Development roadmap of SEERS implementations

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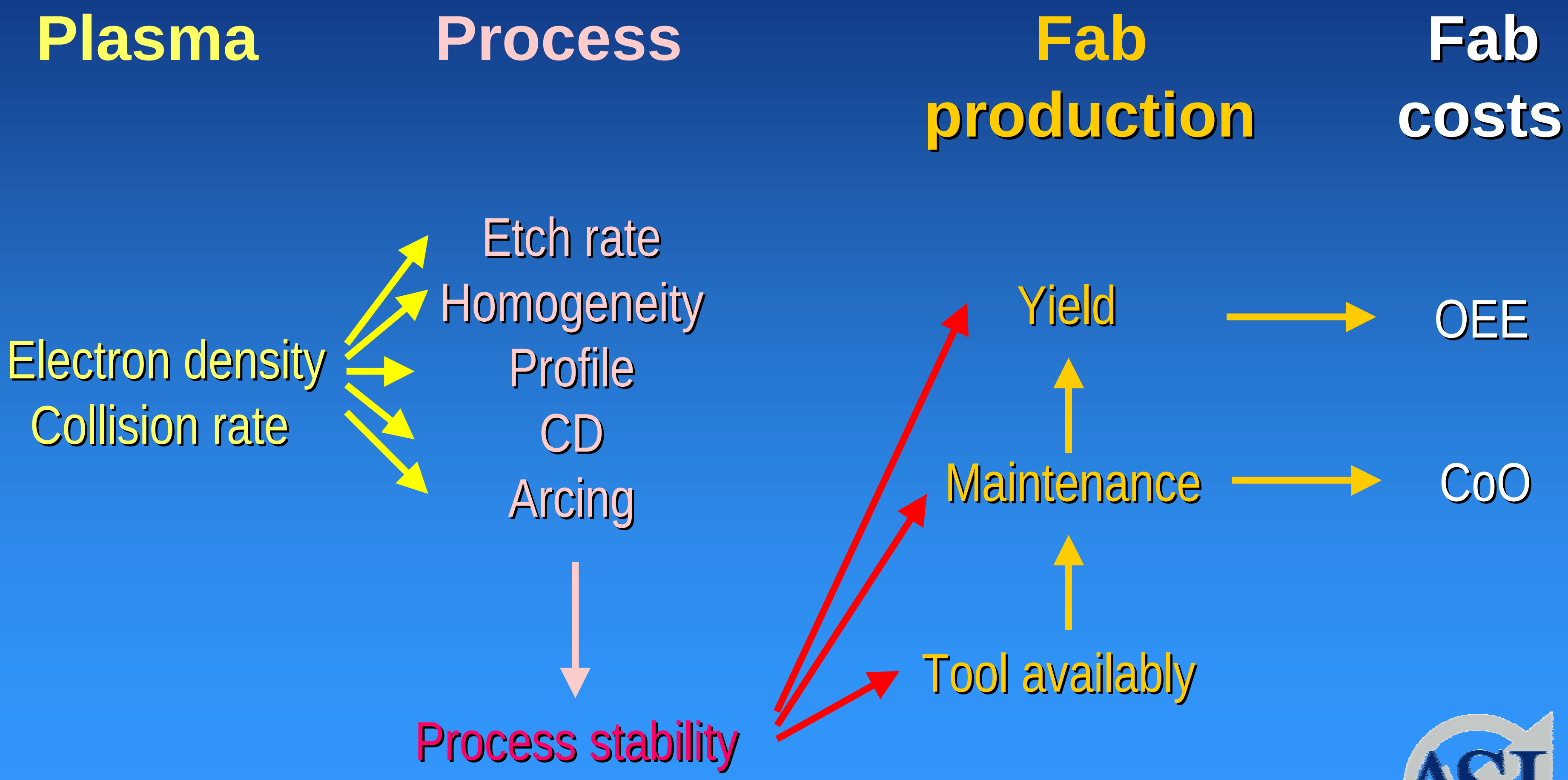
From Process Knowledge to Economic Power



Plasma

Process

Fab production

Fab costs

Electron density
Collision rate

Etch rate
Homogeneity
Profile
CD
Arcing

Process stability

Yield
Maintenance
Tool availably

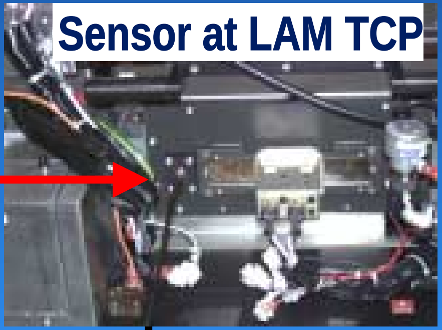
OEE
CoO

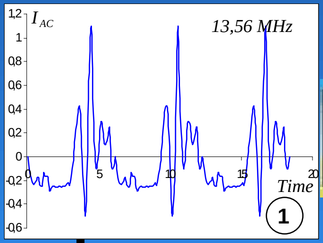
The Hercules principle

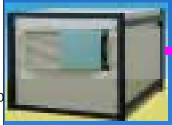
standard second
source part

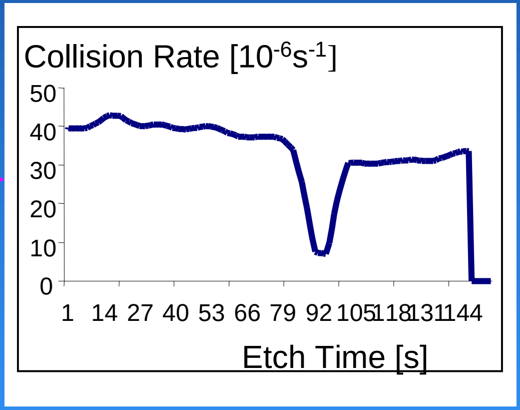
easy installation
no impact on plasma process
absolute plasma parameters

