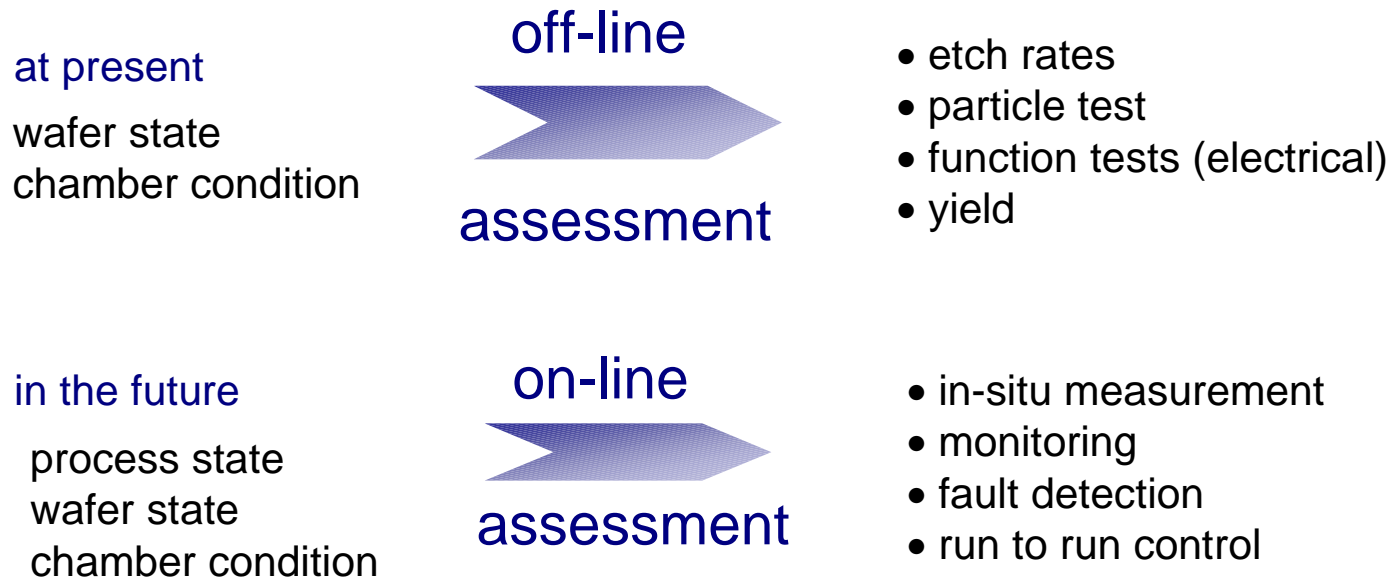


Key Issues in Plasma Processing

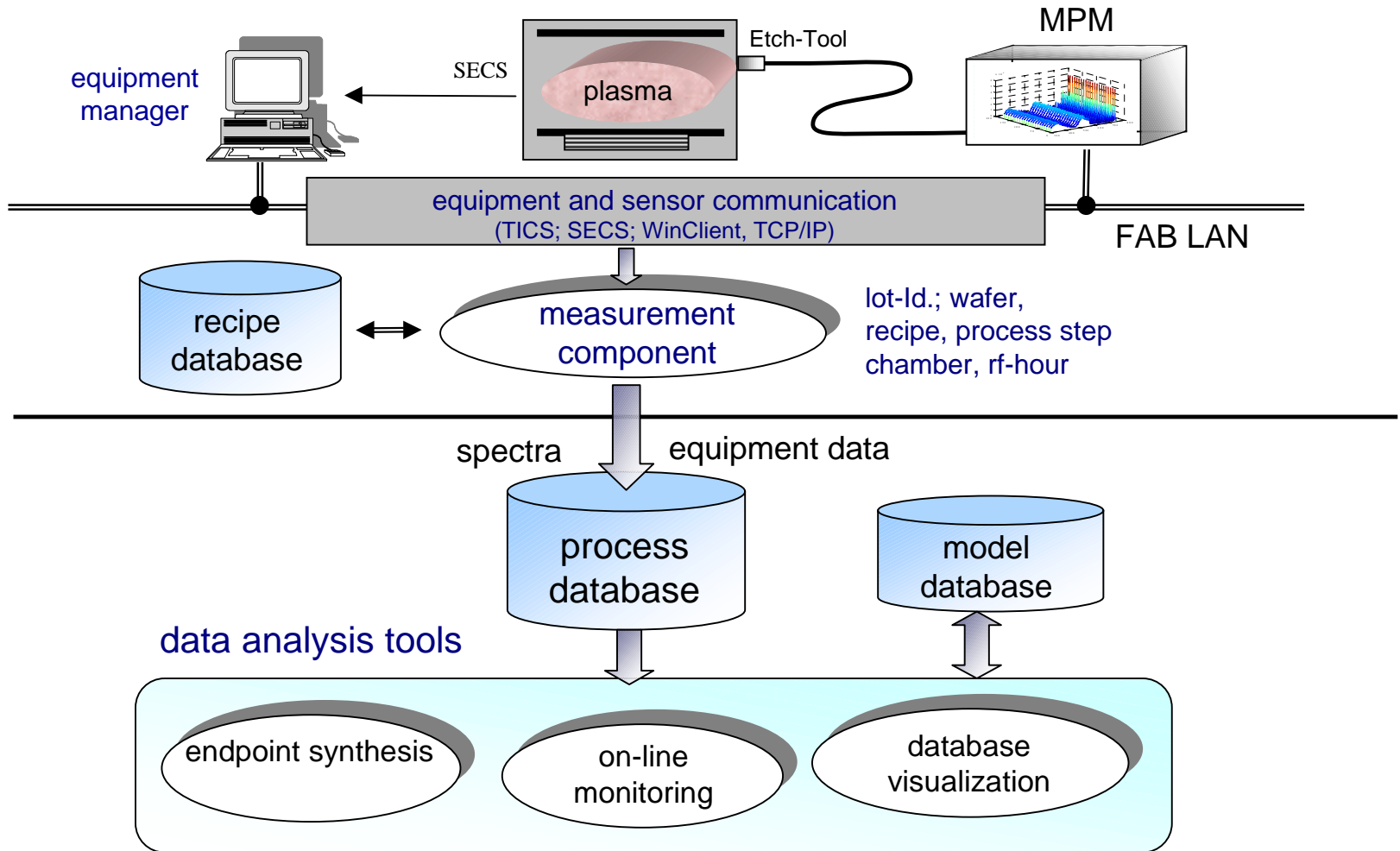


- Lack of diagnostic sensors at plasma processing tools
- Lack of standard sensor interfaces

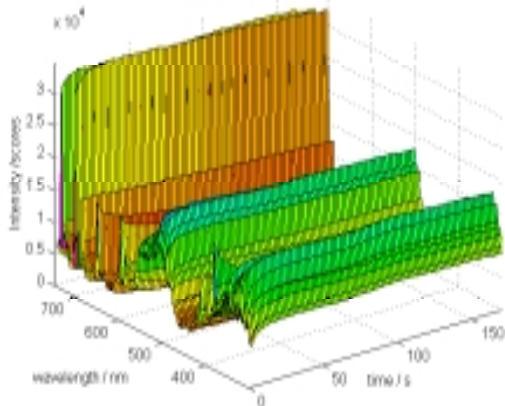
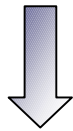
Objectives

- Integration of Optical Emission Spectroscopy in industrial environment for in-situ process and equipment control
- Development and evaluation of advanced mathematical methods for long-term process monitoring, screening and diagnosis
- Synthesis of advanced endpoint signals and detection methods using whole spectral information

Integration of Hamamatsu MPM



Features of Hamamatsu MPM



measured spectral data
from etch process

- spectral range: 200 - 950 nm
- resolution: < 2 nm
- CCD line channels: 1024
- connection to Host PC via TCP-IP, RS 232
- internal memory for 2500 spectra
- internal data processing for endpoint detection; up to 100 endpoint scrip's are available
- digital/analog port's for connection to Etch-Tool

Acquisition of spectra in a database

measurement
component

- manual
- automatic by optical trigger
- automatic by tool communication (TICS, EQM, SECS)

