

ECRIS on high voltage platform for engineering and modification of materials

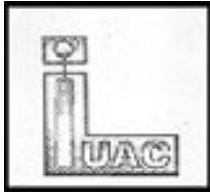
Pravin Kumar
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ECRIS08, 15-18 September, 2008, Chicago

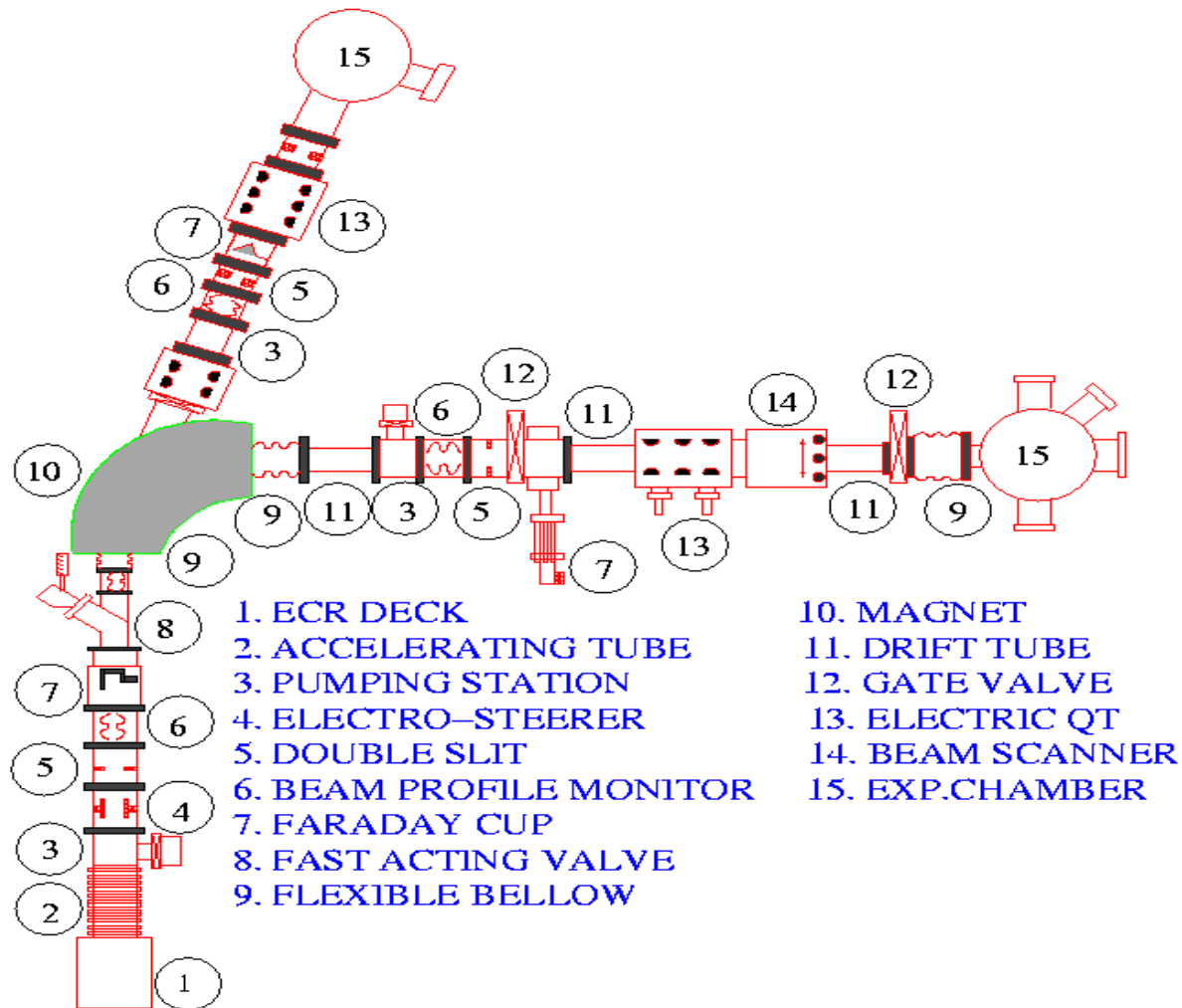


Presentation Plan

- * Introduction to LEIBF
- * Development of typical beams like Ni & Si
- * Ion matter interaction – fundamental
- * Experiments and results
- * Conclusion

