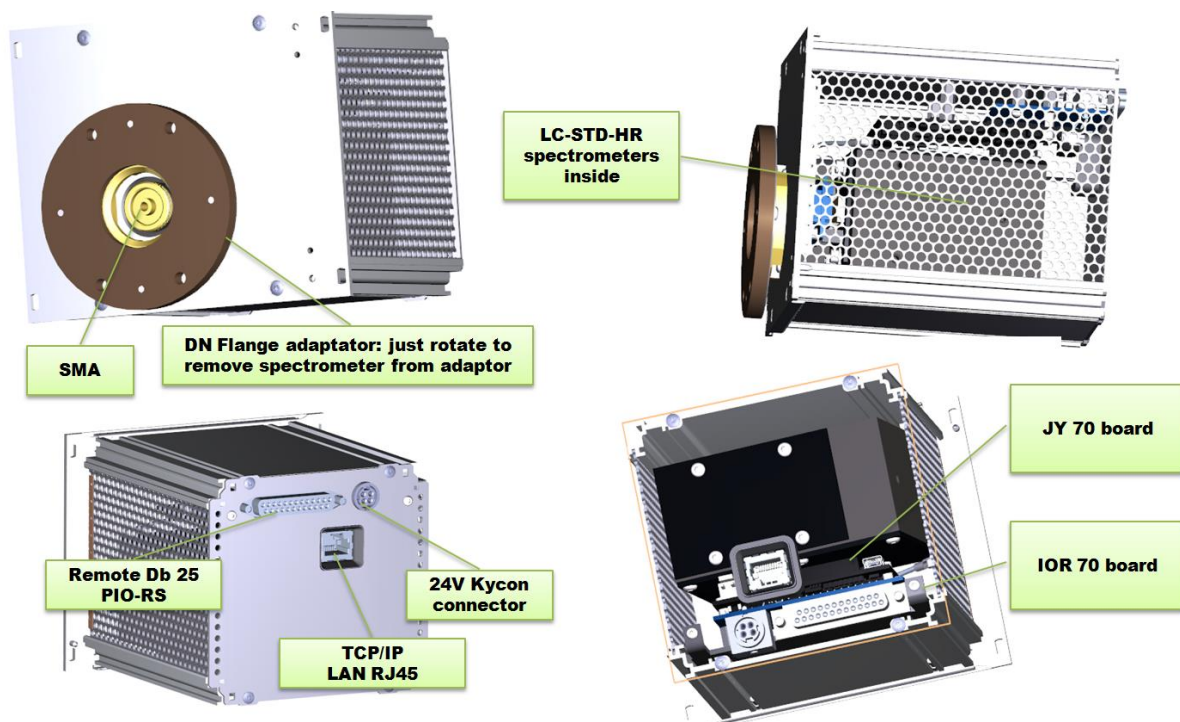## EV 2.0 Spectrometers have 2 Plasma Chamber Integration

Spectrometer compact package incorporates:

- directly an adaptation for any DN flange: easy one click remove spectrometer from adaptation (Baionet)

- or a classical SMA optical fiber input on the sensor part.
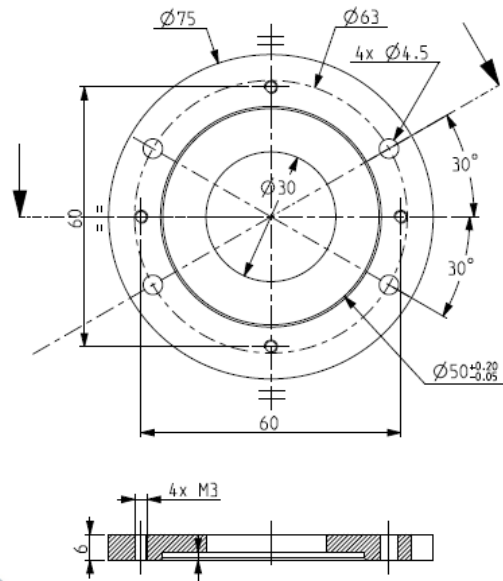
EV 2.0 Spectrometers view in 3D

- 3U Size: Easy rack integration
- LR width = 1/2 STD/HR width

EV 2.0 Spectrometer is connected to a PC (our Engineering PC or any other when SMART, API version) through a LAN connexion and then provides both easy measurement and easy installation advantages to tailor the system capabilities to your experiment's demands.

