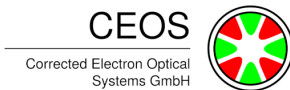


Overview on commercial aberration correctors for TEM and STEM



represented by Felix Börrnert

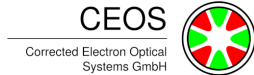
Microscopy Conference 2025, Karlsruhe

Commercial players in the field

The early days



STEM



TEM + STEM



HITACHI

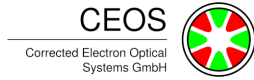


Commercial players in the field

Today



STEM



TEM + STEM



TEM + STEM

HITACHI

STEM



ThermoFisher
SCIENTIFIC

HITACHI

“ C_s correctors” — **nion**

STEM

2001

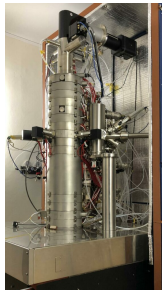
third-order axial
geometric aberrations



second-generation Nion corrector
retrofit to a VG HB 501

2011

fifth-order axial
geometric aberrations



third-generation Nion corrector
complete Nion UltraSTEM column

- ▶ quadrupole/octupole design
- ▶ 30–200 kV
- ▶ 60 pm at 200 kV

“ C_s correctors” — HITACHI STEM

2015

third-order axial
geometric aberrations

- ▶ dual hexapole design (?)
- ▶ 80–200 kV
- ▶ 100 pm at 200 kV



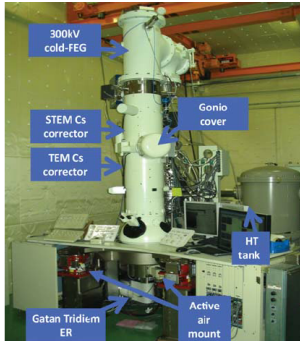
Hitachi HD-2700

“ C_s correctors” — JEOL

STEM & TEM

2007

fourth-order axial
geometric aberrations



JEOL ETA on a 300 kV microscope

2010

fifth-order axial
geometric aberrations



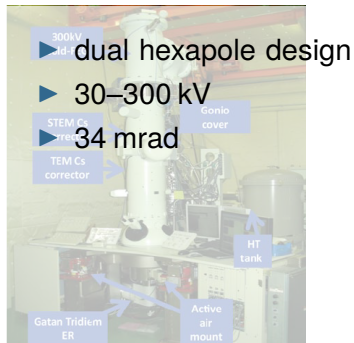
JEOL Delta on a 60 kV microscope

“ C_s correctors” — JEOL

STEM & TEM

2007

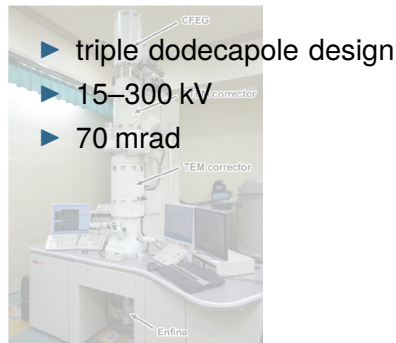
fourth-order axial
geometric aberrations



JEOL ETA on a 300 kV microscope

2010

fifth-order axial
geometric aberrations



JEOL Delta on a 60 kV microscope

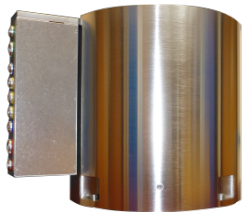
“ C_s correctors” —

STEM



2003

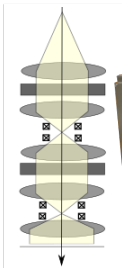
third-order axial
geometric aberrations



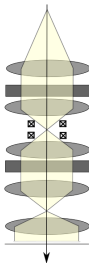
CEOS CESCOR

2009

fifth-order axial
geometric aberrations

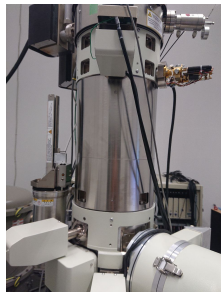


CEOS DCOR/ASCOR/S-CORR



2024

sixth-order axial
geometric aberrations



CEOS LASCOR

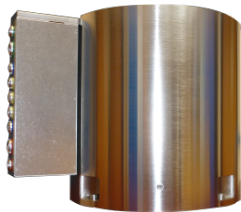
“ C_s correctors” —

STEM



2003

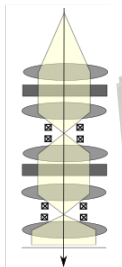
third-order axial
geometric aberrations



CEOS CESCOR

2009

fifth-order axial
geometric aberrations



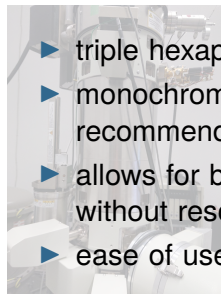
- ▶ dual hexapole design
- ▶ 30–300 kV
- ▶ 60 pm at 200 kV
- ▶ matched to cFEG



CEOS DCOR/ASCOR/S-CORR

2024

sixth-order axial
geometric aberrations



- ▶ triple hexapole design
- ▶ monochromator recommended
- ▶ allows for beam tilt without resolution loss
- ▶ ease of use (no D_6)