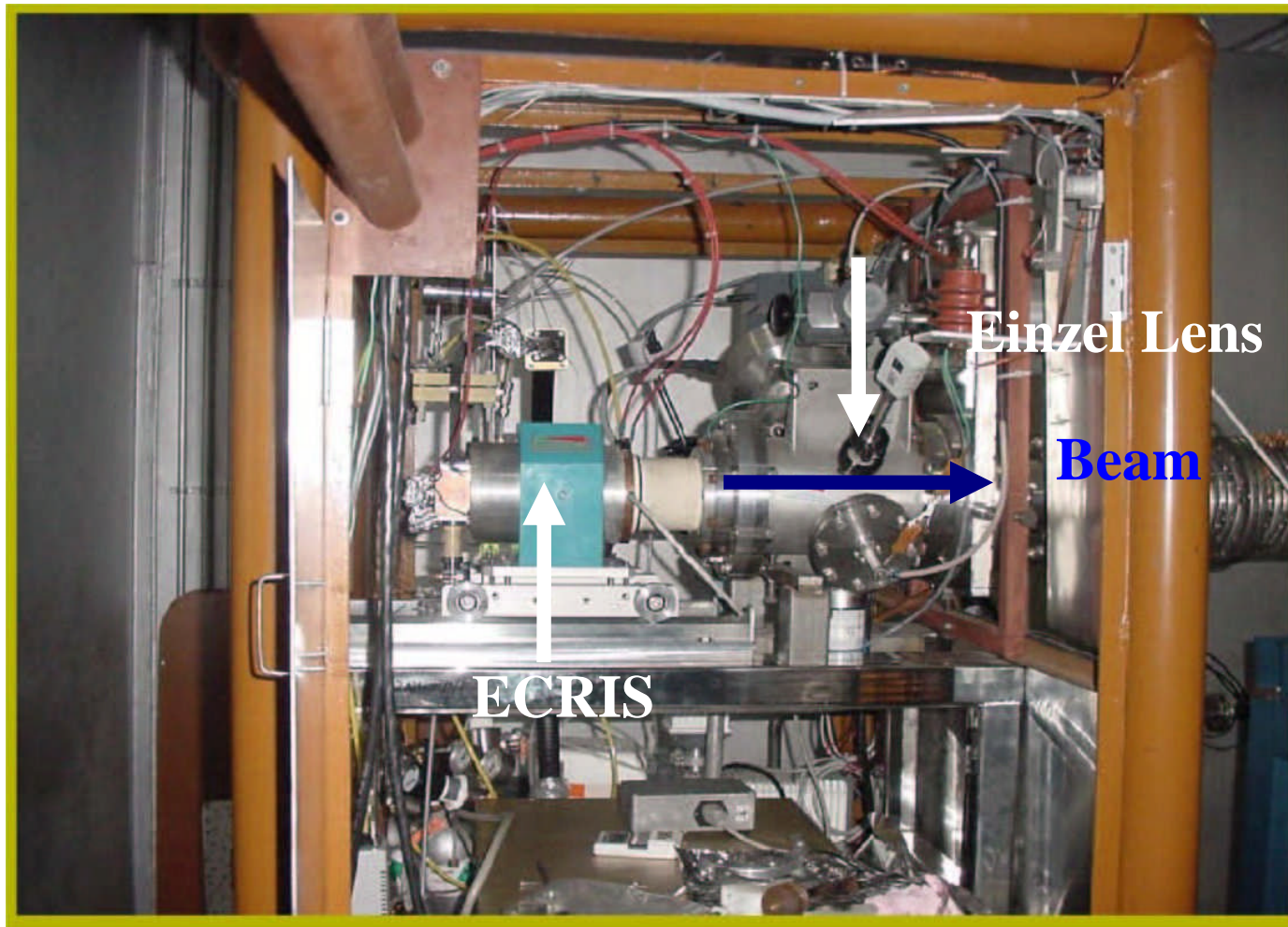


Schematic of Low Energy Ion Beam Facility





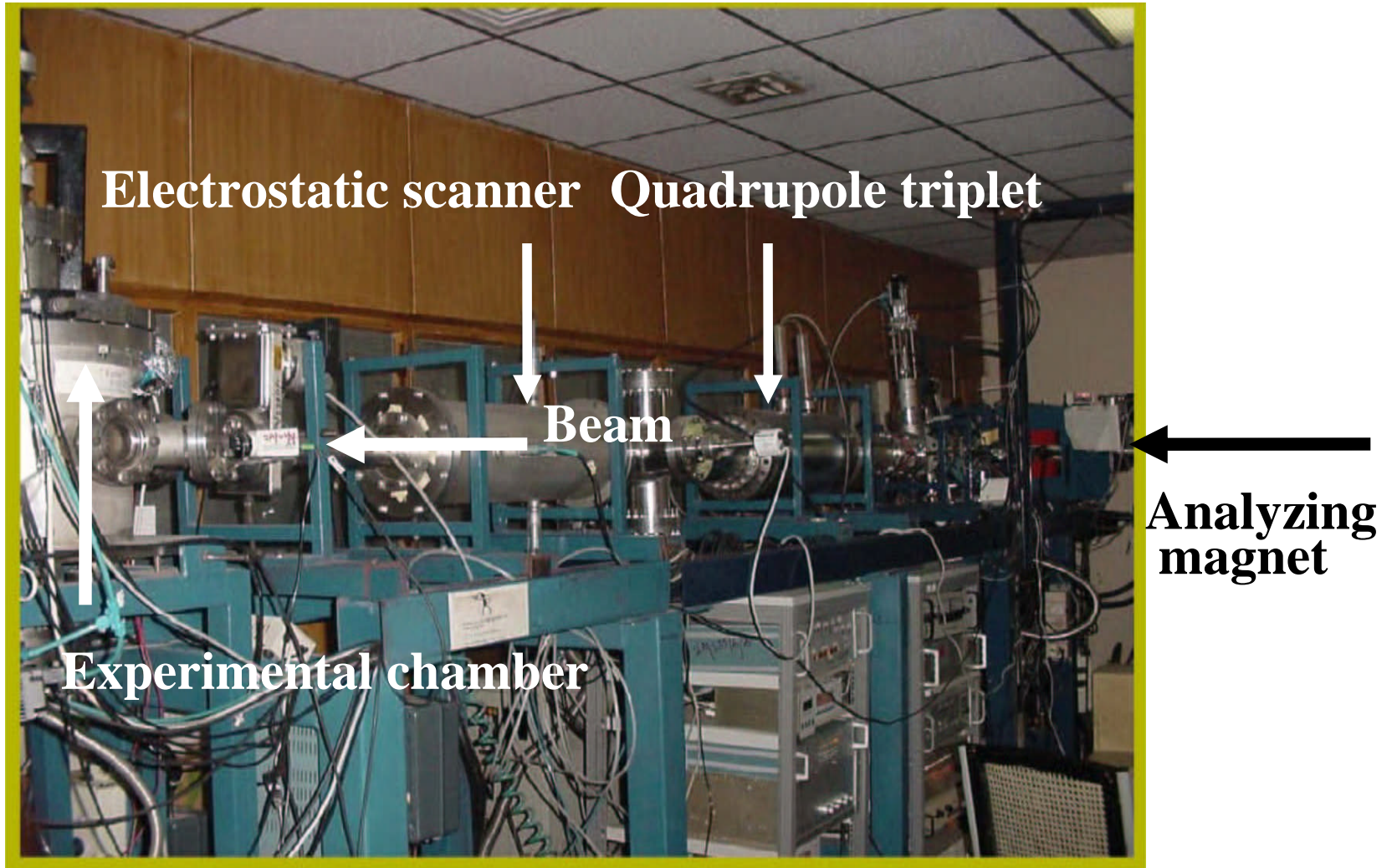
All permanent ECR Ion source



