

Real Time and Run-to-Run Process Control of Plasma Processes Using Internal Machine and External Sensor Data

F.H. Bell, *Infineon Technologies AG, Germany*
D. Knobloch, *Infineon Technologies AG, Germany*
J. Zimpel, *Fraunhofer Institute, Germany*
K. Voigtlaender, *Fraunhofer Institute, Germany*
J. Mathuni, *Infineon Technologies AG, Germany*
P. Hoehmann, *Infineon Technologies AG, Germany*

AVS 99
Oct 25-29, 99
Seattle, Wash.

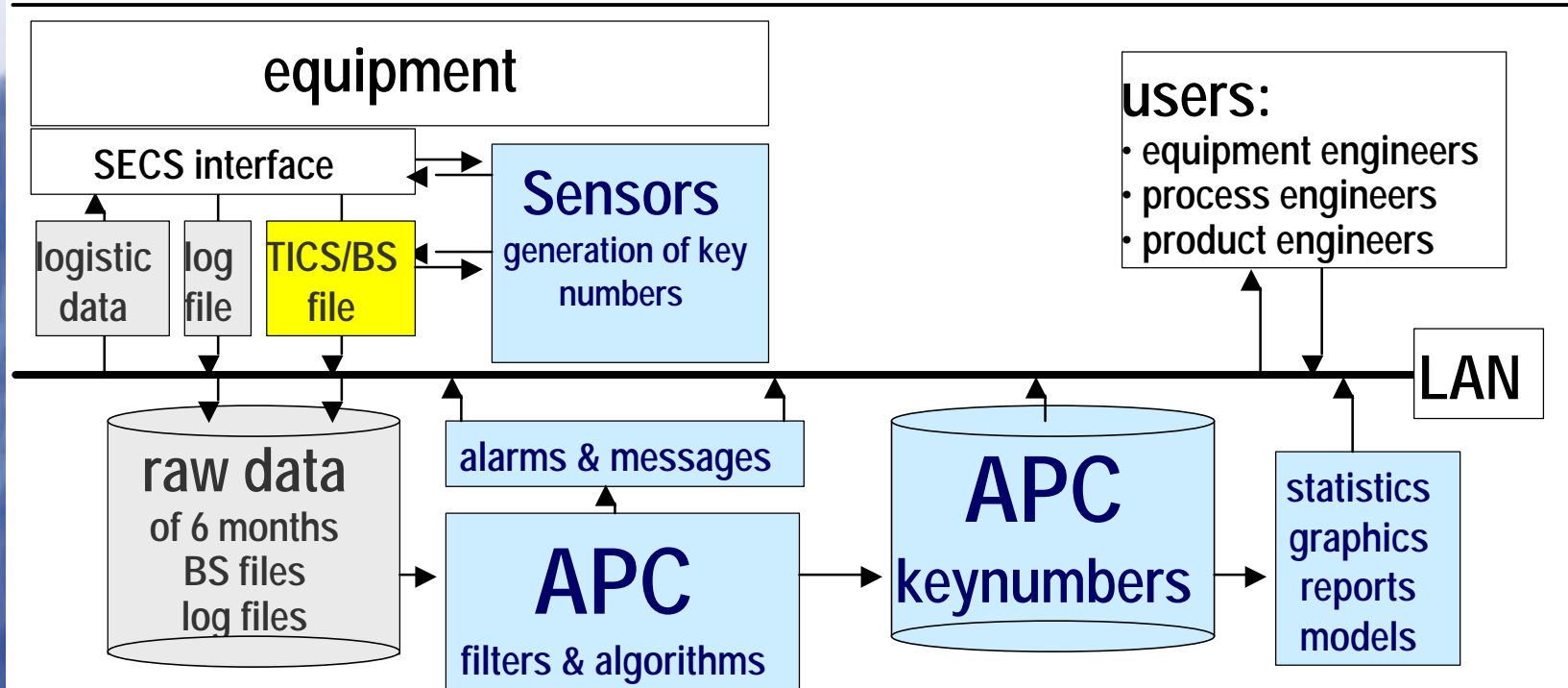
*Infineon Technologies AG is the former semiconductor division
of Siemens AG*

In the frame of Advanced Process Control (APC)

Strategy

- 0.) equipment-integration, sensor-integration,
data acquisition
- 1.) keynumbers per wafer, lot, tool, recipe, ...
trend charts, simple statistics
- 2.) online supervision: alarms, messages
complex algorithms: neuronal networks, PCA, ...
- 3.) correlation with:
 - maintenance data
 - inline-measurements
 - pre-processes (deposition - litho - etch)
 - product data (electr. parameter, yield)

Strategy: IT framework for APC



TICS/BS files: (TICS, Brookside, Keithley, ...)

analog data per sec.