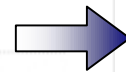
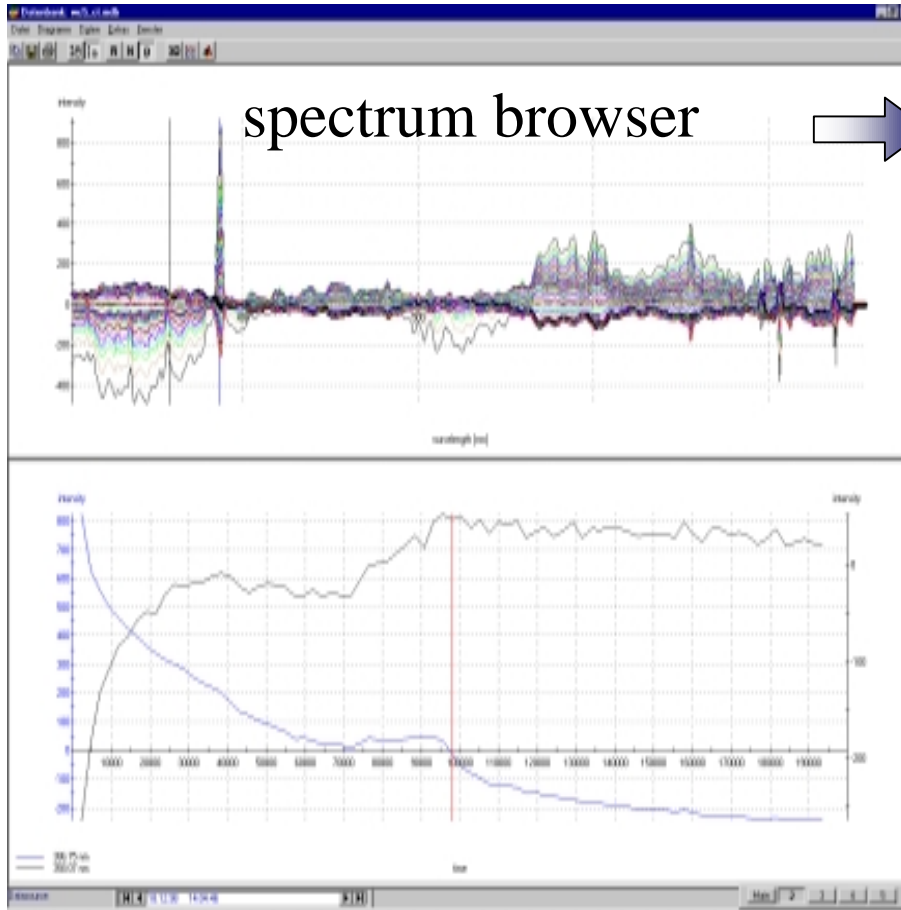
Optical Plasma
Supervision System

