PROPOSED PROJECTS

Introduction

◇ First and foremost:

It is certainly not forbidden to propose a project of your own!

It can for instance be in relation with activities you might have in the framework of your home institution, or in the framework of a university cursus.

Tell about your idea(s), we will discuss it, make sure it fits in the general learning context and level of achievement. Once this is settled... there you go.

Some indications about the project :

◇ The project will be concluded, by the end of PHY684, with two documents:
- a 10∼15 minute slide presentation to the class
- a written report, in a "laboratory technical note" style write-up, 10 pages about

◇ The initial phase of the project will be a bibliographical research. It is expected that 25% of the work time will concern the bibliography. Which will include
- the origins and present context (depending on the topic, it can concern a particular accelerator technology, and/or its applications, and/or the laboratory which houses/develops it, etc.), foreseen future
- a technical review: overview of the theory and technology, parameter lists, detailed descriptions, etc.

◇ Following that, for most of the proposed topics the task will essentially consist in working out accelerator and beam simulations, program and other computing tools developments ...

About the bibliography :

For most proposed topics one or two documents are indicated as a possible starting point for the bibliography.

In any case, a good source for starting your bibliographical research is the accelerator conference web site

www.jacow.org

JaCOW offers a powerful search engine, accepting authors names, fragments of text, etc.

1 ZGS

Simulate the first polarized proton synchrotron, the 12 GeV ZGS [1,2]. Produce spin dynamics simulations.

Plans for this project:

- document the history of the ZGS, and of the acceleration of polarized beams in synchrotrons.
- simulate the ZGS, essentially repeat what we have seen during the lectures, with SATURNE 1: parameter table in a spreadsheet, optical functions, synchrotron motion, start-to-end acceleration, etc. Include polarization and spin dynamics simulations.

Possible starting points for the bibliographical research:

[1] Andre TKATCHENKO, REVIEW OF POLARIZED HADRON BEAMS, Procs. EPAC 1990 Accelerator Conference, http://www.jacow.org/Main/Proceedings.

[2] T. Khoe et al., ACCELERATION OF POLARIZED PROTONS TO 8.5 GeV/c, Particle Accelerators, Vol. 6, pp. 213-236 (1975).

2 Microtron

Simulate the fourth stage (the highest in energy) of MAMI, the Mayence microtron [1].

Plans for this project:

- document MAMI: history of the microtron cascade, characteristics, parameter lists. And their use.

- simulate the fourth stage: produce the nominal optics, optical functions, first order beam properties, beam envelopes, etc.

- produce bunch tracking simulations (transverse and longitudinal phase spaces, etc.)

[1] A starting point can be:

H.-J. Kreidel, M. Dehn, Computer models to optimize the setting of the MAMI double sided microtron, THP056, Proceedings of ICALEPCS2009, Kobe, Japan [1ex] https://search.cern.ch/Pages/results.aspx?k=+domain

3 “alpha” magnetic spectrometer

Study, and simulate particle transport in, a 270 degree “alpha” magnetic spectrometer.

Plans for this project:

- document magnetic mass spectrometry [1] and the “alpha” spectrometer: history including such uses as in plasma acceleration setups, beam analysis in nuclear physics experimental areas, a space experiment. Give typical characteristics, parameter lists. Document their use over the years.

- based on a design of your choice, produce tracking simulations through an “alpha” spectrometer: transverse and longitudinal phase spaces, optical and momentum aberrations, 6D transport and resolution, momentum analysis, spectrometer resolution, etc.

[1] JaCOW is a possible starting point for a bibliographical research, with outcomes as for instance
- A. Savalle et al., The SISSI Facility at GANIL,
accelconf.web.cern.ch/AccelConf/e96/PAPERS/MOPG/MOP050G.PDF
- L. Acosta et al., BEAM TRANSFER STUDIES FOR LINCE EXPERIMENTAL AREAS, THPME032, Proceedings of IPAC2014, Dresden, Germany.

4 Stored ion polarization at eRHIC

Study proton and helion beam polarization in eRHIC e-A collider hadron ring [1,2].

Plans for this project:

- document the electron-ion collider project eRHIC, its hadron ring derived from RHIC and using Siberian snakes [1]: history, characteristics, parameter lists.
- simulate acceleration of polarized proton and 3He beams through the strong snake depolarizing resonances in RHIC, using its present 4 Siberian snakes, and with two more added.
- produce comparisons, optimizations.

Possible starting points for the bibliographical research:

[1] H. Huang et al., Polarized proton beam for eRHIC, TUPWI049, Proceedings of IPAC2015, Richmond, VA, USA,

[2] M. Bai et al., Simulation studies of accelerating polarized light ions at RHIC and AGS, Proceedings of 2011 Particle Accelerator Conference, New York, NY, USA THP102.