Sensor at LAM TCP









sensor

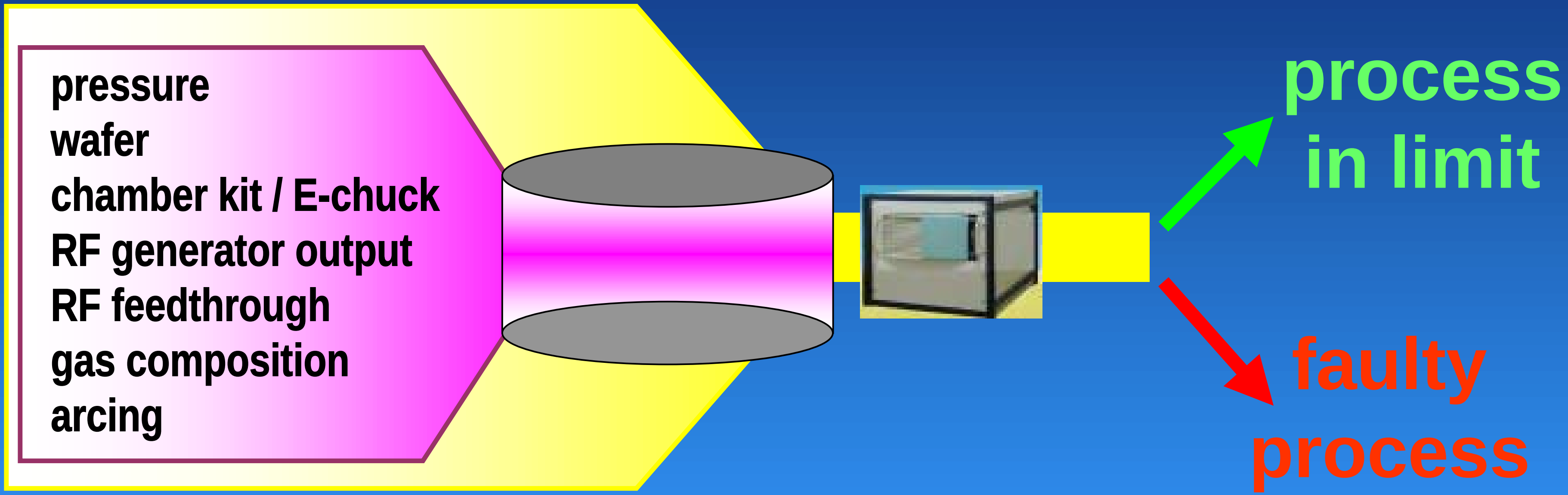
measurement signal

plasma parameters

by courtesy of

Infineon technologies

The Hercules message



pressure
wafer
chamber kit / E-chuck
RF generator output
RF feedthrough
gas composition
arcing

process in limit

faulty process

difficult ← ***decision*** → ***easy***

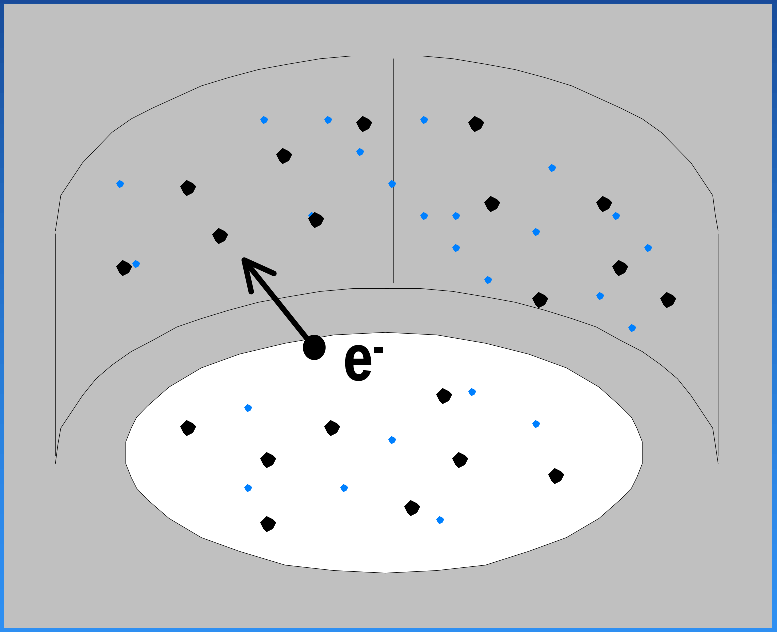
Fab Quality Management through Hercules

- ***ISO 9000***
- ***Enhancing wafer tracking and SPC***
- ***Fault detection and classification***
- ***Fingerprint of Process and Wafer***
- ***Supporting APC***