SPECIFICATION EV 2.0 API **Spectrometer** for Integrators

EV 2.0 API
 	
SDK for integrators
	• **API model is the basic version for OEM integration**
	• NO PC, no Sigma_P, no endpoint recipe, no HORIBA monitoring software: **No (endpoint) recipe!, just spectrometer hardware is provided!**
	• It's a basic OEM version which can be proposed for **OEM own integration**: for those who want to manage software integration by themselves!
	• This model is only sold with:
	   ○ A basic software to show spectra
	   ○ And additional SDK (Software development kit) which permits to OEM to develop his own application

EV 2.0 API is designed for Integrators who want to develop their application by themselves. It contains

- Integrated Spectrograph
    - Model: LR (6.5 nm), STD (2.5 nm) or HR (1 nm resolution)
    - Wavelength Range: Variable depending on model, maximum is [200, 1050] nm
    - Width slit: 50 µm
    - 24 V Alimentation box (else use 24 V on tool)
- Detectors: CCD Line array detectors with 2048 pixels
  With its proprietary high-resolution holographic spectrograph equipped with a 2048x16 pixels Back-Thinned CCD and a fast 16 bits acquisition electronics, the EV 2.0 is capable of acquiring plasma light emission with optimised signal on noise ratio from 200 to 1050 nm (STD model). Exposure time varies from 20 ms to 2.5 s to observe weak or intense plasmas.

- NO HORIBA computer

- To be integrated, spectrometers are provided with:
    - API = Application Programmatic Interface
        - Set of contract functionalities documented permitting to use from an external host client software all the features of the product.
        - Some features are raw quite low-level unitary actions,
        - some features are high level and packaged to minimize the software integrator effort.
    - SDK = Standard Development Kit
        - set of tools, software examples, source code samples, test utilities, help documentation…
        - to allow customer software developer to put the API in action
- Chamber adaptation
    - Use DN Flange adaptor:
        - Prepare your chamber adaptation if necessary
        - If SMA adaptation is installed on spectrometer, please remove it when SMA fiber is not used. Then you will collect a maximum of light.

OPTION

- **Option 1**: Optional SMA Optical fiber:
    - default is: UV type, 3 meters
    - else define length

SPECIFICATION EV 2.0 PC Complete system for Engineering and production

EV 2.0 PC
 	
Sigma_P, RD 2.0 for Engineering
	• **PC model is the complete instrument for engineering and production**
	
	• It permits to manage any engineering using all our software installed on our industrial PC: **all endpoint recipes are located on the PC!**
	• More than **engineering**, this model is also dedicated to **production**.
	• This model contains full ENDPOINT software:
	    o Recipe Designer 2.0 to ease engineering
	    o Sigma-P for real-time 24/24 ENDPOINT monitoring (to manage recipes/data/Monitoring/reprocessing)

EV 2.0 PC is designed for process development, engineering and production tasks including:

- Integrated Spectrograph
  - Model: LR (6.5 nm), STD (2.5 nm) or HR (1 nm resolution)
  - Wavelength Range: Variable depending on model, maximum is [200, 1050] nm
  - Width slit: 50 µm
  - 24 V Alimentation box (else use 24 V on tool)

- Detectors: CCD Line array detectors with 2048 pixels
  With its proprietary high-resolution holographic spectrograph equipped with a 2048x16 pixels Back-Thinned CCD and a fast 16 bits acquisition electronics, the EV 2.0 is capable of acquiring plasma light emission with optimised signal on noise ratio from 200 to 1050 nm (STD model). Exposure time varies from 20 ms to 2.5 s to observe weak or intense plasmas.

