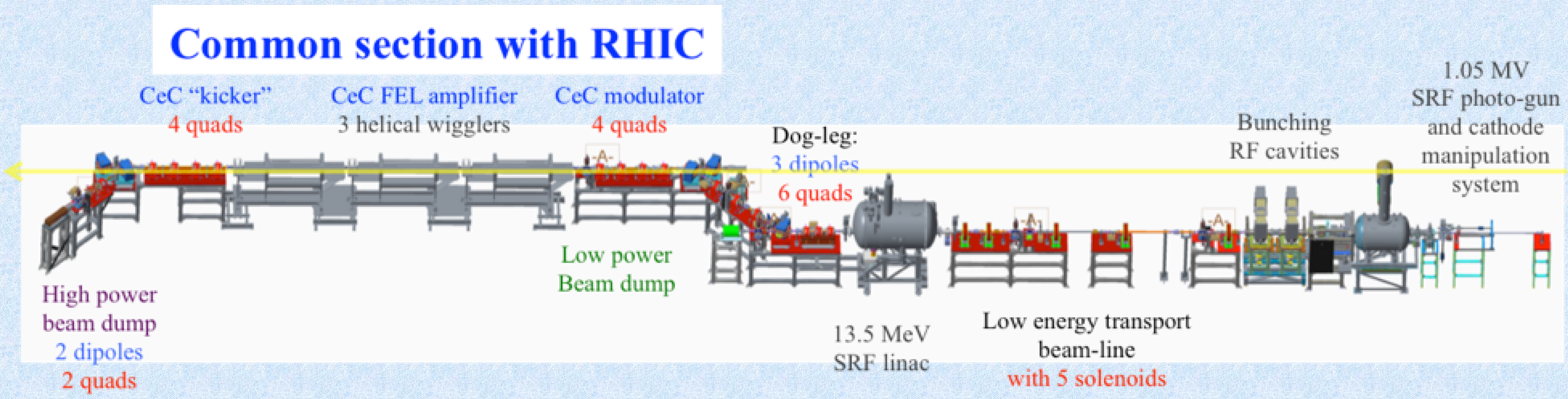
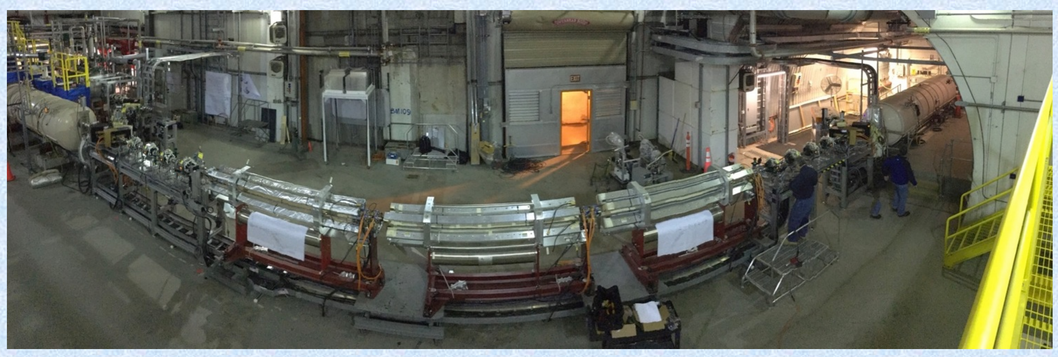
TUPLH24

# PERFORMANCE OF CeC PoP ACCELERATOR

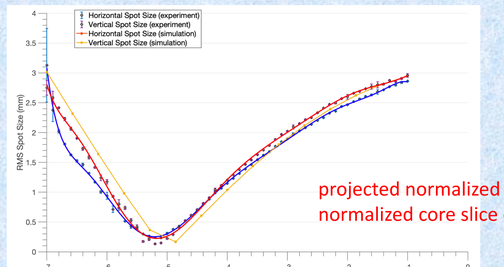


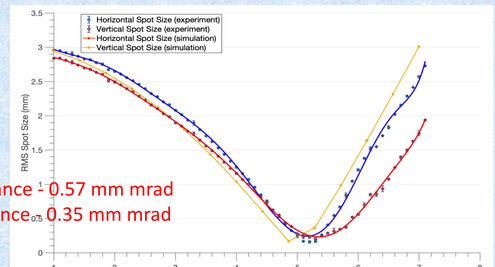



| Parameter | Design | Status | Comment |
|---|---|---|---|
| Species in RHIC | $Au^{+79}$, 40 GeV/u | $Au^{+79}$ 26.5 GeV/u | To match e-beam |
| Particles/bucket | $10^8$ - $10^9$ | $10^8$ - $10^9$ | |
| Electron energy | 21.95 MeV | **15 MeV** | **SRF linac quench** |
| Charge per e-bunch | 0.5-5 nC | 0.1-9 nC | |
| Peak current | 100 A | 50 A | Sufficient for this energy |
| Pulse duration, psec | 10-50 | 12 | |
| Beam emittance, norm | <5 mm mrad | 3 - 4 mm mrad | |
| FEL wavelength | 13 μm | **30 μm** | **Required new IR diagnostics** |
| Rep-rate | 78.17 kHz | 78 kHz | |
| *e*-beam current | up to 400 μA | 120 μA | |
| Electron beam power | < 10 kW | 1800 W | |