spectral data with context information

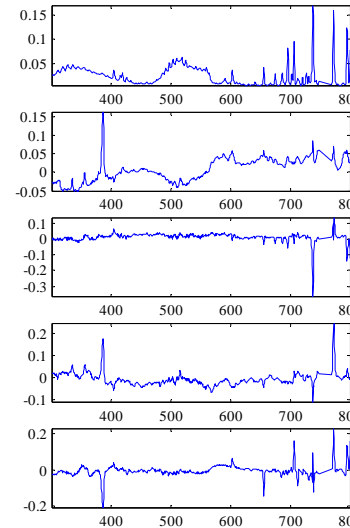
Database

Date	Zeit	Prozess	Step	Lot ID	Wafer	NumberSpec	Start Zeit	Stop Zeit
18.12.98	10:17:00	T CT EMBSS	2	T CT EMBSS B	1	41	2380	37900
18.12.98	10:29:13	T CT EMBSS	2	T CT EMBSS B	17	23	2380	54370
18.12.98	10:34:27	T CT EMBSS	2	T CT EMBSS B	2	35	2380	83850
18.12.98	11:31:35	T CT EMBSS	2	T CT EMBSS B	20	18	2380	40020
18.12.98	12:06:54	T CT EMBSS	2	T CT EMBSS B	1	39	2380	33210
18.12.98	12:06:55	T CT EMBSS	2	T CT EMBSS B	2	39	2380	33210
18.12.98	12:11:40	T CT EMBSS	2	T CT EMBSS B	21	40	2380	95600
18.12.98	12:49:30	P CT ESS BPS	2	ZAB0705 CT	1	01	2380	132600
18.12.98	12:57:30	P CT ESS BPS	2	ZAB0705 CT	2	01	2380	132600
18.12.98	13:06:20	P CT ESS BPS	2	ZAB0705 CT	3	01	2380	132600
18.12.98	13:05:20	P CT ESS BPS	2	ZAB0705 CT	4	01	2380	132600
18.12.98	13:14:27	P CT ESS BPS	2	ZAB0705 CT	5	01	2380	132600
18.12.98	13:33:22	P CT ESS BPS	2	ZAB0705 CT	6	01	2380	132600
18.12.98	13:37:50	P CT ESS BPS	2	ZAB0705 CT	7	01	2380	132600
18.12.98	13:42:30	P CT ESS BPS	2	ZAB0705 CT	8	01	2380	132600
18.12.98	13:46:54	P CT ESS BPS	2	ZAB0705 CT	9	01	2380	132600
18.12.98	13:51:22	P CT ESS BPS	2	ZAB0705 CT	10	01	2380	132600
18.12.98	13:55:51	P CT ESS BPS	2	ZAB0705 CT	11	01	2380	132600
18.12.98	14:00:17	P CT ESS BPS	2	ZAB0705 CT	12	01	2380	132600
18.12.98	14:04:46	P CT ESS BPS	2	ZAB0705 CT	13	01	2380	132600
18.12.98	14:09:14	P CT ESS BPS	2	ZAB0705 CT	14	01	2380	132600
18.12.98	14:13:43	P CT ESS BPS	2	ZAB0705 CT	15	01	2380	132600
18.12.98	14:18:12	P CT ESS BPS	2	ZAB0705 CT	16	01	2380	132600