CEOS LASCOR

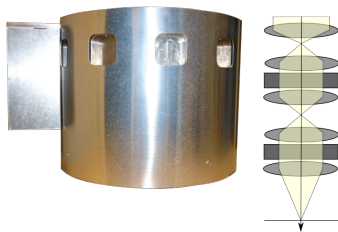
“ C_s correctors” —



TEM

2003

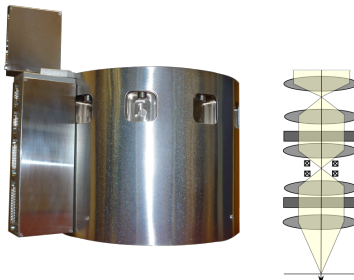
third-order axial
geometric aberrations



CEOS CETCOR

2022

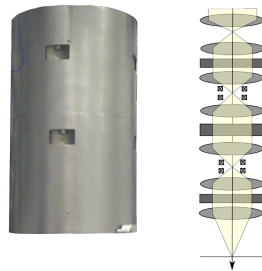
fourth-order axial/
second-order off-axial
geometric aberrations



CEOS ATCOR/CETCORPRIME

2010

fifth-order axial/
third-order off-axial
geometric aberrations



CEOS BCOR

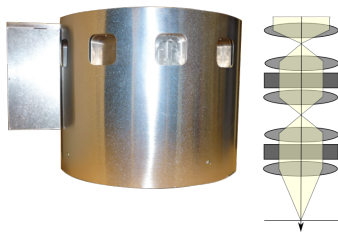
“ C_s correctors” —



TEM

2003

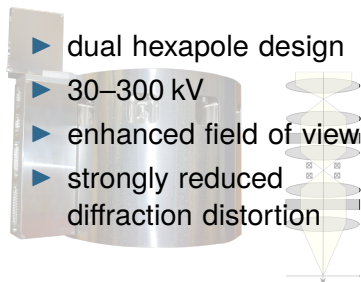
third-order axial
geometric aberrations



CEOS CETCOR

2022

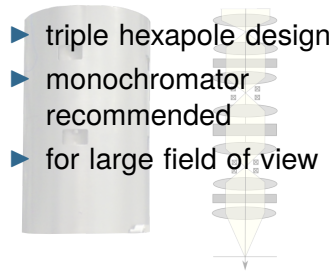
fourth-order axial/
second-order off-axial
geometric aberrations



CEOS ATCOR/CETCORPRIME

2010

fifth-order axial/
third-order off-axial
geometric aberrations



CEOS BCOR



special modifications

- ▶ 300 keV – 1.2 MeV
- ▶ UHV compatible
- ▶ special objective lens adaptations
- ▶ “Lorentz” settings
- ▶ ...

“ C_s/C_c correctors” —

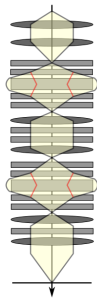


TEM

2010

fifth-order axial / third-order off-axial
geometric aberrations

first-order axial chromatic aberrations



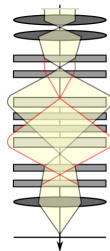
CEOS CCOR

2015

fifth-order axial / third-order off-axial
geometric aberrations

first-order axial chromatic aberrations

SALVE Project
Sub-Angstrom Low-Voltage Electron Microscopy



CEOS SALVE

“ C_s/C_c correctors” — JEOL

TEM

2025



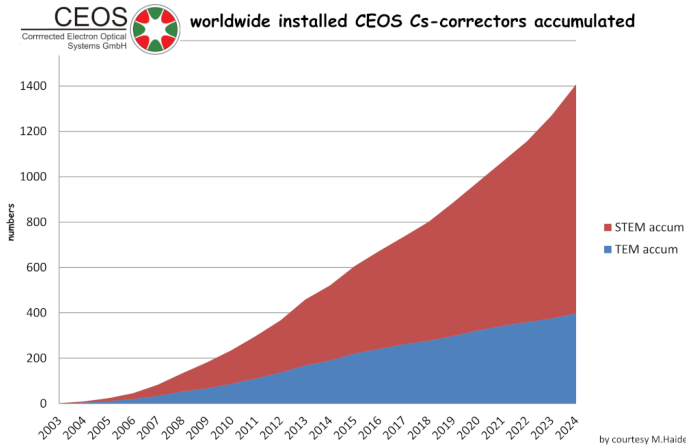
JEOL C_s/C_c corrector instrument delivery

- ▶ no details are publicly known yet
- ▶ instrument is being installed now in RFI, Harwell, UK
- ▶ commercialisation possible but unknown

Some statistics —



No documented numbers for **nion**, **JEOL**, or **HITACHI**



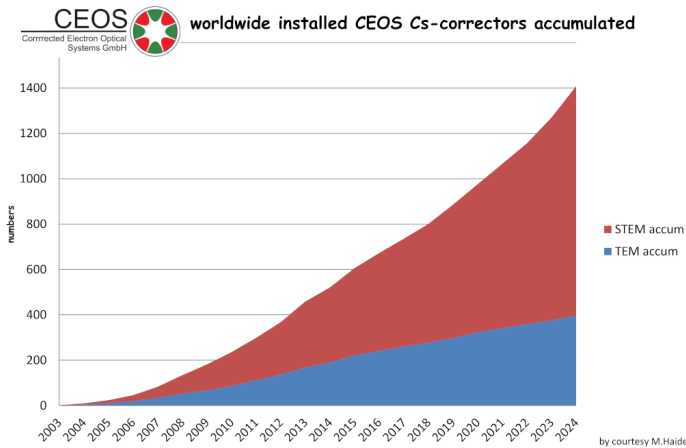
accumulated installations
(informed estimates)

- ▶ **nion**: ~ 40
- ▶ **JEOL**: ~ 150
- ▶ **HITACHI**: ~ 30

Some statistics —




No documented numbers for **nion**, **JEOL**, or **HITACHI**



accumulated installations
(informed estimates)

- ▶ **nion**: ~ 40
- ▶ **JEOL**: ~ 150
- ▶ **HITACHI**: ~ 30

C_C/C_S correctors in total

- ▶ **CEOS** : 5
 - ▶ +2 in installation
- ▶ **JEOL**: 1 in installation

Thank you for your interest.