programs

mcad
astra
CSRtrack
elegant
genesis

input files

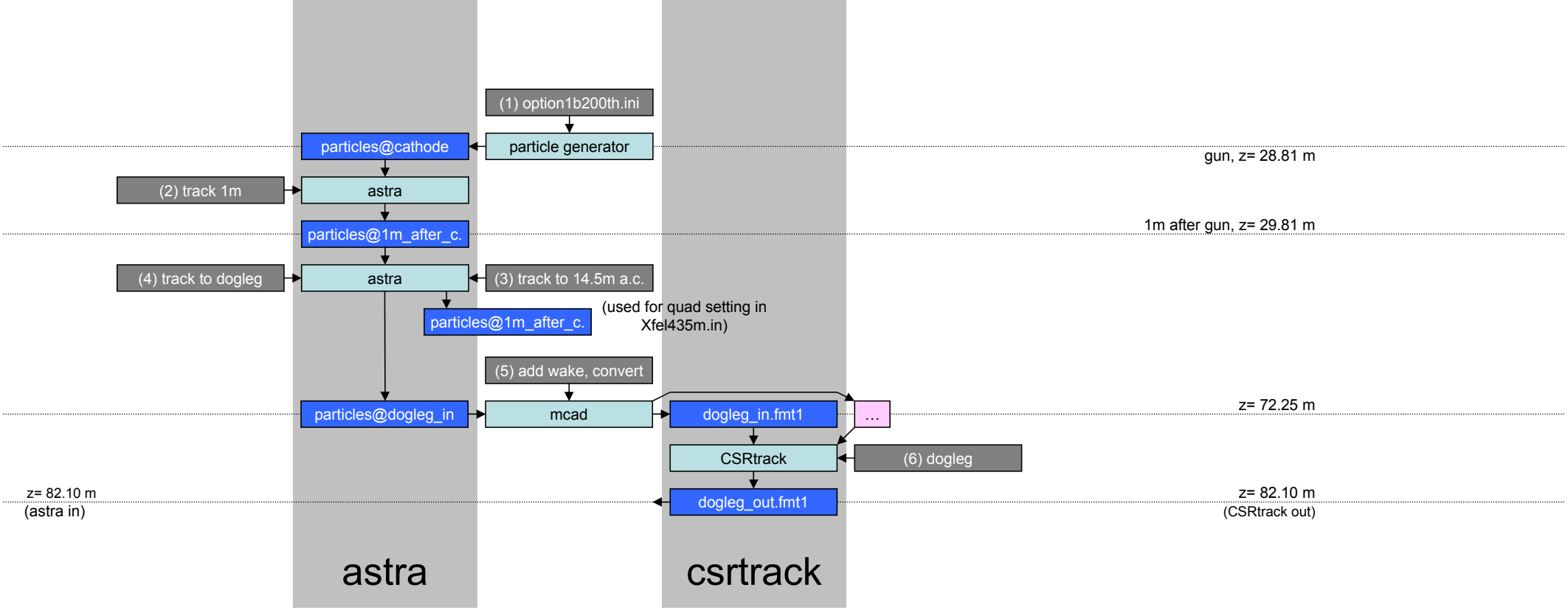
(program control
and lattice)

particle files

file formats:
- astra
- CSRtrack (fmt1 or fmt3)
- elegant (sdds)

