DFS Benchmarking

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The Problem

- We compared the operation of DFS in 4 simulation codes: ILCv/BMAD, MatLIAR, PLACET and SLEPT
  - ★ Although we all use "DFS," results were different. These differences have many causes:
    - ✳ How do you change the energy?
    - ✳ Does the energy gradient change in the "DFS" region?
    - ✳ Do you resteer the incoming off-energy beam, if so, how?
    - ✳ Where, precisely, do your regions begin or end?
    - ✳ Which cavities, precisely, do you turn off?
    - ✳ Where does your first DFS region start? What do you do to resteer the beam upstream of this region?

Simplify the problem

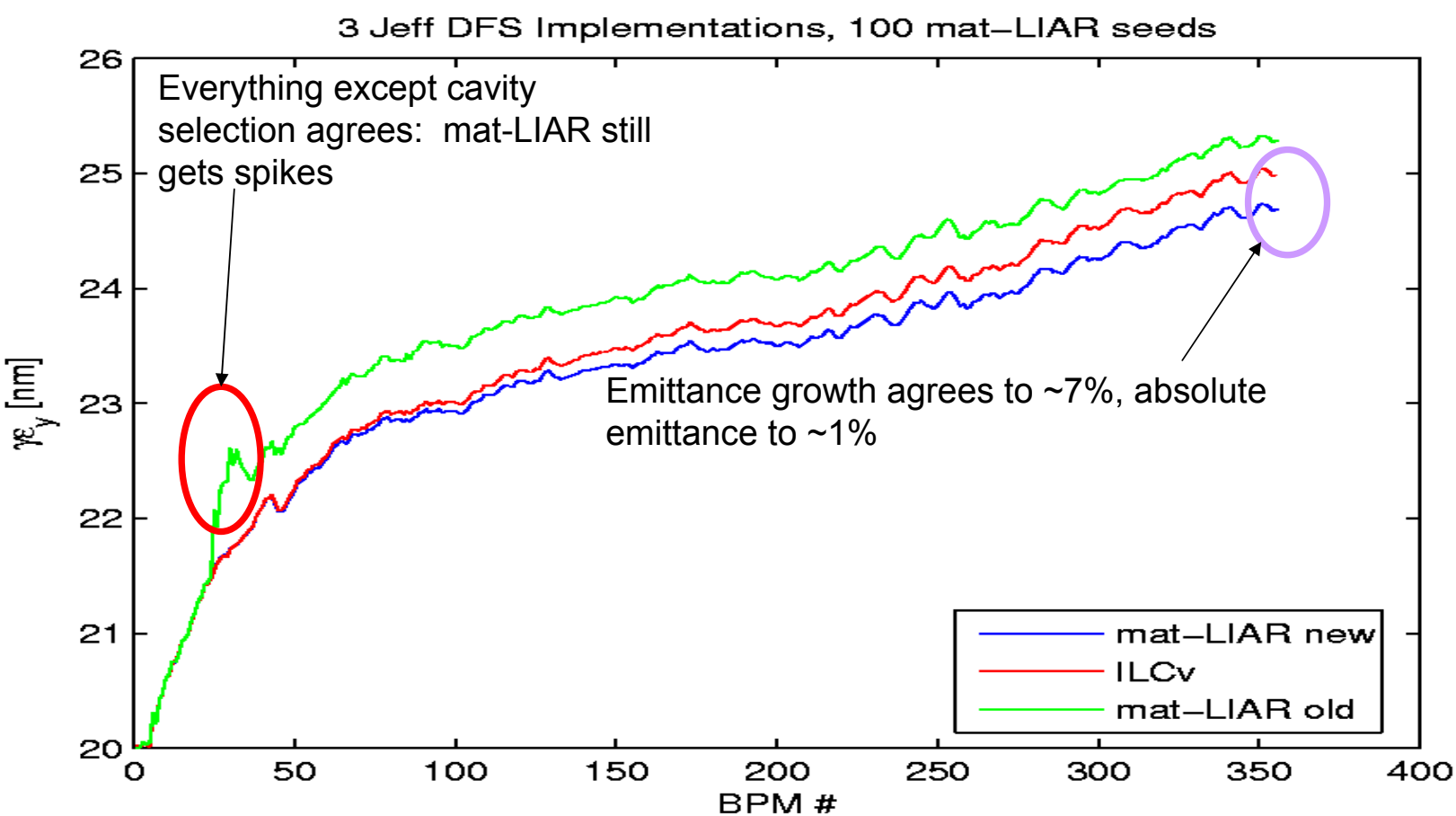
- In an attempt to eliminate some sources of error, certain simplifications were made:
  - ★ Use the exact same lattice and wakefields (took about a month to really get this right!)
  - ★ 0 um BPM resolution (we get different dependencies on this)
  - ★ Started with some simple exercises
    - ✳ Track 5 micron vertically misaligned beam through perfectly aligned linac
    - ✳ All read in the exact same misalignments and corrector settings and see if we get the same results
    - ✳ These two exercises helped us find slight differences (and a few bugs) in our tracking codes and lattice file parsers. We all agree very well now on these two.
  - ★ Use the exact same set of 100 misalignment seeds
  - ★ Perfectly align first 9 cryomodules (and everything on them) to eliminate concerns about launch region steering