- Computer: Windows 10, 64 bits

  - Production: industrial PC

Windows 10 Controller	
EV 2.0 standard PC (Default)	
CPU	64bits, Intel® Pentium® N4200, 2.5 GHz
Controller Dimensions	197 (W) x 110 (D) x 55 (H) mm
Controller Mass	2 kg
EV 2.0 High Grade PC (Optional)	
CPU	64bits, Intel® Core™ i7-7700T 2,9 GHz
Controller Dimensions	264 (W) x 96.4 (D) x 186.2 (H) mm
Controller Mass	4.5 kg

- R&D: Laptop type or Intel compute stick

- Dedicated software with Windows 10, 64 bits
  - **Real time Software: Sigma-P**
  - **Engineering Software: Recipe designer 2.0**

- Chamber adaptation
  - Use DN Flange adaptor:
    - Prepare your chamber adaptation if necessary
    - If SMA adaptation is installed on spectrometer, please remove it when SMA fiber is not used. Then you will collect a maximum of light.

OPTION

- **Option 1**: Optional SMA Optical fiber:
  - default is: UV type, 3 meters
  - else define length

- **Option 2**: No Remote in standard product
  - PIO, RS, TCP/IP remote: check our specifications
  - If special remote adaptation is needed, specifications must be sent.

- **Option 3**: Training at customer site, one day during installation
  - Prepare classical samples to process
  - We will develop together recipes: From spectra acquisition to relevant elements and endpoint using Recipe Designer 2.0, the essential tool for process Engineer:
  - One day by default, more if needed

  - Backup and send data
  - Distant engineering can be done

SPECIFICATION **EV 2.0 SMART Embedded system** for Mass production

EV 2.0 SMART
 	
Autonomous for Mass Production
	• **SMART model is the embedded version for mass production**
	
	• NO PC, no Sigma_P: **all endpoint recipes are located on the Spectrometer!**
	• It's an autonomous version which can be integrated for **Mass production**, for OEM who needs to duplicate ENDPOINT and/or Control recipes on many Tools/chambers.
	• This model contains full ENDPOINT algorithms/remote integration integrated on the SMART spectrometer: This SMART spectrometer can work on a blind mode (just link to OEM tool for start/stop/endpoint)
	    ◦ We provide a SMART 2.0 suite which can be installed on any Windows 10 PC (to manage recipes/data/Monitoring/reprocessing)
	    ◦ We can provide Recipe Designer 2.0 as an option to do engineering and create endpoint recipe (which then can be downloaded to spectrometer)

EV 2.0 SMART is designed for Mass production tasks including:
- Integrated Spectrograph
  - Model: LR (6.5 nm), STD (2.5 nm) or HR (1 nm resolution)
  - Wavelength Range: Variable depending on model, maximum is [200, 1050] nm
  - Width slit: 50 µm
  - 24 V Alimentation box (else use 24 V on tool)

- Detectors: CCD Line array detectors with 2048 pixels
  With its proprietary high-resolution holographic spectrograph equipped with a 2048x16 pixels Back-Thinned CCD and a fast 16 bits acquisition electronics, the EV 2.0 is capable of acquiring plasma light emission with optimised signal on noise ratio from 200 to 1050 nm (STD model). Exposure time varies from 20 ms to 2.5 s to observe weak or intense plasmas.

- NO HORIBA computer

- Embedded software on Spectrometer electronic board
  - After Engineering with EV 2.0 PC model, convert Endpoint recipe for SMART model.
  - Connect Spectrometer on the Tool PC. Remote communication is established between Tool PC & Spectrometer
    - Download recipe on Spectrometer directly
    - Start/Stop/Endpoint…
   - Send data to tool PC if necessary (No data save on spectrometer)

- Chamber adaptation
  - Use DN Flange adaptor:
    - Prepare your chamber adaptation if necessary
    - If SMA adaptation is installed on spectrometer, please remove it when SMA fiber is not used. Then you will collect a maximum of light.

OPTION

- **Option 1**: Optional SMA Optical fiber:
  - default is: UV type, 3 meters
  - else define length

- **Option 2**: No Remote in standard product
  - PIO, RS, TCP/IP remote: check our specifications
    - EV 2.0 Smart version **can select recipe** to execute by:
      - TCP link (messages)
      - USB VCP (messages)
      - UART serial (messages)
      - PIO IOR 70 (wires combination permits to identify a recipe ID number)

    - EV 2.0 Smart version **can modify recipe parameters** from Tool host to execute and **can exchange real time live data with host** during recipe endpoint execution by:
      - TCP link (messages)
      - USB VCP (messages)
      - UART serial (messages)

    - Best and easy link is TCP/IP (production grade, reliable)

  - If special remote adaptation is needed, specifications must be sent.