auxiliary particle files

extracted offsets
CSRtrack: field generating particles

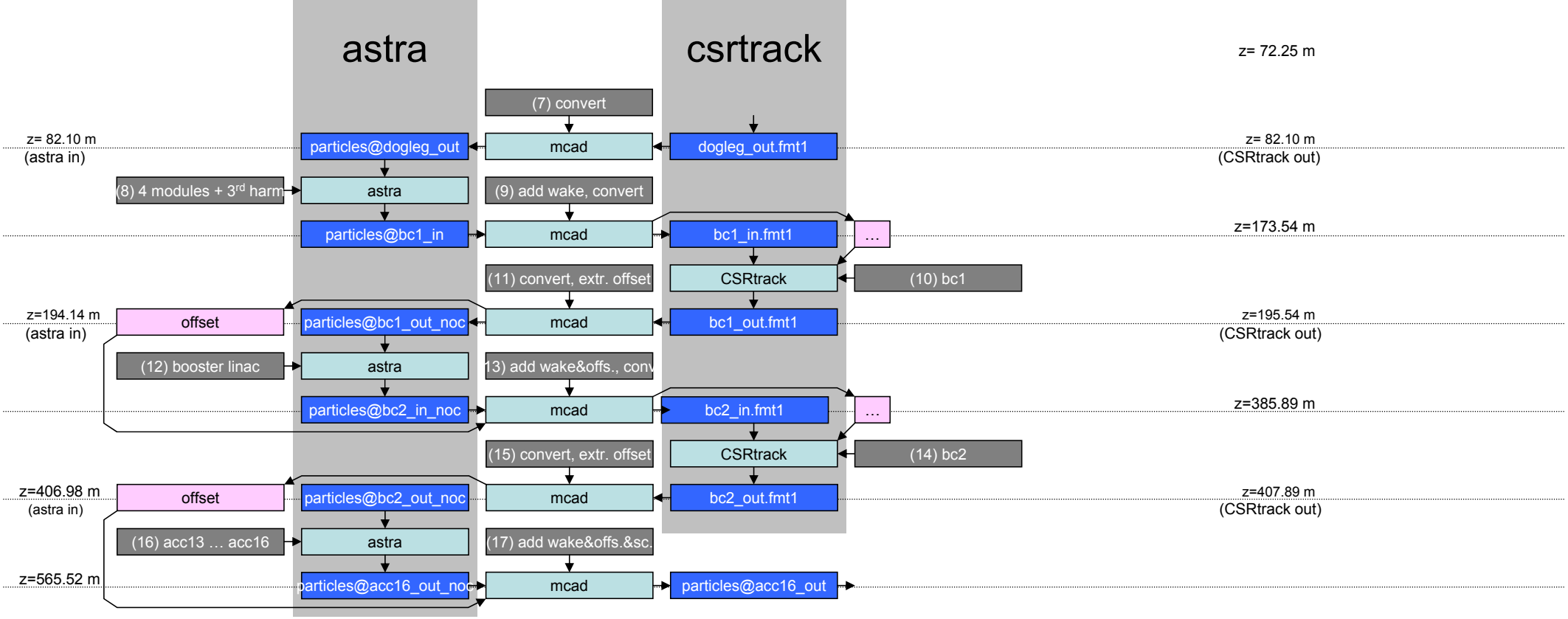


1) properties of input distribution
charge = 1nC, length = …, more info from K. Floettmann

2) ASTRA tracking to 1m after cathode; rf: 60 MV, 44 deg; solenoid: 0.2 T;
more info from K. Floettmann

3, 4) ASTRA tracking to 14.5 m after cathode and 43.45 m after cathode; position 14.5 m a.g. is directly before the 1st quadrupole (still symmetry of revolution); 43.45 m a.c. is 0.1m before the 1st dogleg dipole;
in principle steps 2&3 or 2&4 could be combined, but it is advantageous to decouple the gun calculation from the rest; rf cavity 1, 2, 3, 4: 23 MV, 1.6deg; rf cavity 5, 6, 7, 9: 33.58 MV, 0.33deg; (K. Floettmann)
settings of quadrupoles ACC00-Q, QL3, QL4 and QL5 adjusted for required optics;

5) preparation for CSRtrack: the dog-leg is vertical, but CSRtrack is written for motion in the horizontal plane; therefore the input distribution is flipped by 90 degrees and the output distribution is flipped back; see a) for CSRtrack calculation in principle;