MatLIAR Spikes

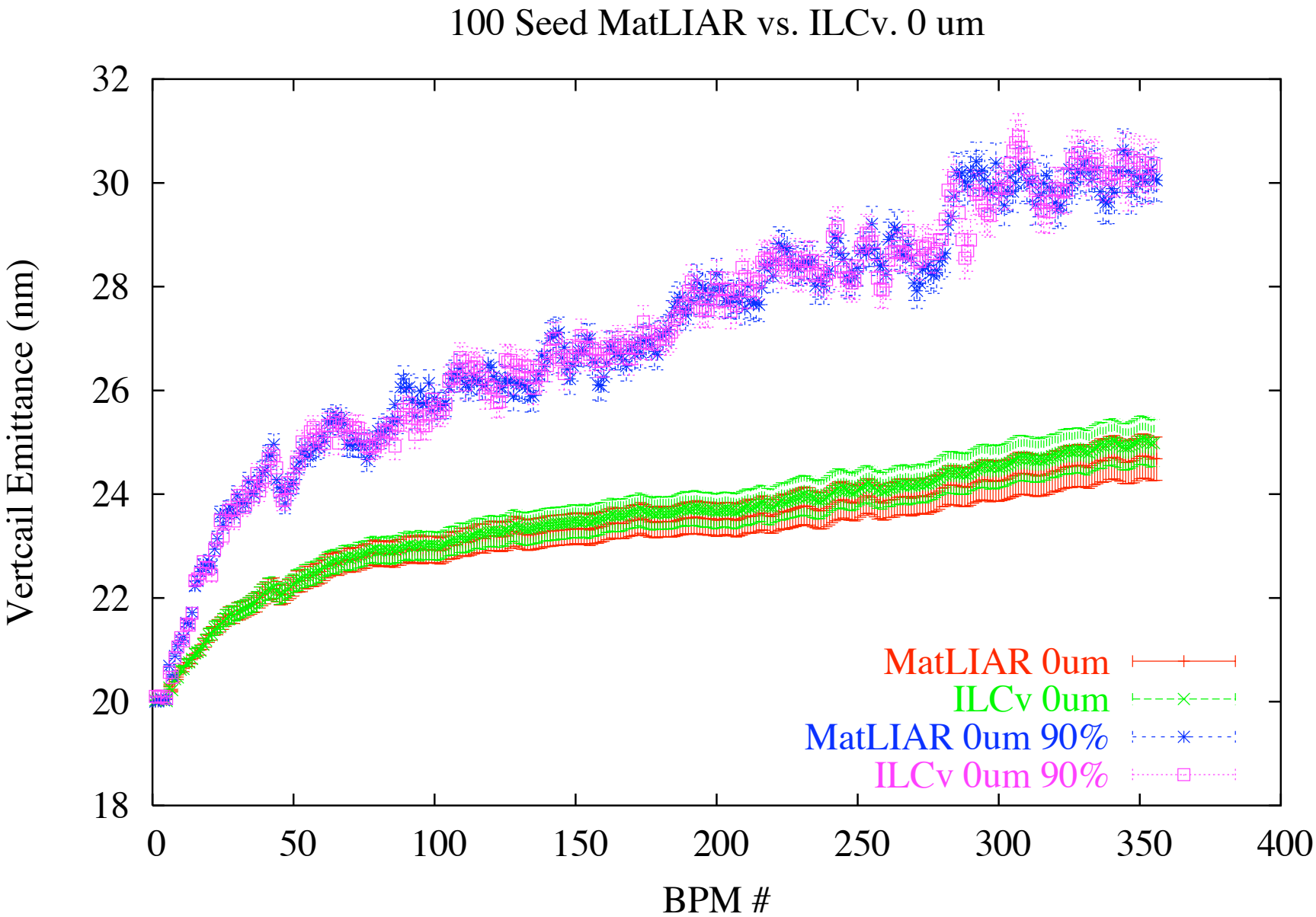
- MatLIAR produces spikes in emittance at beginning of linac, ILCv does not.
  - ★ Most of this was due to the method used to resteer the beam upstream of the first DFS region
  - ★ However, slight differences in how the regions were defined and precisely which cavities were switched off also contributed.
  - ★ Also, two different methods were used to resteer the beam. MatLIAR was converted to use the ILCv method.
  - ★ I began to create a slide giving the details of the ILCv DFS algorithm but stopped after realizing there were way too many relevant details to fit on one slide, likewise with MatLIAR's original algorithm. This all needs to be explained in a paper (and eventually my thesis).

