Answers to PSACI-PAC

CPES

1. What have you done and what is your plan for the future to verify XGC1?

[C.S. Chang, S. Ku, TTF2007]

Done

1. Single particle motion in spatiotemporally changing E_r
   - Verify correct neoclassical polarization response

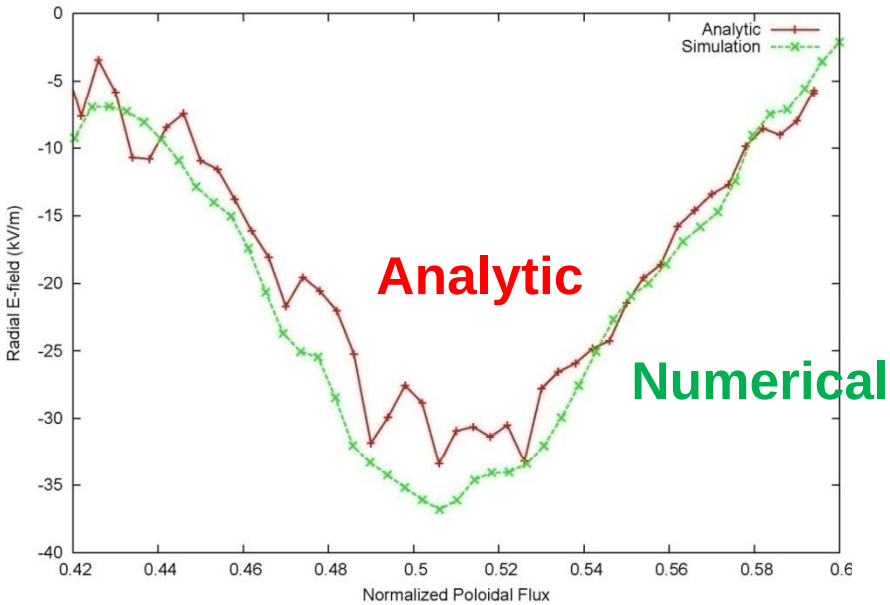
   H. Baek, S. Ku, C.S. Chang, PoP **13**, 012503 (2006)
2. Neoclassical E_r-$V_{||}$ relationship in trans-collisional core pedestal
3. Chang-Hinton χ_I
4. Manufactured solution with homogenous charge
5. ITG turbulent transport in cyclone geometry

Future plan: Manufactured solution with a model turbulence source (Weitzner, Greengard, Ku, Chang)

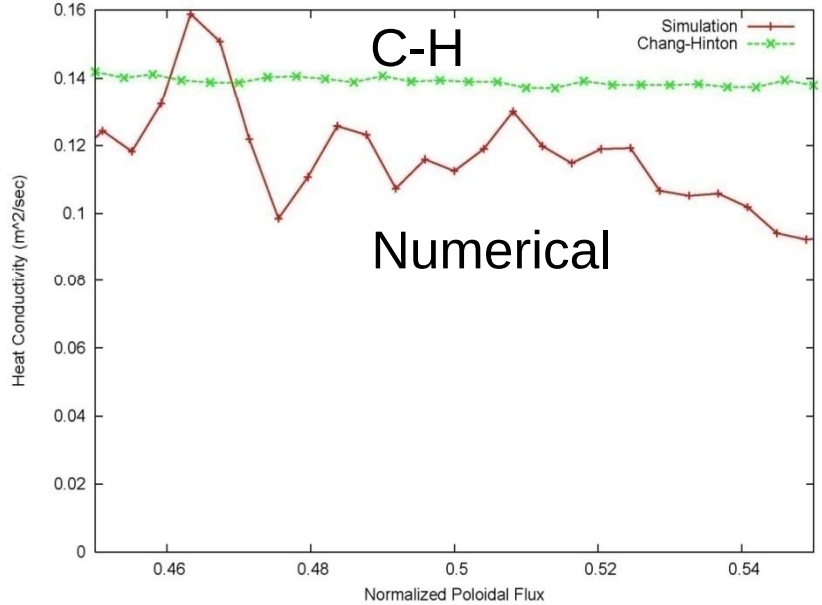
Two examples of Full-f XGC1 verification

[Chang, Ku, TTF/ECC, 2007]

E_r(kV/m)



$\chi_i(m^2/s)$



Ψ_N

Ψ_N

Banana Plateau collisional

2. Identify the most promising specific validation studies in over the next two years (XGC1).

Validation must be performed at all primacy hierarchy, starting from the lowest possible level

Our validation metrics include

1. Highest level: Profile of V_ϕ (C^{+6}), n, T, and E_r
2. Intermediate level: Heat, momentum, particle fluxes
3. Lowest level: Fluctuation of n, T, ϕ, B

in C-Mod, DIII-D, NSTX, JET.

Use dimensionless parameter for machine to machine comparison

3. What common verification and validation be between ESL and CPES in two years?

It depends upon the ESL's developmental schedule.
V&V is to make sure that the model equation

- is solved correctly and accurately and
- represents the real world

We need to wait until the LLNL's ESL kinetic code obtains a solution.