←
**200 kV
Accelerating
tube**

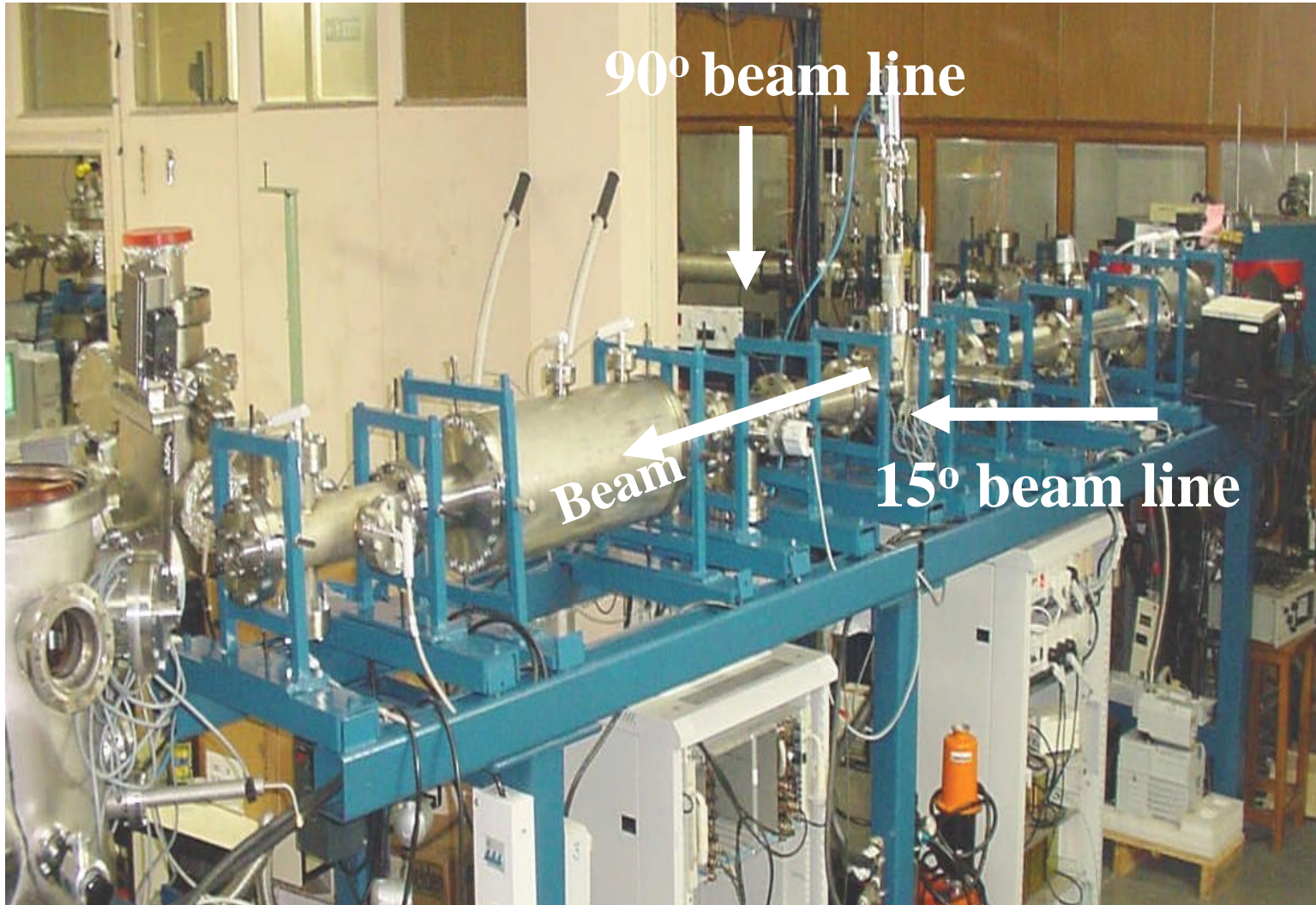


View of 90° beam-line



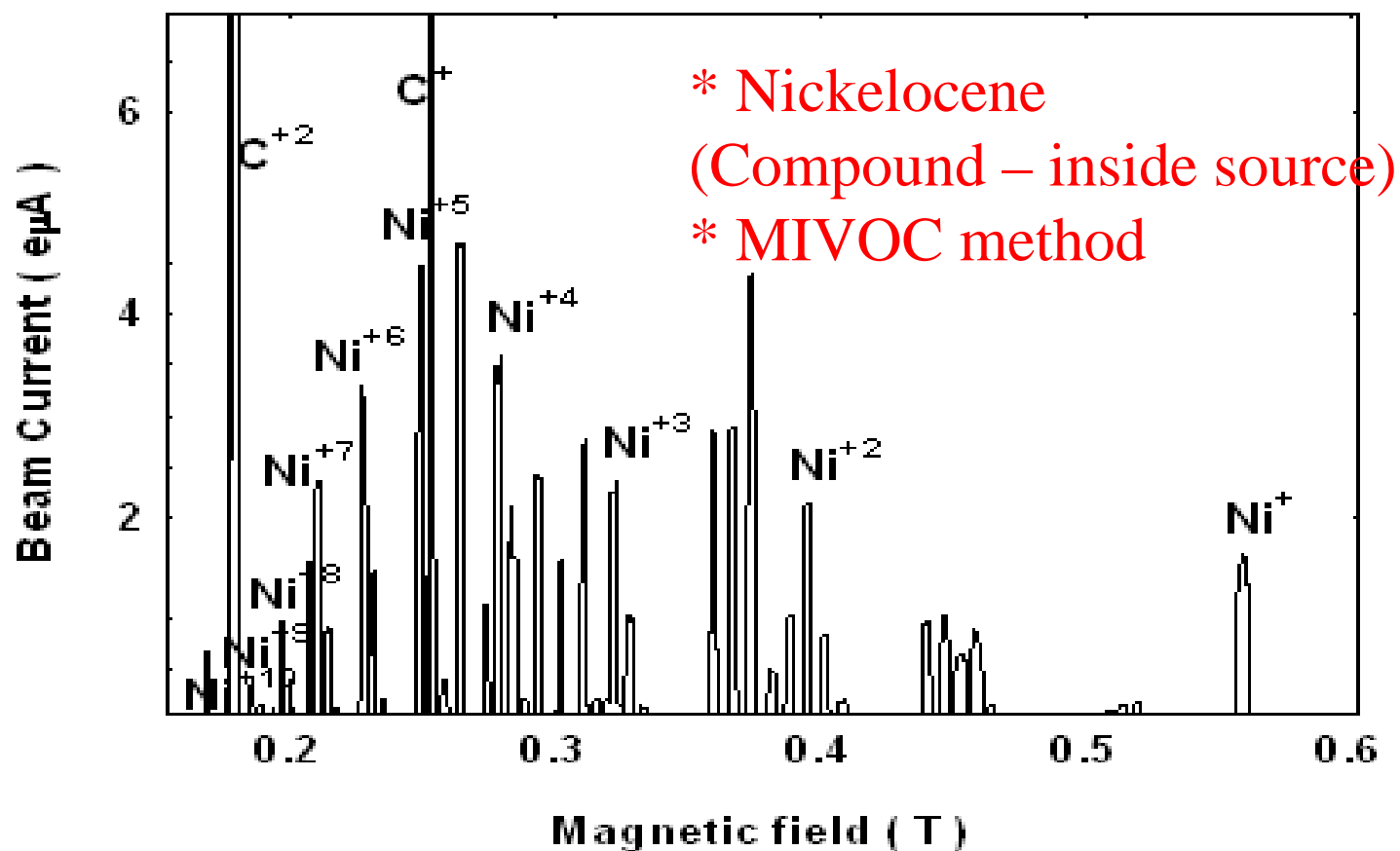


