RF-IF connections

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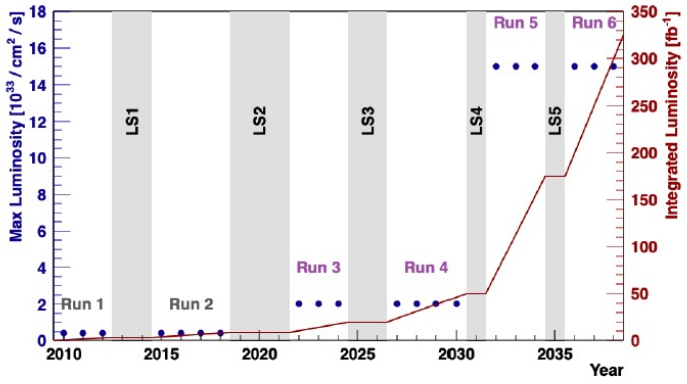
A reminder of the structure of the frontier

- A quick summary of the experimental landscape and LOI submitted with overlap with IF [highlighted are the experiments that submitted IF-RF LOIs]
  - RF1 – weak decays of b and c quarks
    - Belle II, **LHCb upgrades**, HL-LHC, FCCee, BESIII**.**
  - RF2 – weak decays of strange and light quarks
    - NA62-KLEVER, KOTO, LHCb, new generation π,η experiments (**REDTOP)**
  - RF3 – fundamental physics in small experiments
    - **EDM**, **gravity, new forces**, g-2, **quantum interference** to study various fundamental properties
  - RF4 – baryon and lepton number violating processes
    - neutrinoless ββ decay experiments, proton decay (NF interface), LHCb upgrades, Belle II, $n\bar{n}$ oscillations
  - RF5 – charged lepton flavor violation
    - **Mu2e,** MEG2, e^+e^- b-factories, LHCb upgrades
  - RF6 – dark sector studies at high energies
    - Beam dump experiments, fixed target, K-factories, e^+e^- b-factories, LHCb upgrades, neutrino experiments
  - RF7 – hadron spectroscopy
    - e^+e^- b-factories, LHCb, tau-charm factories

LHCb Upgrade – IF/EF synergies

SNOWMASS-RF-IF-CompF-001

- Goal: operate at a luminosity of $1.5 \times 10^{34} cm^2 s^{-1}$
- Instrumental challenges:
  - pile-up→ fast timing (4D tracking, integration of timing information/selection in PID, including neutral reconstruction)
  - Huge data rates, software trigger (trigger/daq synergies)
  - FE electronics for fast timing, clock distribution, local data concentration ASICs..



- FTDR presented to LHCC in Sept. meeting, will be made public

Fundamental physics in small experiments

Examples of areas of investigation:

- Quantum information science

SNOWMASS21-IF0_IF0-RF0_RF0_Daniel_Ambrose-094
SNOWMASS21-IF1_IF0-RF3_RF0-CF1_CF2_Steve_Lyon-055
SNOWMASS21-RF3_RF0-CF2_CF0-IF1_IF0_Andrew_Geraci-076
SNOWMASS21-RF3_RF0-IF0_IF0_V_Sudhir-075

Synergy between QI and fundamental physics to devise dedicated high sensitivity probes of a variety of BSM forces/interactions

- Mechanical tests of quantum-gravity interface

Cavity optomechanics to measure fundamental forces

MU2E upgrade

SNOWMASS21-RF5_RF0-IF4_IF0_Franco_Spinella-044
SNOWMASS21-RF5_RF0-IF4_IF0_Gianantonio_Pezzullo-040/41/42
SNOWMASS21-RF5_RF0-IF4_IF0-039
SNOWMASS21-IF0_IF0-RF0_RF0_Daniel_Ambrose-094

- Instrumentation developments important for this upgrade:
  - ”massless tracker”: very light straw tube detectors
  - Fast crystal calorimeters (BaF2, R&D on on suppressing the slow component by doping with dopants such as yttrium and developing)
  - Tracking in trigger [partial tracking in FPGA, GPU, software trigger]

Baryon and Lepton number violation

SNOWMASS21-IF8_IF0-NF5_NF0-RF4_RF0_RGuenette-086
SNOWMASS21-NF5_NF10-RF4_RF0-IF9_IF8_Ben_Jones-048

- The two LOIs encompass technologies relevant to neutrinoless ββ decay [barium tagging, high-pressure xenon gas time-projection chamber]
- Additional items of overlaps & synergy with NF are experimental techniques for proton decays

REDTOP experiment η–η' factory

SNOWMASS21-RF2_RF6-IF6_IF3_REDTOP_Collaboration_-_new-083

- Subnanosecond timing
- 5D calorimetry
- Muon polarization measurements
- LGAD pixel tracker in the forward direction

Conclusions

- RF frontier's physics goals require the development of novel technologies, with efforts synergistic with other frontiers:
  - subnanosecond timing in tracking and calorimetry
  - Low mass tracking
  - Advanced trigger and data acquisition technologies
  - QI for fundamental "small scale experiments"
- Looking forward to working with IF on these many interesting areas!