One exercise we can do is a code-to-code comparison with GA's EGK-NEO code, by bringing XGC1 to the same core plasma and prescribe the E_r distribution in the same way as in EGK-NEO.

4. Describe on going effort to develop the full-f EM algorithm

Full-f ions and full-f electrons:

1. Use the electron sub-cycling to save computing time. Implicit electrons can help, too, but not necessary.
2. Noise in δj_e from tail particles may require more total number of particles (longer computing time), unless we preferentially use more particles at tail and ignore the energy collisions

Two step solver: Full-f ions and full-f electrons + delta-f split weight electrons

1. Electron push is only for the lower energy non-adiabatic electrons. Tail electrons are adiabatic.
2. Use logical sheath.

5. When do you think you can draw the conclusion that this is a soluble problem?

The answer is “NOW.”

Why do you think that this may not be a soluble problem?

The cancellation problem was solved several years ago and the split weight scheme has been working since then (Chen-Parker). Computational economy is what we are trying to improve under large n-perturbation .

1. Full-f_e E&M is easier than full-f_e ES due to the Courant condition in ES ω_H mode.
2. It is matter of the computing power (x10). HPC will go the peta flops and beyond soon.
3. Delta-f split weight scheme can save time over full-f electrons by not requiring much more particle statistics for tail δj_e .

6. What is your plan for collisional effect in the edge?

XGC1 inherited the conserving MC collision operator from XGC0 from its birth [See Chang and Ku, June, PoP 2008]. We even have a non-MC Fokker-Planck operator working in XGC0 [to be submitted]. Another non-Monte Carlo scheme published [Hinton, PoP, '08]

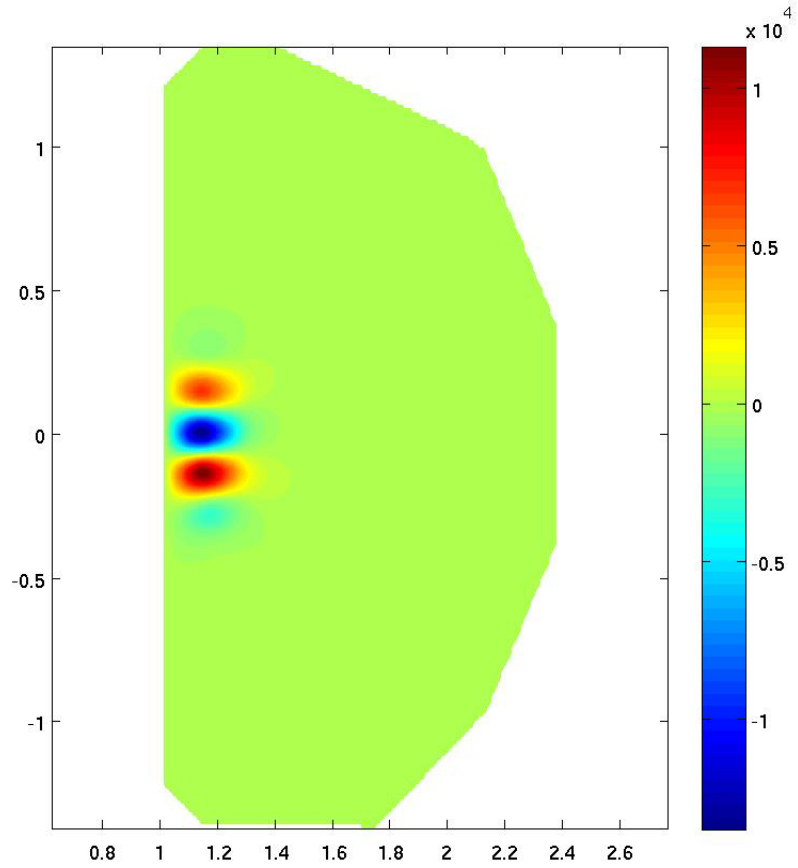
We did not have it on to get better physics separation and to save computing time.

We plan to turn it on to study collisional effect on ITG.

We plan to turn it on to study the resistive balooning modes at low temperature.

7. Would you be able to, as an interim procedure, describe electrostatic resistive ballooning mode?

1. Yes, after we get the implicit electron push scheme working (to avoid the ω_H mode problem).
2. Or, after we get the split-weight scheme installed.
3. Or, after we get the E&M installed.



8. What is your experience of the utility of various framework tools and what is the implication for FSP?

- Different frameworks for different functions
- Reliable and efficient use by non-experts
  - Reliable: specification in the input deck and launch
  - Efficient: certain smarts, hide seems between components
- Flexible enough to adopt and adapted to new technology. For example, in CPES EFFIS
  - Logistical Networking → Provenance tracking and SRM-lite
  - Elvis technology → Dashboard, in response to advanced Web 2.0 technologies and large amount of data.
- Should not bother the unit codes, or it will be used!
  - EFFIS solution: Change XML file only.