

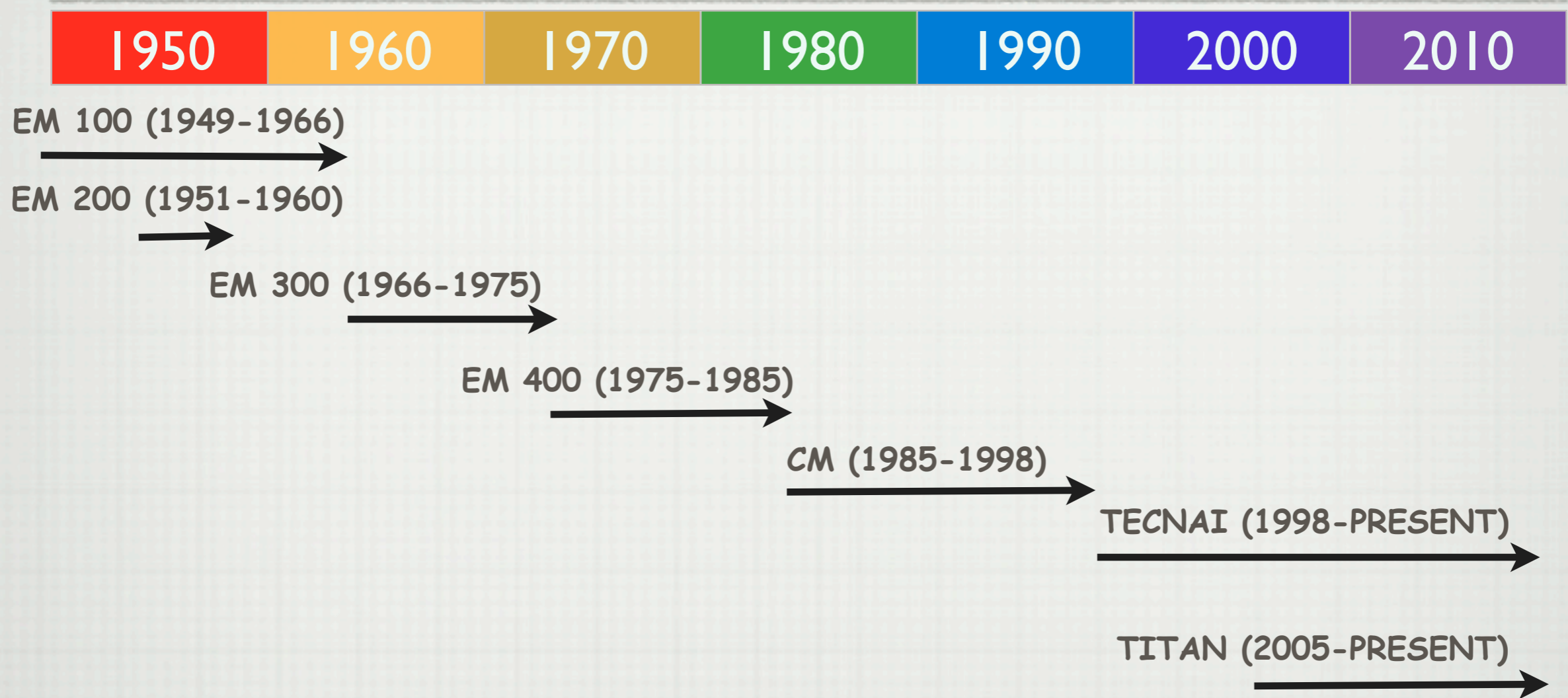
# 60 YEARS OF REUSE

SASQ MEETING JUNE 2011

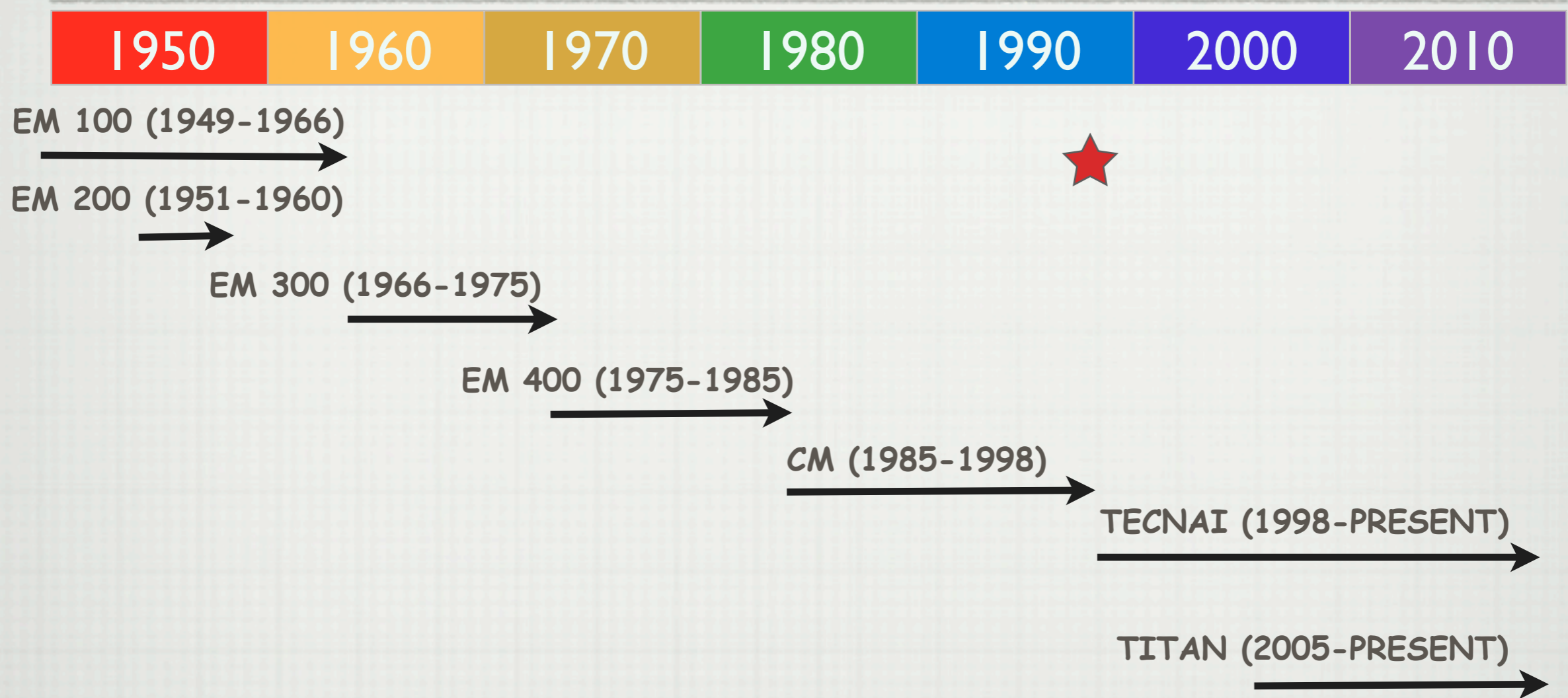
AUKE VAN BALEN

FEI ELECTRON OPTICS

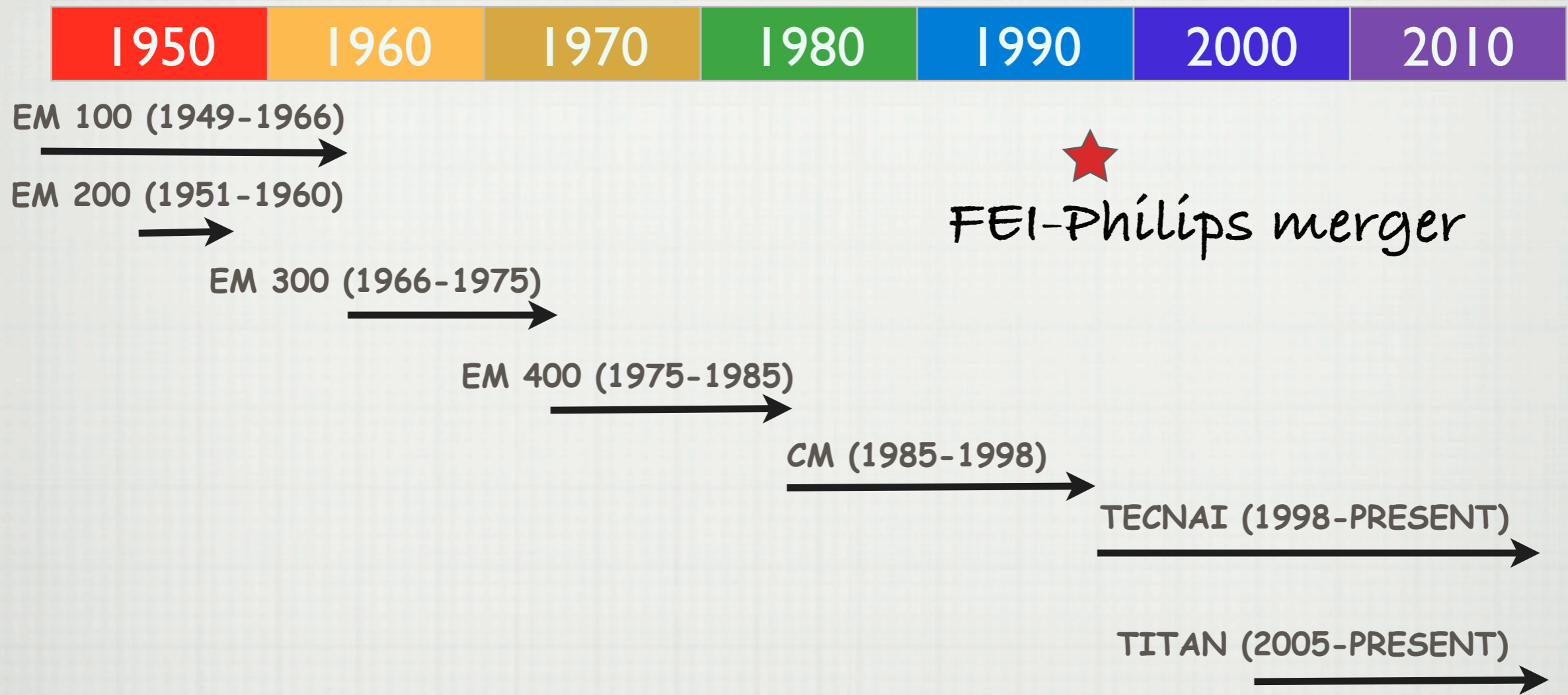
# TEM products over the years



# TEM products over the years



# TEM products over the years



# The