# ComPASS SciDAC-3 Computational Accelerator Physics Tools for the Intensity Frontier

PI: P. Spentzouris[1] – Co-PIs: J. Cary[2], W. Mori[3], C. Ng[4], E. Ng[5], B. Norris[6], E. Prudencio[7], J.-L. Vay[5]
[1]Fermilab, [2]Tech-X, [3]UCLA, [4]SLAC, [5]LBNL, [6]ANL, [7]UT Austin

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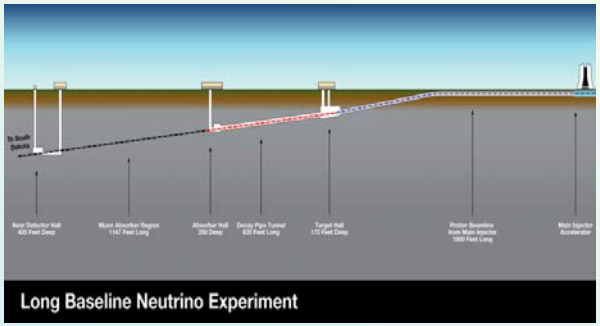
## CONTEXT

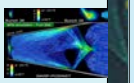
### *High intensity accelerators are needed for precision measurements of rare processes, which challenge the Standard Model*



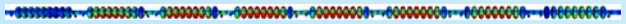

### *Higher-intensity accelerators needed for*

- o Project X
- o Neutrino factory
- o Muon collider

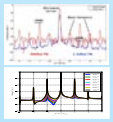
### *Accelerator computations needed for*



- o understanding interaction with materials
  - Plasma created by secondary electrons from interaction with walls
  - Plasma created by interaction with background gas
- o understanding the effects of self fields
  - internal to the beam
  - created by interactions with structures (wakes)



  - created by plasma formed in the transport system
- o diagnosing the state of the accelerator
  - Propagation of microwaves through region of plasma -- phase shift gives integrated plasma density (absent transverse variation)

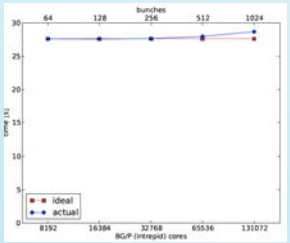


## METHODS & TOOLS

### *The ComPASS computational accelerator applications collectively cover the space of high-performance accelerator physics with overlap while being distinct, allowing cross checking*

- o ACE3p: Finite-element, unstructured mesh, EM, particles
- o QuickPIC: Reduced dynamics (quasistatic) for faster execution, pipeline parallelism
- o Synergia: Multigrid, transport through accelerator lattices, self consistent fields
- o Vorpal: Finite difference, conformal embedded boundaries, metal/dielectrics, 2ndary electrons
- o Warp: AMR multigrid, plasma production,

### *In SciDAC-2, ComPASS computational applications were pushed to high concurrencies*




### *and to use of GPUs*

- o PIC in Osiris
- o Conformal EM in Vorpal

## APPLICATIONS

### *ComPASS SciDAC-3 will enhance the physics in existing computational accelerator tools, while pushing performance and porting to new platforms*

- o Benchmarking improving predictive capabilities of all codes
- o Inclusion of physics processes (secondary electron emission, impact ionization, avalanching) with greater precision and detail
- o Performance enhancements come through activities synergistic with those of the energy frontier
- o New platforms (beyond CUDA): AVX, MIC, OpenCL

### *Many opportunities for interacting with the SciDAC institutes*

**FastMATH**

- Scalable solvers for implicit electromagnetics
- Implicit particle-in-cell solvers
- AMR methods for electromagnetics

**QUEST**

- Calibration of models (e.g., secondary electron yield)
- Application of uncertainty quantification to comparisons among codes and between codes and experimental data

**SDAV**

- Domain customized applications and/or one-click visualizations
- More and better CAD import for visualization

**SUPER**

- Performance analysis & optimization for PIC, collisions
- Non-linear parameter optimization for fitting to plasma data

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