< 70 channels (int. & ext. sensors)

150 MB per month & machine

log files: (machine specific)

time stamp, events, alarms, logistics

1 MB per month & machine

APC keynumbers:

significant engineering numbers

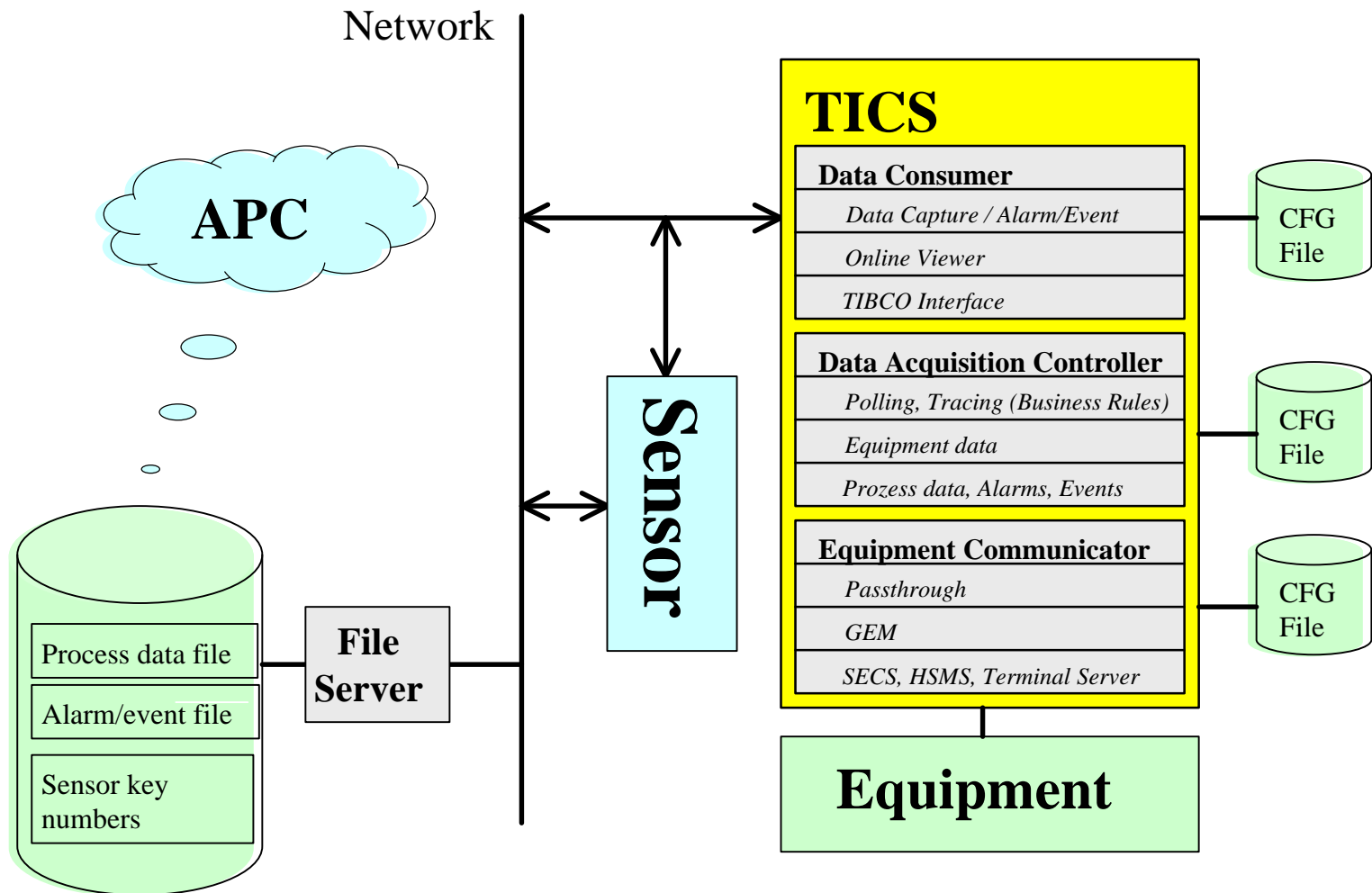
per wafer, lot, recipe, tool, ...