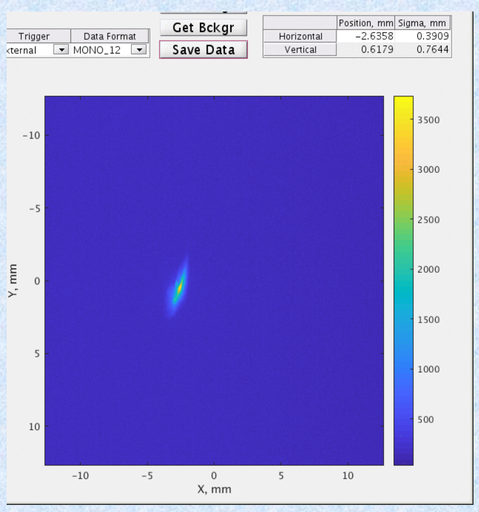
Electron beam is generated by 113 MHz SRF gun with $CsK_2Sb$ photocathode driven by a 532 nm laser. Two 500 MHz copper cavities provide energy chirp and beam is compressed to desired peak current. After compression beam is accelerated by a 704 MHz SRF cavity and merged into CeC PoP structure having three helical undulators.

- 113 MHz SRF gun with room-temperature $CsK_2Sb$ cathodes demonstrated excellent performance
  - $CsK_2Sb$ cathodes survived for months of operation (and exhibit QE improvement during operation)
  - Beam with charge up to 10.7 nC per bunch were demonstrated
  - Projected normalized emittance of 0.32 mm mrad was demonstrated for 0.5 nC bunches
  - Multipacting is well understood and a process of avoiding it is developed, tested and implemented
- World's first 2K cryostat with superfluid heat exchanger (used for 5-cell 704 MHz linac) demonstrated excellent performance and good microphonics isolation (Δf~10 Hz pk-to-pk)
- Beam-based alignment using solenoids was demonstrated with full restoration of the beam trajectory
- Method of beam energy measurement using trajectory rotation by solenoid was developed

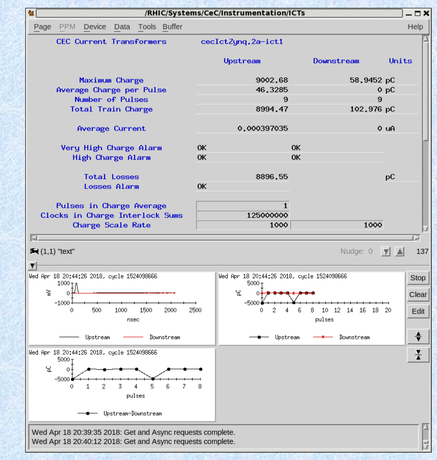


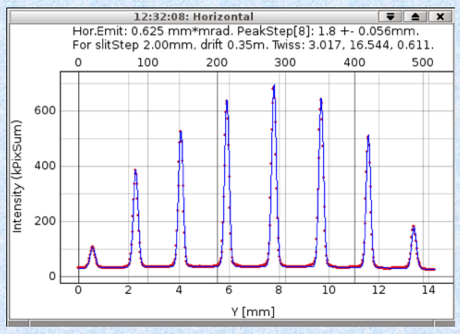

projected normalized emittance 0.57 mm mrad
normalized core slice emittance 0.35 mm mrad

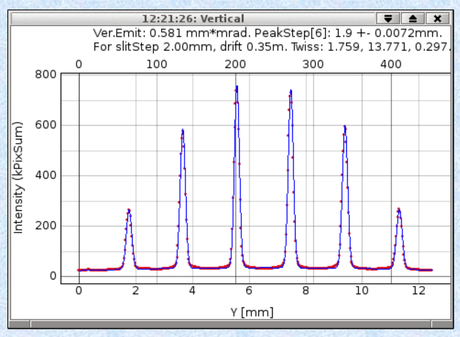



Horizontal beam size of 0.39 mm and dispersion of 1.2 m gives energy spread below $3x10^{-4}$

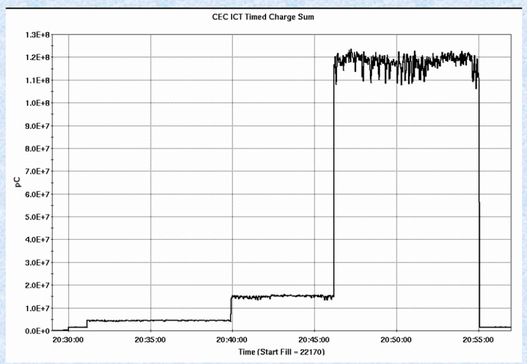



Maximal bunch charge reported by control system

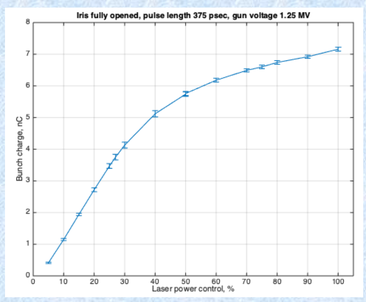


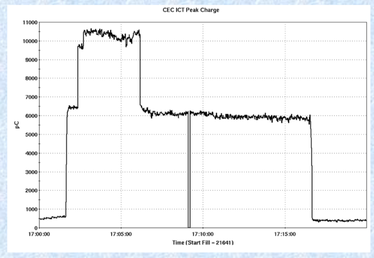




Low operational frequency of the electron gun (quarter wave design) allow generate beam on the peak of the cathode electrical field. It allows to obtain low emittance with substantial bunch charge. We shall continue on the more detailed study of the gun performance.




Average current during experiment




Study of bunch charge dependence on laser power. On Y axis charge in picoCoulombs, on X axes laser power control (% of maximal). Laser spot diameter is 6 mm, gun voltage 1.25 MV (cathode field 10 MV/m), pulse duration 375 picoseconds.