View of 15° beam-line





CSD of Nickel



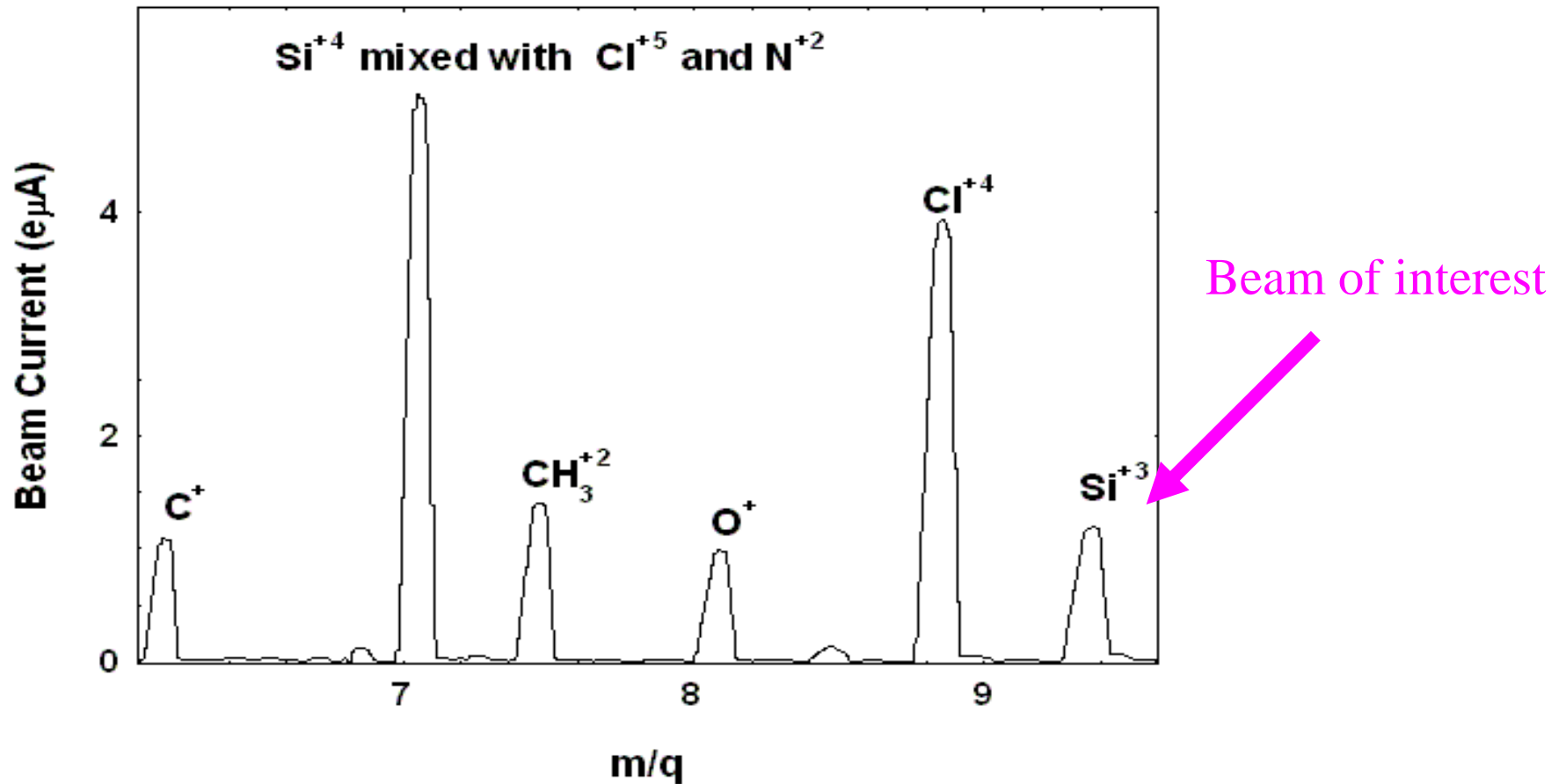
P. Kumar et.al., *J. Vac. Sci. Technol. A*, **26(1)**, 97 (2008)