early years: EM 100



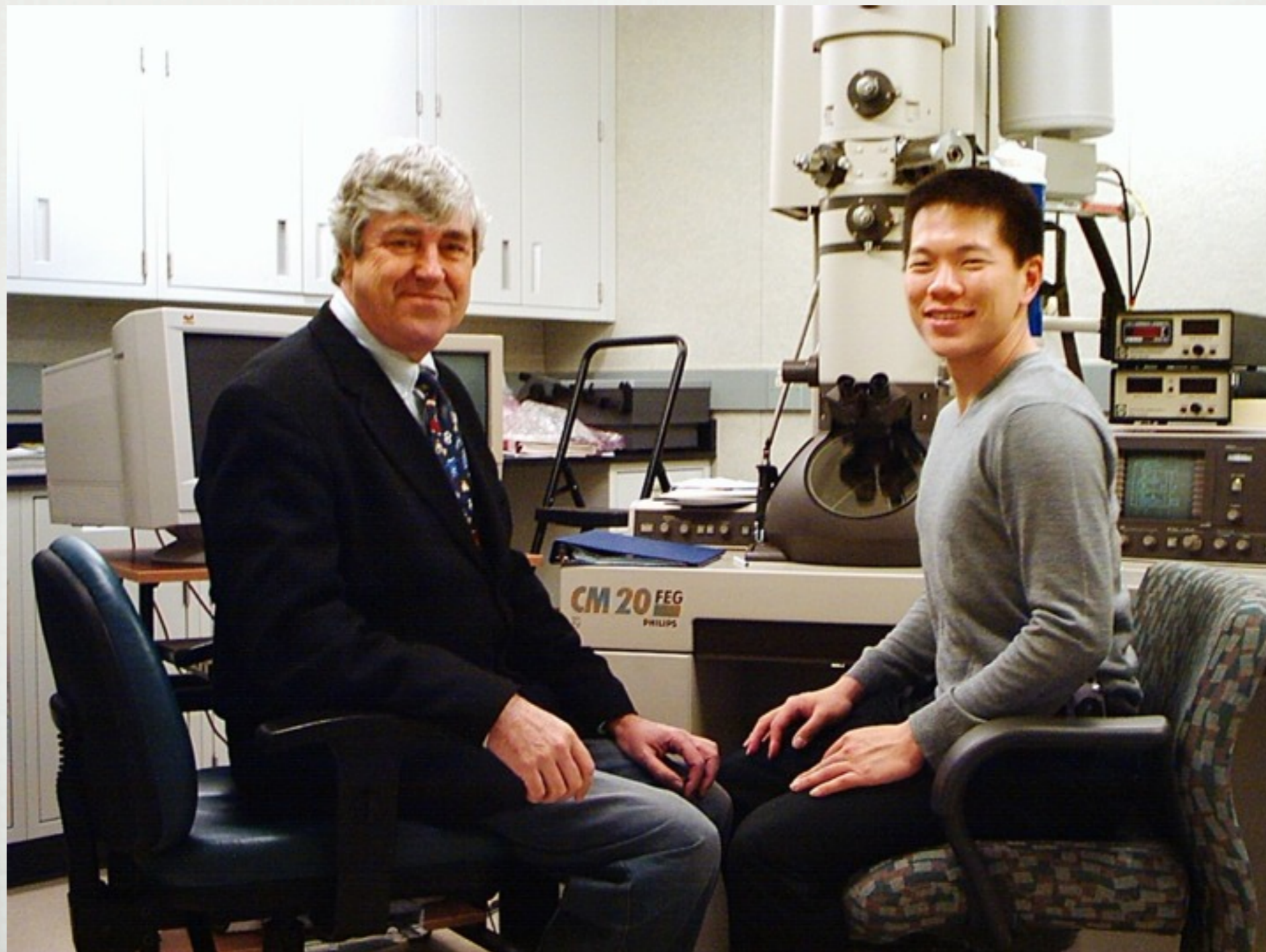
# Solid state: EM 300

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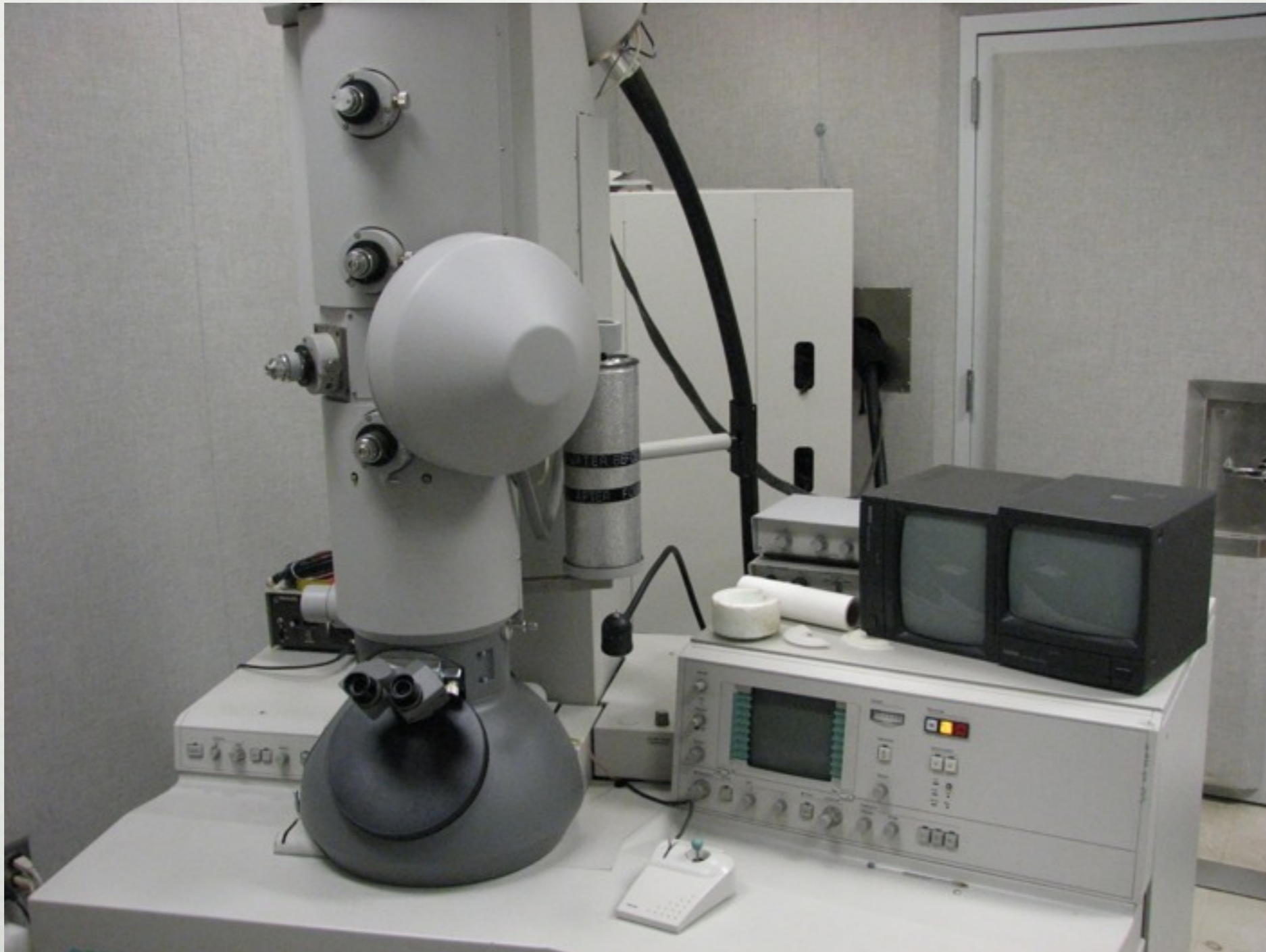


# Microprocessor control: CM 20

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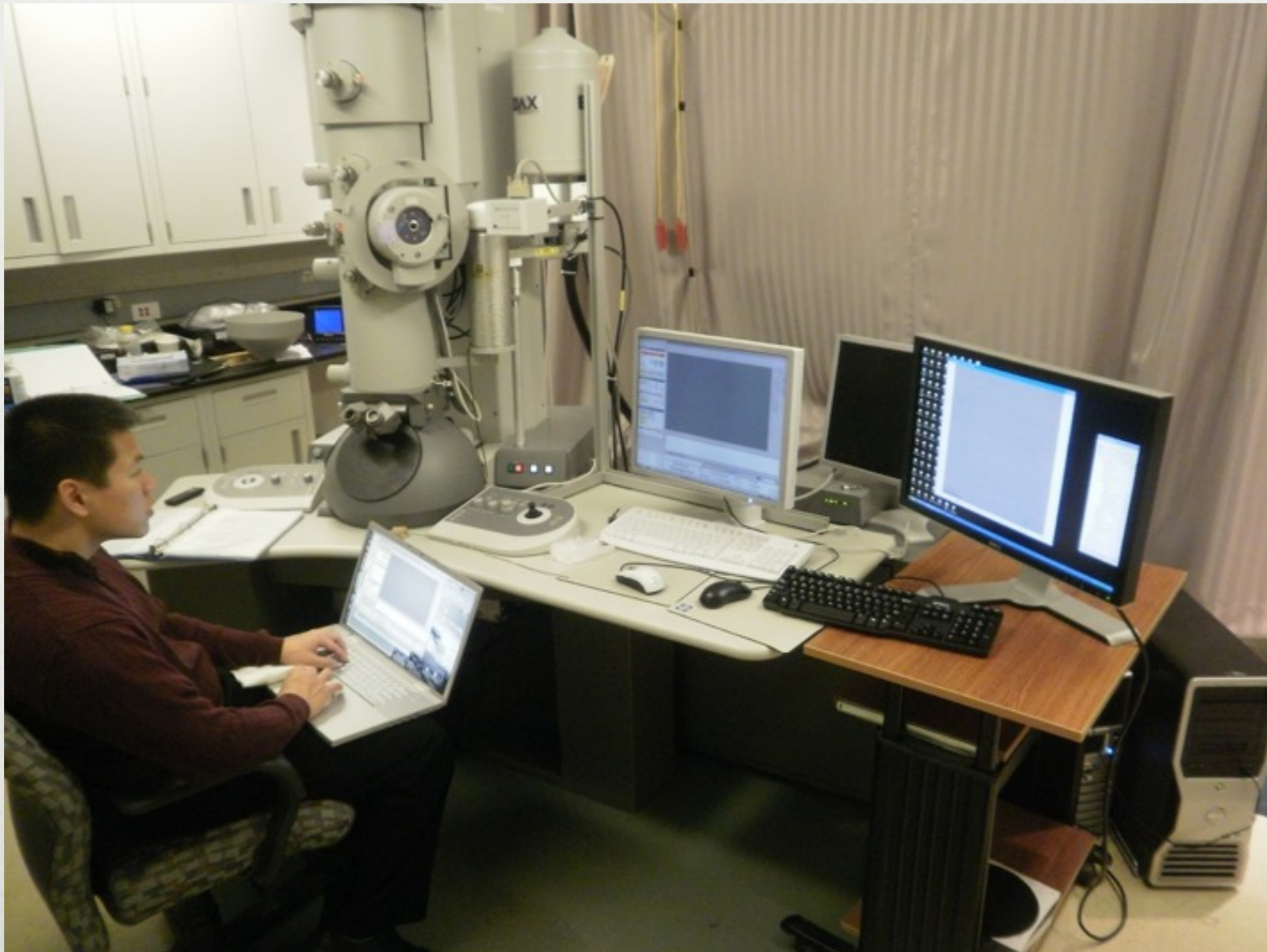


