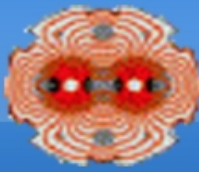




# A review of the COMBI code

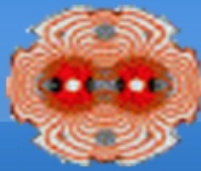
X. Buffat, W. Herr, T. Pieloni



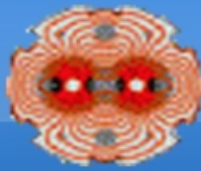
- Why ?
- How ?
- Future plans



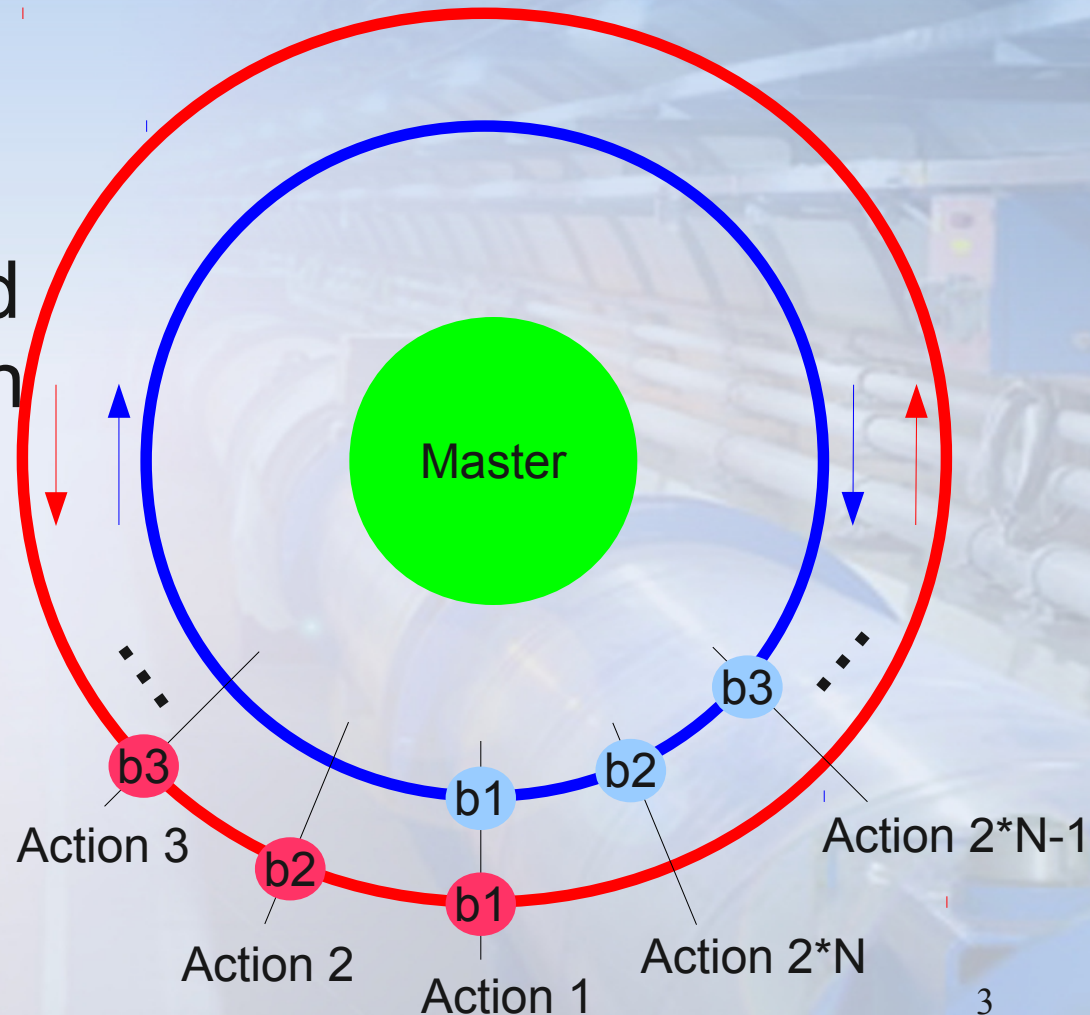
# COMBI – Why ?