→ ***Cost reduction***

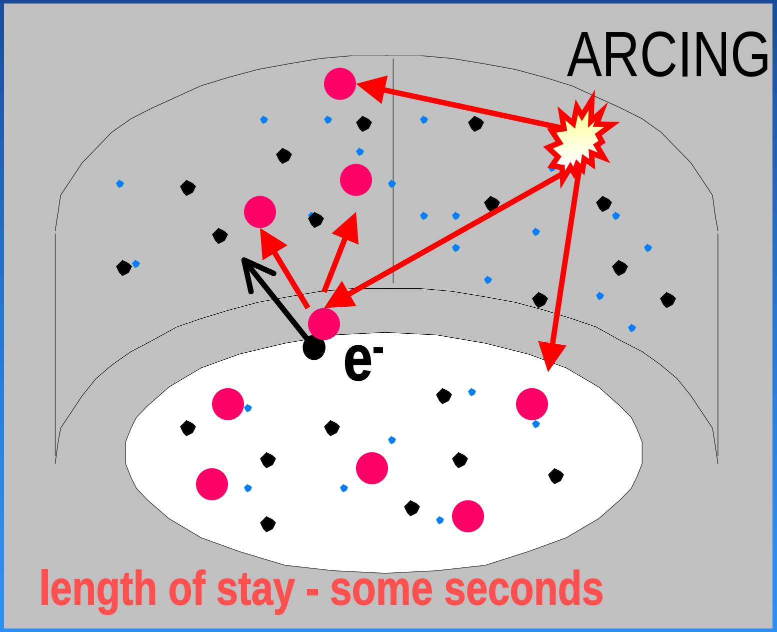
Arcing detection

No arcing



Process gas

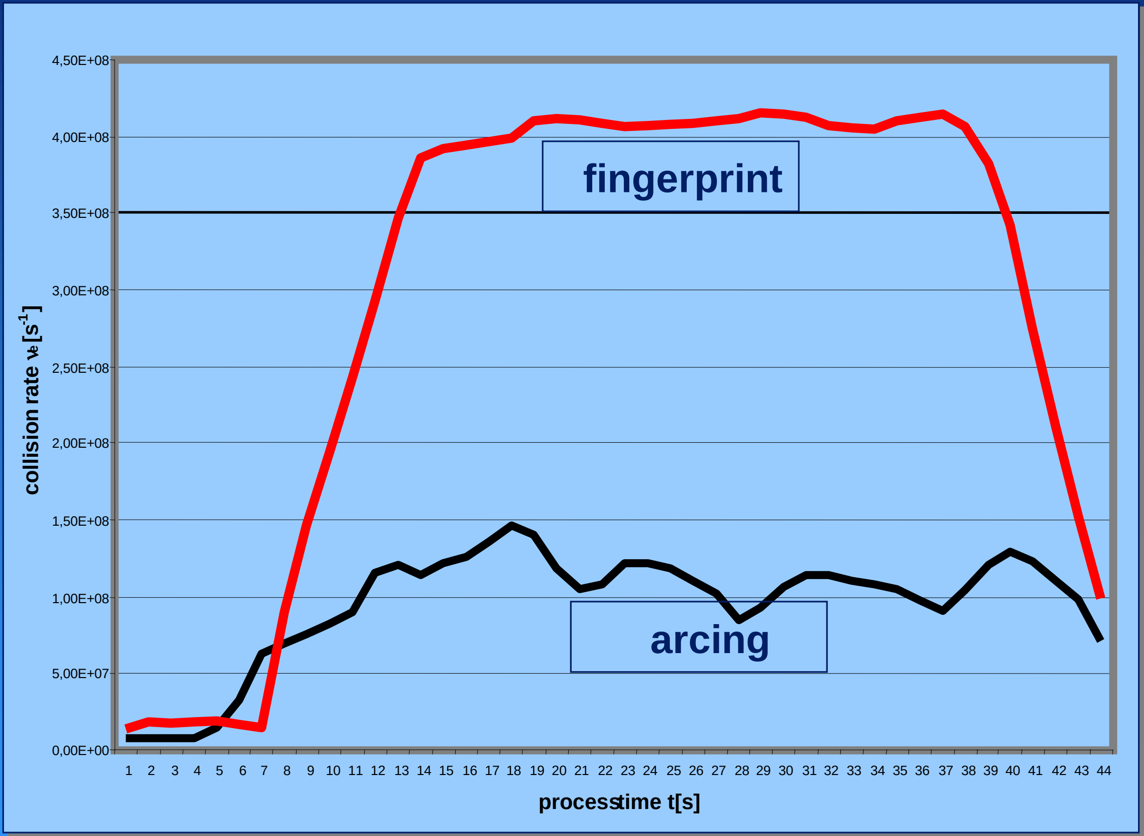
In case of arcing - Impact on collision rate