5 Spin dynamics in a synchrotron

Produce spin dynamics simulations in the vicinity of, or across, depolarizing spin resonance [1].

Plans for this project:

- document the acceleration and storage of spin polarized particle beams: history, from SATURNE and the ZGS to today's state-of-the art, future. Theory, technologies.

- simulate spin dynamics in the vicinity of, or across resonances, in a ring of your choice, confront outcomes to theory.

[1] A starting point can be:

References in projects number 1 and 4.

6 Medical synchro-cyclotron

Simulate the S2C2 synchro-cyclotron [1], just launched in the hadrontherapy arena!

Plans for this project:

- document hadrontherapy: history, method, current status.
- document the S2C2: origin, characteristics, parameter list. Plans for future.
- Simulate it to produce accelerator parameters and beam properties. Simulate acceleration from start to end, including beam extraction towards the patient.

Possible starting points for the bibliographical research:

[1] THE IBA SUPERCONDUCTING SYNCHROCYCLOTRON PROJECT S2C2, W. Kleeven et al., Cyclotrons2013, Vancouver, BC, Canada, MO4PB02.

7 Edge radiation at the SPS

The SPS has plans to resurrect an old synchrotron radiation diagnostics technique: the visible light edge radiation.

Plans for this project:

- document the "edge radiation" at the SPS [1,2]: history, characteristics, parameter list. And its use.

- Simulate the 1979 experiment, produce spectral-angular light distribution (Refs. [1,2] can be used as a guidance)

Possible starting points for the bibliographical research:

[1] R. Bossart et al., Observation of visible synchrotron radiation emitted by a high-energy proton beam at the edge of a magnetic field, Nuclear Instruments and Methods, Volume 164, Issue 2, 15 August 1979, Pages 375-380.
[2] J. Bosser et al., Characteristics of the radiation emitted by protons and antiprotons in an undulator, Journal de Physique Lettres, 1984, 45 (7), pp.343-351.

8 Proton-therapy

Proton-therapy is in use in many dedicated cancer treatment centers over the world. It is based on the ballistic of the Bragg peak, and uses proton beams in the range 70-230 MeV. These beams are produced using synchrotron, synchrocyclotron, or cyclotron accelerators.

Plans for this project:

- document hadrontherapy: history, method, current status.

- Choose a protontherapy accelerator in operation, and simulate it. From simulations, produce all accelerator parameters and beam properties. Simulate acceleration from start to end, including beam extraction towards the patient.

accelerate from start to end, including beam extraction towards the patient.

9 Drift tube linac

Simulate a drift tube linac. Choose a simple, classical DTL, in use today.

Plans for this project:

- document the DTL type of linac: history, characteristics, parameter lists, state-of-the-art.

- Based on your bibliography, select a DTL in use today. Produce its parameter list, optics, optical functions, beam parameters, beam envelopes, etc.

- produce start-to-end bunch tracking simulations (transverse and longitudinal phase spaces, etc.)

[1] A starting points can be:

J. Le Duff, Dynamics and acceleration in linear structures, ”CAS - CERN Accelerator School : 5th General Accelerator Physics Course”, Yellow-Report CERN-94-01, http://cds.cern.ch/search?cc=CERN+Yellow+Reports&p=

10 Betatron

Install a betatron in Zgoubi.

Plans for this project:

- document the betatron accelerator [1]: history to these days, theory, characteristics, energy limit.

- write a program that simulates the magnetic and induction electric fields in the useful 3D region in the gap of a betatron magnet,

- install it in zgoubi,

- validate by appropriate numerical simulations, modeling an existing a (past or present) betatron, including orbit compression at injection, adiabatic damping of betatron oscillations, synchrotron radiation, etc., confront to theory,

- produce start-to-end bunch tracking simulations: transverse and longitudinal phase spaces, “damping” (decrease in amplitude) of the betatron oscillations, etc.

[1] A starting point can be:

http://web.mit.edu/course/22/22.09/ClassHandouts/Charged%20Particle%20Accel/CHAP11.PDF

11 Slow extraction at the CERN SPS

The 400 GeV proton beam at the SPS is slow-extracted towards experimental areas (the “North Hall”), using a third integer resonance technique. This is an on-going program, including theoretical studies and experiments [1], aimed at reducing beam losses at extraction.

Plans for this project:

- document the SPS: history, theory, characteristics. And its use.

- document the technique of slow extraction. And the goals of the ongoing studies at the SPS. Using the SPS computer code model, produce the nominal optics: optical functions, first order beam properties, beam envelopes, etc.

- simulate the slow extraction process, provide the 6D phase space of the extracted beam spill.

[1] F.M. Velotti et al., Characterization of the SPS slow-extraction parameters, THPOR055, Proceedings of IPAC2016, Busan, Korea.