Spikes Elliminated!

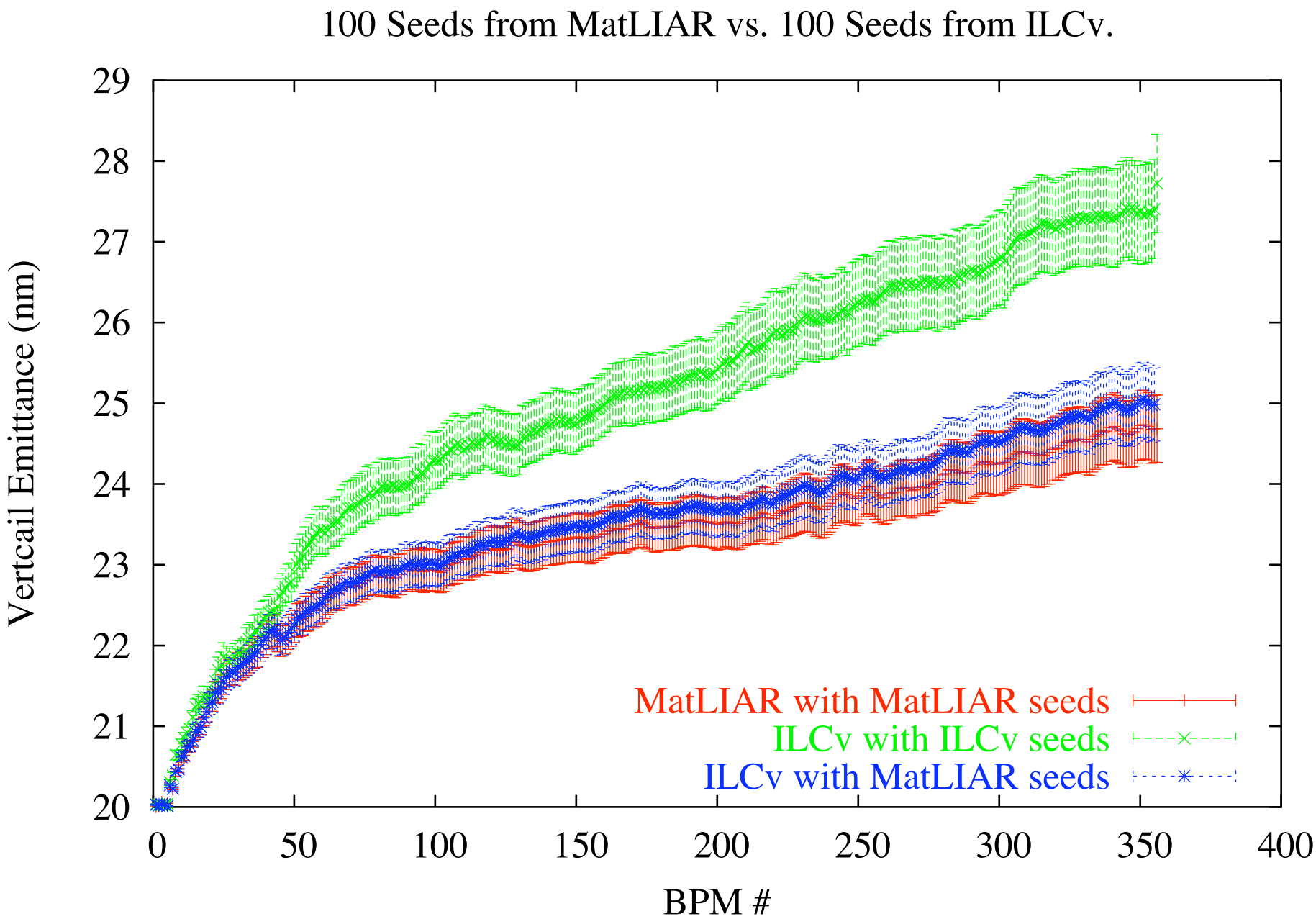
- Precisely which cavities to turn on and off and where the regions begin and end have an effect on DFS performance