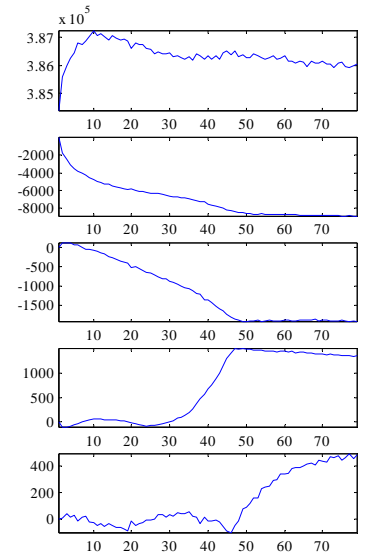
Spectra simple view



decomposition of measured
data into main spectral and
time-related components



wavelength



time

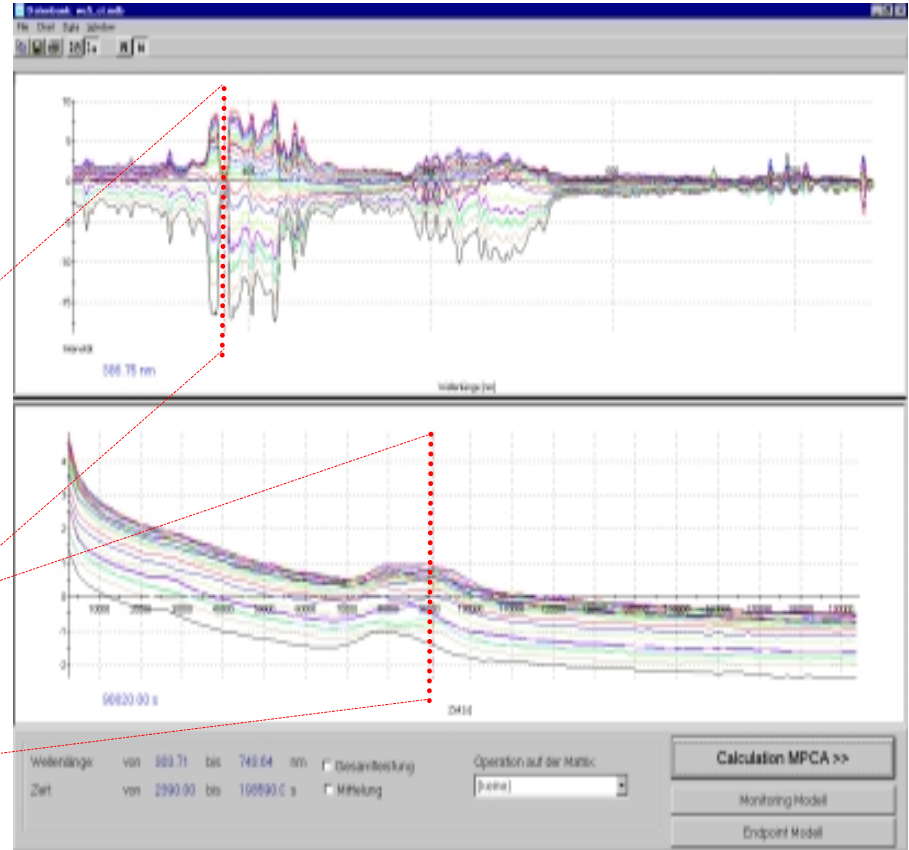
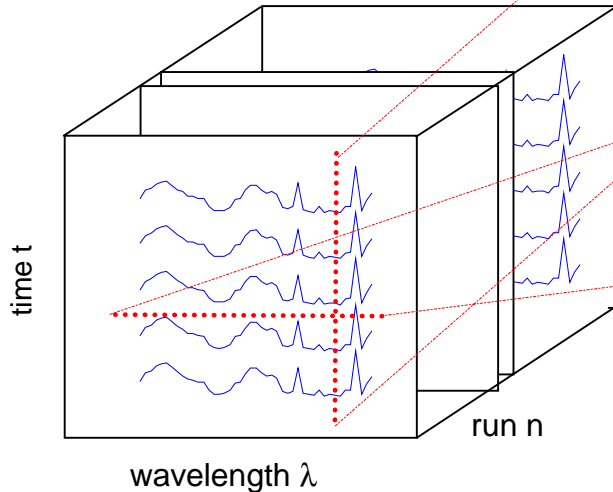