In a different color: CM 300

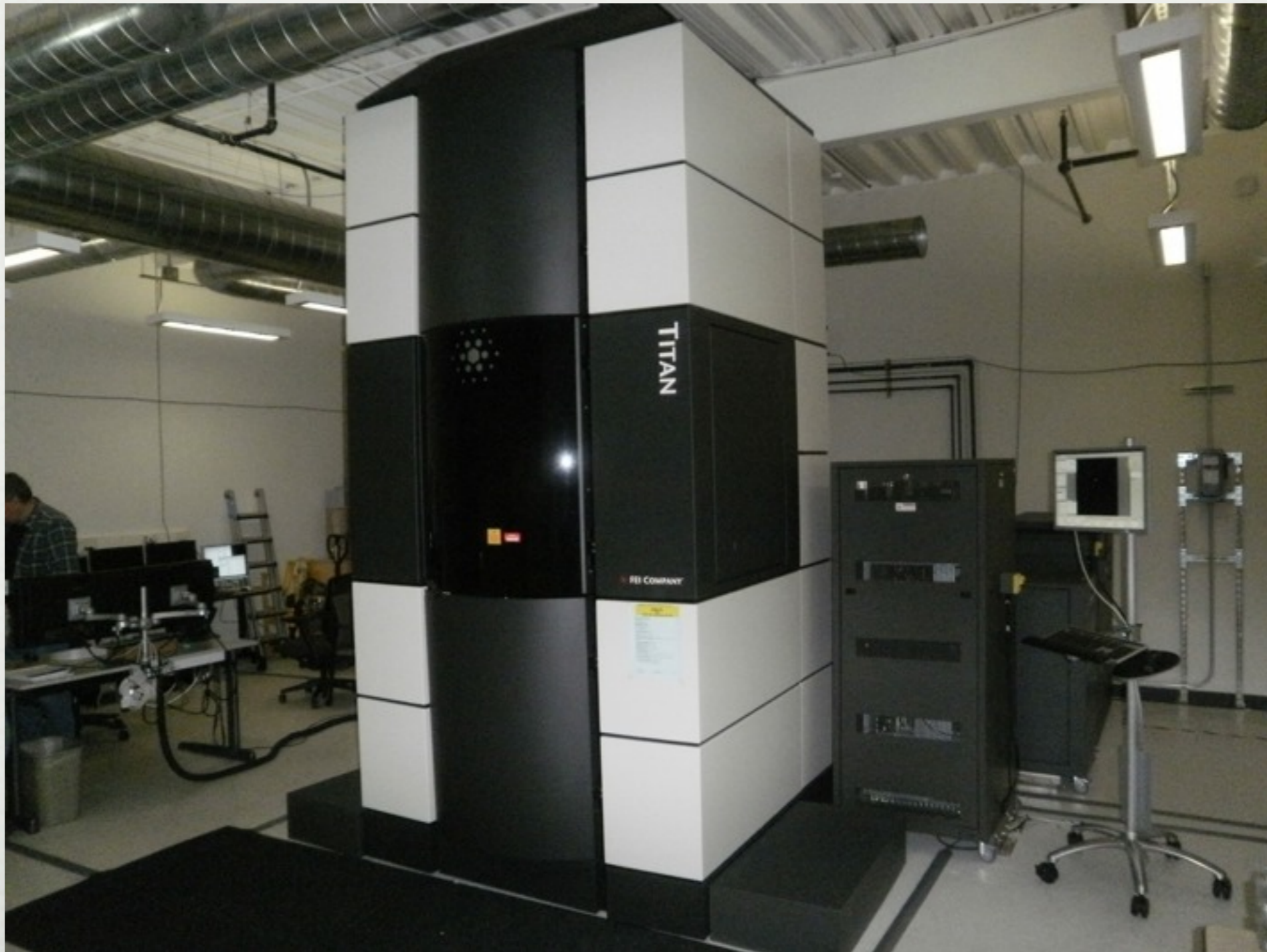




# PC control: Tecnai

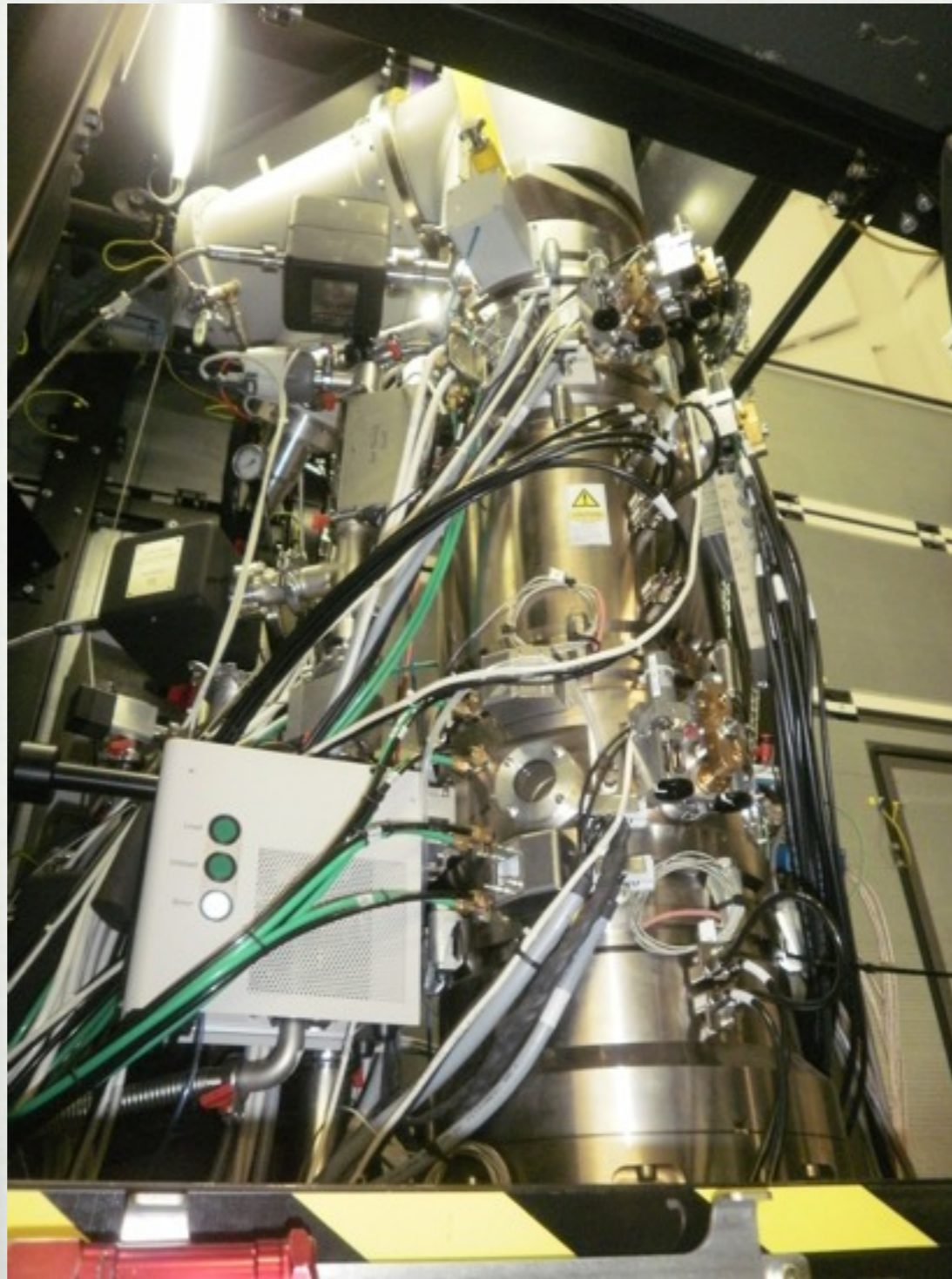


# The ultimate instrument: Titan



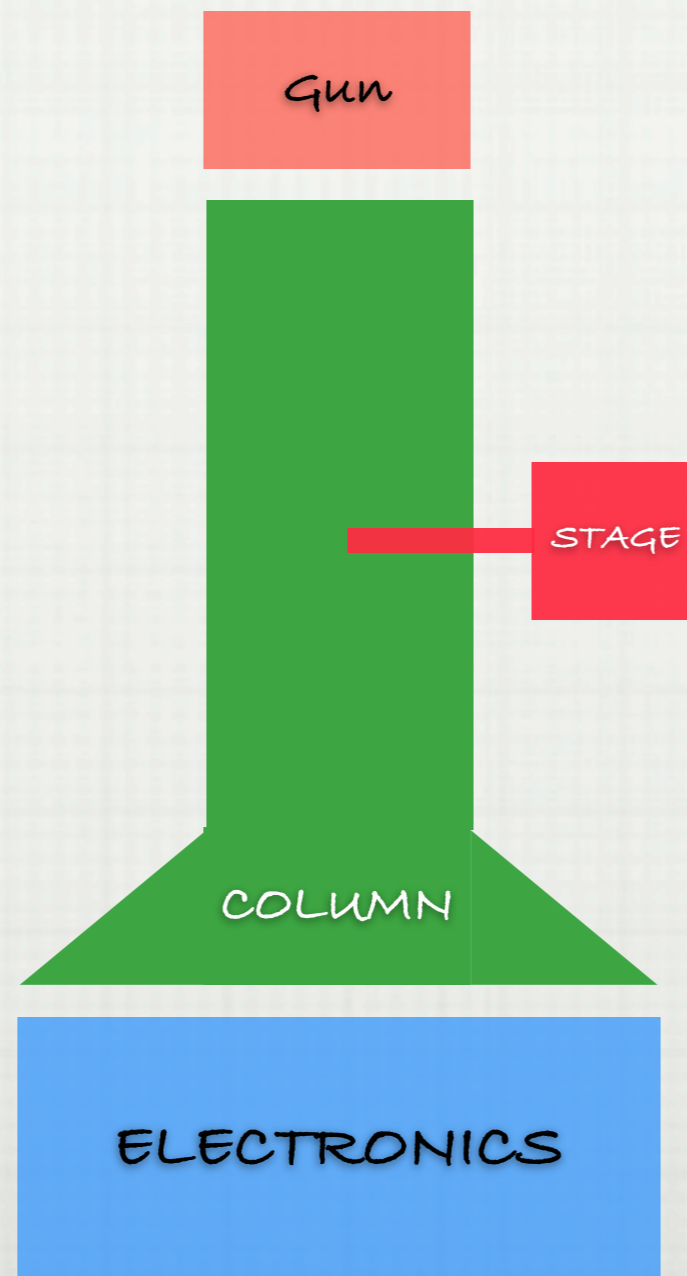
# Top performance: TEAM

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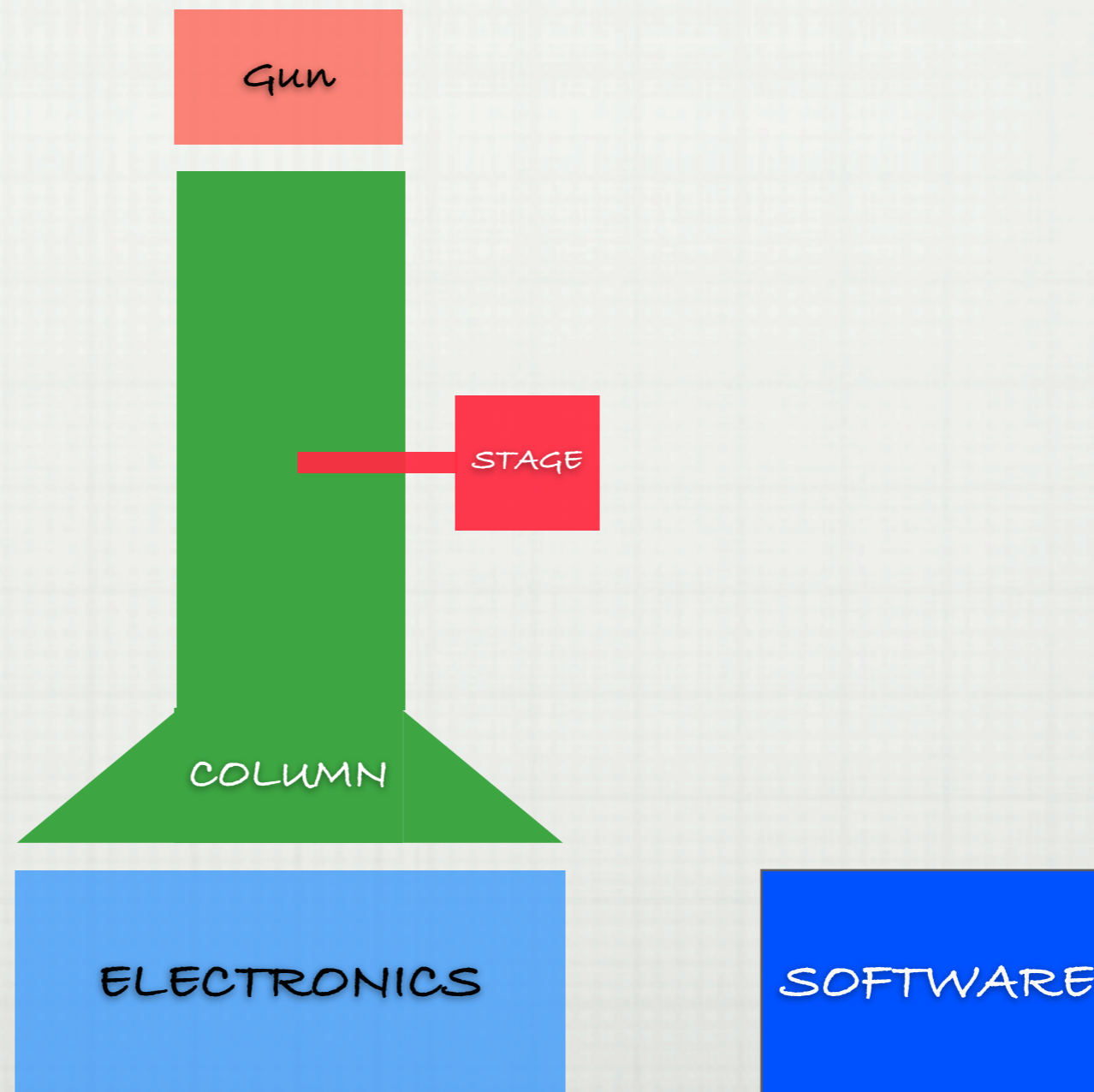
# Transmission Electron Microscope

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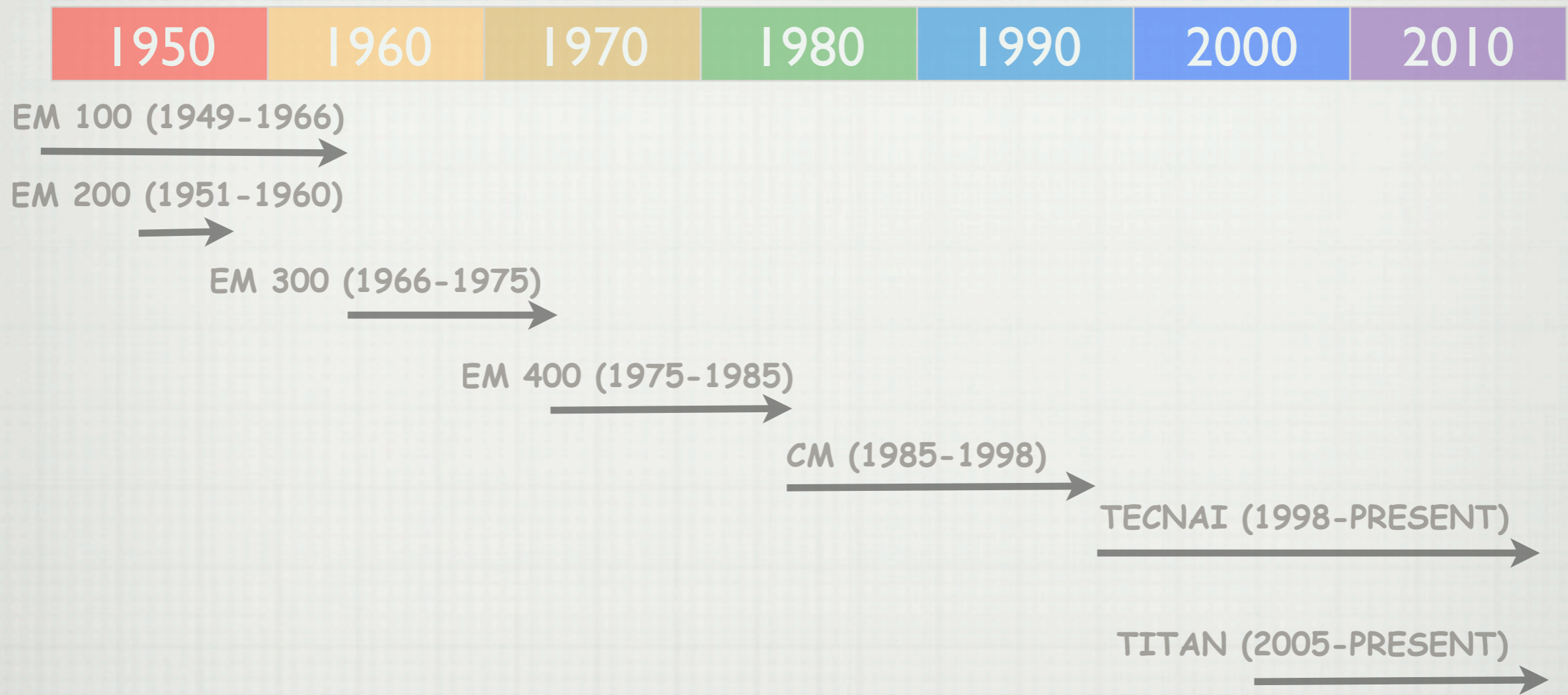