CSD of Silicon

Trimethylchlorosilane

Modified gas panel





Ion matter interaction -fundamentals

Energy loss of ion in solids (dE/dx)

Nuclear Energy Loss (S_n)
- Elastic collisions

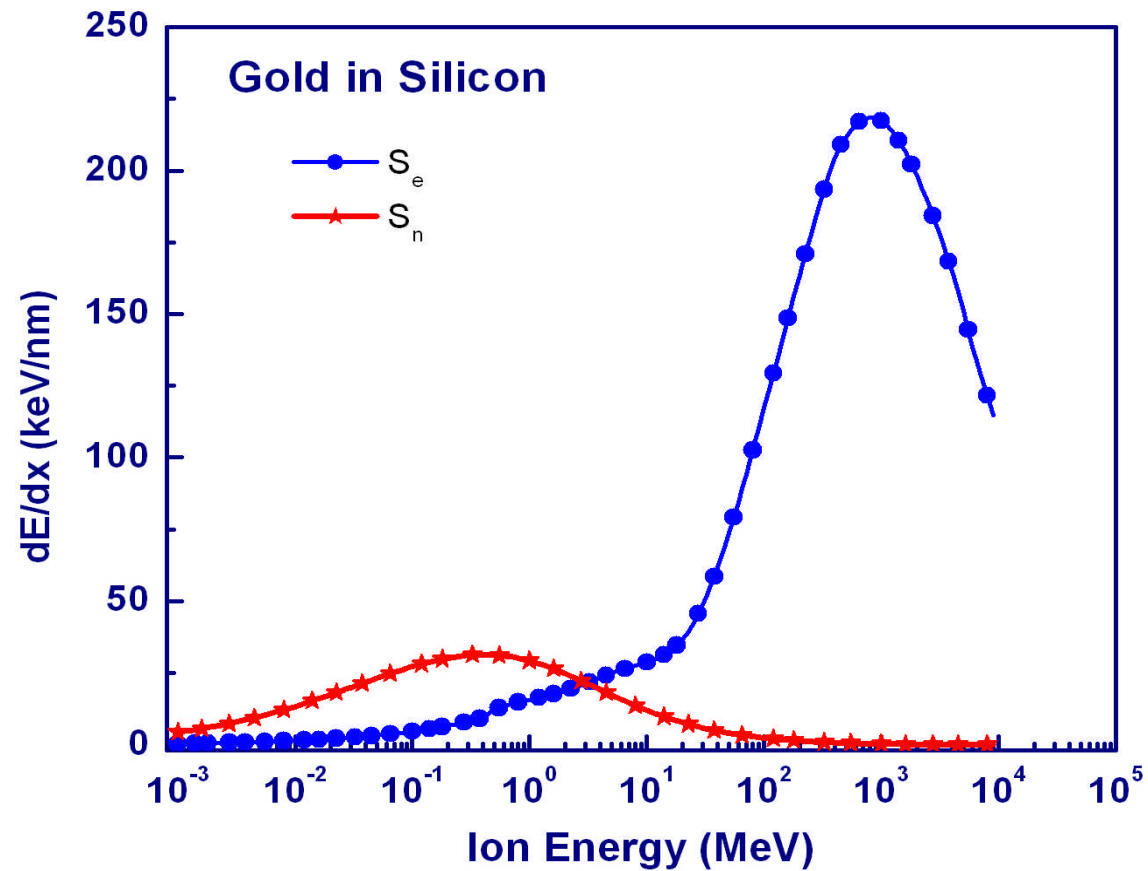
Dominates at low energies

Electronic Energy Loss (S_e)
- Inelastic collisions

Dominates at high energies

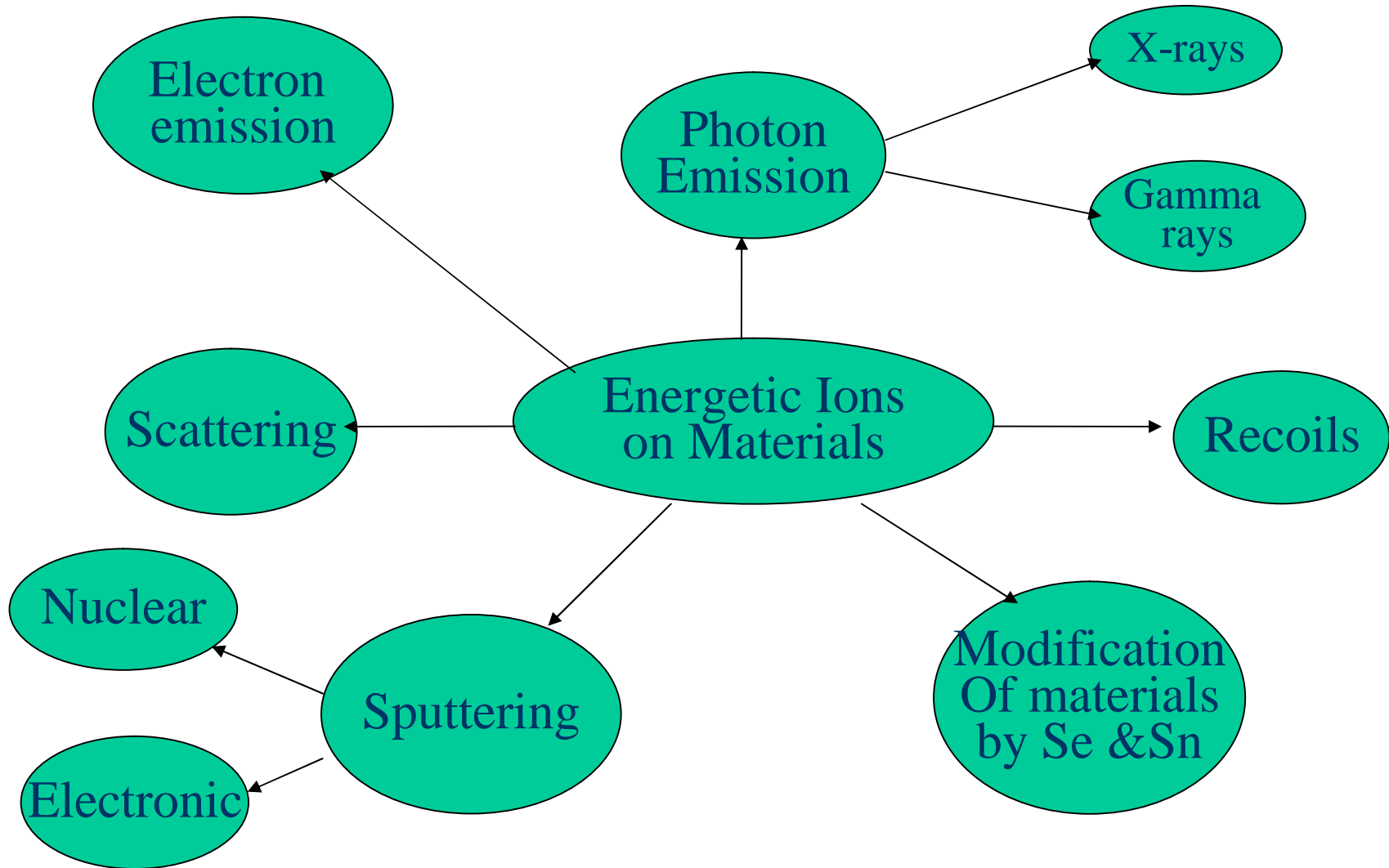


Energy loss of ion in matter





Various processes involved in ion matter interaction





A few ion assisted research areas in materials science

Synthesis

- * Nanocomposites
- * Dilute magnetic semiconductors
- * Doped semiconductors

Modifications

- * Recrystallization
- * Ion beam mixing
- * Size and shape of nanoparticles in composites
- * Phase transformations



Ion beam requirements

- # For materials engineering and modifications by S_n
- * Energy of ions from a few keV to a few MeV
- * Beam currents – order of micro-amps
- * All type of beams (H to Pb)