length of stay - some seconds

Process gas and polymer

Fast Tool start up



Arcing traces at gas distribution

Recipe

Step 1

25mtorr / 215W / 30G/ 50 sccm O2

Step 2

25mtorr / 215W / 0G/ 50 sccm O2

by courtesy of AMD

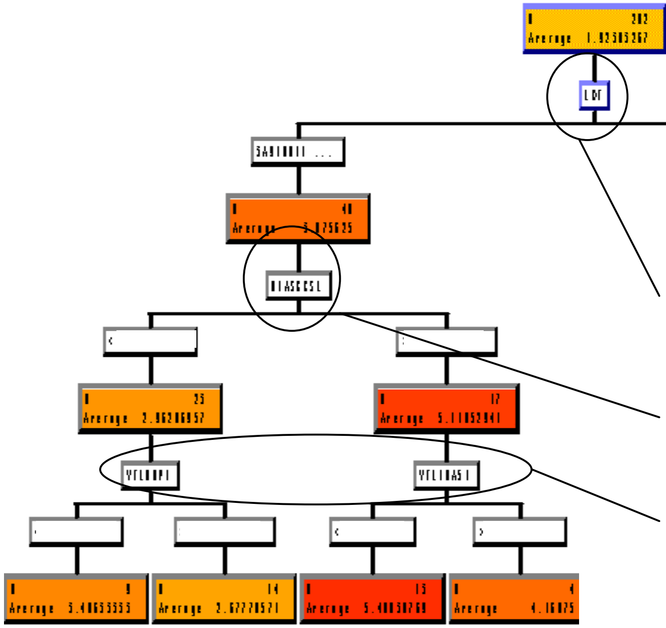
Arcing detected at new tool

Benefit during tool start up

- ***Tool availability***
- ***Spare parts savings***
- ***Lower process risk during ramp up***

⇨ ***Time saving and cost reduction***

Influence of Pre-Processes



- *LOT*
- *Gate Contact BIAS*
- *other electr. data*

Data Mining:
Decision Tree

- **based on statistics**
- **suitable for high data volume**
- **detects correlation**

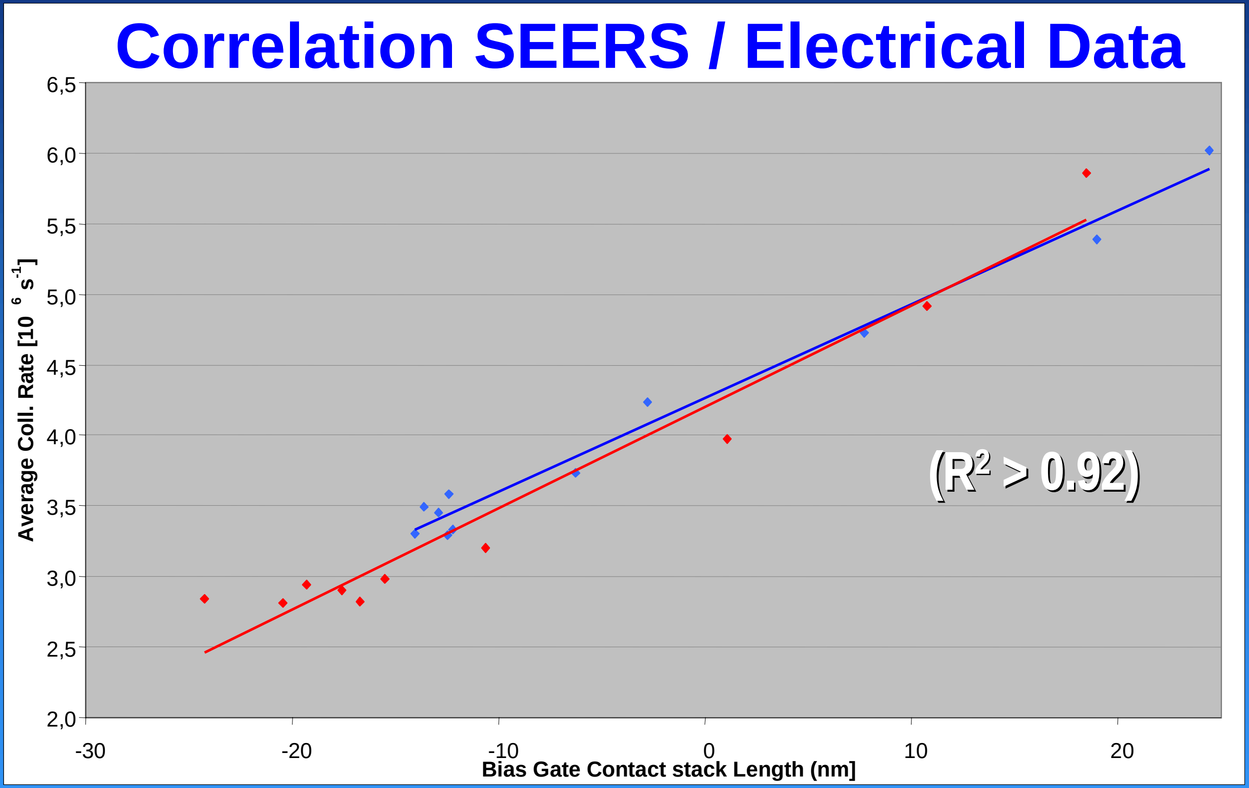
Target for decision tree: Plasma Collision Rate