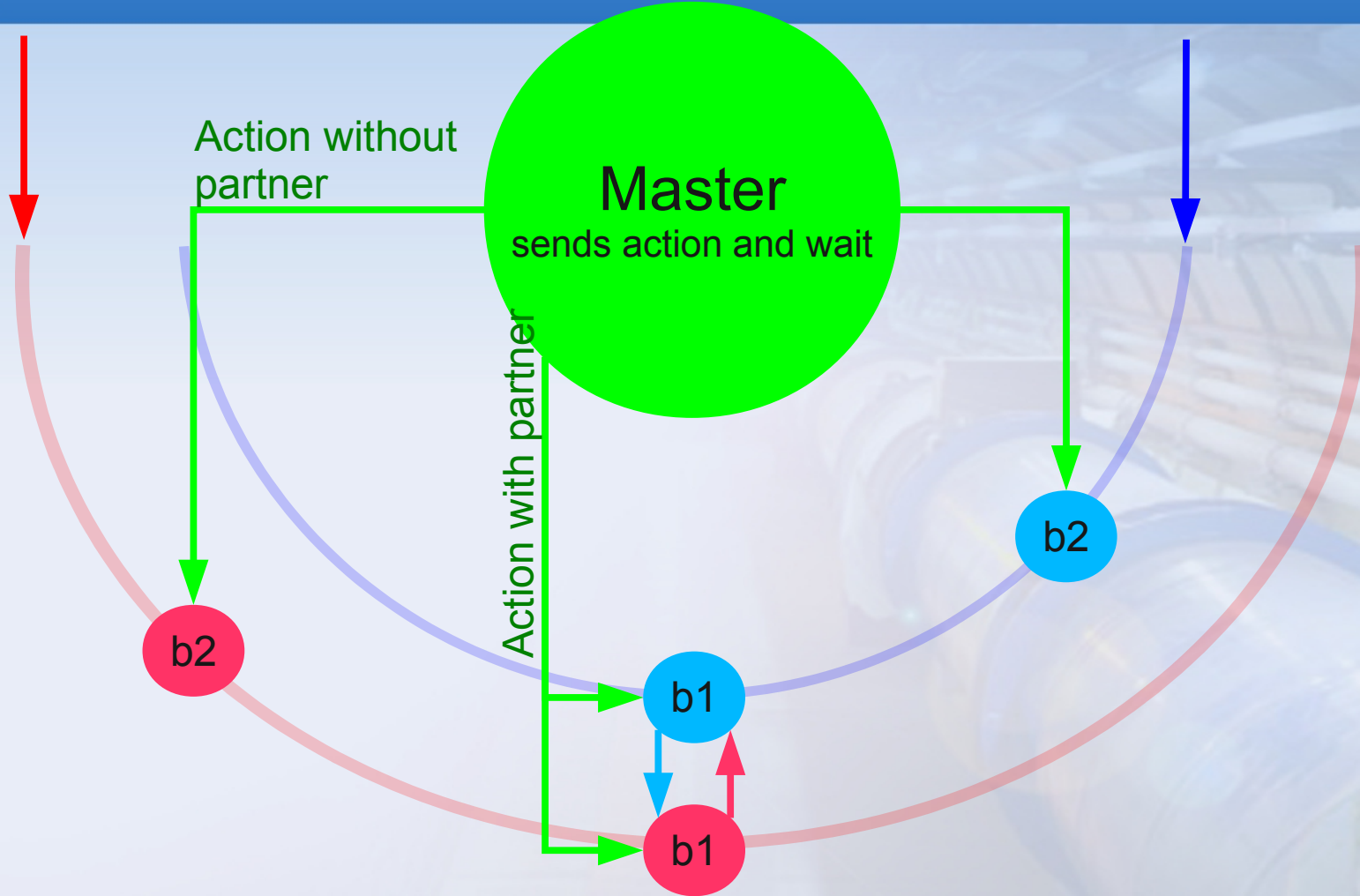
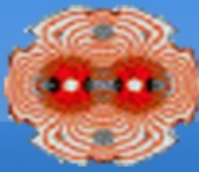
- COherent Multibunch Beam-beam Interaction
- Meant to study beam-beam coherent modes in the multibunch regime with maximum flexibility (many IPs, asymmetric filling scheme, ...)
  - T. Pieloni, W. Herr, Models to Study Multi-bunch Coupling through Head-on and Long-range Beam-beam Interactions, EPAC 2006, Edinburgh, Scotland
  - T. Pieloni, A Study of Beam-Beam Effects in Hadron Colliders with a Large Number of Bunches, PhD thesis, EPFL, 2008
  - F. W. Jones, W. Herr, T. Pieloni, Self-Consistent Parallel Multibunch Beam-Beam Simulation Using A Grid-Multipole Method, Pac'09, Vancouver, Canada
- Benchmarked against :
  - BeamBeam3D (J. Qiang)
  - RHIC BTF measurement and observations of coherent motion in the LHC



