Gamma-Factory:

Recent News, Activities, Plans.


News:

1. Camilla Curatolo and Luca Serafini — INFN-Milan group joined the Gamma Factory study group.

2. Very recent public presentations of the Gamma Factory initiative:
   - CERN - AWAKE PEB meeting April 2017: “A path towards Gamma Factory at CERN involving ion beam cooling tests at the SPS”

3. Forthcoming presentation: EPS Conference July 2017

4. April 2017: A group was formed in Japan to study the Partially Stripped Ion beam driven gamma source for KEK:
   - KEK: Y. Honad, K.Yokaya, M.Yoshida
   - RIKEN: O.Kamigaito, T.Nakagawa, Y.Kanai, Y.Ichikawa, T.Nagatomo Waseda, K.Sakaue

   Goal: produce 1-7 MeV gammas with intensity of 10^{15}-10^{17} Hz by using the KEK ring (new superconducting magnets to achieve $\text{gamma}_L=250$). N.B. For Hydrogen-like ions SASE-FEL as the photon source required.

Critical accelerator tests

1. Acceleration and storage of partially stripped ion beams.
• MD requested for 2017 to run Xe39+ beam in the SPS (MD request - SPS MD 2026 - done by Django Manglunki and Reyes Alemany Fernandez)
• MD request for 2018 to run Pb54+ beams in the SPS (pending)
• MD request for 2018 Pb80+ beams in the LHC (pending)
• MD request for the parasitic ep collisions with the Pb80+ beam (generate interest of the LHC experiments for these collisions already this year to increase a chance of storing the Pb80+ beam in the LHC ring in 2018)
• Optimization of the stripper for Pb80+ ions (work in this direction to be started)

Software development

1. The easy-to-use photon-PSI collision framework for studying the betatron oscillation, stability of the beam and the beam cooling techniques. (being developed - by Alexey Petrenko)

2. More general framework including full beam particle dynamics and the Atomic Physics framework for collisions of photons with PSIs. (work to be started next week by Armen Apyan, and Iryna Chaikovska as of October 2017. Camilla Curatolo and Luca Serafini plan also to contribute to this work)

3. Analytical calculations. (preliminary calculations of the cooling times by Evgeni Bessonov of the P-like Xenon ion beams in the SPS, with realistic photon and ion beam parameters performed)

4. Dedicated GEANT code for conversion of photons into lepton pairs close to the lepton-pair production threshold. (initial discussions with the GEANT team - the “official” support for a work in this direction needed)

5. GEANT code for photo-production of neutron and radioactive ion beams. (pending)

Critical simulation tests

PSI beam-losses and the life-times of the PSI beams in the LHC and in the SPS.

1. Ionisation by double photon absorption
2. Ionisation by interactions with the residual gas in the machine.
3. Ionisation by intrabeam scattering
4. Electron stripping by the Quantum Stark effect

(initial estimations made, but their results must be verified by more realistic simulations using more advanced, and more realistic, software tools which need to be developed)
The first Gamma-Factory workshop

Initial discussions with Frank Zimmermann on the necessity and the framework of the first Gamma Factory workshop (to be organized in the fall of 2017/ winter 2018)

Conceptual studies

1. Lasers and resonators for the SPS test experiment.
   *(initial discussions with F. Zomer, K. Dupraz, K. Cassou, A. Martens of the Orsay group)*

2. IP - design for SPS: collision angle, mechanical system resonator length, last pulse length.
   *(initial discussions with B. Goddard - CERN F. Zomer, K. Dupraz, K. Cassou, A. Martens of the Orsay group)*

The Gamma Factory research tools - conceptual development

1 Polarised positron source
   *(initial studies made by O. Dadoun — need new Geant-implemented generator for a progress)*

2. Polarised Muon source
   *(initial studies made by O. Dadoun — need new Geant-implemented generator for a progress)*

3. Radioactive ion source

4. Neutron source

5. photon-photon collider
   a) based on two LHC gamma beams
   b) collisions of the LHC gamma beam with laser photons

6. The LHC ep collider
   *(initial studies made — need a dedicated simulation studies and trigger studies by the LHC experiments)*

7. Photon- nucleon collider in the LHC

8. Cooled PSI beams as the driving beams for wake-field acceleration
   *(initial ideas and simulations by Alexey Petrenko already made)*

9. Muon Collider and Neutrino factory based on the Gamma Factory’s lepton sources
**Basic physics cases which could be addressed and documented**

1. Physics of ep and gamma-p collisions at the LHC
2. Precision EW-physics with high Z H-like ions (BSM access)
3. Dark matter searches with gamma beams (axions, WISPs, ALPs)
4. Study of confinement phenomena at the color production threshold
5. Physics of a gamma factory driven neutrino factory
6. Dark matter searches with neutron beam
7. Neutron dipole moment and neutron-antineutron oscillations
8. Physics with radioactive ions (Isolde-like) programme
9. Rare muon decay BSM physics
10. Physics of the TeV scale muon collider
11. Fundamental QED measurements
12. DIS programme with the polarised positrons and muons at the SPS

**Applied physics cases which could be addressed and documented**

1. Muon catalysed cold fusion
2. Gamma-beam catalyzed hot fusion
3. Accelerator Driven System (ADS) and Energy Amplifier (EA) research
4. Nondestructive assay and segregation of nuclear waste
5. Transmutation of nuclear waste
6. Material studies of thick objects
7. Production of ions for Positron Emission Tomography (PET) and for the selective cancer-cell therapy with alpha emitters