→ **Correlation: Collision Rate / Gate Contact BIAS for special lots with high collision rate**

by courtesy of Infineon technologies

Decision Tree for Electrical Data

In-line Metrology with SEERS



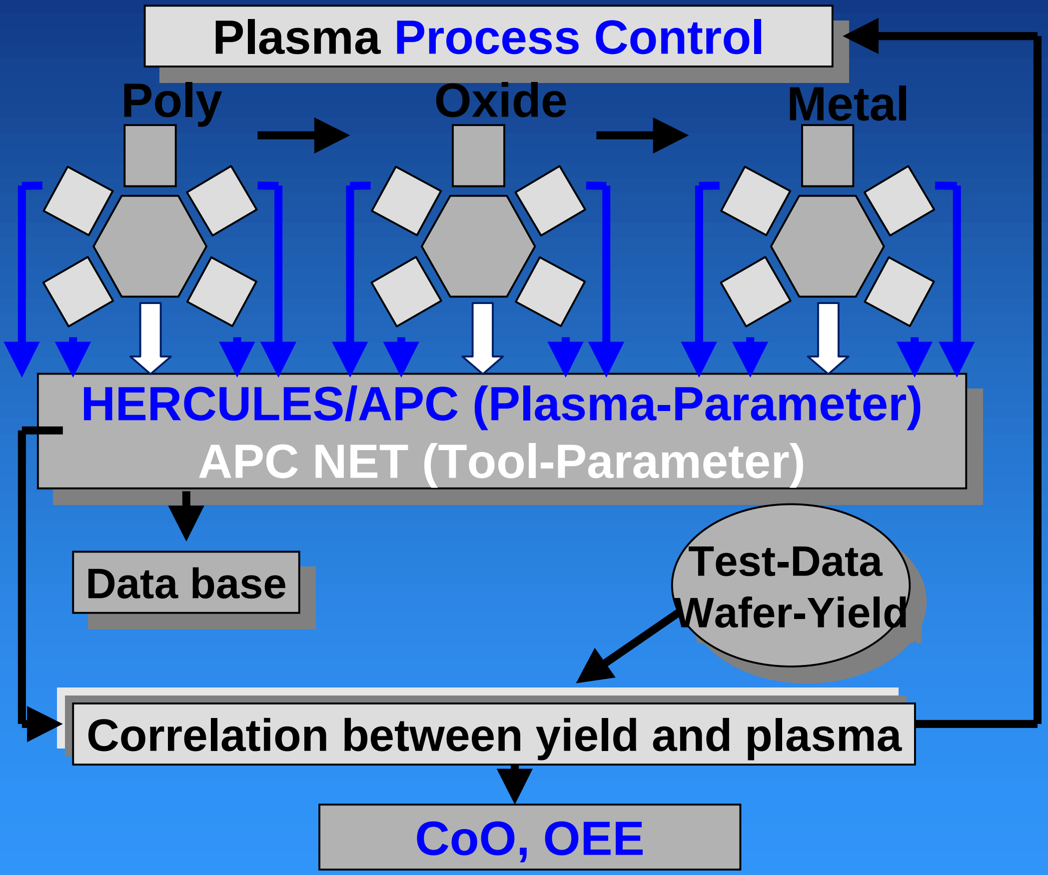
by courtesy of

Strong correlation between real time plasma parameter (collision rate) and off-line electrical test data (Gate Contact bias) for indicated lots with high collision rate

Verified applications

• Development and optimizing processes	yes
• Long and short term tool stability	yes
• Tool start and release & chamber matching	yes
• Control of chamber conditioning	yes
• Control of power coupling into plasma	yes
• Endpoint detection	possible
• Layer resolution	possible
• Uniformity	yes
• Reduction of test- and monitor wafers	yes
• Detection of tool failure	yes
• Arcing detection	yes
• Automatic fault detection	yes

Control System Set Up



Plasma **Process Control**

HERCULES/APC (Plasma-Parameter)

APC NET (Tool-Parameter)

Data base

Test-Data Wafer-Yield

Correlation between yield and plasma

CoO, OEE

Evaluation site

focus on
  - process control
  - economical benefit

- 100% supervision on monitored etch processes
- up to 12 chambers
- approx. full POR
- link to logistical data
- different processes
  - poly / metal / oxide
- different chamber types
  - capacitive / ICP

Participants

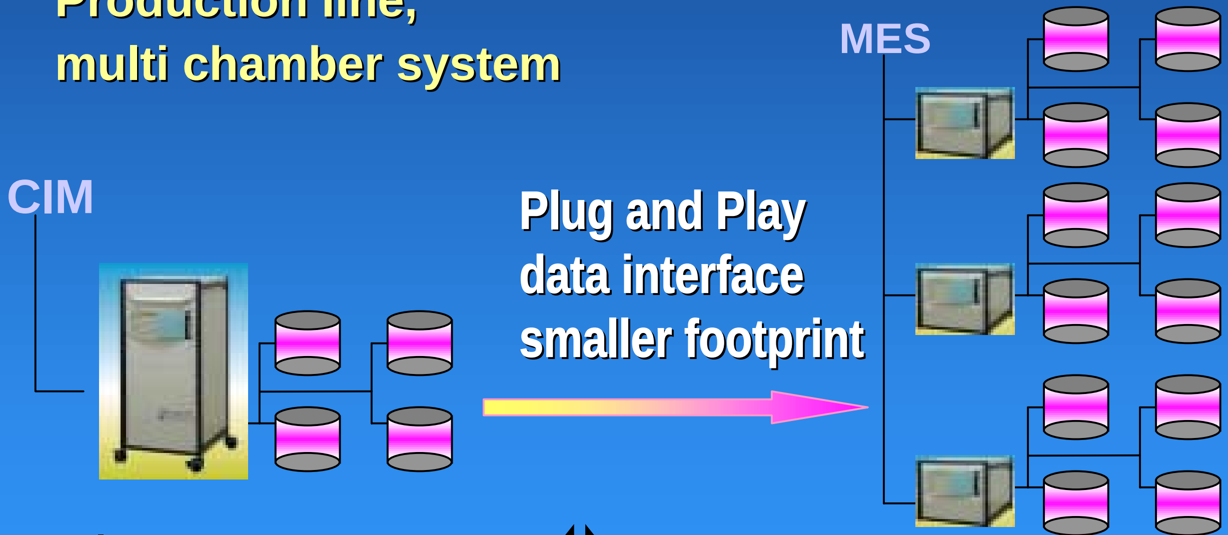
- different applications at single tools
- mutual exchange of results