6 MB per month & machine in Oracle DB

**quality & productivity
control procedures**

TICS

Tool Integration Concepts & Systems



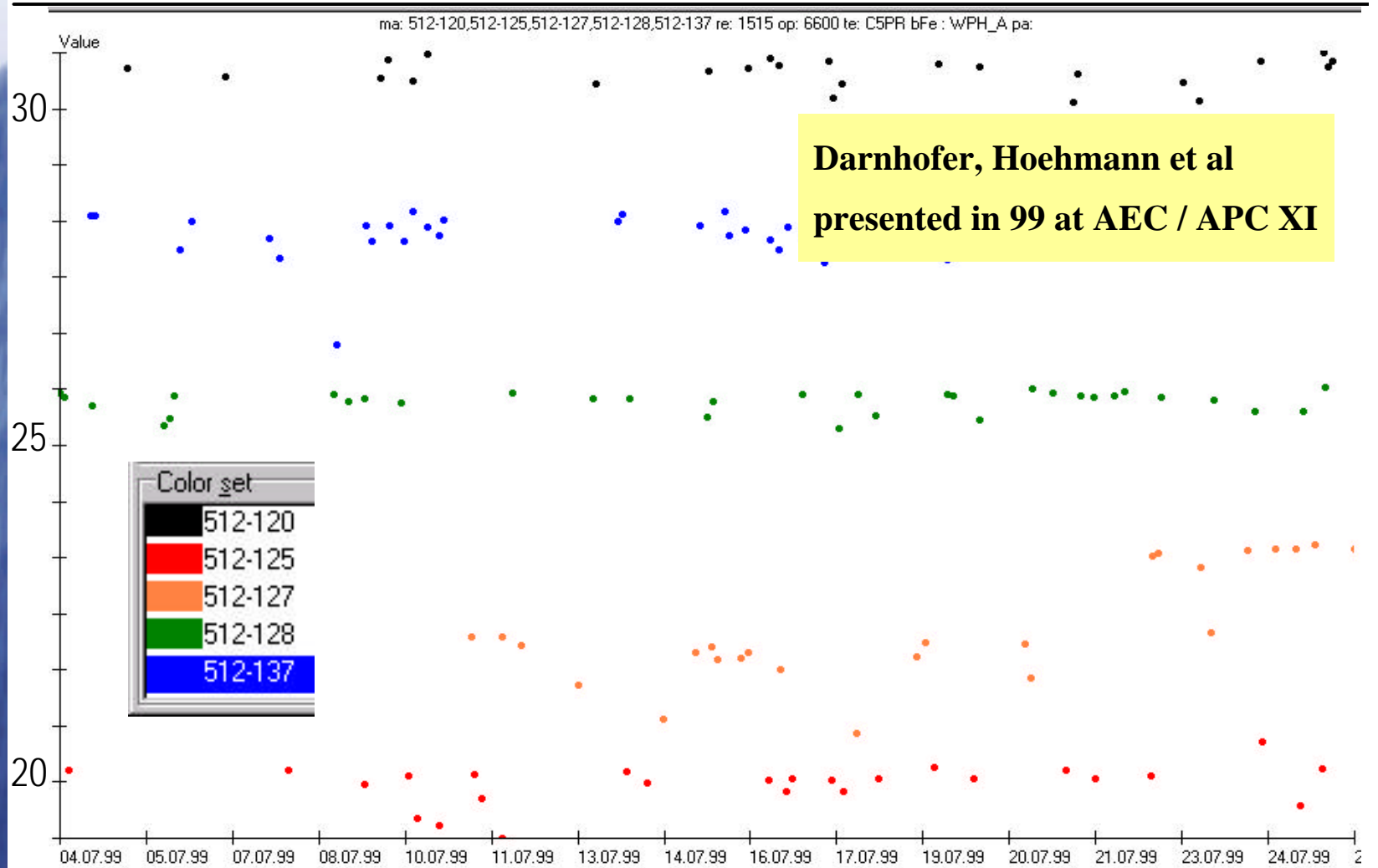


Extraction of keynumbers from event-logfile:

08/14/98 04:05:09 (01)Door Open
08/14/98 04:06:41 (01)Button Pressed 6-DOOR
08/14/98 04:07:28 (01)Door Closing
08/14/98 04:08:25 (01)Button Pressed 1-WAFER XFER
08/14/98 04:08:25 (01)Start Load - **17-OHNE-4C** ————— **SEQUENCE**
08/14/98 04:09:03 (01)Door Closed
08/14/98 04:09:04 (01)Load Chamber Pumpdown Started }
08/14/98 04:10:10 (01)Wafer counting completed } **TIME_PUMP**
08/14/98 04:32:19 (01)Load Chamber Pumpdown Done
08/14/98 04:32:48 (01)Start Cassette CASSETTE IN PORT04
08/14/98 04:38:38 (01)Load Chamber Pumpdown Started
08/14/98 04:38:39 (01)End Load - 17-OHNE-4C
08/14/98 04:39:01 (01)Recipe Started - **C3-MET-1000** ————— **RECIPE**
08/14/98 04:39:01 (01)Step Started C3-MET-1000 01
08/14/98 04:39:36 (01)RF On C3-MET-1000 01
08/14/98 04:39:46 (01)Load Chamber Pumpdown Done
08/14/98 04:42:47 (01)RF Off C3-MET-1000 01
08/14/98 04:42:47 (01)Step Started C3-MET-1000 02

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Example: throughput (wafers per hour)



equipment differences in wph up to 30%

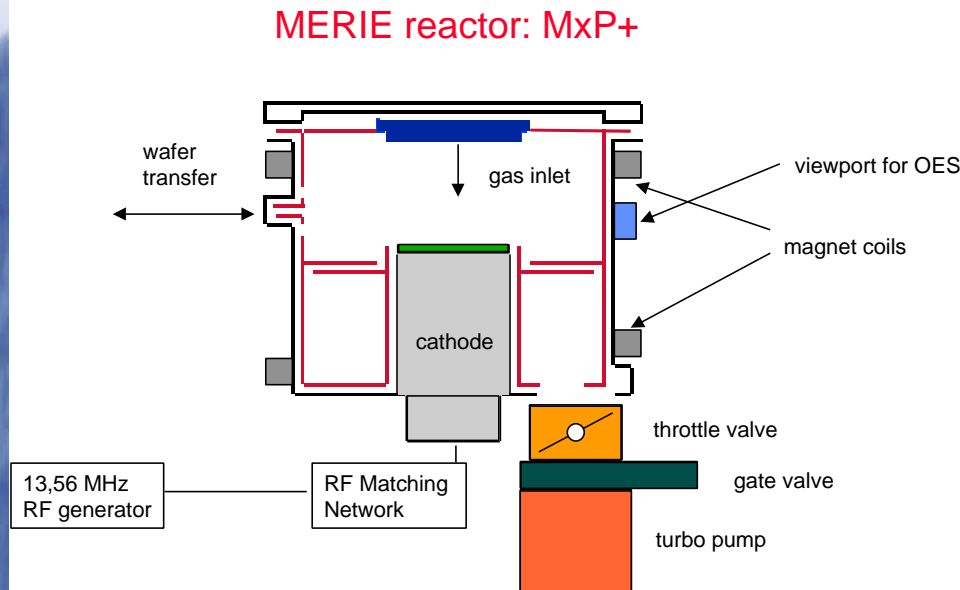


List of sensors at Infineon sites

Sensor (Optical)	Site	S	Target
Optical emission spectrometer (OES) , (Hamamatsu)	DD, Vi, MchP, HL MH E, SC 300	12	Endpoint, dry-cleans, seasoning, wet-clean cycles, etc
LES 1200 (Leybold Inficon)	DD	1	etch rate uniformity
Sensor (electrical)			
Arcing sensor In-house development	DD, Vi, MchP	16	Arcing detection
Hercules sensor (ASI Institute)	DD, Rgb	3	electron collision rate / density
IFT (Scientific Systems)	Rgb	1	ion flux / polymer deposition rate
PIM (Scientific Systems)	Rgb	1	RF Voltage Current Phase Monitoring System
Z-Scan (HF-Sensor) (A&E)	Rgb	1	RF Voltage Current Phase Monitoring System