Agreement very good even for 90% confidence level



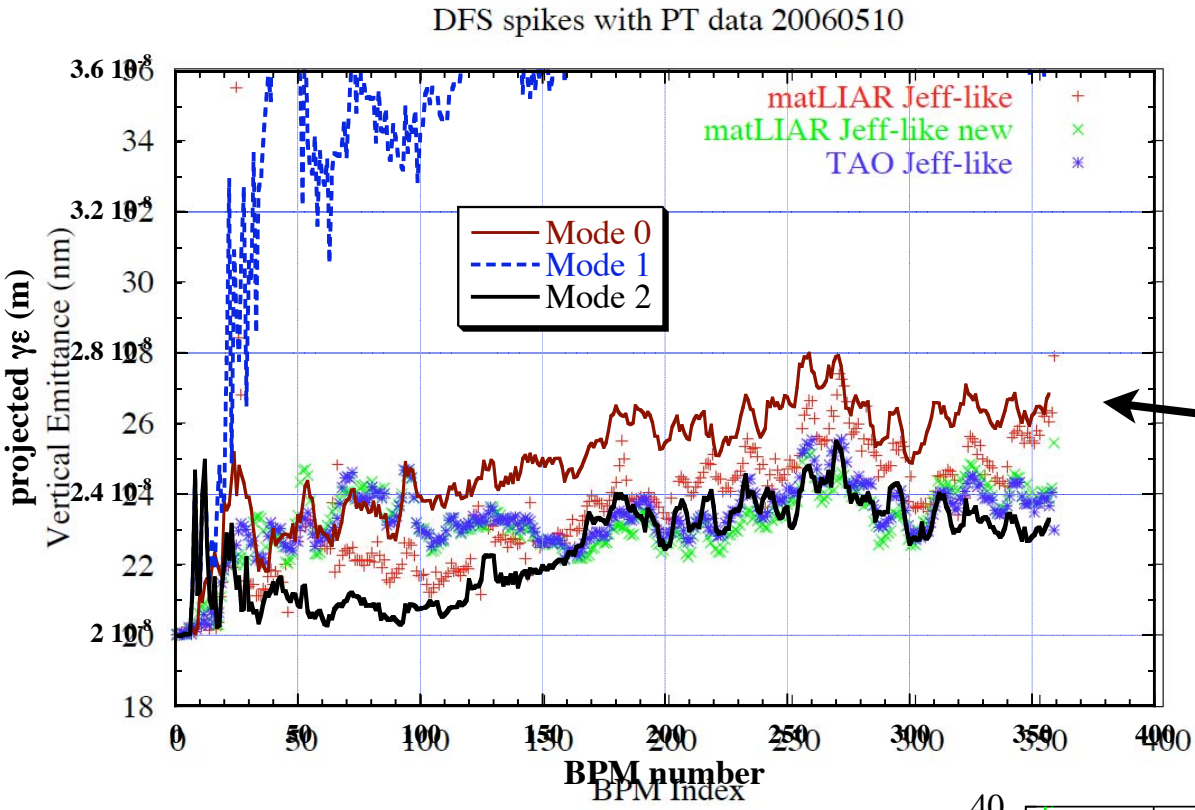
Must use the same 100 seeds for this comparison