Database Viewer

data acquisition

- SQL based selection of etch-steps
- time and wave range extraction by zooming



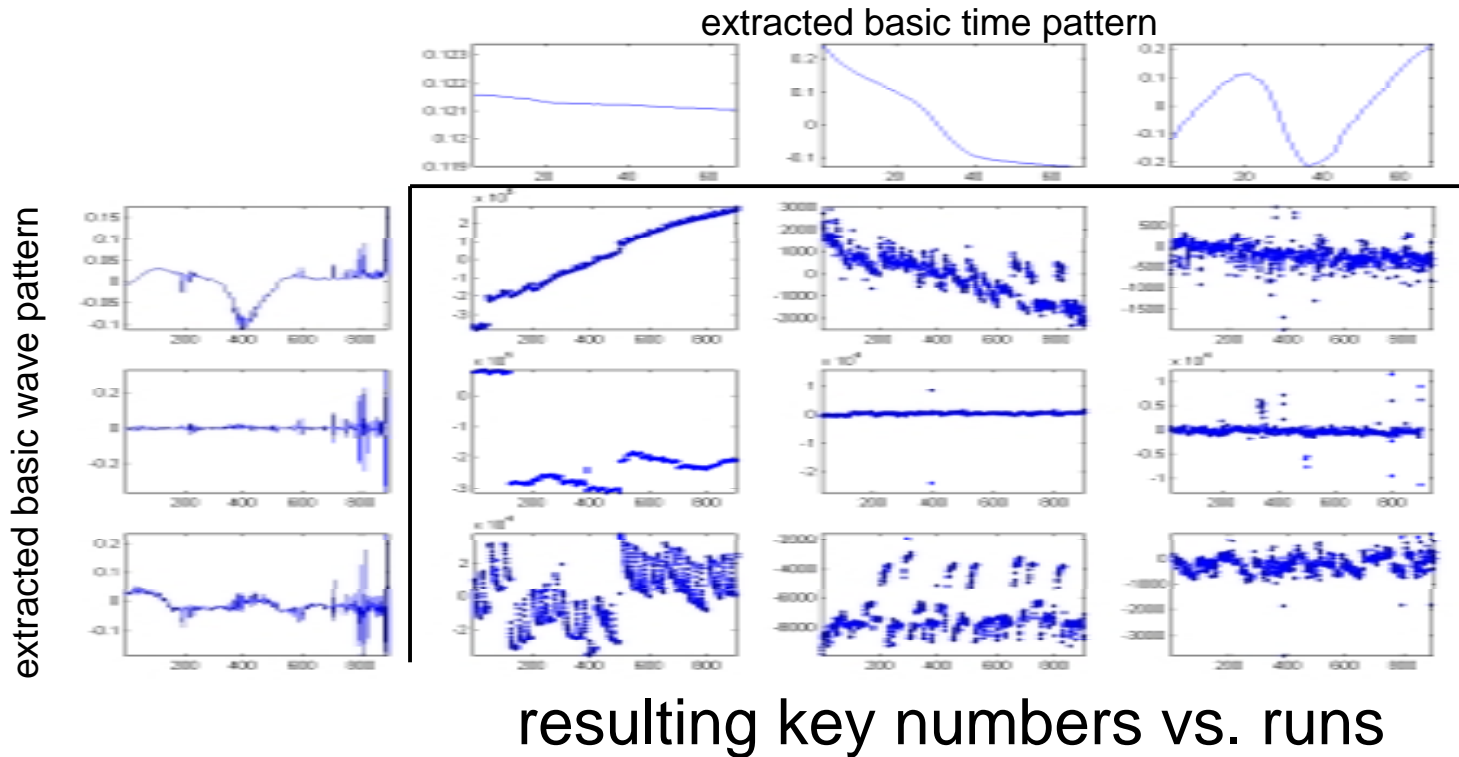
data block $\Lambda \in \mathbb{R}^{\lambda \times t \times n}$