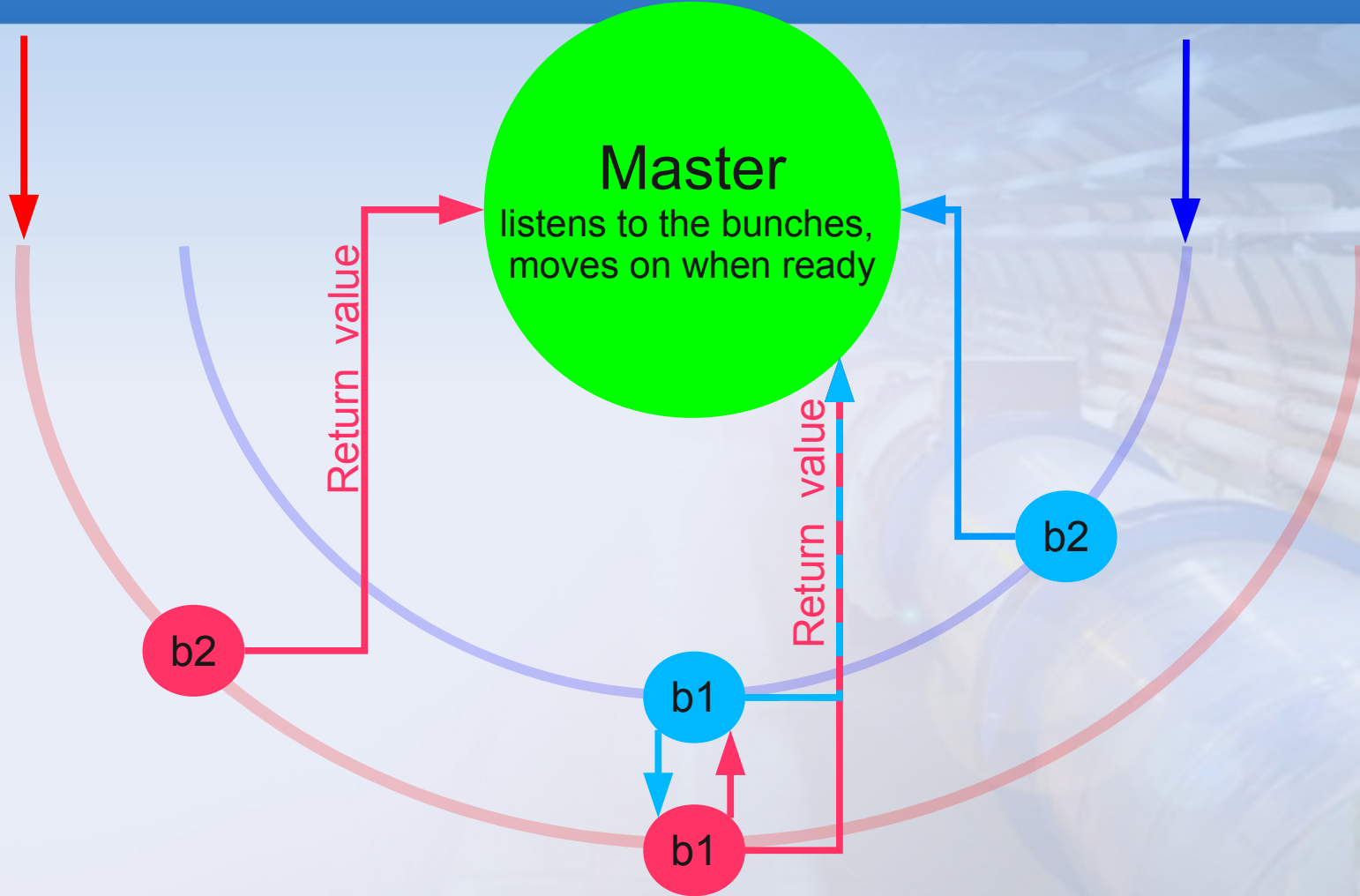
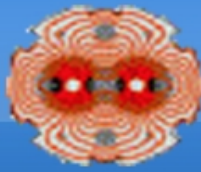
- One bunch per process + 1 master
- Each bunch is described by its particle distribution in 6D
- Master knows the position of the bunches and communicate the action (with necessary info) to the bunches