SLEPT DFS modes vs. ILCv DFS

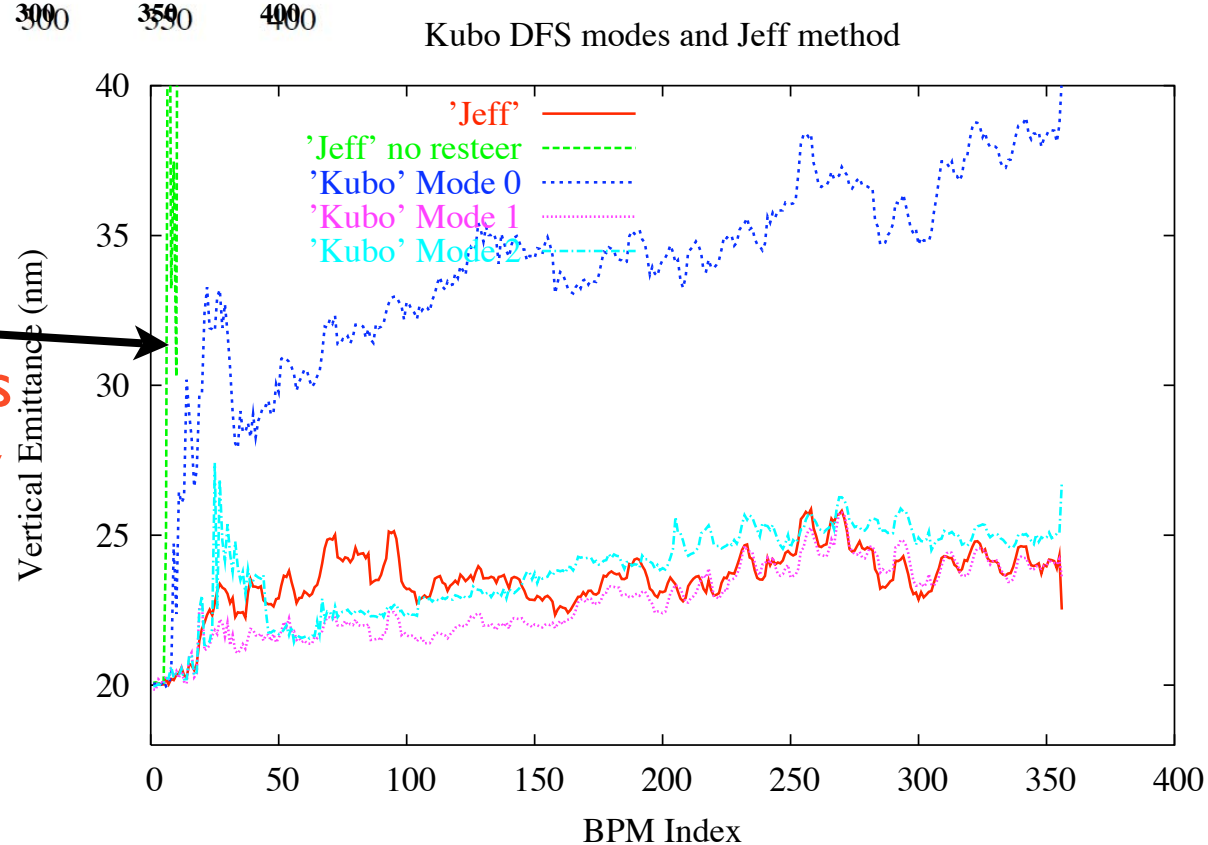
- SLEPT has three "modes" of DFS.
- It changes the energy by scaling all cavities by a constant value versus turning off an appropriate set of cavities (like MatLIAR and ILCv)
- Resteering method is a little different
- Implemented SLEPT's three modes in ILCv

Kubo modes in SLEPT and ILCv with 1 canonical seed



Kubo Modes via SLEPT (compared with ILCv data)