EV 2.0 Remote Specifications

Remote connectors are located on spectrometer Rear Side
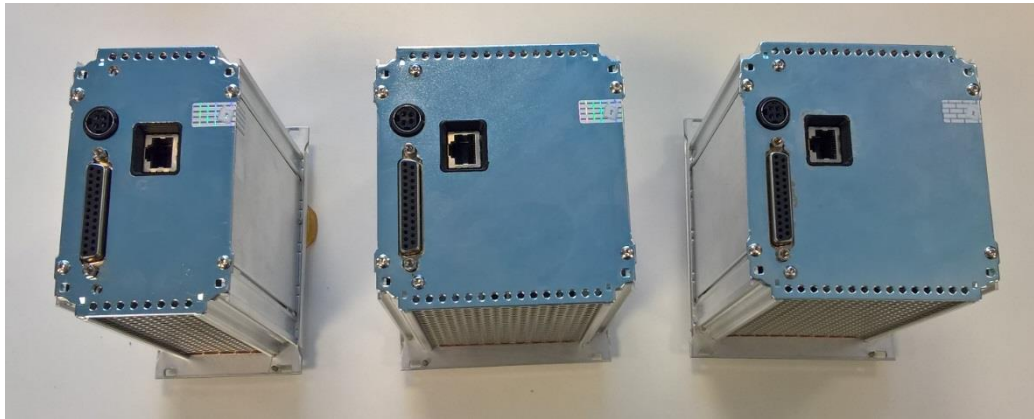
- EV 2.0 may be connected to any host through digital Linkwith RJ 45 connector: TCP/IP
- EV 2.0 contains an interface board to provide galvanic isolation between the host controller hardware of the OEM / Tool from the spectrometer main electronics.
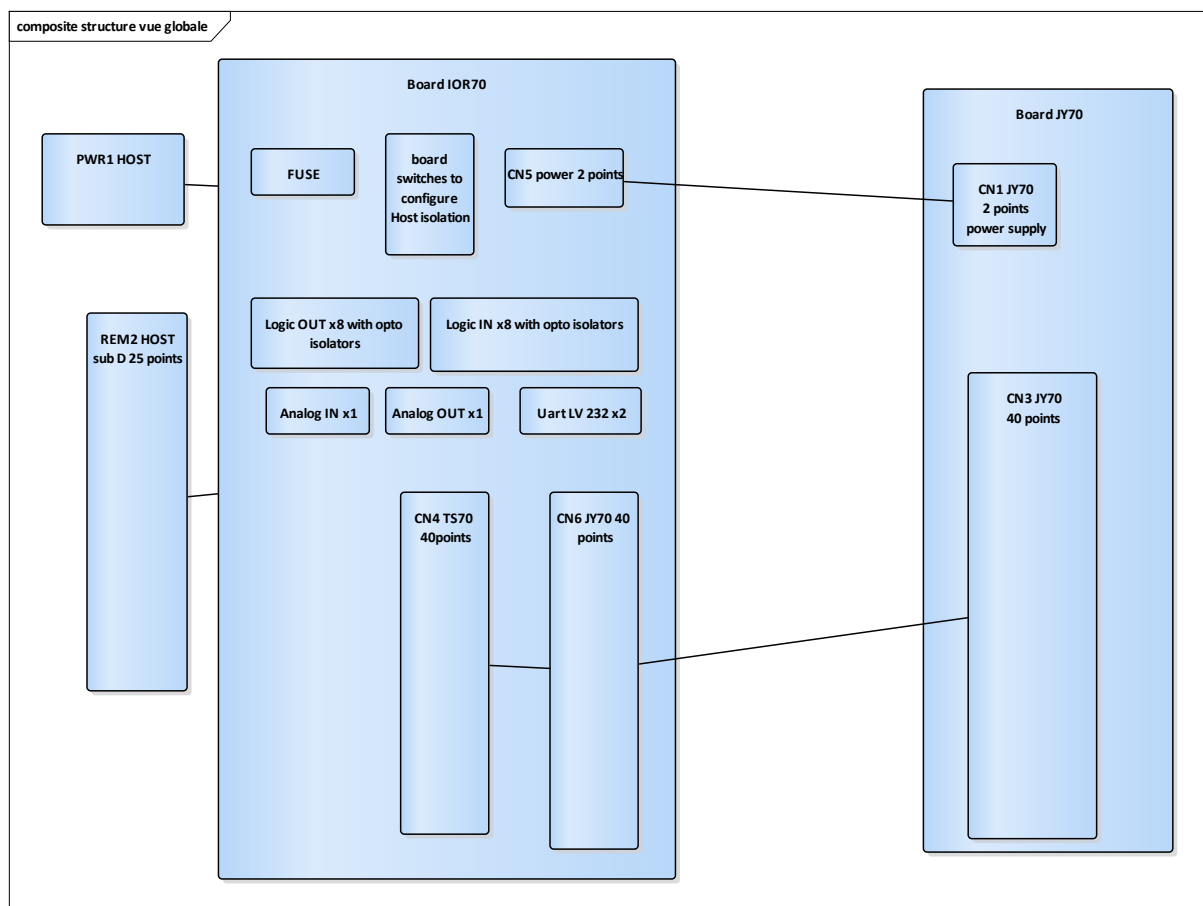
- This permits to communicate by logic wiring, fast, deterministic with full optocouplers and power spikes isolation, frequently found in industrial fab environment