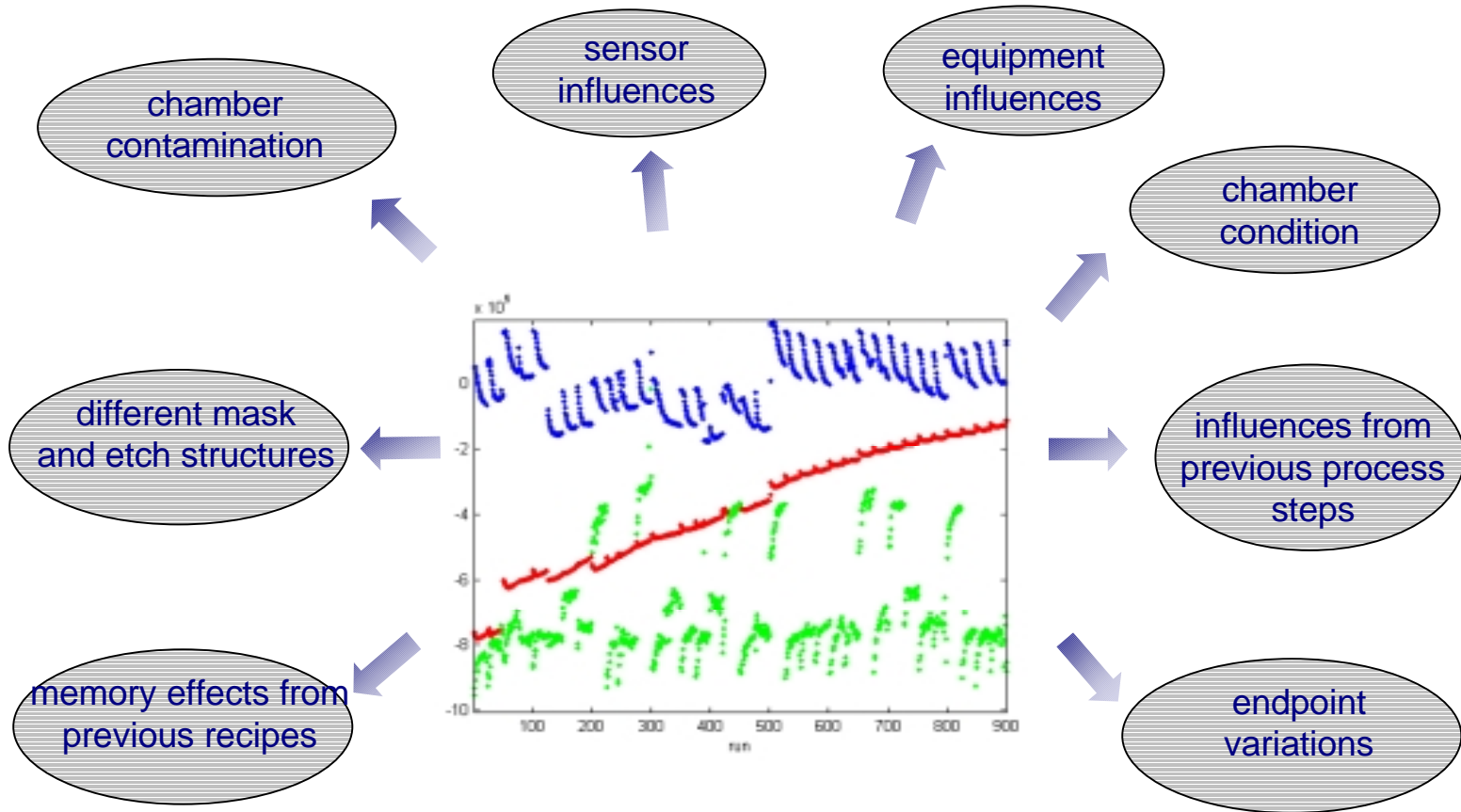
visualization of spectra and time
behavior of selected runs