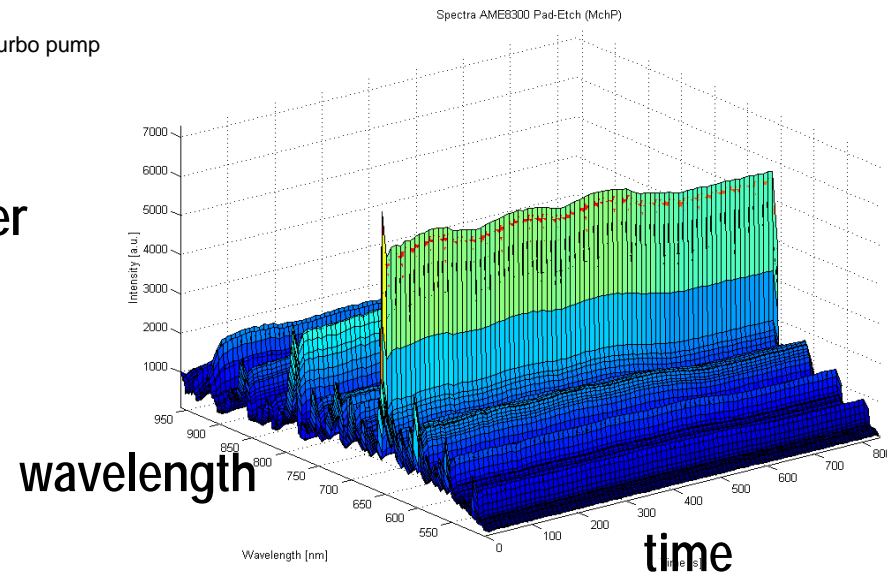
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Example: OES, oxide etch on MxP+