# Transmission Electron Microscope

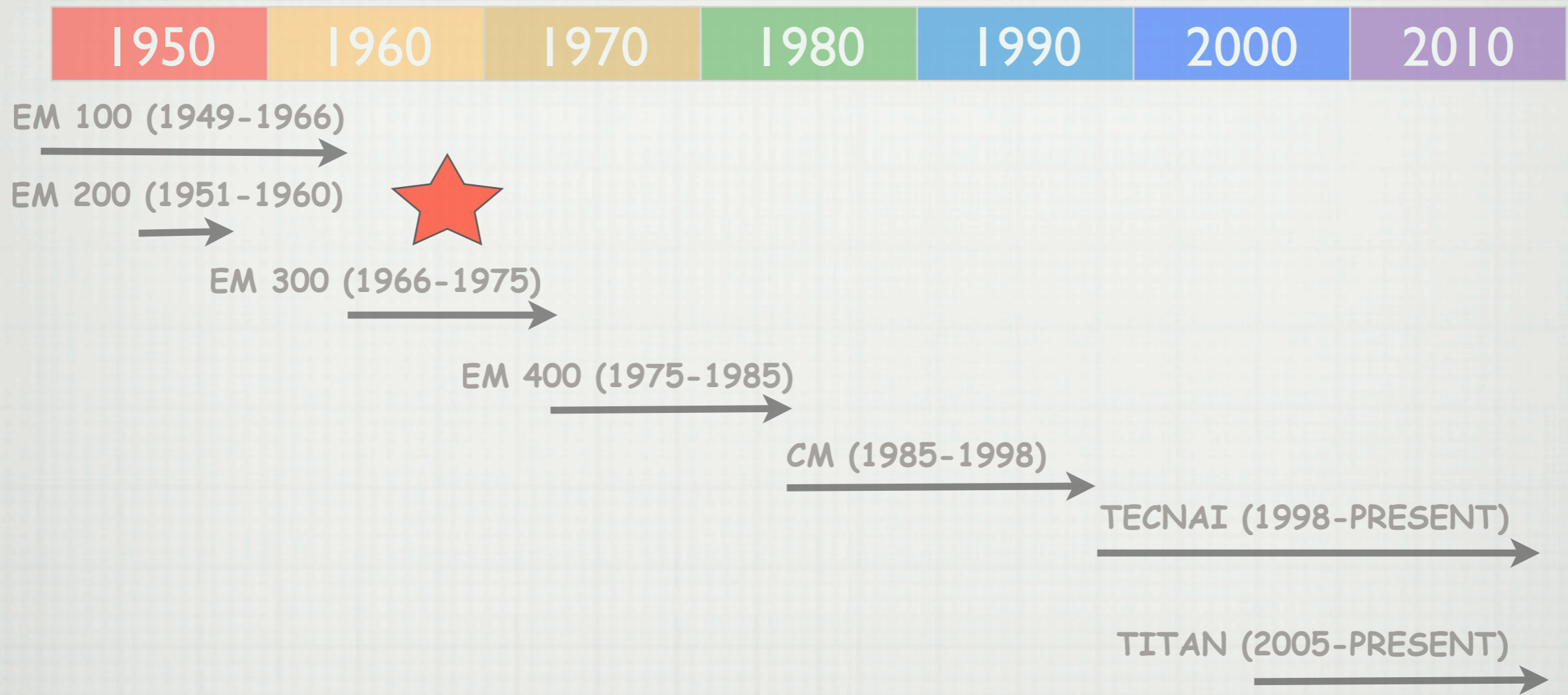
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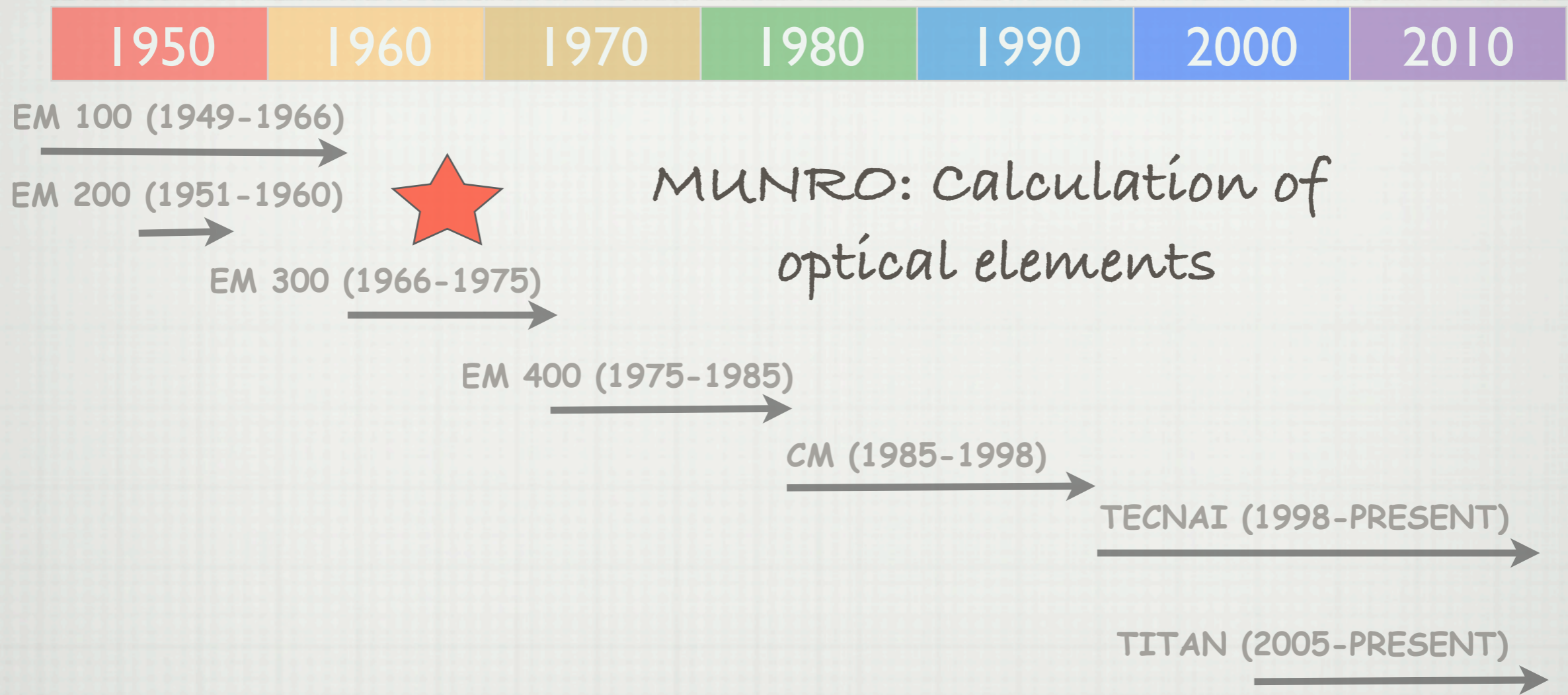
# Electron Optics



