Fundamentals of Ion Sources

USPAS, Jan 25 – Feb 5, 2015, Austin, TX

Syllabus

Monday Morning (9 AM – 12 PM)

1. Course Organization
2. Introduction
    2.1. Front Ends
    2.2. Ion Sources – Overview of the Main Types
3. Plasma Physics for Ion Sources
    3.1. Basic Plasma Parameters
    3.2. Plasma Sheath
    3.3. Creating Ions
    3.4. Confinement
    3.5. Plasma Stability
4. Beam Quality Parameters I
    4.1. Introduction

Monday Afternoon (1:30 PM – 3:30 PM)

5. Beam Quality Parameters II
    5.1. Definitions
    5.2. Introduction to Measuring Beam Quality
6. Ion Extraction
    6.1. Introduction
    6.2. Theory
    6.3. Different types of Extraction Systems – What to consider
    6.4. Emittance
    6.5. Computer Codes

Monday Late Afternoon/Evening

Homework

Computer Labs

Tuesday Morning (9 AM – 12 PM)

7. Multicusp Ion Sources
    7.1. Basic Principles of Multicusp Ion Sources
    7.2. Usages: Protons, H^-, H_2^+, Others
    7.3. Positive Ion Sources
    7.4. Negative Ion Sources
8. Electron Cyclotron Resonance Ion Sources (ECRIS) – Part I
    8.1. Brief History
    8.2. ECR Ion Source Fundamentals

8.3. Physics and Operations of ECR Ion Sources

Tuesday Afternoon (1:30 PM – 3:30 PM)

9. Electron Cyclotron Resonance Ion Sources (ECRIS) – Part II
    9.1. Plasma Confinement – Magnetic Field
    9.2. Scaling Laws
    9.3. ECR Heating
    9.4. Gas Mixing
    9.5. Some Examples

Tuesday Late Afternoon/Evening

Homework
Computer Labs

Wednesday Morning (9 AM – 12 PM)

10. Influence of Magnetic Fields on Emittance
    10.1. Review of Ion Behavior in Magnetic Fields
    10.2. Extracting Ions from Magnetic Fields
    10.3. Calculation of Emittance Growth Based on Charge State and Mass
    10.4. Surprising finding from ECR ion sources
11. Low Energy Beam Transport (LEBT) – Part I
    11.1. Goals of Transport
    11.2. Typical Types of Elements Used in LEBTs
    11.3. Space Charge Compensation

Wednesday Afternoon (1:30 PM – 3:30 PM)

12. Diagnostics
    12.1. What Would We Like to Know About Our Beams
    12.2. How to Measure This Information Experimentally
13. Simulating LEBT Beam Transport (TRACE)
    13.1. Predicting and Analyzing Beam Transport Properties Using Computers
    13.2. TRACE Overview
    13.3. Intro to Twiss Parameters
    13.4. Addressing DC Beams in TRACE
    13.5. Examples

Wednesday Late Afternoon/Evening

Homework
Computer Labs

Thursday Morning (9 AM – 12 PM)

14. Space Charge

14.1. Introduction/Theory
14.2. Simulation Codes That Include Space Charge
14.3. Space Charge Compensation
14.4. Useful Hints to Designing Ion Source and LEBT: Minimizing Loss and Degradation

15. Vacuum
15.1. Why is Vacuum Important for Ion Sources
15.2. Source of Beam Contamination and Capacity Limitation (EBIT Ion source)
15.3. Beam Loss in Beam Transport Systems
15.4. Vacuum Systems – Definitions
15.5. Pumping systems
15.6. Limitations on Final Pressure
15.7. Estimating Average Beamline Vacuum – Available Programs

Thursday Afternoon (1:30 PM – 3:30 PM)

16. Electron Beam Ion Sources/Traps (EBIS/EBIT)
16.1. Brief History
16.2. Fundamentals
16.3. Main Processes in the EBIT Source
16.4. Ionization Potential and Final Charge State in an EBIS/EBIT
16.5. Trap Capacity
16.6. Cathode – Electron Beam Production
16.7. Collector
16.8. Electrodes and Trapping
16.9. Charge Breeder

Thursday Late Afternoon/Evening

Homework
Computer Labs

Friday Morning (9 AM – 12 PM)

17. Finals
18. Closeout Session