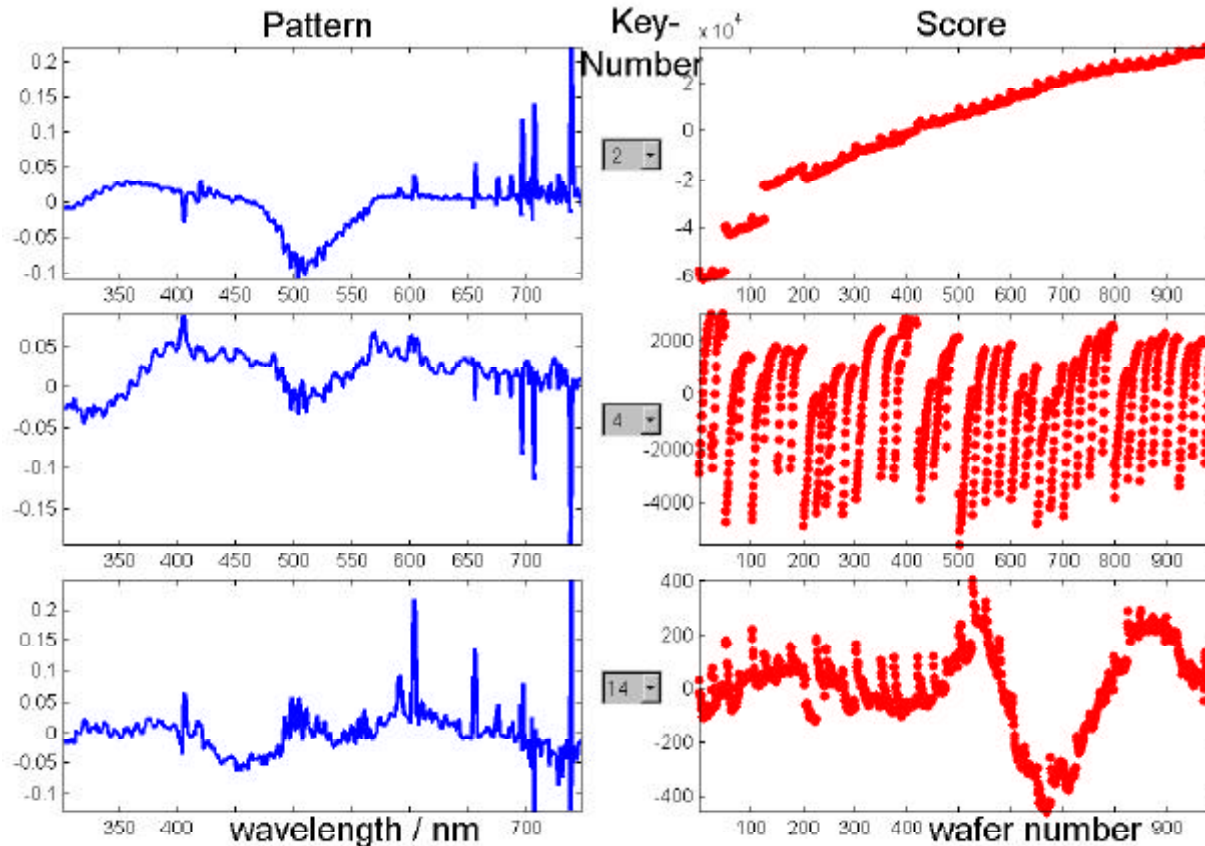
Optical Emission Spectrometer

- MPM C7460, Hamamatsu
- based on CCD
- 200-950 nm
- 1.5nm resolution



Example: OES, oxide etch on MxP+

Monitoring of 1000 wafers / PCA analyses



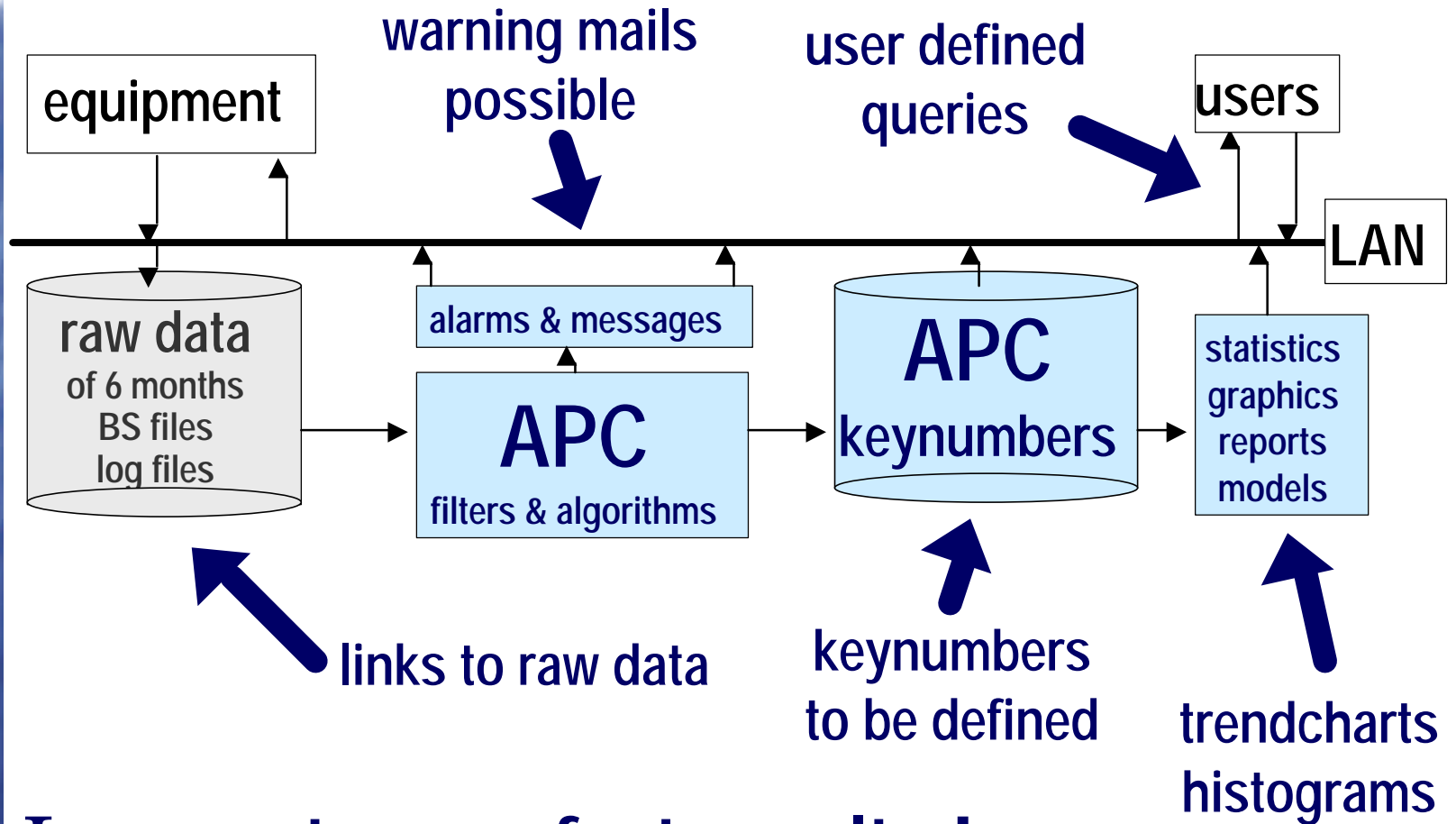
Key numbers

Cleanliness
of the chamber

„first“ wafer
effect

Chamber drift
due to process mix

Software: APC-Trend



Ⓟ easy to use, fast results !

one software for all process areas

APC-Trend query definition

area

Location
RBG-W

Bereich
FOTO

Workcenter
I_LINE

Equipment
510-123 Update

Recipe
M0380B4S Update

Operation
2265 Update

Technology
C5FR3 Update

equipment
recipe
operation
technology

time range

absolute time range

Date from
07.07.99

to
22.07.99

relative time range

last 14 days

Lotlist Edit

Category X
Equipment

Category Y
None

categories

keynumber

Key numbers for ... Info

Batches

Runs (phys.)