# Electron Optics

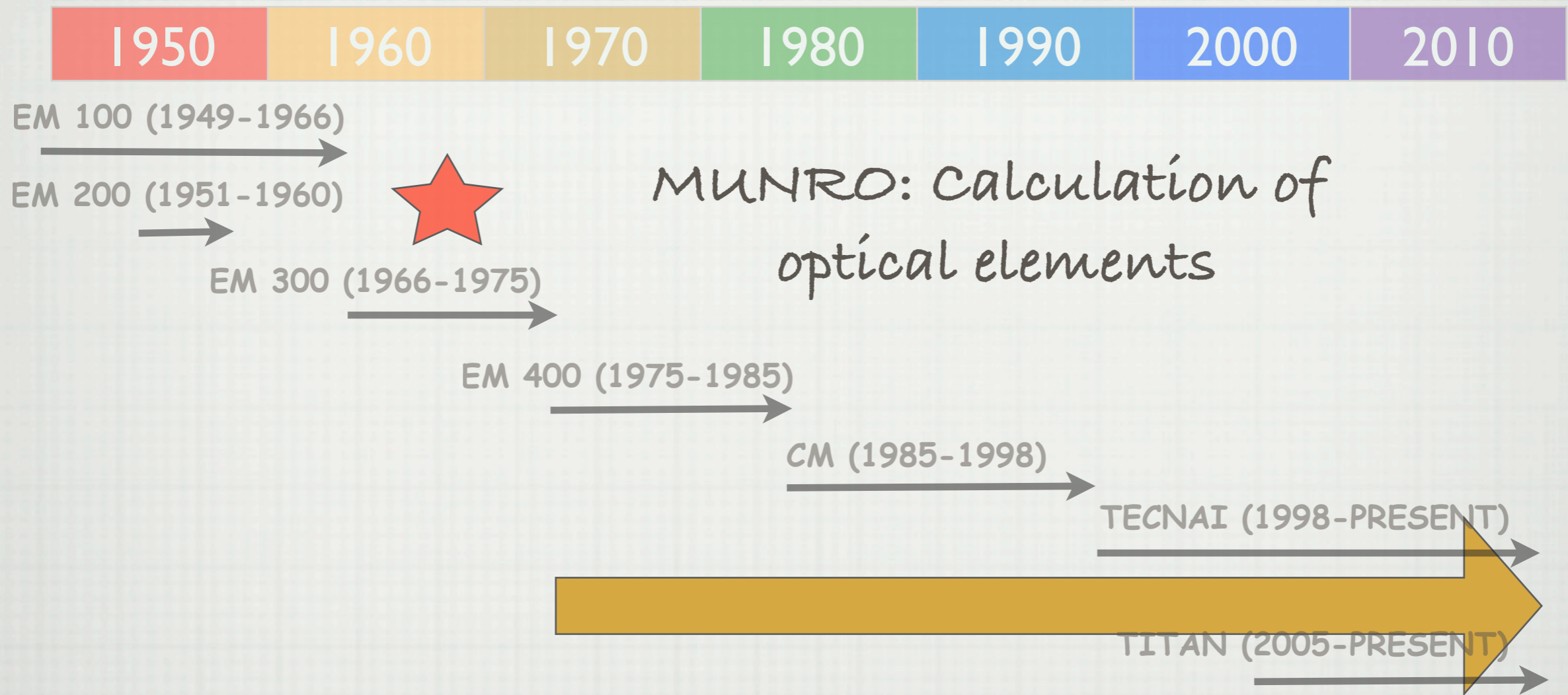


# Electron Optics

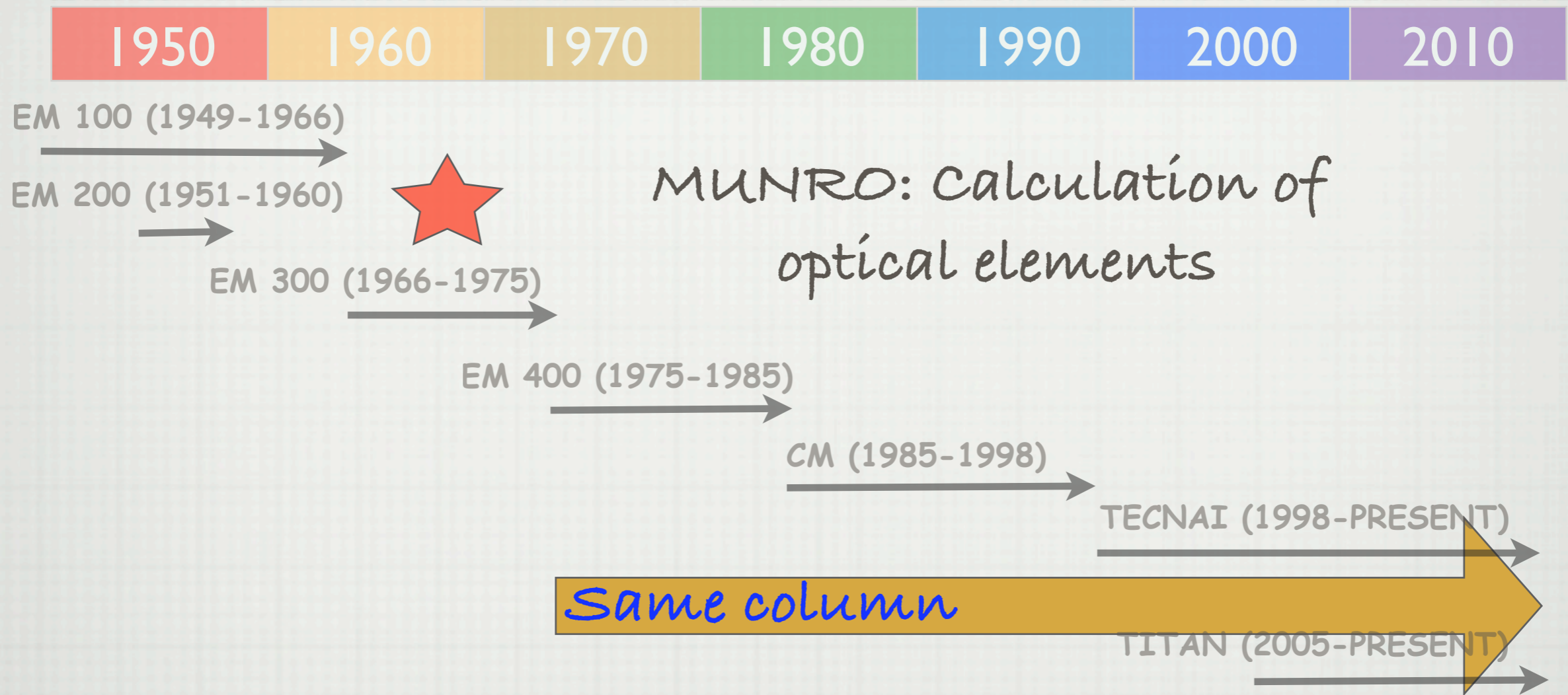




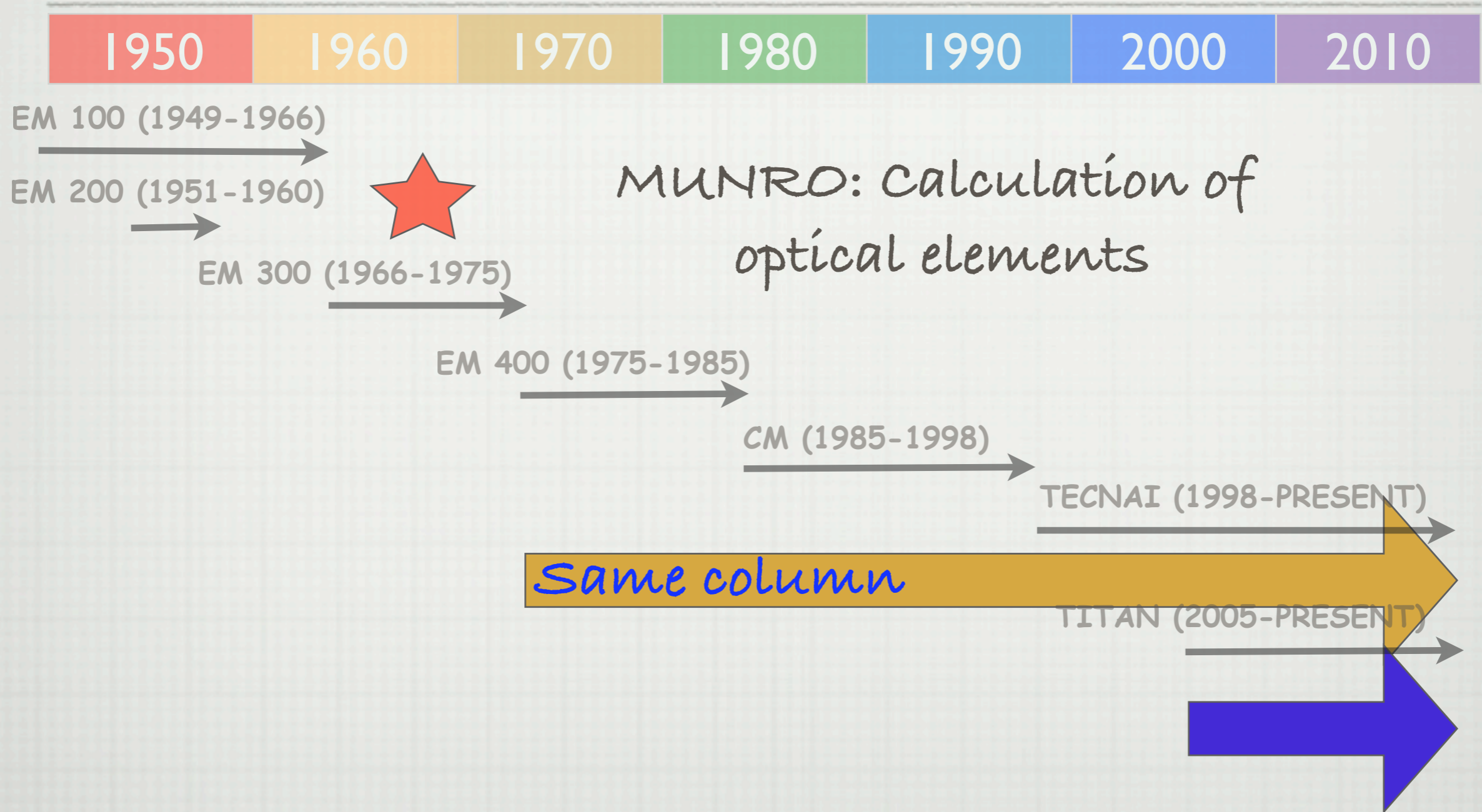
# Electron Optics



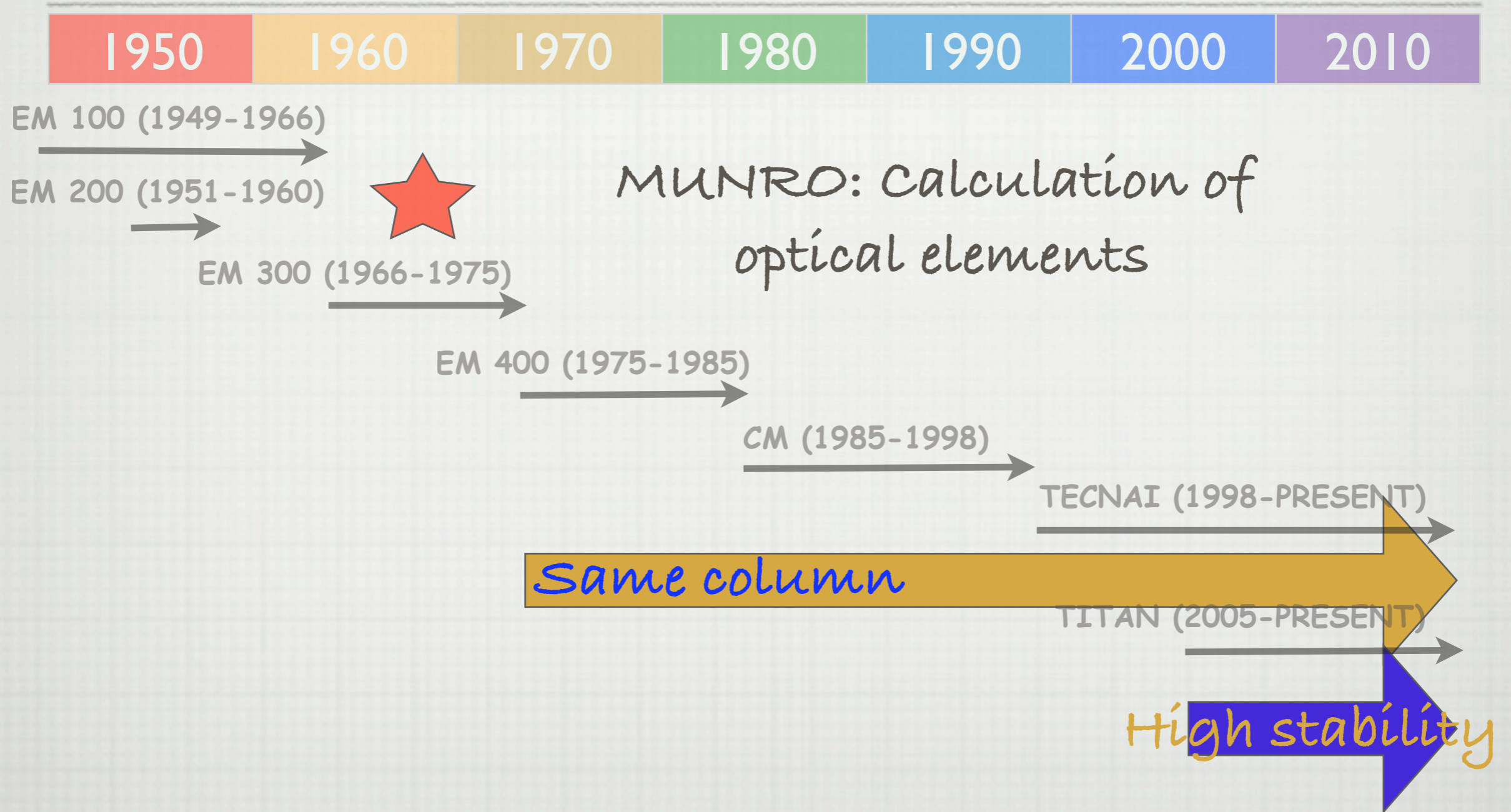
# Electron Optics



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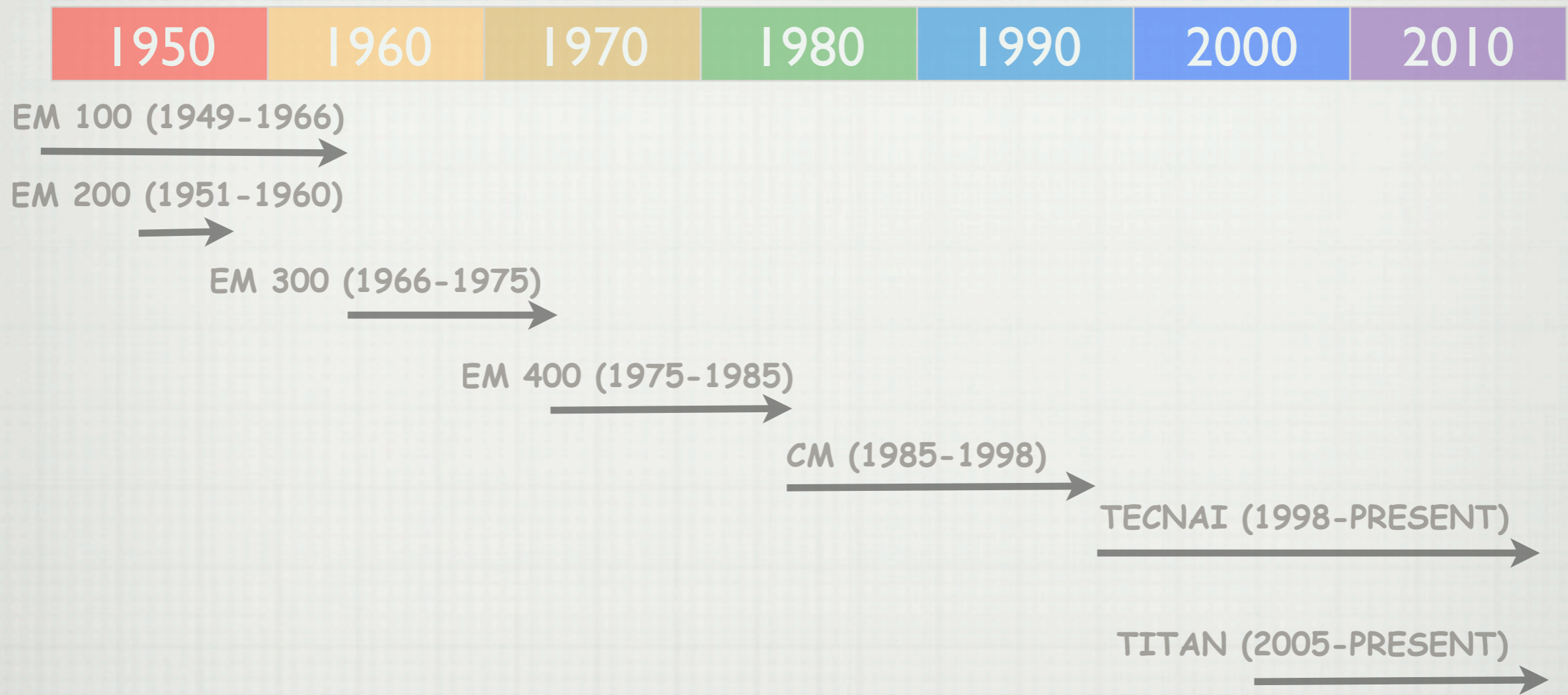


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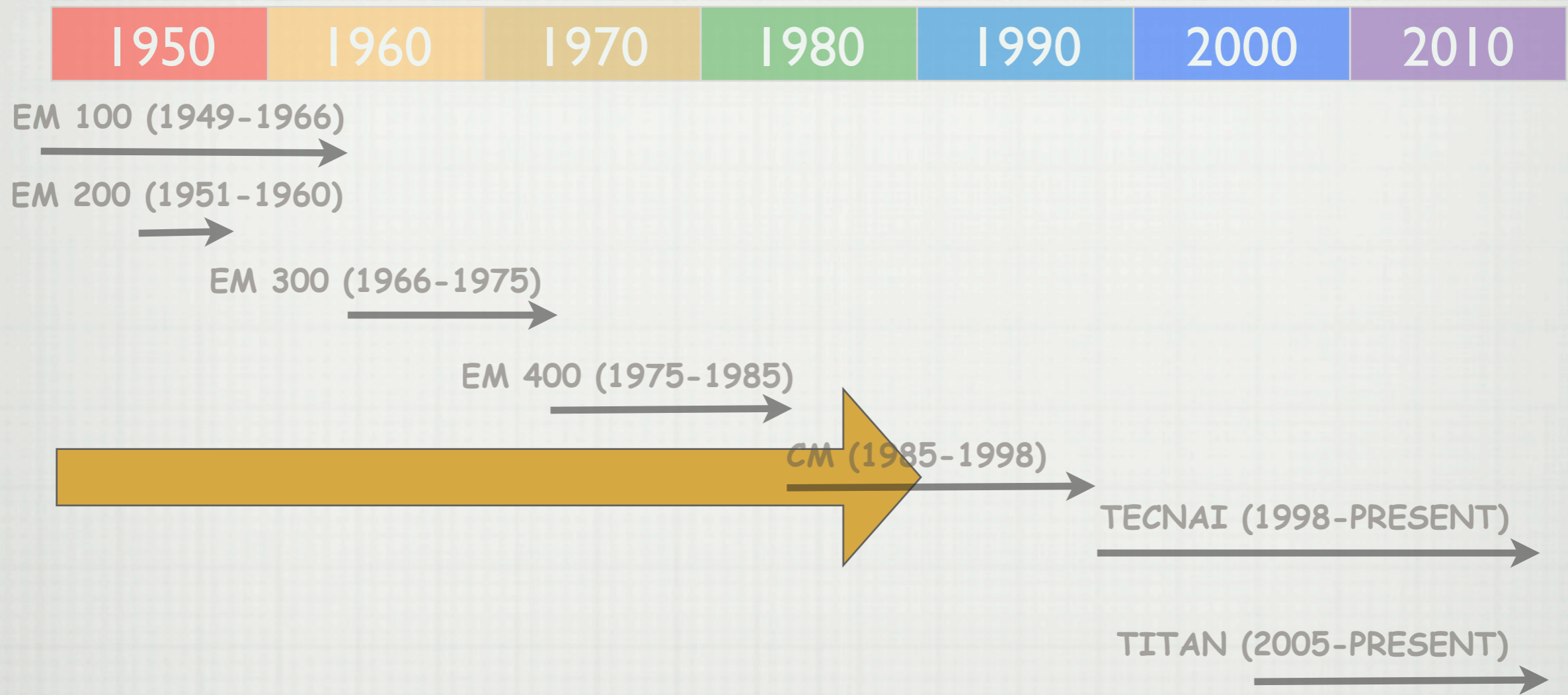
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- EM400/CM/Tecnaí column is more than 30 years old but optical performance still adequate
- Extremely "value-engineered": difficult to make even cheaper
- New column design = \$ 20 M development costs
- Tecnaí and Titan column will be used in next generation instruments