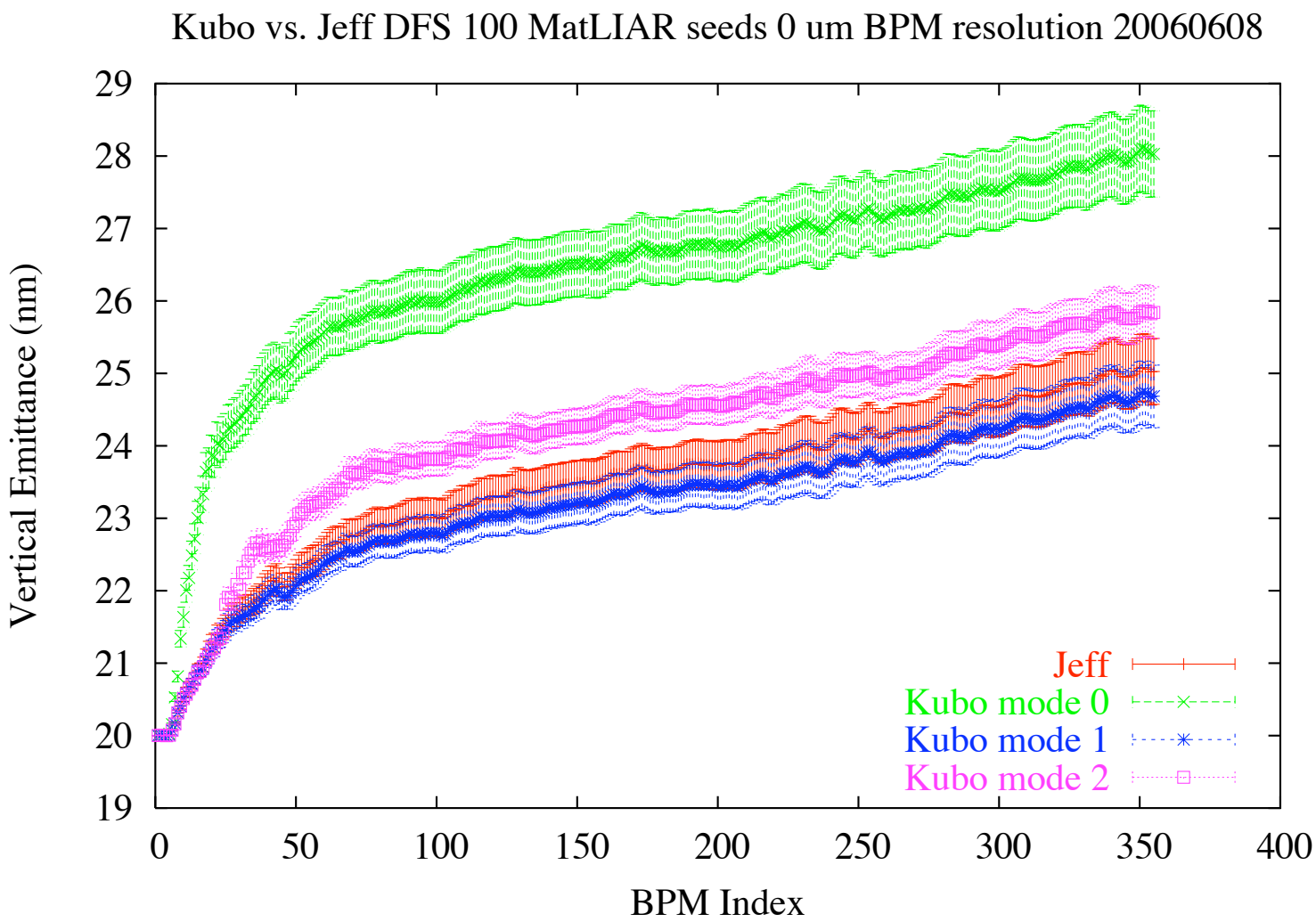
Kubo Modes via ILCV (compared with two "Jeff" modes)



Conclusion: Some differences but Mode 1 behaves similarly between codes and with "Jeff" mode (it's the most similar in algorithm to the "Jeff" mode)

