

USPAS 2016

Unifying Physics of Accelerators, Lasers and Plasma

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Lecture 0: Organizational matters

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USPAS16 Course description

The course will be suitable for students of various levels between senior undergraduate and graduate students in physics, those who are interested exploring the exciting science arising from synergy of three areas – accelerators, lasers and plasma, which is essential for creation of the next generation facilities, devices and scientific instruments. We will explore novel laser-plasma acceleration methods comparing them with traditional accelerators. We will study design of national scale as well as compact Free Electron Lasers. We will study what would it take to make a next generation particle therapy facility based on plasma acceleration, studying in meanwhile the effect of radiation on DNA and as well as elements of medical imaging. We will explore the designs of colliders which could be built after LHC. We will highlight similarities and differences of terminology and mathematical apparatus used for description of similar phenomena in these areas of physics, building bridges of understanding between accelerators, lasers and plasma. We will discuss these three areas of physics in tandem with the industrial methodology of inventiveness to connect the areas further, and to stimulate our students for taking on the challenges of scientific and technological innovation.

Reading materials:

“Unifying Physics of Accelerators, Lasers and Plasma”, A. Seryi, CRC Press 2015

Acknowledgement

- **Materials of the USPAS2014 and USPAS2016 course "Unifying Physics of Accelerators, Lasers and Plasma" are based in part on undergraduate and graduate lectures developed by JAI colleagues**
- **Particular thanks to Profs Riccardo Bartolini, Emmanuel Tsesmelis, Ted Wilson, Bob Bingham, Zulfikar Najmudin, Peter Norreys and many more JAI colleagues**
- **The USPAS2014 course lectures were further developed into a textbook "Unifying Physics of Accelerators, Lasers and Plasma" which we will use in this course**
- **Many and many illustrations for this USPAS course and for the textbook were created by Elena Seraia**
- **I would like to express gratitude to all colleagues who helped with preparation of this course and who I missed to thank here**

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USPAS16 Course Lectures Timeline

- **Monday**
 - Lecture 1: Basics of accelerators and the art of inventiveness
 - Lecture 2: Transverse dynamics
 - Lecture 3: Synchrotron radiation
- **Tuesday**
 - Lecture 4: Synergies between accelerators, lasers and plasma
 - Lecture 5: Conventional acceleration
 - Lecture 6: Plasma acceleration
- **Wednesday**
 - Lecture 7: Light sources
 - Lecture 8: Free Electron Lasers
 - Lecture 9: Proton plasma acceleration
- **Thursday**
 - Lecture 10: Advanced beam manipulation I (short and small)
 - Lecture 11: Advanced beam manipulation II (stability)
 - Lecture 12: Inventions and innovation in science & future directions

USPAS16 Course Projects & Tasks Timeline

- **Monday**
 - Project 1: Analysis of inventions
 - Project 3: Compact ring-based X-ray source with laser plasma injection
 - Homework 1: Tasks
- **Tuesday (continue/start these projects)**
 - Project 2: Laser-plasma acceleration betatron X-ray source
 - Project 3: Compact ring-based X-ray source with laser plasma injection
 - Homework 2: Tasks
- **Wednesday (continue)**
 - Project 3: Compact ring-based X-ray source with laser plasma injection
 - Homework 3: Tasks
- **Thursday (continue)**
 - Project 3: Compact ring-based X-ray source with laser plasma injection
 - Exam preparation time
- **Friday**
 - Exam

Projects

- **Organization of work for projects**
 - **Three/two working groups**



- **Interactive discussions within the groups during project time**
- **Short presentation by the groups at the end of the day**

Projects – aim and motivation

- We plan to study (in Project 3) a relatively new configuration, which was not studied in the past in much detail
- We may come up with something worth sharing with our community
- Based on the work in USPAS class, we will aim to write a paper for NA-PAC 2016
- You all will be the authors of this paper
- Tentative title is
 - “Compact ring-based X-ray source with on-orbit and on-energy laser-plasma injection - USPAS students project report”
 - As NA-PAC abstract submission deadline already over, the placeholder abstract was submitted in advance. We will update it during the USPAS class.
- Before submitting to NA-PAC, we will pass our report via internal peer review by USPAS colleagues – Bill Barletta et al
- Some of you will present this paper/poster at NA-PAC
- This is a new, for USPAS, training experiment
 - This is modelled from JAI’s training methods, and even going somewhat beyond
- USPAS management supports this plan
- We hope that it gives additional strong motivation to our work

Let's start our work