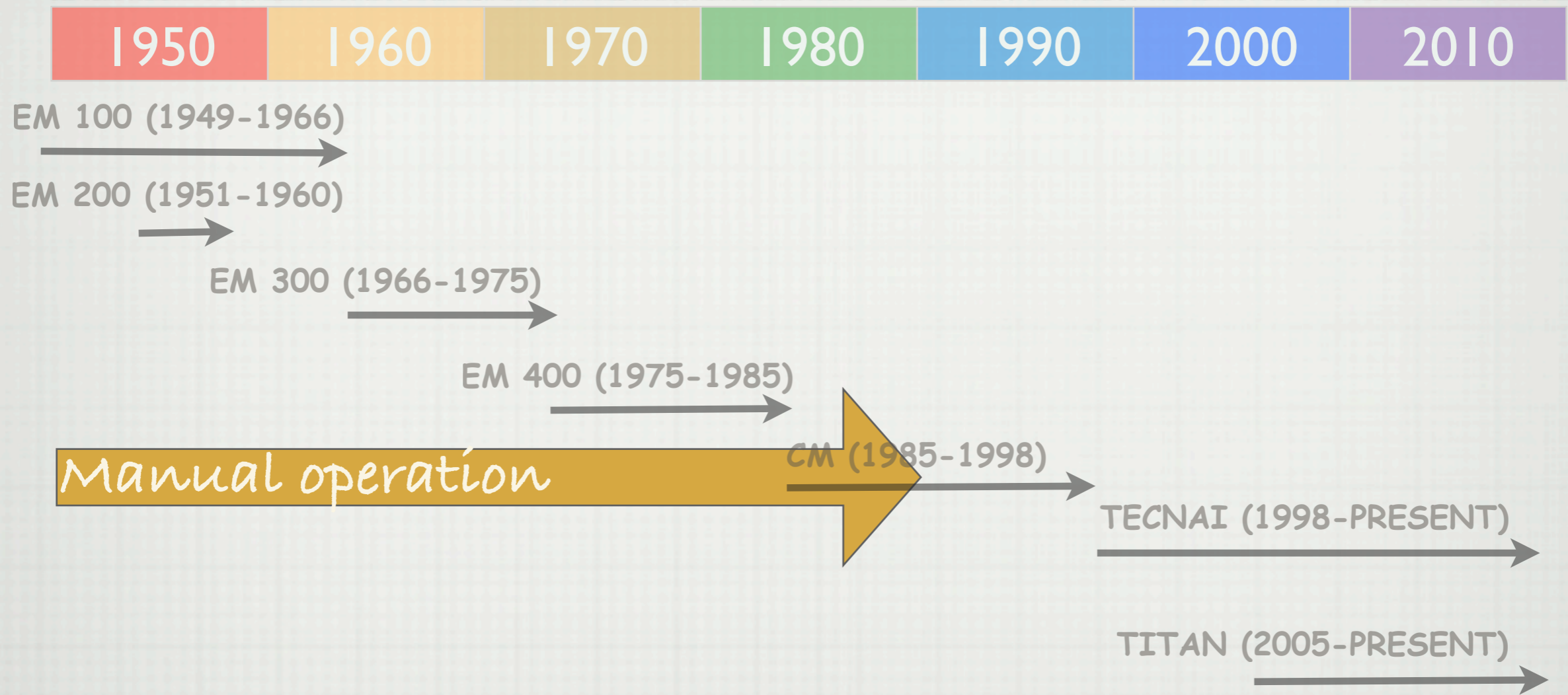
# Specimen stage



# Specimen stage

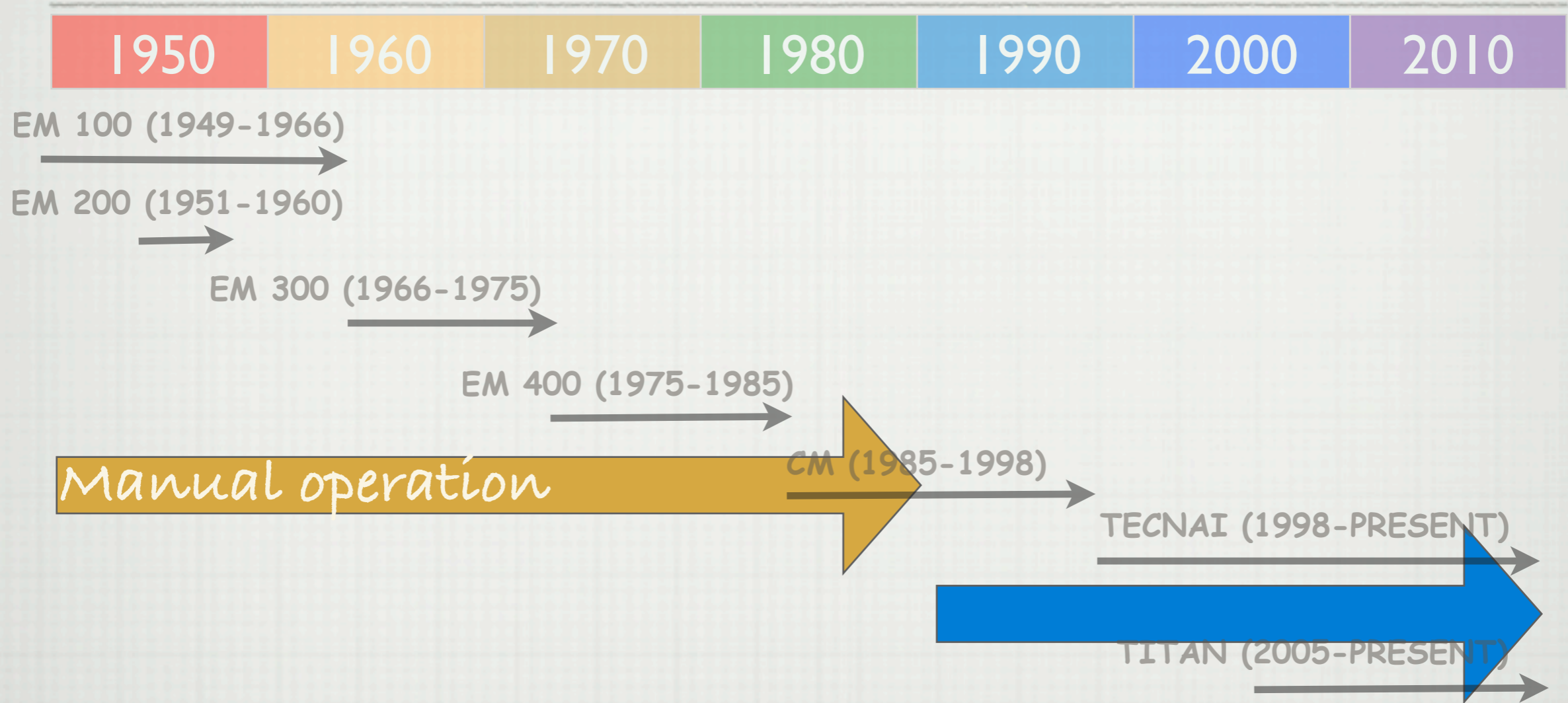


# Specimen stage

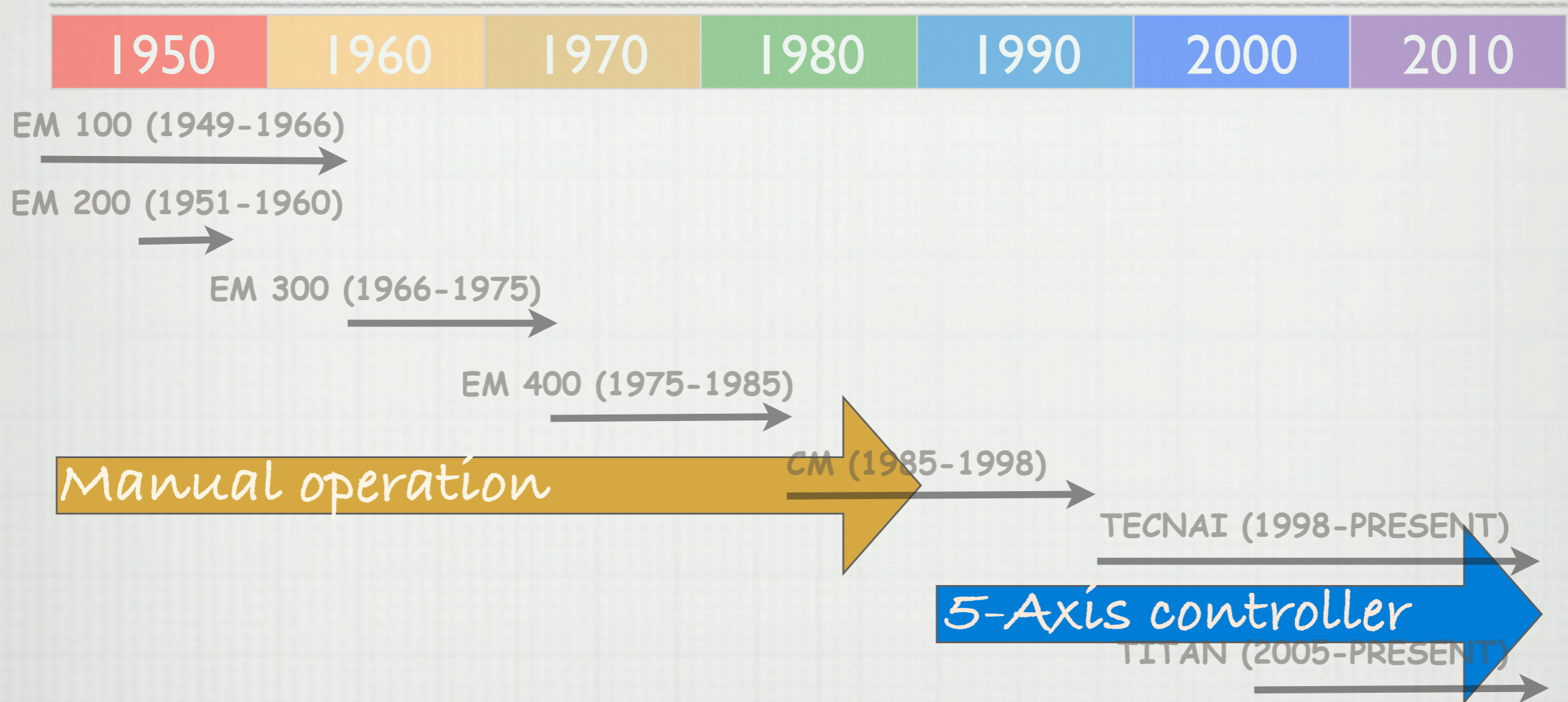




# Specimen stage



# Specimen stage

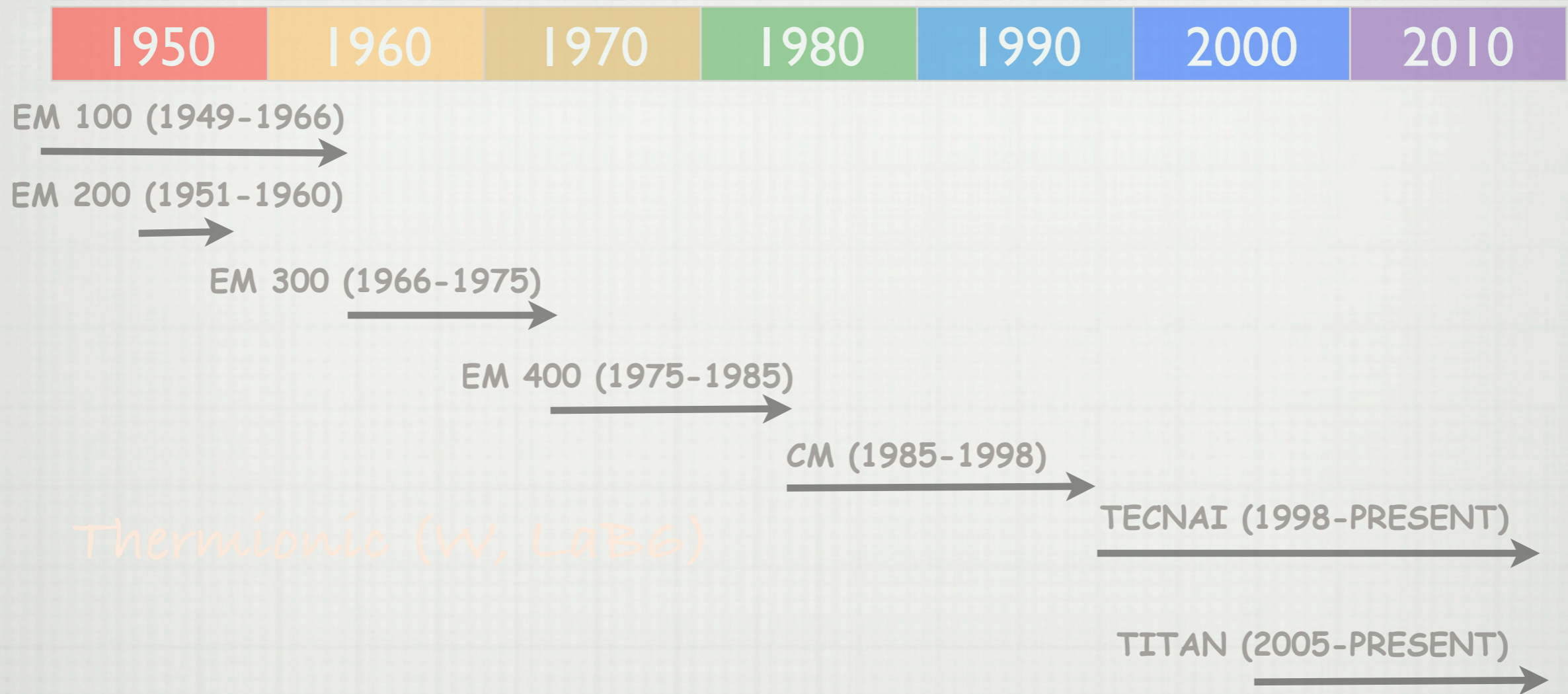


# Specimen stage

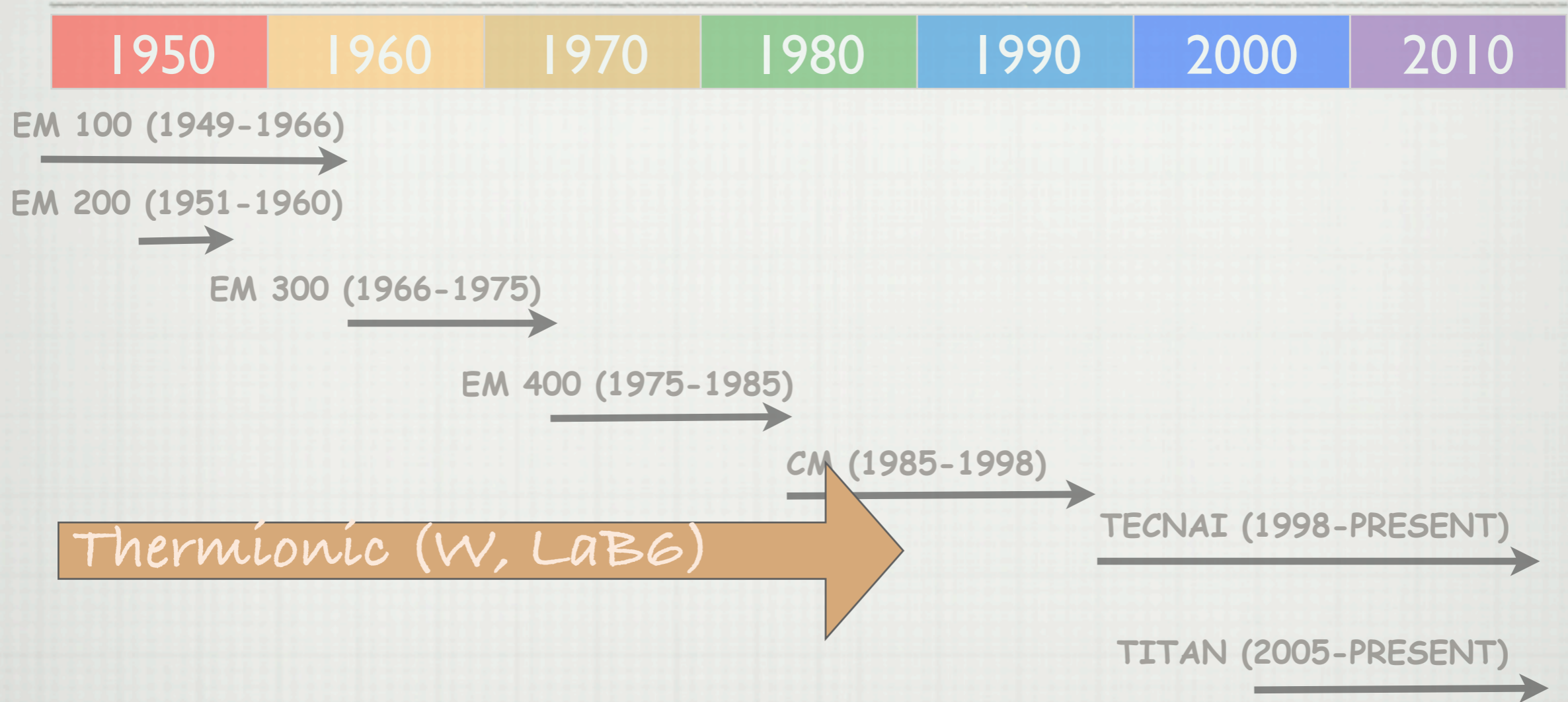
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- High precision mechanics but "value engineered"
- Specimen holders are third party items, FEI cannot change dimensions easily
- Positioning accuracy and drift still adequate
- New development: piezo stack "on top of" existing mechanism
- TEAM stage: less successful than hoped