Multi-Way statistical analysis for process monitoring

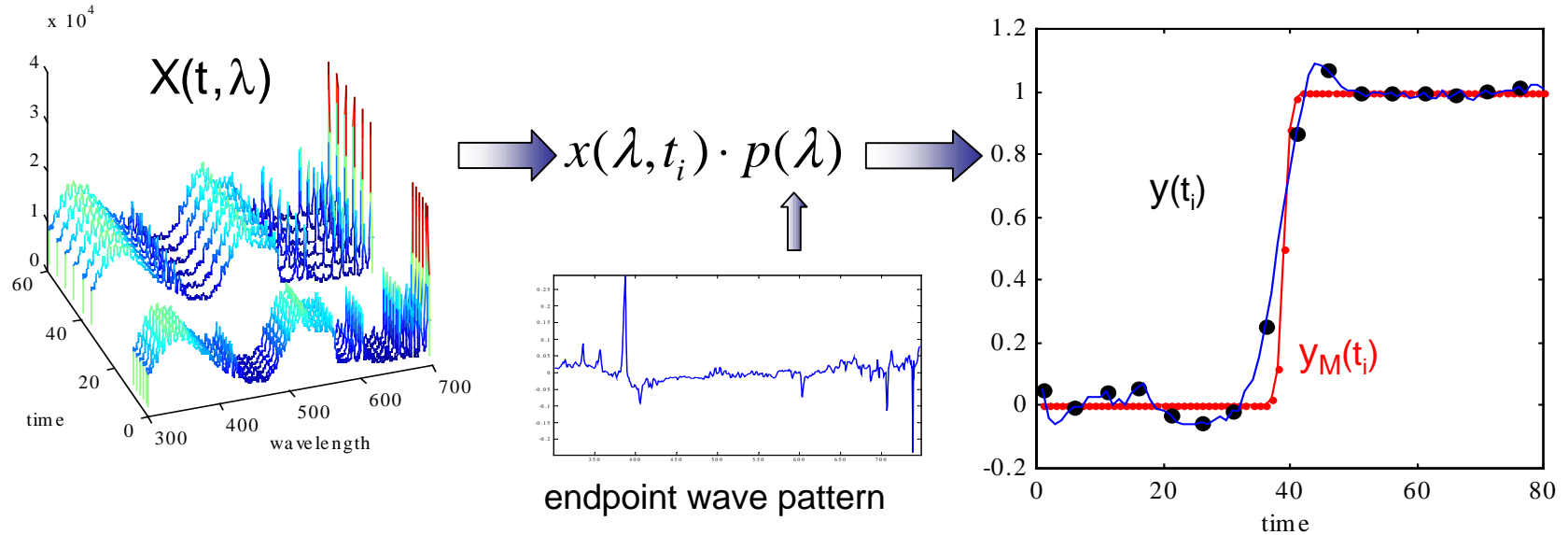
➔ extraction of significant process related key numbers



