ABP on HPC

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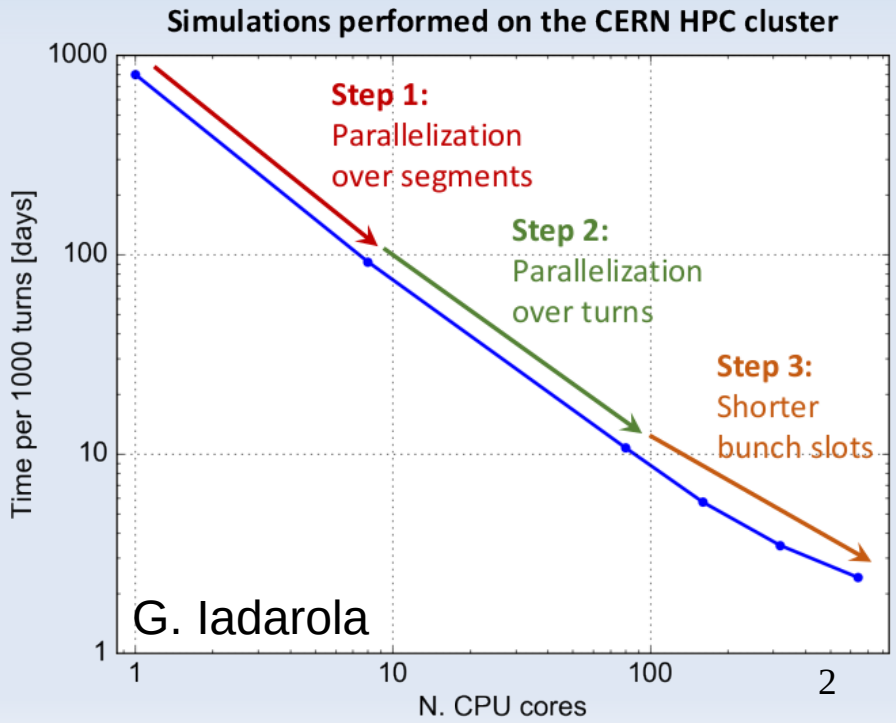
- PyHEADTAIL(-PyECLOUD): Coherent instabilities
- COMBI : Coherent beam-beam effect
- PyOrbit : Space-charge effects
- Overall feedback

Multibunch PyHEADTAIL - PyECLOUD

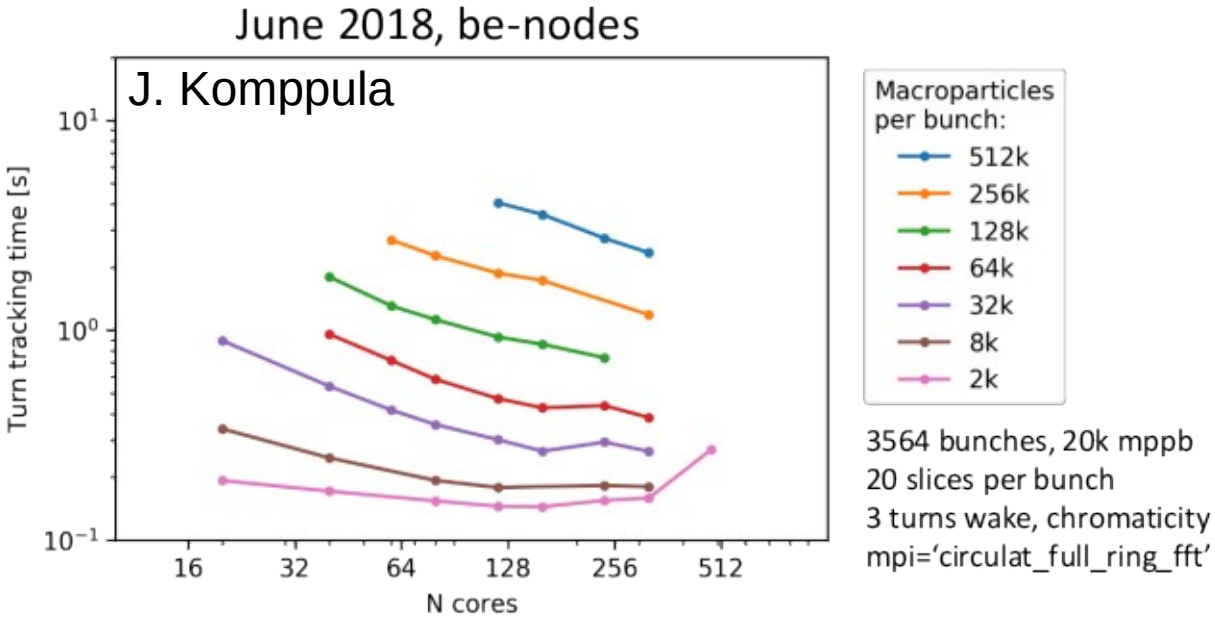
- Watch the result of a simulation of a full SPS batch (288 bunches, modelled with 10^6 macroparticles each) circulating in the LHC, interacting with electron clouds around the machine ($3 \cdot 10^8$ macroparticles) at this link
- Impressive scaling with various levels of parallelisation

