HIF-VNL assets

- **Theory/Computation**

WARP/POSINST: a unique integrated set of tools for beam/ECE studies

- **3-D, 2-D XY/RZ, 1-D R/Z**
- **Multi-species**
- **Accelerator lattice (quads, bends, accelerating gaps, drifts, …)**
- **Realistic pipe geometries (any shape)**
- **Electrons production: photo-electrons, secondaries**
- **Parallel**
- **New interpolated mover for bridging e- and ions time scales**
- **First PIC code with mesh refinement capability (saving of ~4 orders of magnitude on field solve for 1 LHC FODO cell)**

HIF-VNL assets – continued

- **High Current Experiment (HCX)**

Capabilities

- 1-1.5 MeV, K^+, 0.18-0.5A, 5 μs
- Gas desorption, electron emission coef. diagnostics
- E-cloud and gas diagnostics in magnetic quads & drift regions
- Optical diagnostics for
  - Beam profile
  - Slit scanner: cross products as well as x, x', y, y'
  - Velocity of desorbed gas
- Flexibility
  - Add or change diagnostics
  - Add components (e.g. solenoids)
  - Test mitigation

We are the user community – we get the beam time we want

Suggested HIF-VNL contributions for LHC

- ## Theory/Computation

1. **Apply WARP/POSINST to LHC FODO cell(s): various bunch spacings and intensities, surface modifications, SEY, …**
   - **3-D self-consistent studies (beam, e-clouds, lattice, realistic pipe, photo-electrons, secondaries, gas, …)**
     - **start with 1 bunch in 1 FODO cell: in progress (movie)**
     - **then short trains/multiple cells**
   - **Simulations using reduced models**
     - **Electrons: POSINST mode (in place) + WARP features (pieces exist)**
     - **Beam: HEADTAIL/QUICKPIC modes (have most pieces)**
     - **Beam+electrons: 2-D/3-D WARP/POSINST with maps (needs development)**
2. **Seek understanding of ~1s electron lifetimes in SPS**
   - **May be a magnetic confinement/slow-drift effect, since high reflectivity of walls for low energy electrons is only sufficient to explain the ~1 μs lifetimes in PSR.**
   - **Our Magnetic Fusion experience is highly relevant here; HCX exp'ts possible.**
3. **Model amplitude modulation of microwaves transmitted through beam tube (Casper, Kroyer)**
   - **Include wall-desorbed dust, arc to wall, …**

HIF-VNL contributions for LHC

- **Experiment**

1. **Velocity distribution of ion beam desorbed gas** [initial measurements of gas velocity underway, with 1 MeV 180 mA K+ ion beam to desorb gas and to excite it, then observe visible light with gated camera]

   Desorption mechanism discovered (HCX/STS); scales to high energies (GSI)

   - **Determine the desorbed species (spectroscopically,…)**
   - **Inject those gas(es) to pressure (measure with ion gauge calibrated to those gas(es) with calibrated leaks) high enough to see with camera. This absolutely calibrates the camera for the gas desorption coefficient.**
   - **Measure at angles away from normal incidence, to within several deg. of grazing.**
   - **Measure f(v,θ) of gas.**

2. **With calibrated camera above, test NEG coatings for gas desorption coef's, without the NEG's pumping perturbing the measurement (as it does for pressure rise measurements - Mahner, HB2004)**

   - **Technique could be extended to measuring desorption from cryo surfaces. Would require a UHV addition to the present high-vacuum HCX, probably isolating the UHV tank with 4 or more UHV magnetic quads.**

HIF-VNL contributions for LHC

- ## Experiment

3. Simulate ECE multipactoring by driving electrodes with rf near the electron bounce frequency in a long (5 μs) beam pulse, with a beam potential of up to 2 kV.
   - RF voltage low enough that SEY<1. Expect to pump-out electrons.
   - RF voltage higher (order 100 V) so SEY > 1. Electron clouds should build up.

4. Our flush electrode techniques could be applied to the band in LHC bombarded with 44 eV photons to measure (or suppress with positive bias) the photoelectron production rate in situ. [But inaccessibility of dipole bends probably prohibits us from supplying a plug-in diagnostic – CERN staff would probably have to implement any such diagnostic.]

HIF-VNL contributions for LHC

- **Experimental Validation of Code**

5. **Measure and simulate development of electron cloud from ionization of background gas, halo particle scraping, etc., including electron and ion dynamics in quads, drifts, solenoids, using HCX facility**

HCX can be used to make sure that codes calculate the physics correctly.