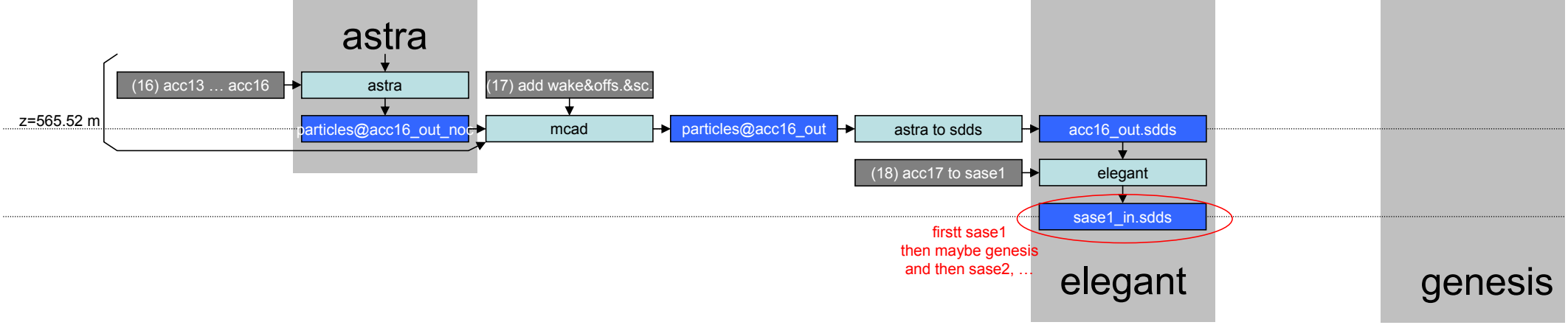
8) ASTRA calculation: 4 TESLA modules, 8 modules with 3rd harmonic rf; **the setting of amplitude and phase is quite critical** for the compression process; the values in the ASTRA input file have been optimized in several iterations;
nominal 1.3GHz-rf: 442.842714 MV, 1.378 deg; 3.9GHz-rf: 90.635894 MV, 143.348 deg

10) BC1; r56 = -104 mm @ 500 MeV/c

12) booster; rf: 12 x 133.33 MV = 1.6 GV, 20 deg; quadrupoles ACC16-Q, QD1, QD2, QD3 are tuned;
ASTRA calculation with extracted centroid offsets see b)

14) BC2; r56 = -17.6 mm @ 2 GeV/c

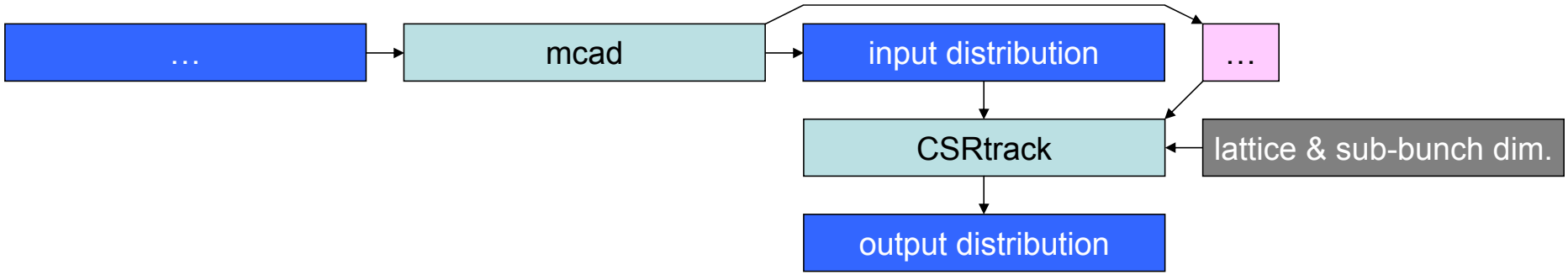
16) 8 TESLA modules (to ~3.2 GeV): 8 x 155 MV = 1.24 GV, 0deg;
ASTRA calculation with extracted centroid offsets see b)