  → Multi-node parallelisation is essential
- Mainly python, using MPI4Py
- Currently ramping up the usage, smooth testing / debugging
  - Could profit from IT expertise on profiling tools



Multibunch PyHEADTAIL

- **Used CERN HPC between Sept.'18 and Jan.'19**
  - *PyHEADTAIL*: multi-core particle tracking simulations
  - based on Python 2.7, *using also h5py-parallel, cython, mpi4py, etc.*
  - openMPI 1.8.4 module

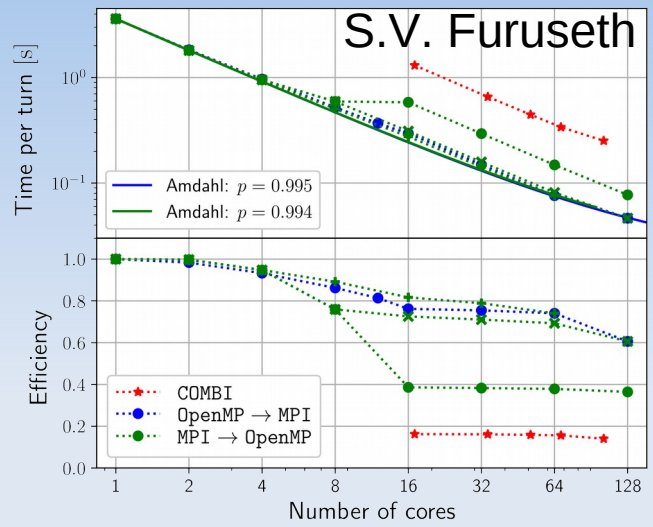


- **Experience**
  - ✓ Efficient job handling: typically jobs start running within minutes, *scancel* with immediate effect, *squeue* refreshes fast
  - ✓ Usually useful logs for debugging
  - ✓ No unexplained aborts once using "correct" submission parameters (# cores, hyper threading) – see issues below
  - ✓ Generally a very positive experience