Experiments

- * 100 keV Ni implantation in SiO_2
- * 200 keV Si implantation in SiO_2

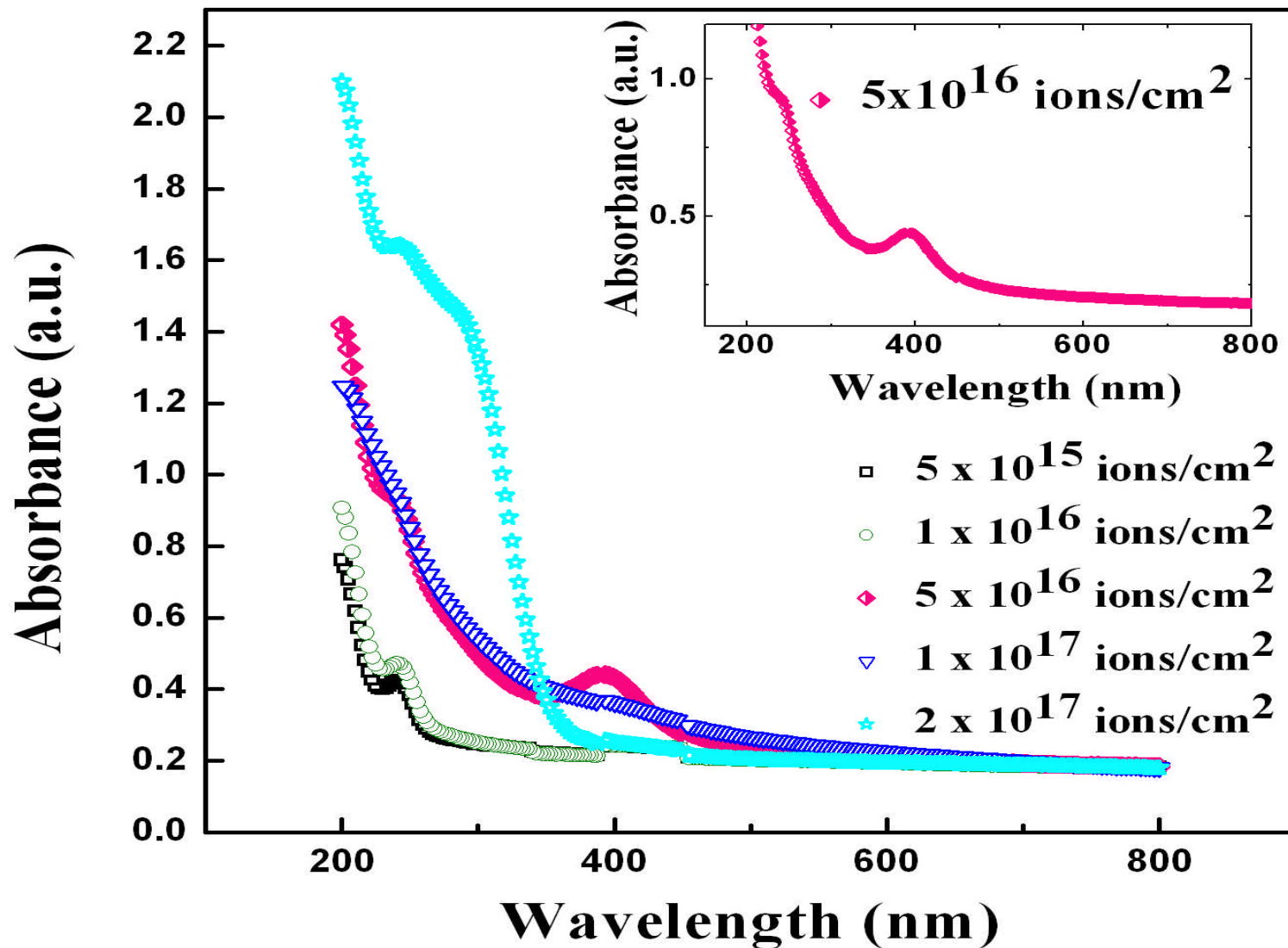
Characterization

UV-Visible spectroscopy, AFM/MFM,

Dc-magnetization, XAS, Photoluminescence

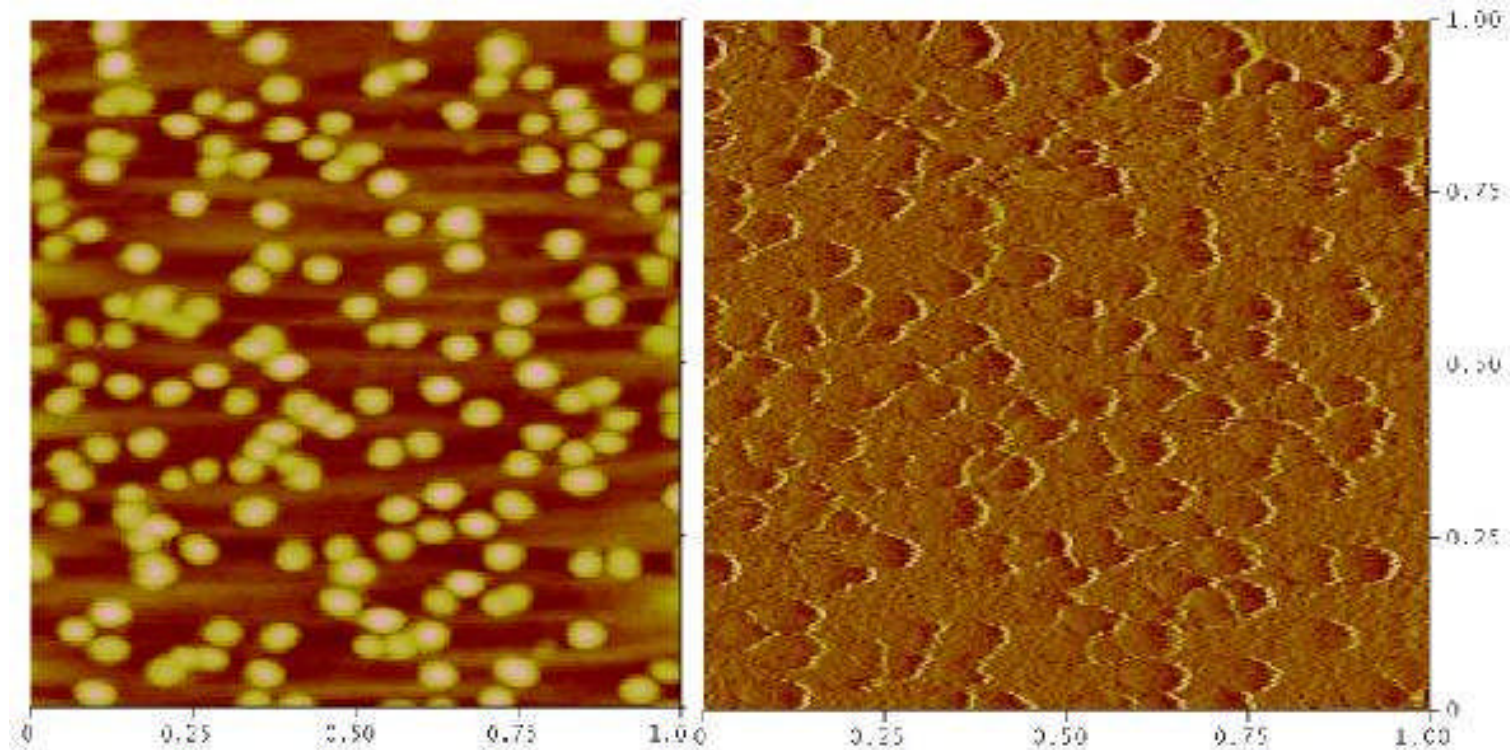


Results





Results

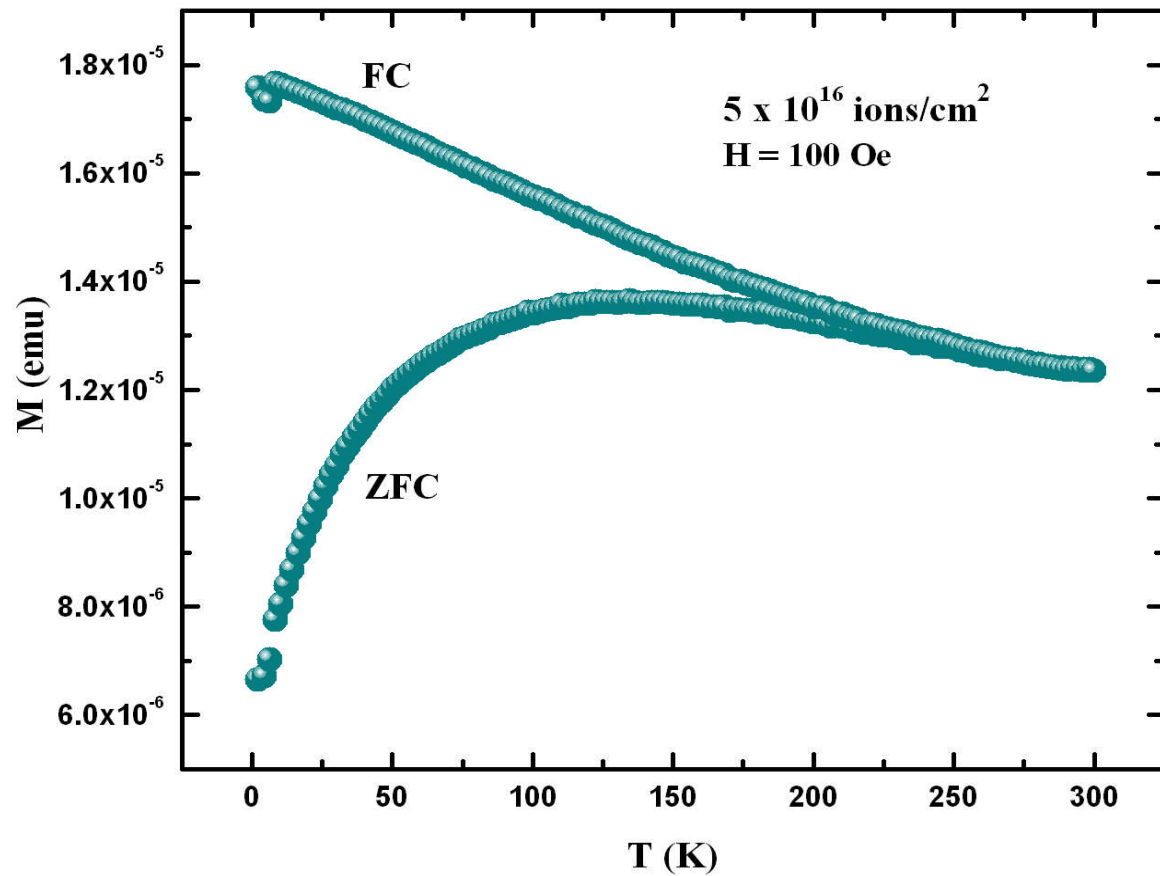


AFM/MFM of sample implanted at 5×10^{16} ions/cm²

P. Kumar et al., *J. Vac. Sci. Technol. B*, **26(4)**, L36-L40 (2008)