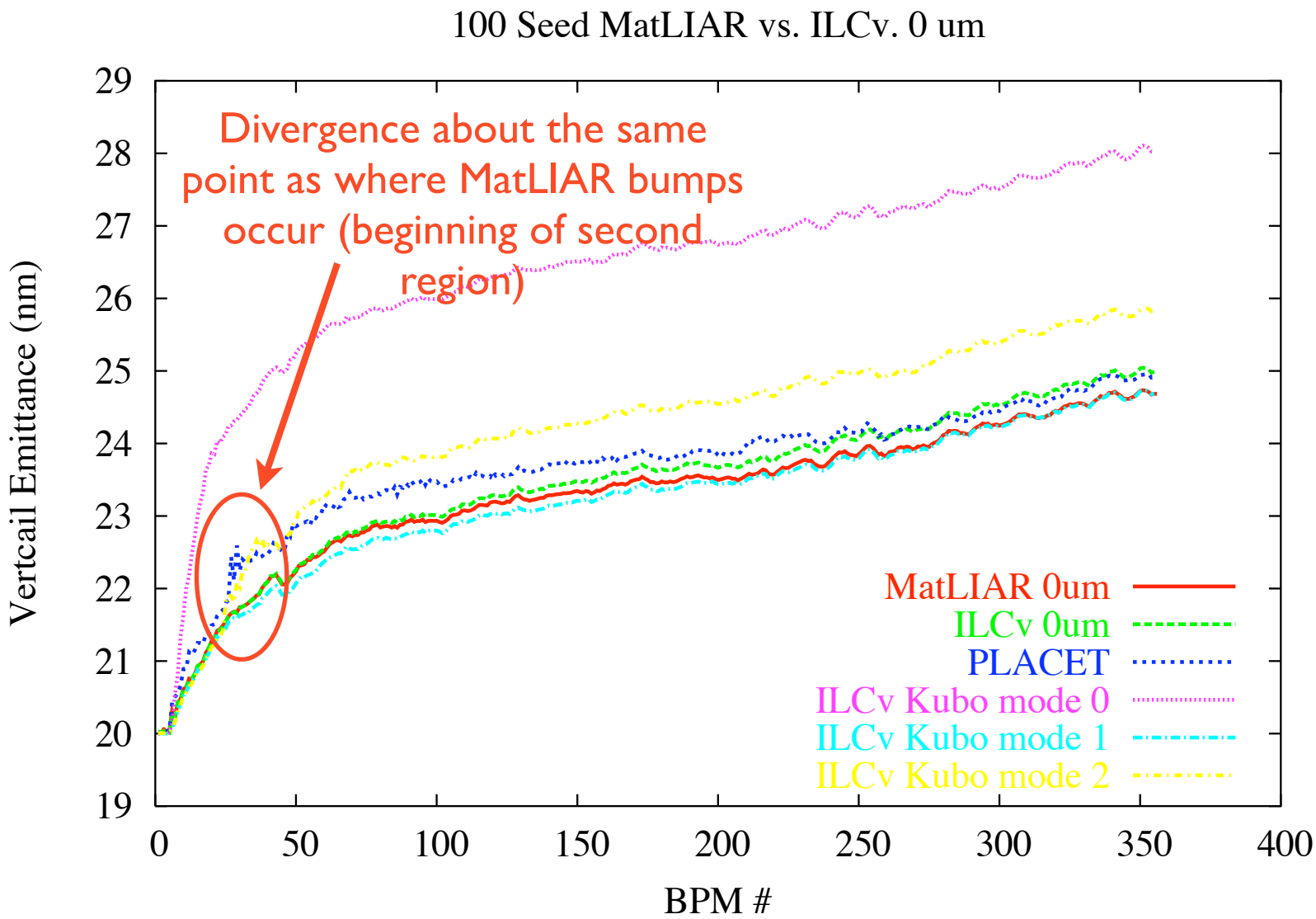
Now using 100 MatLIAR Seed

- Again, mode 1 behaves very similarly to "Jeff" mode.



Now all together with PLACET data

- PLACET most similar to Kubo Mode 2 in method but diverges a little in performance.



I Consider this a Success

- 4 independent programs with 4 independent code bases now perform virtually the same with a specific set of misalignments and lattice conditions.
- However, still need to run MatLIAR's 100 seeds in SLEPT for comparison
- Sensitivity studies would be good to do next:
  - ★ BPM resolution
  - ★ Beam Jitter
  - ★ Component alignment sensitivities
  - ★ I.e. do we all show the same dependence to alignments errors?
- Now that the ILC main linac lattice is in a more developed state I don't think we should work with the dated TESLA lattice anymore.