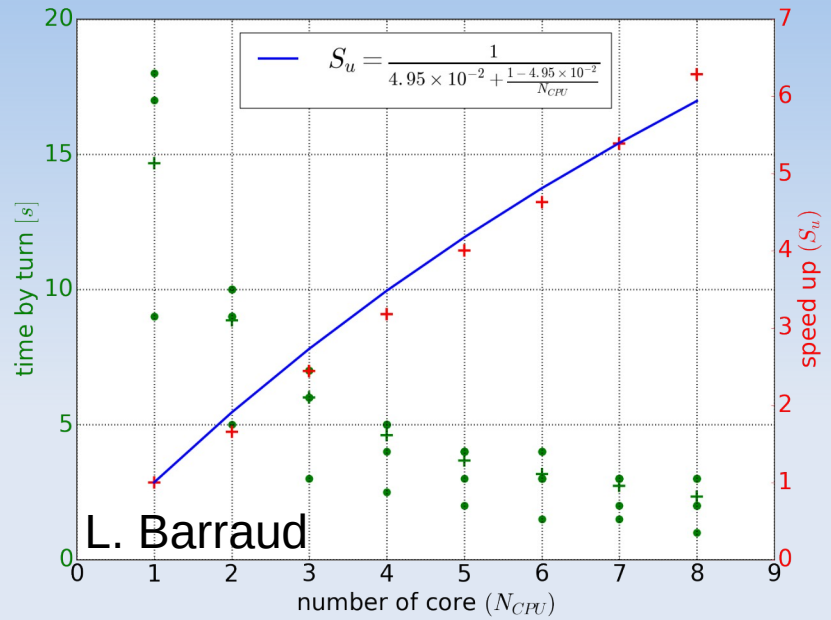
Issues

- # cores: jobs would fail if # cores not integer multiple of # cores per node (depending on queue: BE 20 cores per node, Batch: 16 cores per node)
- Had to disable hyper threading, otherwise inexplicable job aborts at beginning (input from experts in reply to trouble ticket opened by J. Komppula)

COMBI
Beam-beam interaction

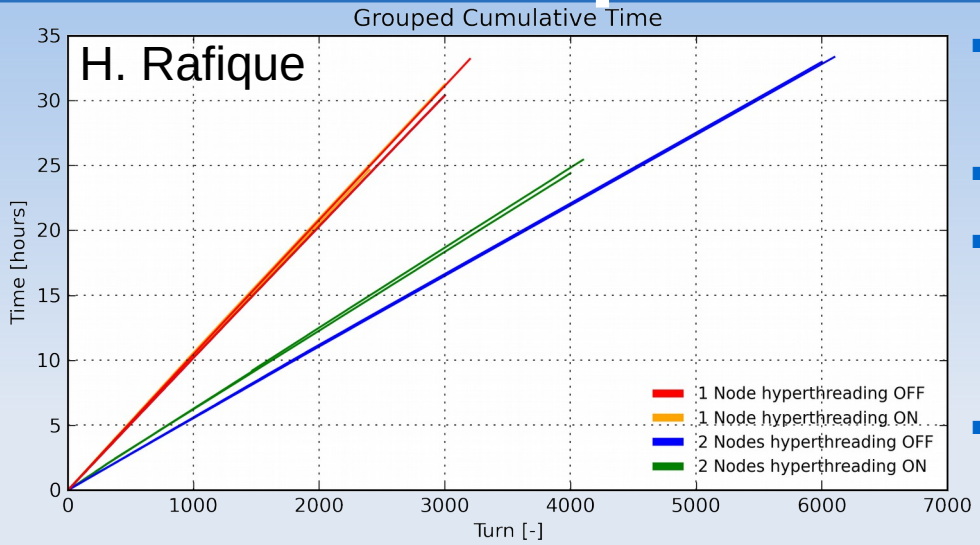


(d) 2 beams ($N_{b1} = 8 = N_{b2}$). 1 wakefield calculation and 3 beam-beam calculations, as in Fig. 4c.



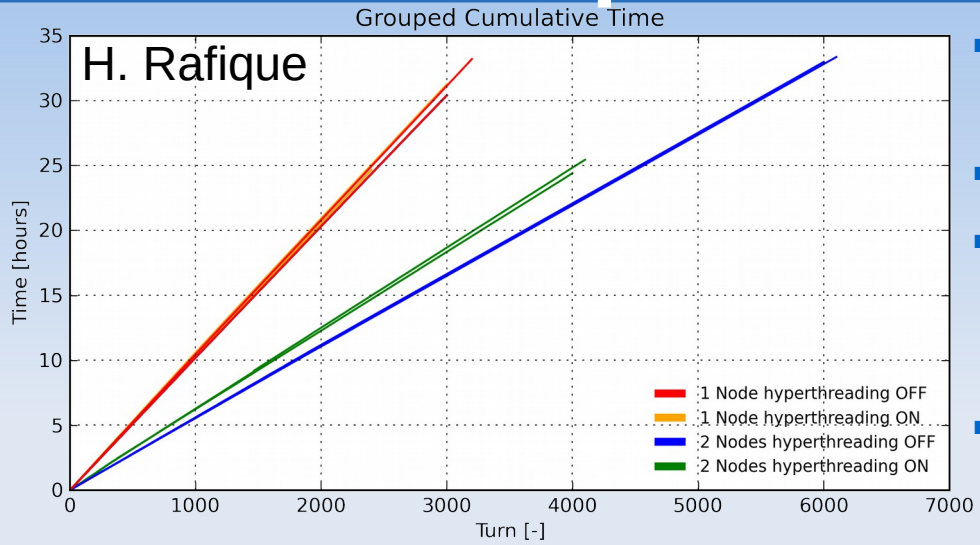
- COMBI is used mostly for instability simulations involving beam-beam interactions and/or noise
  - 10^5 to 10^7 macroparticles per bunch, up to tens of bunches per beam
  - Hybrid OpenMP and MPI parallelisation (C and Fortran, using gcc and mvapich2 on HPC) : Some effort when starting, but currently running smoothly
  - Multi-node parallelisation is required for multibunch studies, probably ramping up the usage towards end of summer
  - Most single/two bunch studies are now ported to HTCondor (still running on HPC when parallel resources fall short on HTCondor)