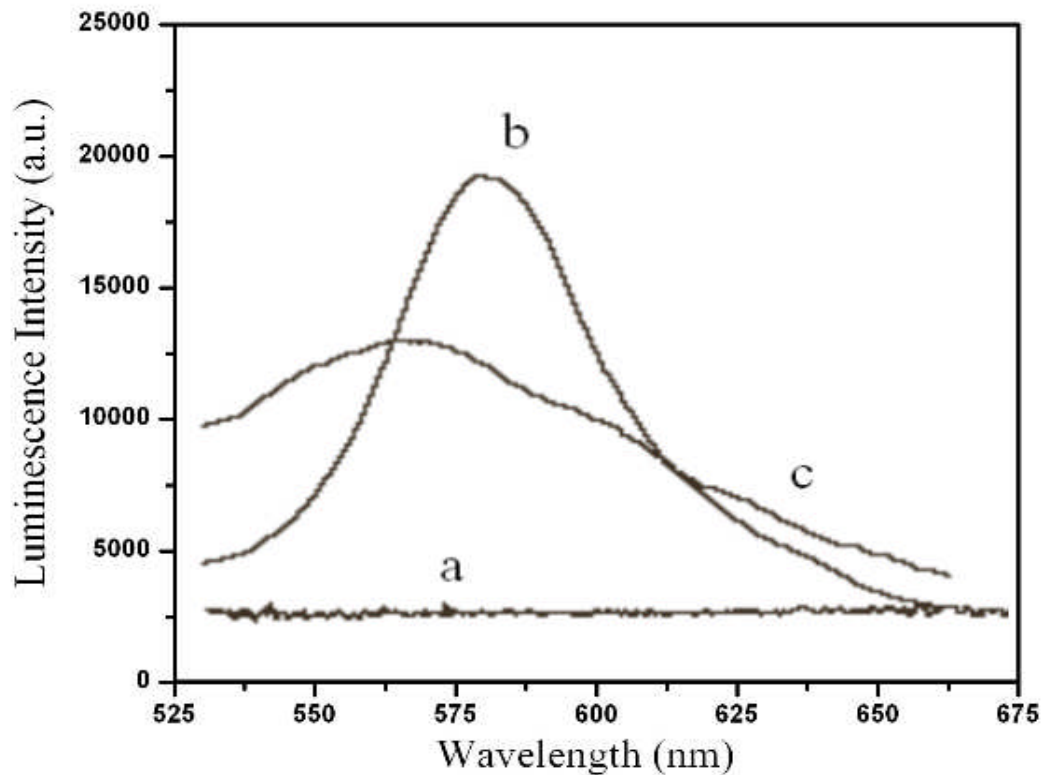
Results



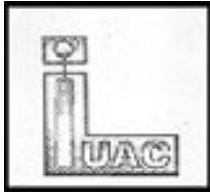
Zero field cooled and field cooled measurements of the sample for ion fluence of 5×10^{16} ions/cm²



Results

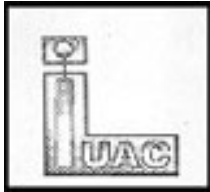


Photoluminescence spectra of (a) Si-implanted and unannealed SiO_2 , (b) Si-nanoparticles grown in SiO_2 due to thermal annealing at 1050°C and (c) Si nanoprecipitates grown in SiO_2 due to 70 MeV Si-irradiation-induced annealing.



Conclusion

- * Beams from ECRIS on HV Platform are regularly being used for modification and engineering of materials for future technology.
- * Energy in the range of a few keV to a few MeV, moderate beam Intensity, multi-element beams and long term stability are mainly needed for such experiments
- * ECRIS on HV platform is well suited for these requirements



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Thanks