17) mcad post-processing: add centroid offset and wake of 8 TESLA modules
mcad pre-processing: calculate and add space charge wake of remaining LINAC to dog-leg

18) elegant

a) CSRtrack calculation in principle (using Green's function method)



the general s2e tracking procedure is based on a 6D random distribution of equi-charged particles; such distributions are appropriate for the 'projected' or '1d' method in CSRtrack but not for the "Green's function method"; therefore the 6D random distribution is converted to a 4D systematic distribution of sub-bunches with individual charges; this distribution is a smooth description of essential phase space properties of the initial distribution (especially horizontal and longitudinal);

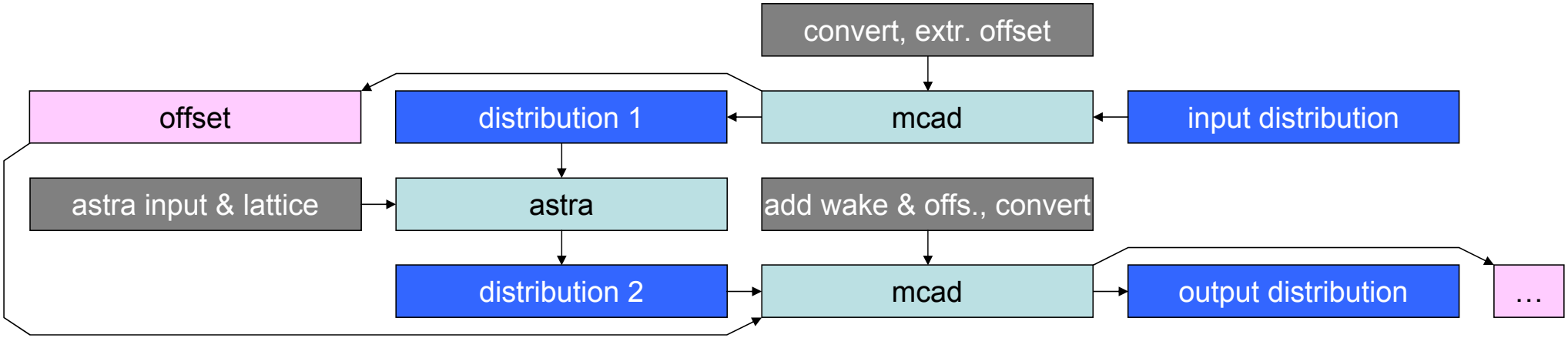
the auxiliary 4D sub-bunch distribution is tracked "self consistently" (under the influence of self-fields) through the dog-leg or bunch compressor chicane; the sub-bunch dimensions are controlled by an external file according to requirements of the compression process;

the original input distribution is tracked together with the auxiliary distribution, but all charges are set to zero; therefore these particles are influenced by the external magneto static fields and by electromagnetic fields caused by the smooth auxiliary distribution;

even after the last dipole (of dispersive sections) the particle dynamic is affected by the radiated electromagnetic field, e.g. the energy is changed by the longitudinal electrical field; to consider such interactions at least partially, an additional drift of about 2 m is calculated (even if the next magnets are nearer) and afterward the particles are back-tracked by the same distance;

b) ASTRA tracking with extracted centroid offsets:

an 2d algorithm (rotational symmetry) was used to calculate space charge effects (although there may be 3d routines); to avoid errors by the slowly varying offset of the slice centroids, these offsets are extracted and before ASTRA tracking and added afterwards:



1) the slice centroids of the “input distribution” are calculated and extracted
→ distribution 1 (centroids at origin)
offset (all extracted particle offsets)

2) ASTRA tracking (space charge, magnetostatic- and rf-fields)
→ distribution 2 (centroids at origin)

3) mcad processing:
longitudinal phase space – cavity wakes are calculated and added
transverse phase space – offsets are transformed according to linear optic and added
→ output distribution

additionally an auxiliary particle file is created with a systematic field generating particle distribution for CSRtrack (Green’s function method)