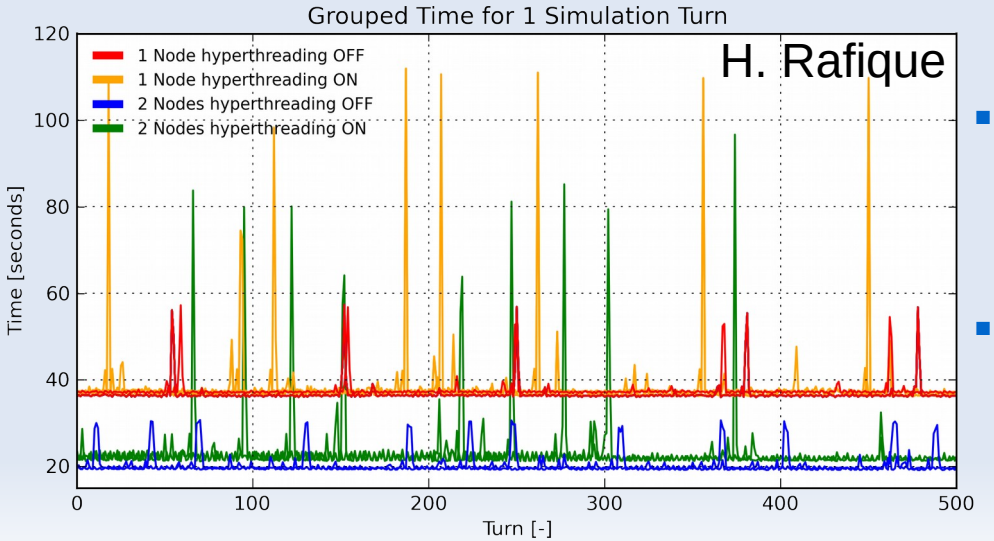
PyORBIT
Space-charge effects



- PyORBIT is used on HPC mainly for working point studies in the PS
- $5 \cdot 10^5$ macroparticles, 2.5D PIC solver
- Good scaling on two nodes, but absence of scaling / detrimental effect with hyperthreading
- Access to a shared system is critical as the building of the code is heavy
  - Currently AFS performs well, but after ?

PyORBIT
Space-charge effects





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  - Currently AFS performs well, but after ?
- The execution does not seem smooth, with identical parts executing significantly slower at times
- This feature is not limiting, but can it be understood ?

Feedback

- Overall the feedback from the users of the HPC in ABP is very positive: The machines are efficient and most of the issues solved rapidly via tickets
- Four potential improvements :
  - Provide expertise with profiling tools
  - Often the output data can be (at least partially) processed on the cluster to avoid large data transfer to other file systems → The frontends are sweating and requesting a an interactive job seems like an overkill (and is pretty inconvenient if the queues are full)

    → Is there an efficient solution, e.g. powerful frontends or dedicated 'post-processing' nodes
  - Hyperthreading does not always behave well (jobs killed, absence/negative scaling)
  - Could jobs running batch-* queues have access to bescratch ?