- CN2 Power Supply Connector

  o EV 2.0 is connected to Power supply (24 V) through a Kycon connector

  o Surface mounted power supply Kycon 4 pins KPJX-4S horizontal, industrial connector to receive the +9 to 24 Volts with common.

- CN2 pin specification

CN2	KPJX-4S
1	VIN_COM
2	+VIN
3	VIN_COM
4	+VIN

- CN1 Remote control Host : Sub D 25pins female, 2 rows of pins, horizontal, DSUB25S, surface mounted:

  o Contains 8 Digital inputs named DI0 to DI7 as TTL, 24V logic, 12V logic selectable, with optocoupler isolation and noise filtering.

  o Contains 8 Digital outputs named DO0 to DO7, as TTL, open collector 60mA max, 24V logic selectable

  o Contains optional external Host VCC to polarize pull ups

  o Contains external Host COM to link the common

  o Contains 1 analog output as voltage 0 to +5Volt or as current 0 to 20mA, named AO1

  o Contains 1 analog input 0 to 5 Volt named AI1

  o Contains 2 LV TTL 232 serial channels: named TX1, RX1 and TX2, RX2

  o Contains the COM common of spectrometer interface board

- CN1 Pin specification

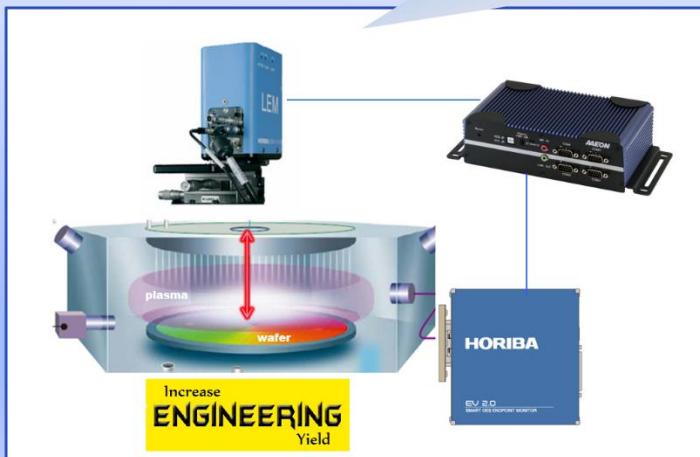| CN1			DSUB25S
1	DI0	14	DO0
2	DI1	15	DO1
3	DI2	16	DO2
4	DI3	17	DO3
5	DI4	18	DO4
6	DI5	19	DO5
7	DI6	20	DO6
8	DI7	21	DO7
9	HOST COM	22	TX1
10	HOST VCC	23	RX1
11	AO1	24	TX2
12	COM	25	RX2
13	AI1		

HORIBA

- ## TWIN 2.0

TWIN 2.0 is EV 2.0 OES spectrometer + LEM Interferometric camera embedded in one single instrument package (Win10 64bits PC based) to enhance engineering and process development.