Evaluation Site: Infineon Technologies SC300

Hercules roadmap (SEERS)

HERCULES PL+ - 1999
Production line,
multi chamber system

HERCULES APC - 2001
Full Integration into Manufacturing Excecution System (MES), ready for FDC applications



Plug and Play
data interface
smaller footprint

Plasma process parameter ↔
Wafer, Lot Product ID, Recipe,
Wafer and lot history

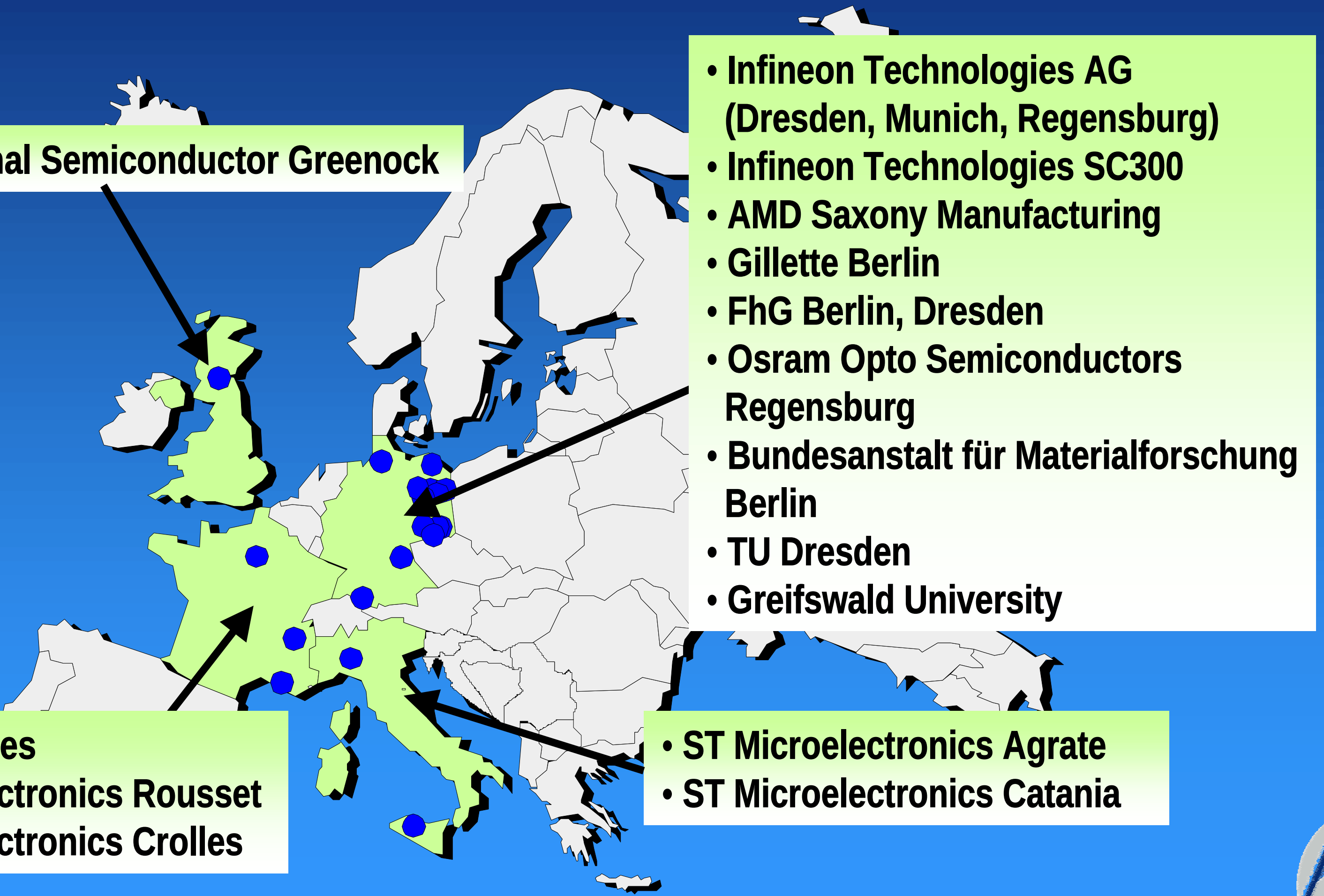
100 % production control
(ISO 9000/9001),
APC software included