separated effects from spectral data



Synthesis of an optimal endpoint signal

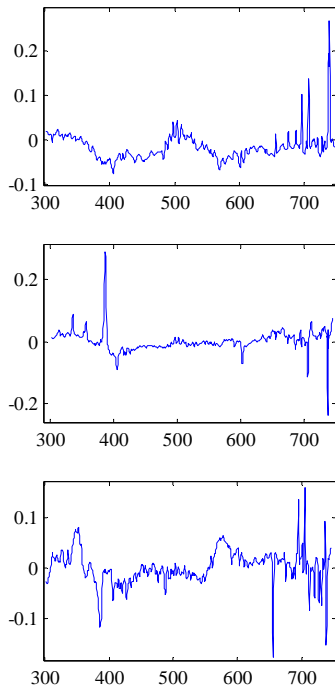


objective:

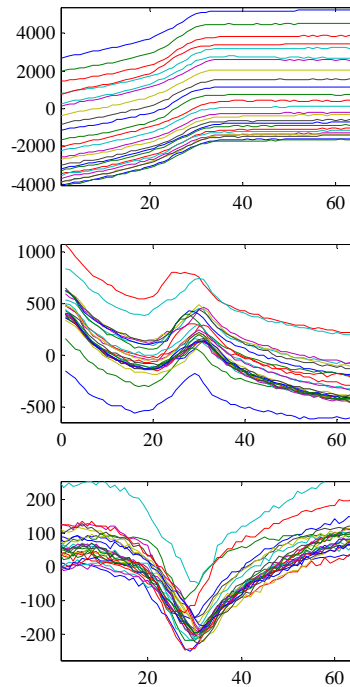
➡ generation of suitable wave pattern which yields to sensitive and long-term robust endpoint signals

Decomposition of several runs for endpoint synthesis

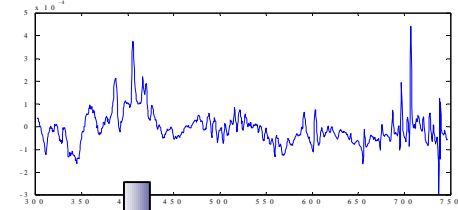
decomposed
wave components



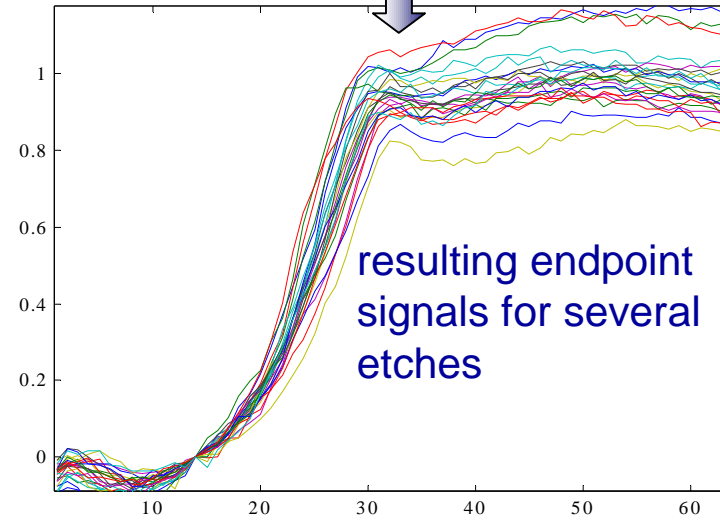
resulting time signal
for several etches



resulting endpoint wave
pattern



suitable
superposition



Summary

- Integration of MPM spectrometer within FAB-IT-Infrastructure for automatic measurement at etch tools
- Development of multiway statistical methods for extraction of key numbers associated with characteristic equipment and process features
- Synthesis of sensitive and robust endpoint signals by selecting a suitable superposition of the dynamics of each spectral channel