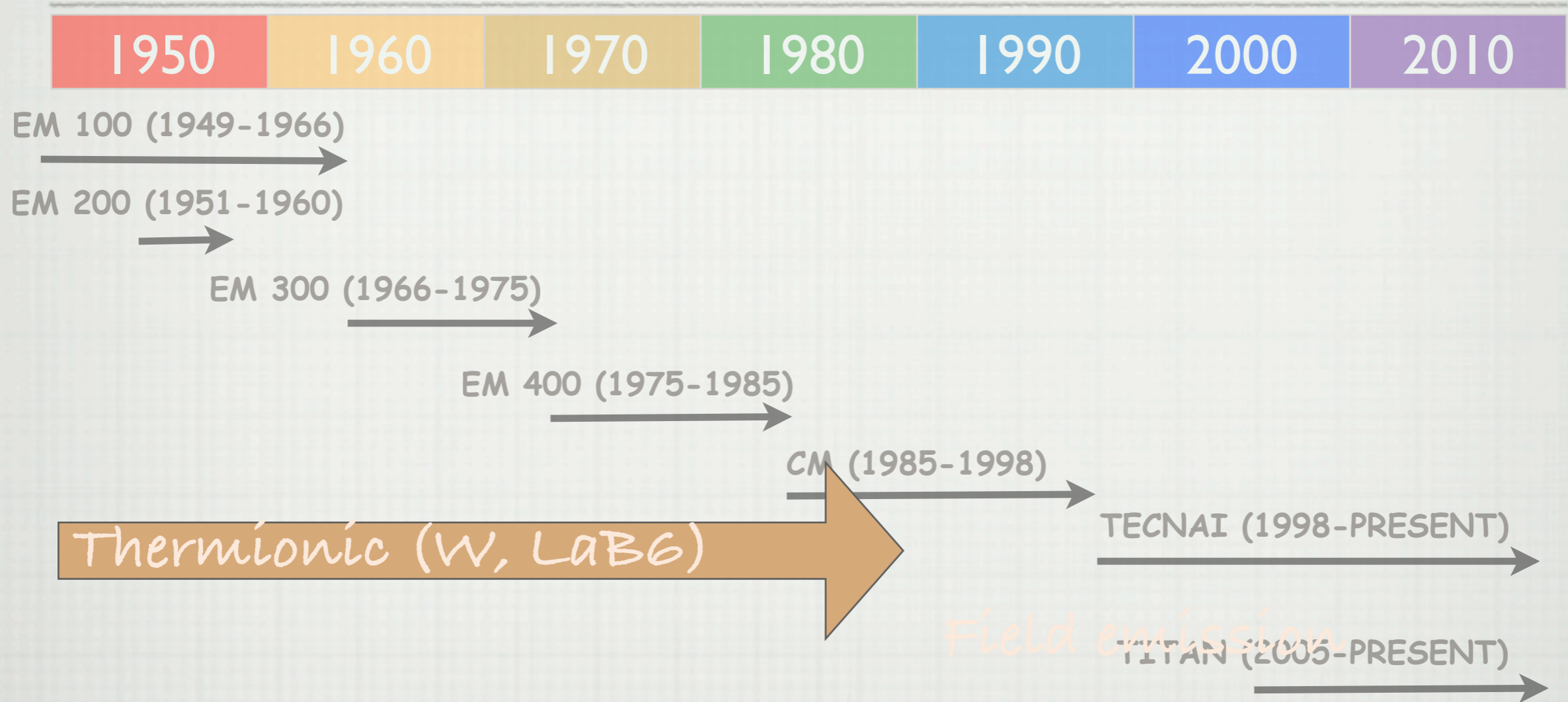
# Gun & High Tension



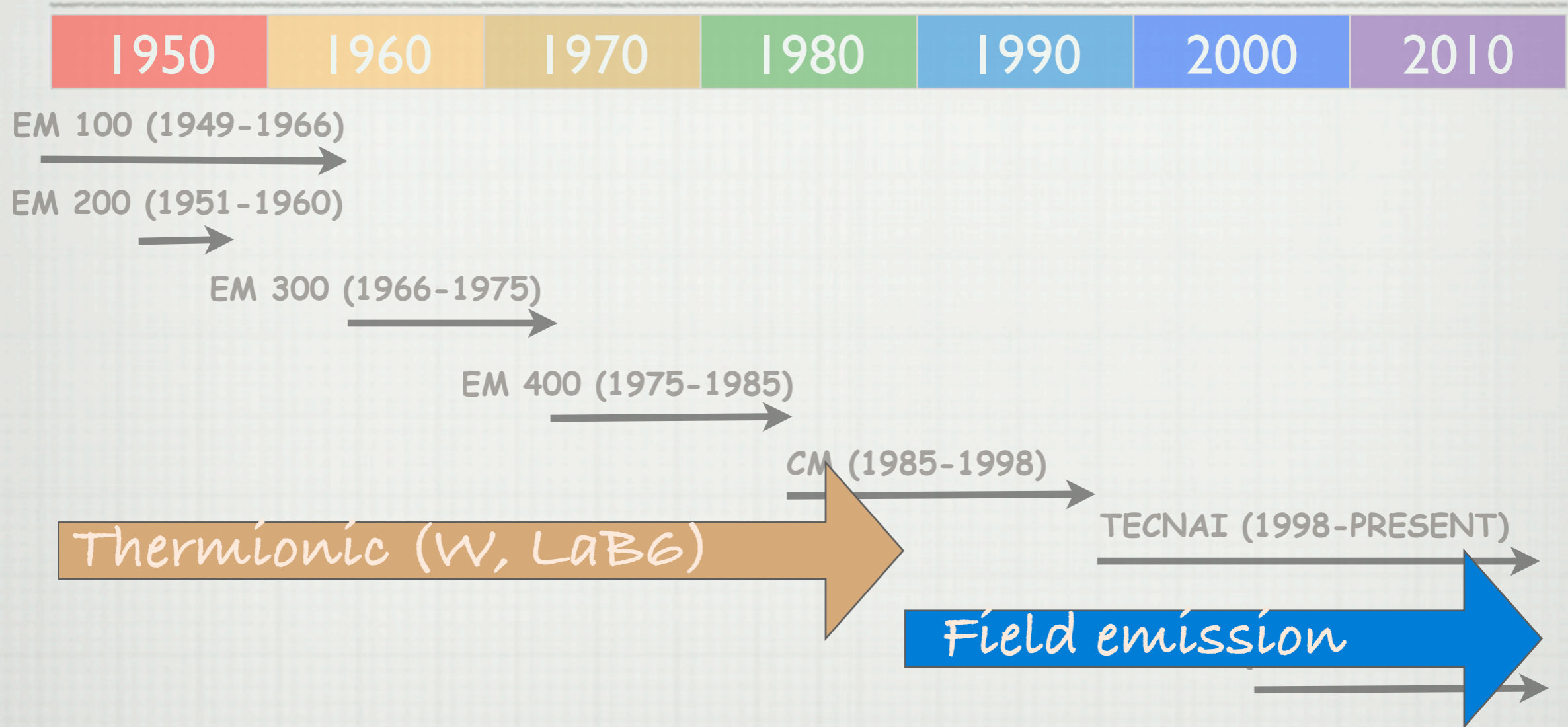
# Gun & High Tension



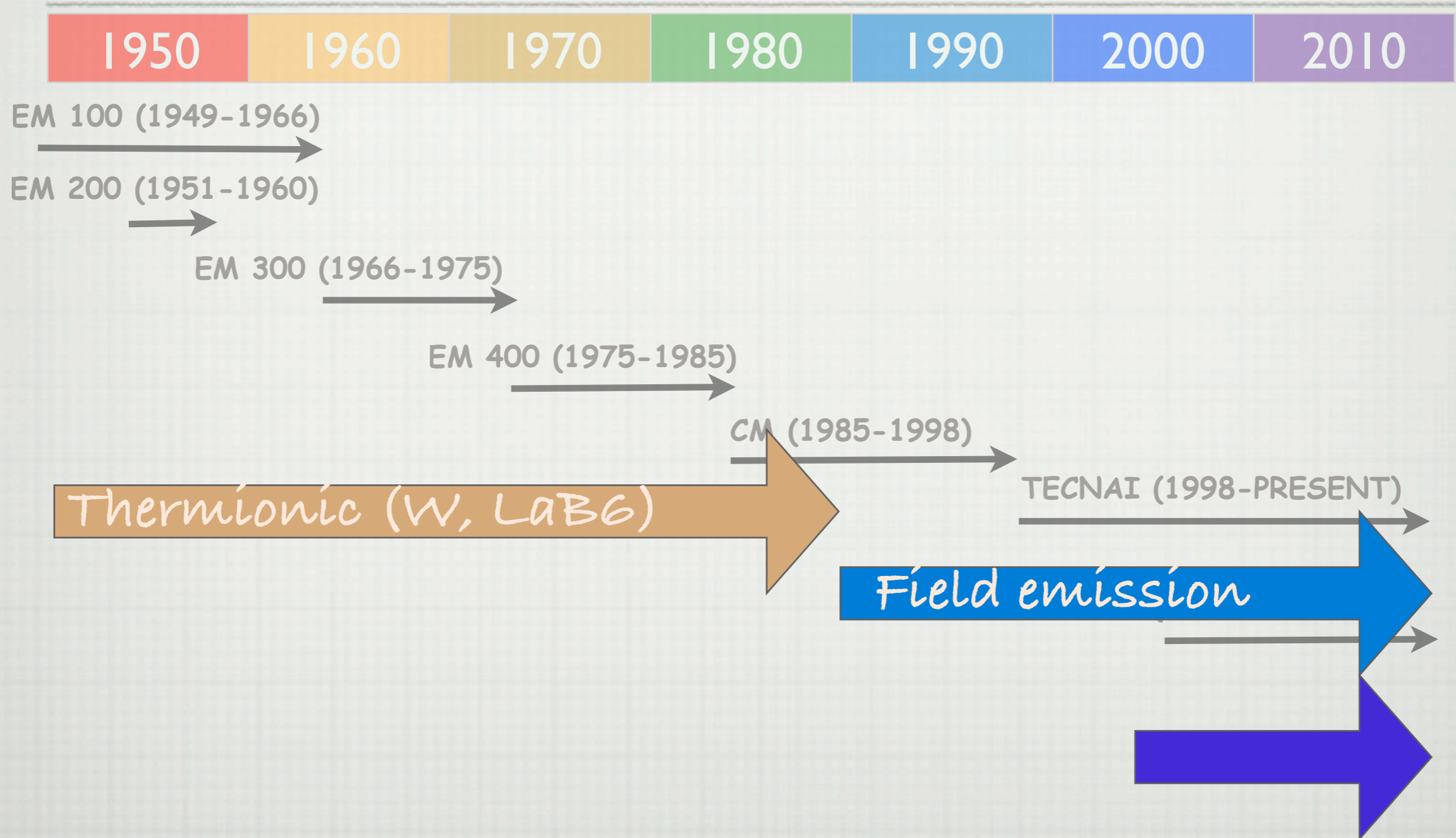
# Gun & High Tension



# Gun & High Tension

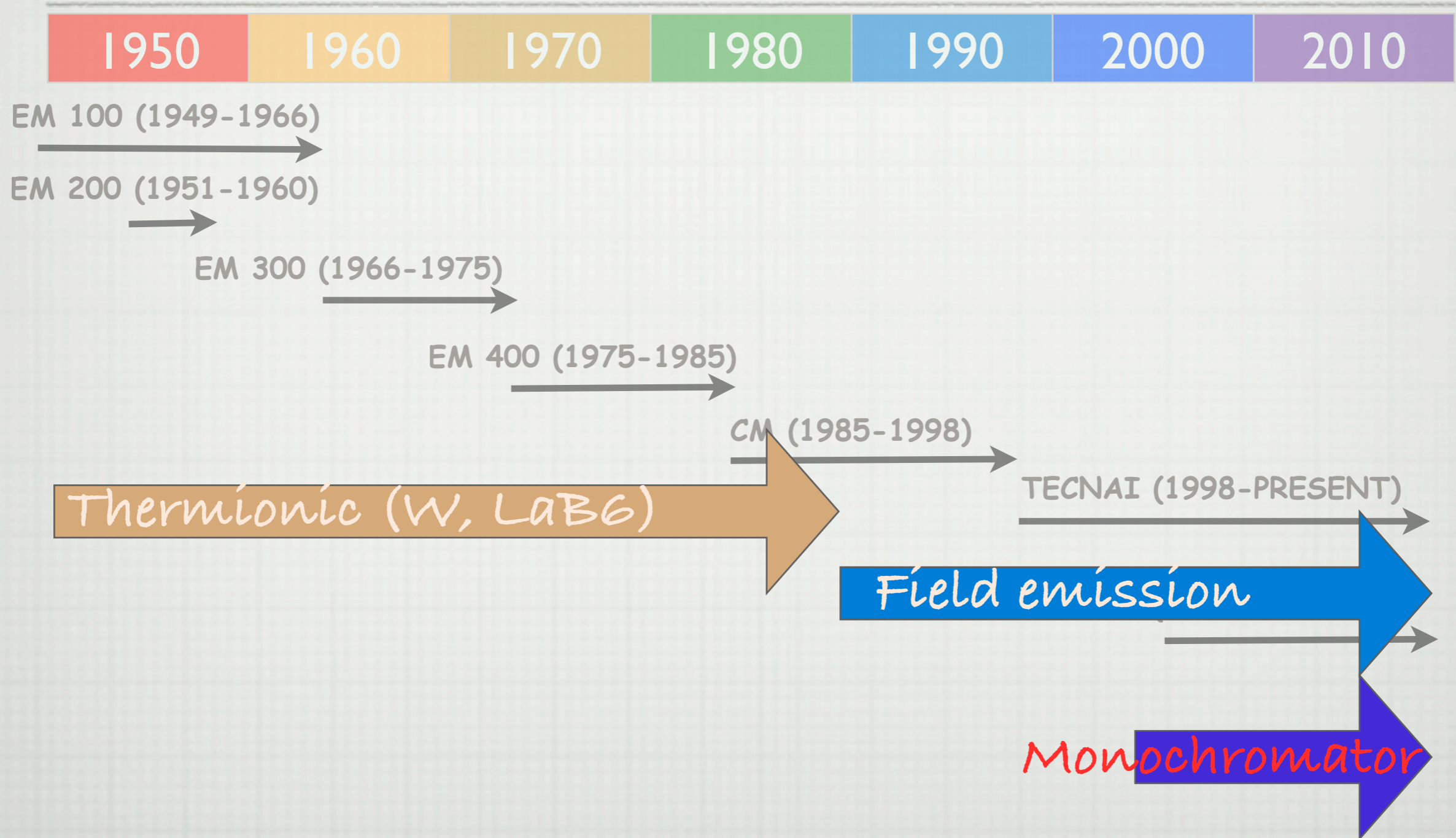


# Gun & High Tension





# Gun & High Tension

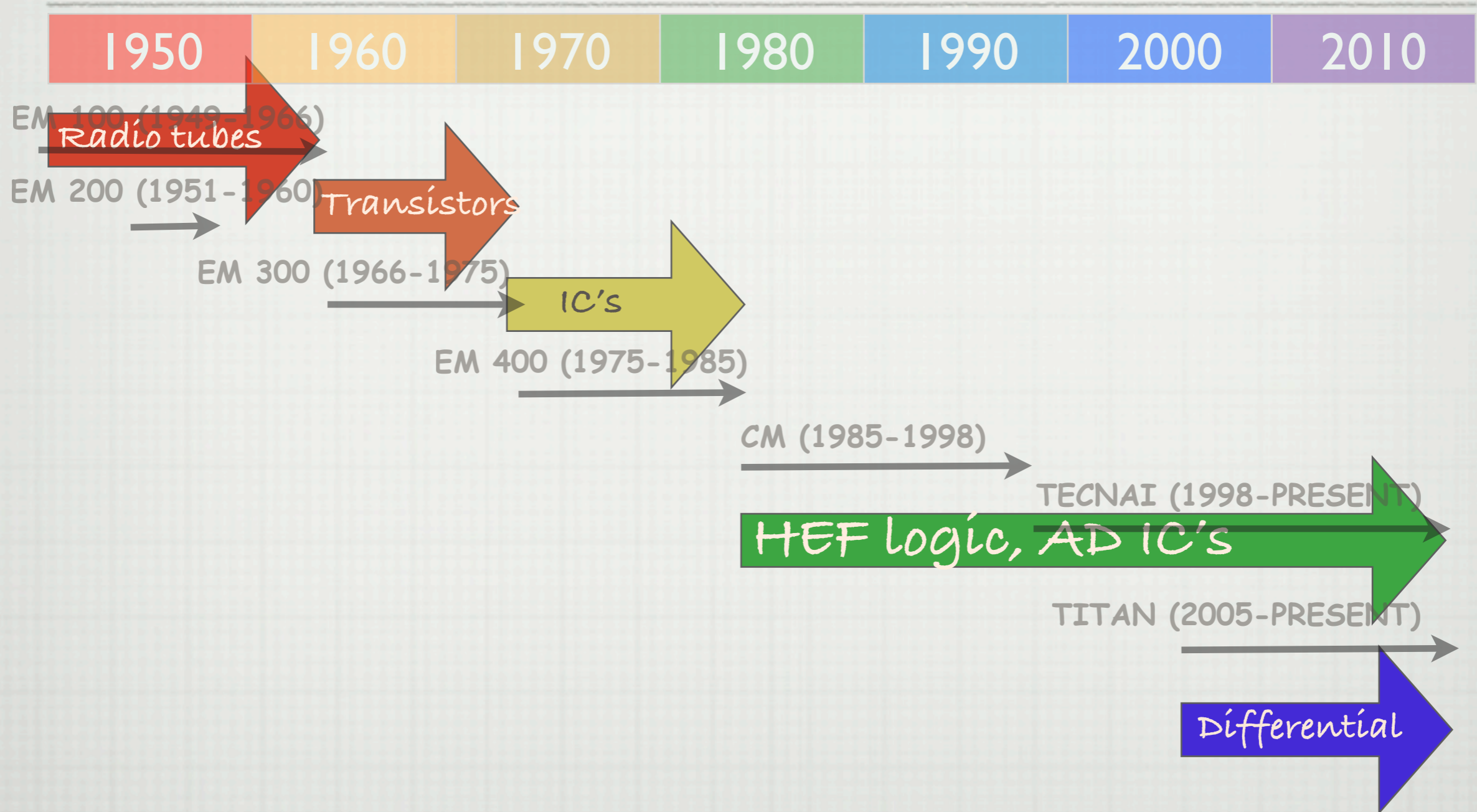


# Gun & High Tension

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- Technology unchanged over the years
- HT stability requirement:  $< 1 \text{ V} / 300 \text{ kV}$
- Difficult to make cheaper: mechanics, safety requirements
- Monochromator is FEI's specialty

# Electronics

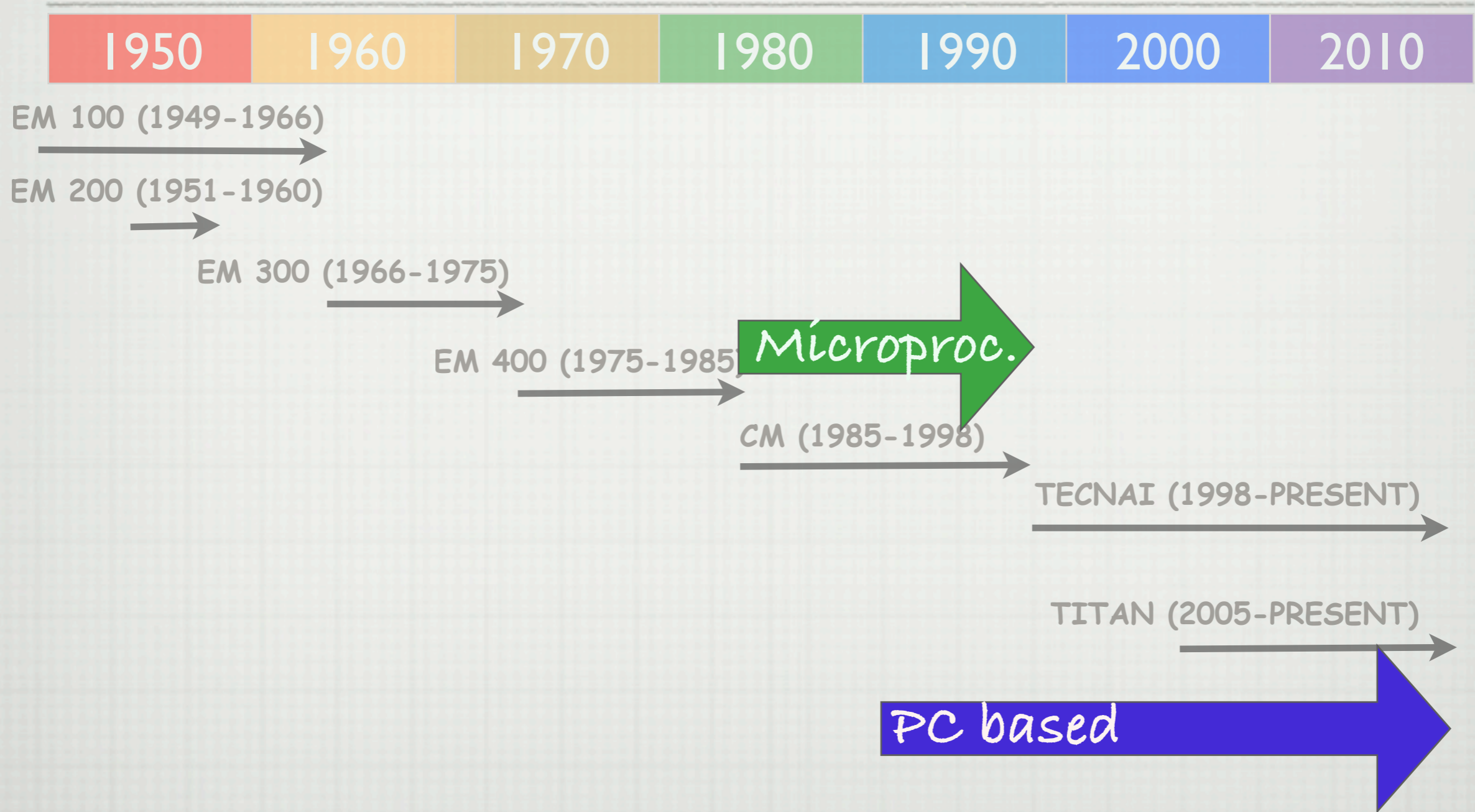


# Electronics

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- Component obsolescence major threat
- Low volume, high precision electronics
- Tru-hole components getting scarce
- Single-ended design
- RoHS compliance
- Re-engineering effort required, takes significant resources

# Software

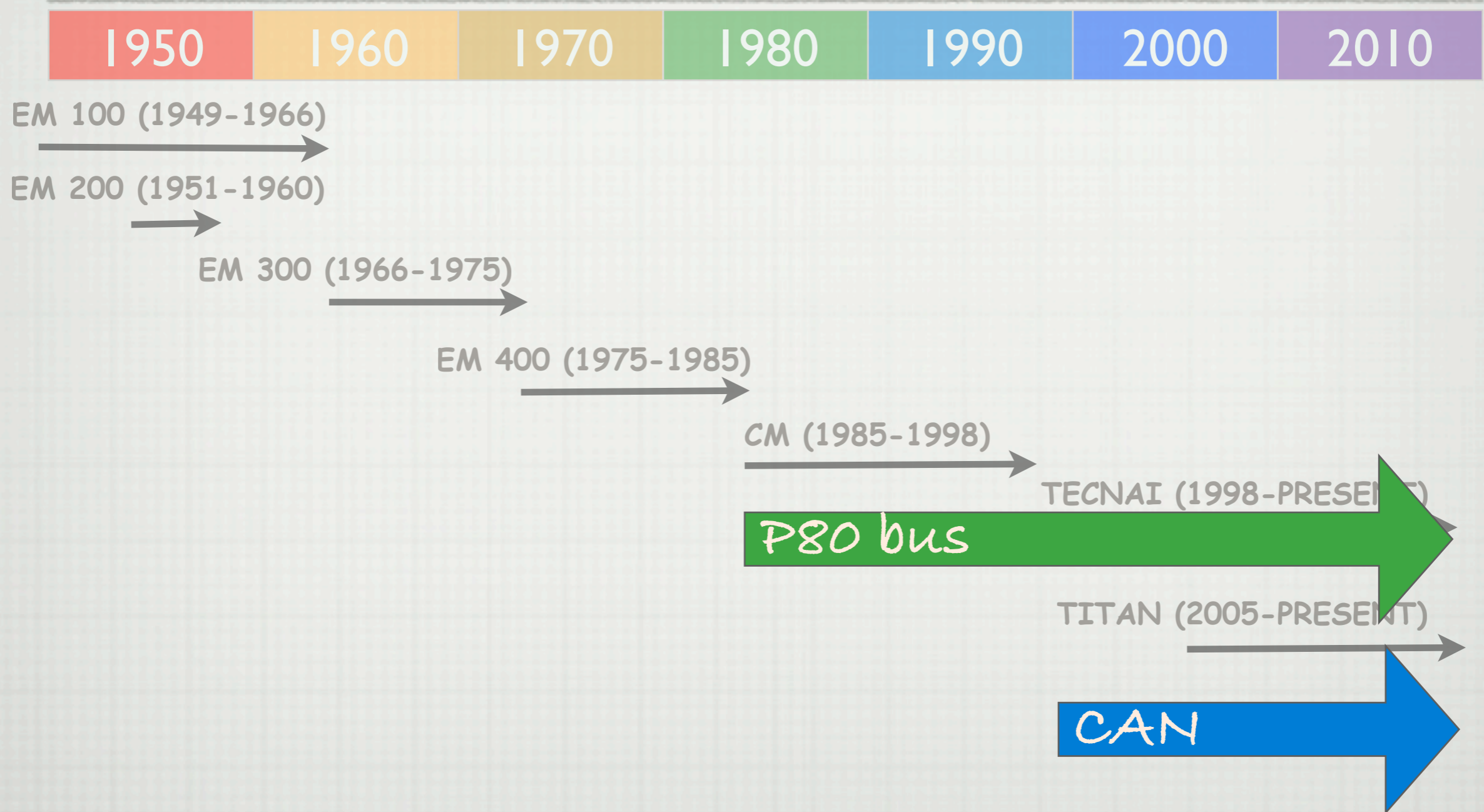


# Software

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- Started on a 8086 embedded processor in PL/M
- Moved to embedded processor + PC control in 1990
- Completely PC-based with Tecnaí, Windows NT as OS
- Tecnaí and Titan share code base
- Third party integration essential (camera's, energy filters, equipment for X-ray analysis)
- Configuration complexity exploded

# Infrastructure & common components



# Infrastructure & common components

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- Electronics infrastructure shared for TEM and SEM/SDB
- Some electronic components shared (scan system, detectors)
- Software component architecture shared
- Development environment, archiving, building shared
- Multi-site development



# Conclusions

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- We cannot maintain our product portfolio without re-use
- Consider re-use at the system level, not on component level
- Use for re-use essential: practice proven convinces most

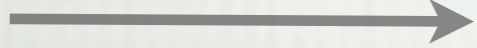
# Questions for the discussion

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- Could we have done better over those years?
- How to increase speed of innovation?
- How to manage re-engineering?



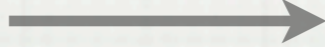
EM 100 (1949-1966)



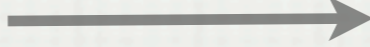
EM 200 (1951-1960)



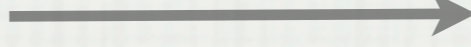
EM 300 (1966-1975)



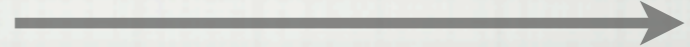
EM 400 (1975-1985)



CM (1985-1998)



TECNAI (1998-PRESENT)



TITAN (2005-PRESENT)



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TEXT