New level for APC

- Hercules allows to use plasma etch tool also as an in-line metrology tool
- Correlation between real time plasma parameter and electrical device test data (14 days later)
- Prediction of device quality control

→ **Time saving and cost reduction**

Hercules® in Europe



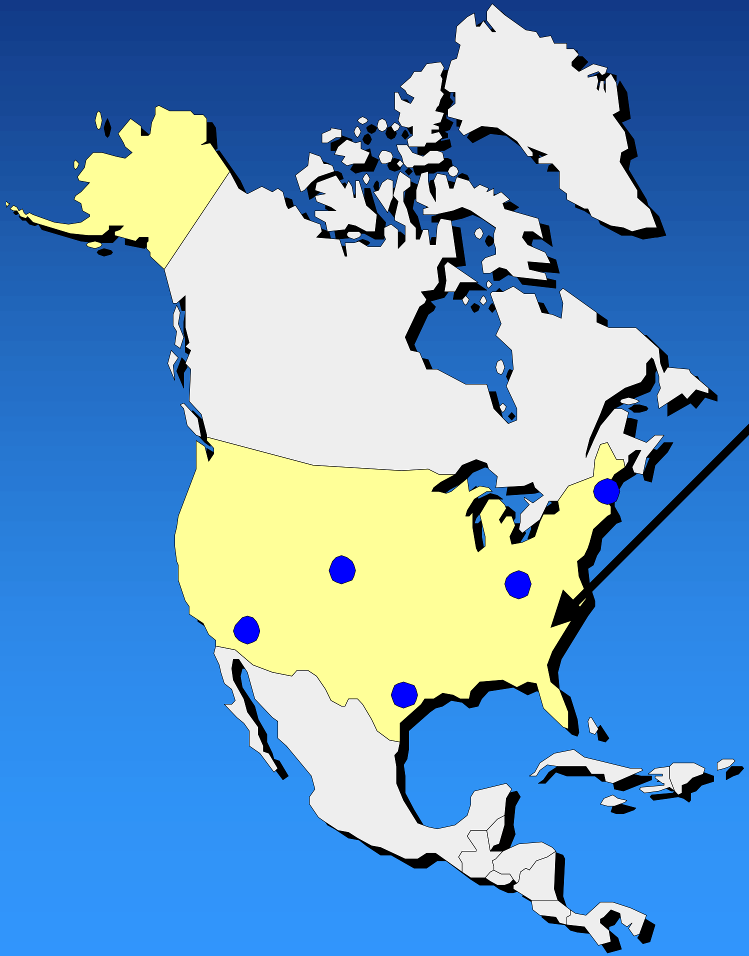
- National Semiconductor Greenock

- Infineon Technologies AG (Dresden, Munich, Regensburg)
- Infineon Technologies SC300
- AMD Saxony Manufacturing
- Gillette Berlin
- FhG Berlin, Dresden
- Osram Opto Semiconductors Regensburg
- Bundesanstalt für Materialforschung Berlin
- TU Dresden
- Greifswald University