Key number(s)
TIME_LOT

Runs per Batch between
0 and 0

Trend

Histogram

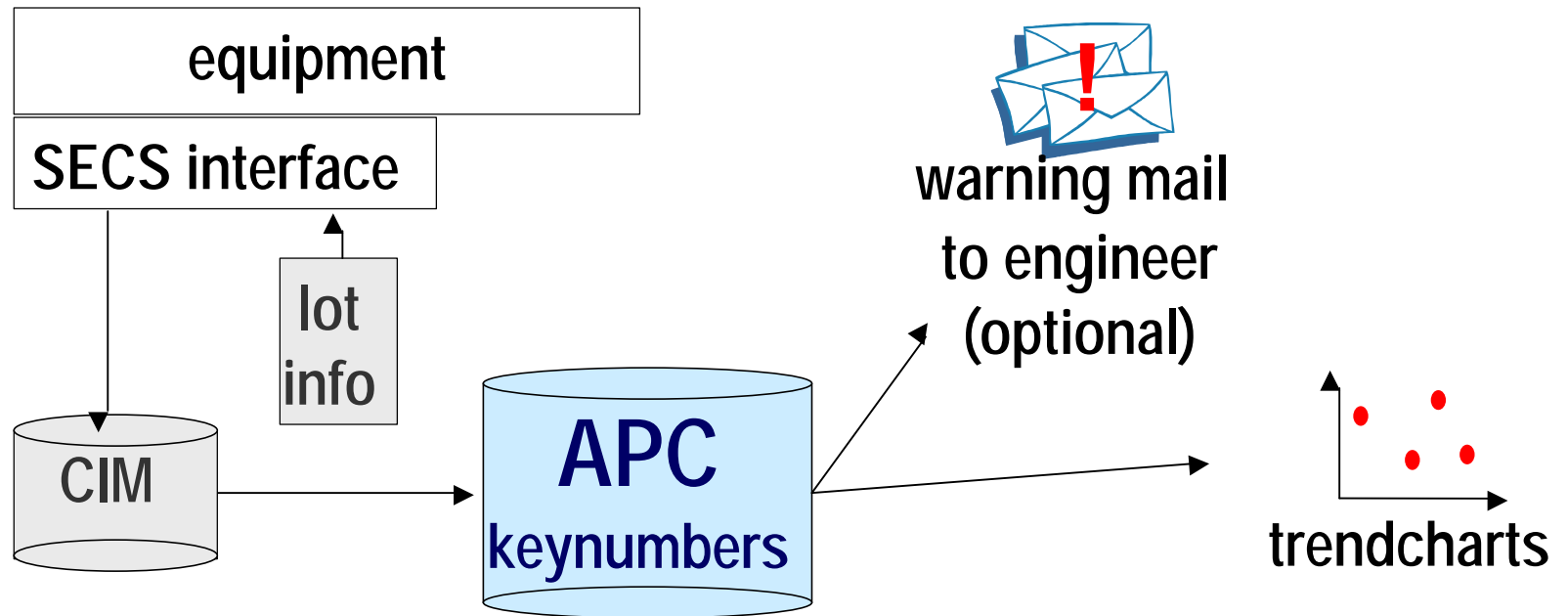
Data browser

Data extract

graphics

OK Cancel

APC technology business process



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- realized for litho and etch
- in preparation for all other areas (CVD, etc...)

APC delivers information:

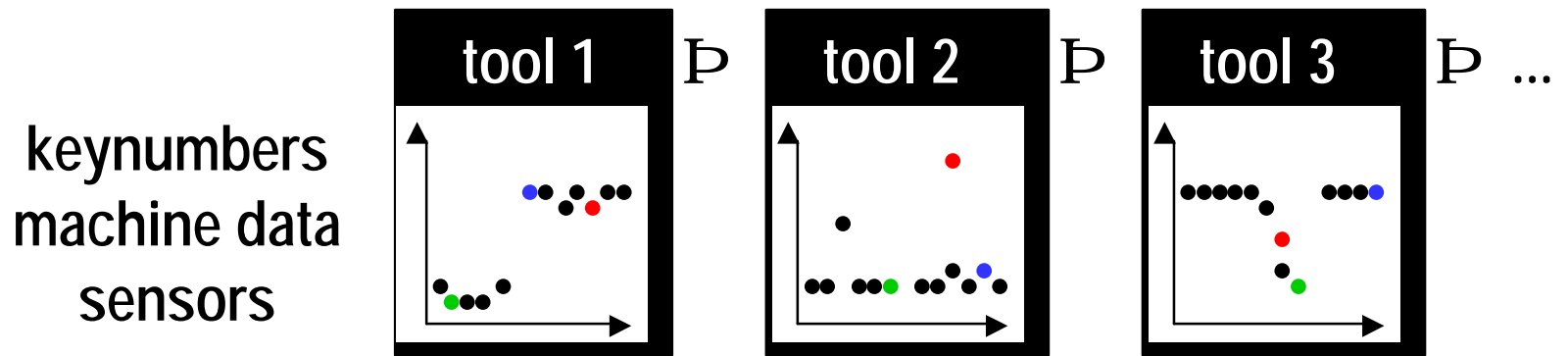
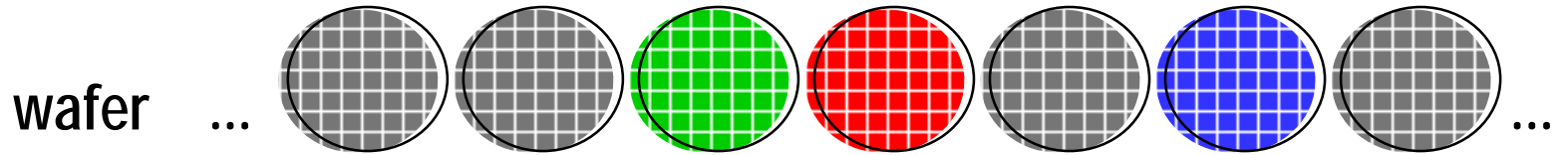
- product wafers ... not testwafers
- all wafers, recipes, products ... not samples
- continuous in time ... not momentarily
- automatically recorded ... not manually booked

APC delivers improvement:


- keynumbers ... quality, stability, productivity
- problem detection ... wafers, lots, tools, recipes
- optimization ... recipes, process (mix)
... tools, maintenance
... cleans, conditioning
... use of test wafers

**⊖ estimation from results in dry etch:
>1 % yield & >10 % productivity**

Outview: correlation with product data



correlations ?



electr. parameter
product data