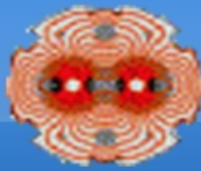


# Bunch Communication



# Bunch Communication

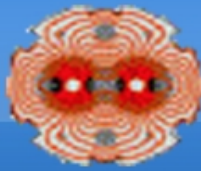




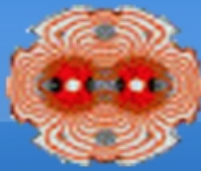
- Linear transport (6D)
- Head-on collision (HFMM\*)
- Long range collision (soft – gaussian / FMM)
- Noise source (white / colored)
- Collimator (simple "in or out" model)
- Impedance (in progress\*\*)
- Octupole
- ...



# FMM (Fast Multipole Method)

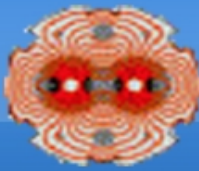


- Compute field from charge distribution
  - J. Carrier, L. Greengard, V. Rokhlin, A Fast Adaptive Algorithm for Particle Simulation, Yale U. Comp. Sci. Dept. RR # 496. Sep.86, Revised Jan.87
- Still quite slow for large particle density
  - Especially when the beams are slightly separated
- In a parallel implementation, the position and charge of all particles have to be send to the other process, very slow in clusters without shared memory