- IBM Essonnes
- ST Microelectronics Rousset
- ST Microelectronics Crolles

- ST Microelectronics Agrate
- ST Microelectronics Catania

Hercules® in America

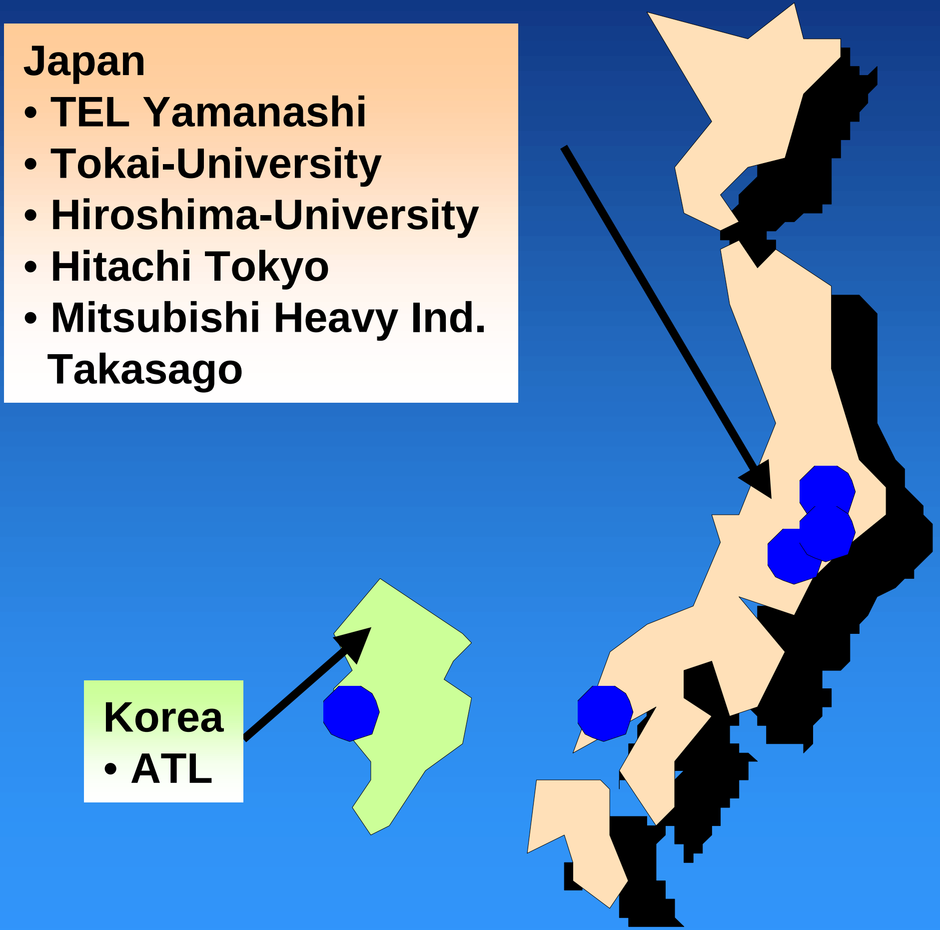


Arizona
- **TEL Phoenix**

Texas
- **Motorola Austin**
- **IBM Fishkill**

Utah
- **Fairchild**

Hercules® in Asia



Japan
- **TEL Yamanashi**
- **Tokai-University**
- **Hiroshima-University**
- **Hitachi Tokyo**
- **Mitsubishi Heavy Ind. Takasago**

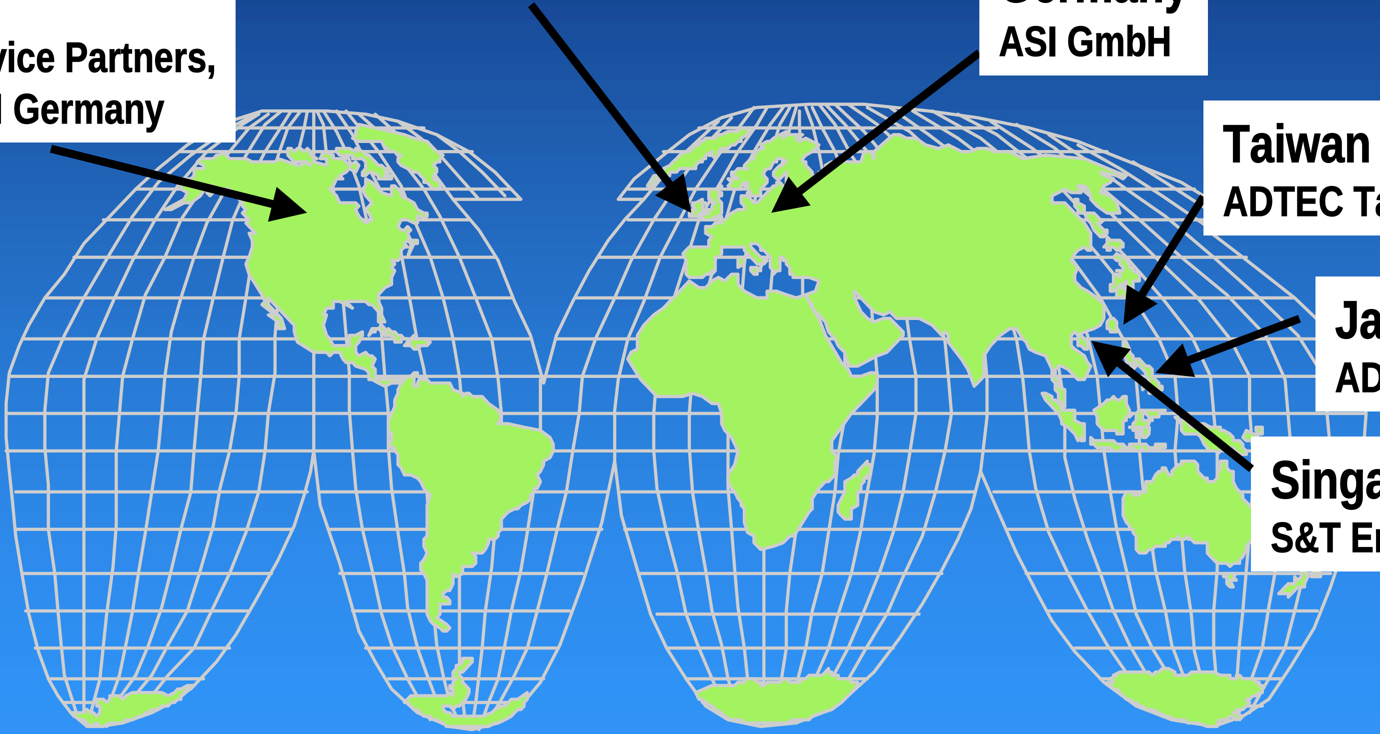
Korea
- **ATL**

Sematech about Hercules

„To integrate smart sensor systems for plasma processes within the APC framework is a difficult matter due to the fact, that it seems nearly impossible without disturbing the plasma itself and being supported by the major tool manufactures. Beside the lack of sensors and a good business model there is still a lack in fab automation integration and data of benefits. ASI with the Hercules product has overcome some of these difficulties and is capable to provide an automated real time solution with absolute internal plasma values.
The Hercules system is one of few available systems that has a model based approach.“

Brad van Eck - Project Manager Sensor Integration for improved OEE at Sematech

Worldwide technical support



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