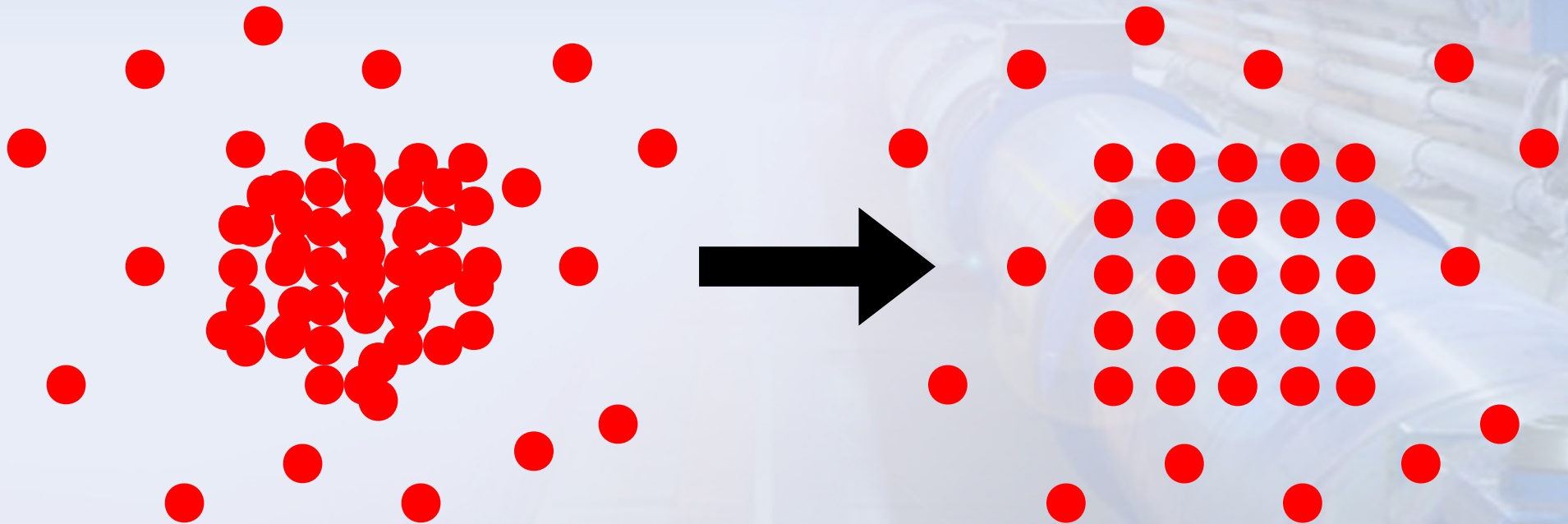


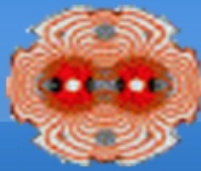
- Designed for space charge :
  - F.W. Jones, H.O. Schönauer, New Space-Charge Methods in Accsim and Their Application to Injection in the CERN PS Booster, 1999 Particle Accelerator Conference, New York, USA
- Used in BEAMX
  - W. Herr, M.P. Zorzano, F. Jones, A hybrid fast multipole method applied to beam-beam collisions in the strong-strong regime, Workshop on Beam-beam Effects, Fermilab, Batavia, IL, USA , 25 - 28 Jun 2001
  - W. Herr and F. Jones, Parallel computation of beam-beam interactions including longitudinal motion, PAC 2003, Portland, USA



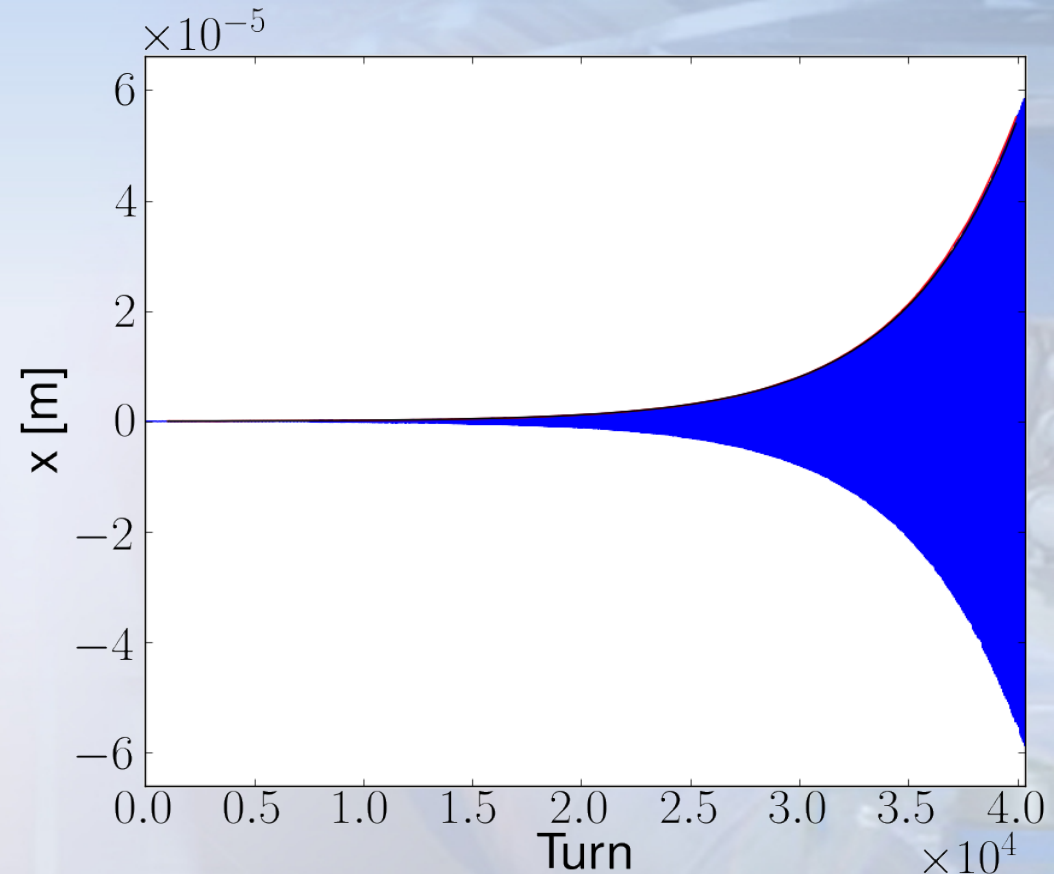


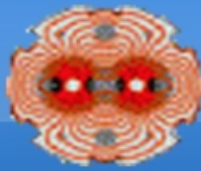
- Lower the number of macroparticle by gridding the core of the beam
  - Efficient transfer of the information between cores





- Equally populated slices
- Kick based on LHC impedance table
- Multiple kick per turn possible





- Benchmarking impedance with single bunch ongoing
- Implementation with multibunch also ongoing
- Implementation of a transverse damper forseen

Thanks a lot to Nicolas and Simon for the fruitfull collaboration