ESRF | The European Synchrotron

IPAC17

ESRF developments of the Accelerator Toolbox

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on behalf of the Beam Dynamics group of the ESRF

Accelerator Toolbox collaboration meeting
May 17 2017

OUTLINE

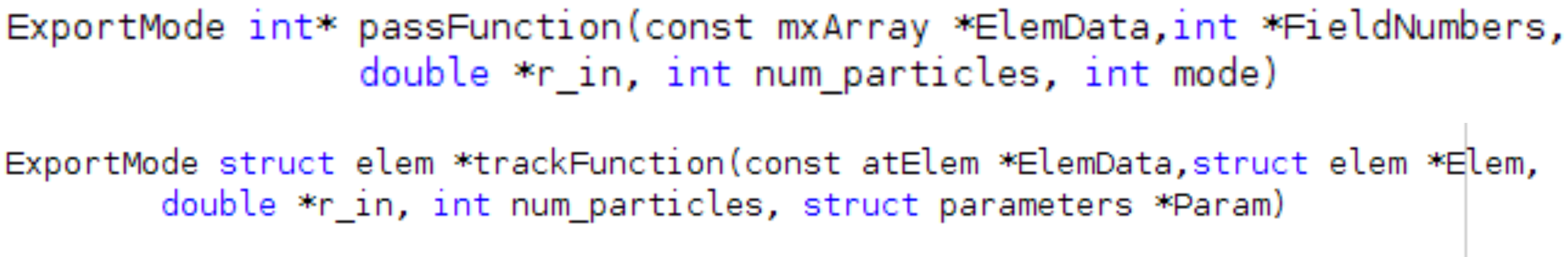
- Pass methods
- Turn number and RFCavityPass
- Physical apertures and losses
- Atplot
- Quantum diffusion
- Atfastring
- Atmatch
- Touschek lifetime

PASS METHODS

Each PassMethod file has three functions:

- The integrator => it does the tracking
- The passFunction (or trackFunction) => it is called by atpass and it calls the integrator
- The mexFunction => it is used to call the integrator from the matlab command window

With the new AT, both passFunction and the trackFunction can be used, but the trackFunction is faster.



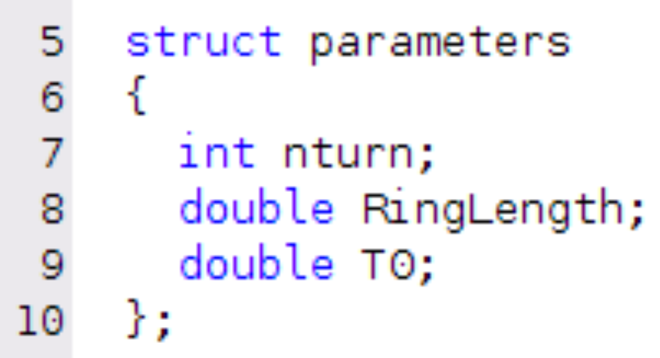
```
ExportMode int* passFunction(const mxArray *ElemData,int *FieldNumbers,
                double *r_in, int num_particles, int mode)

ExportMode struct elem *trackFunction(const atElem *ElemData,struct elem *Elem,
        double *r_in, int num_particles, struct parameters *Param)
```

PASS METHODS

The matlab structure of each element is copied to a C structure at turn 0, then the access is faster.

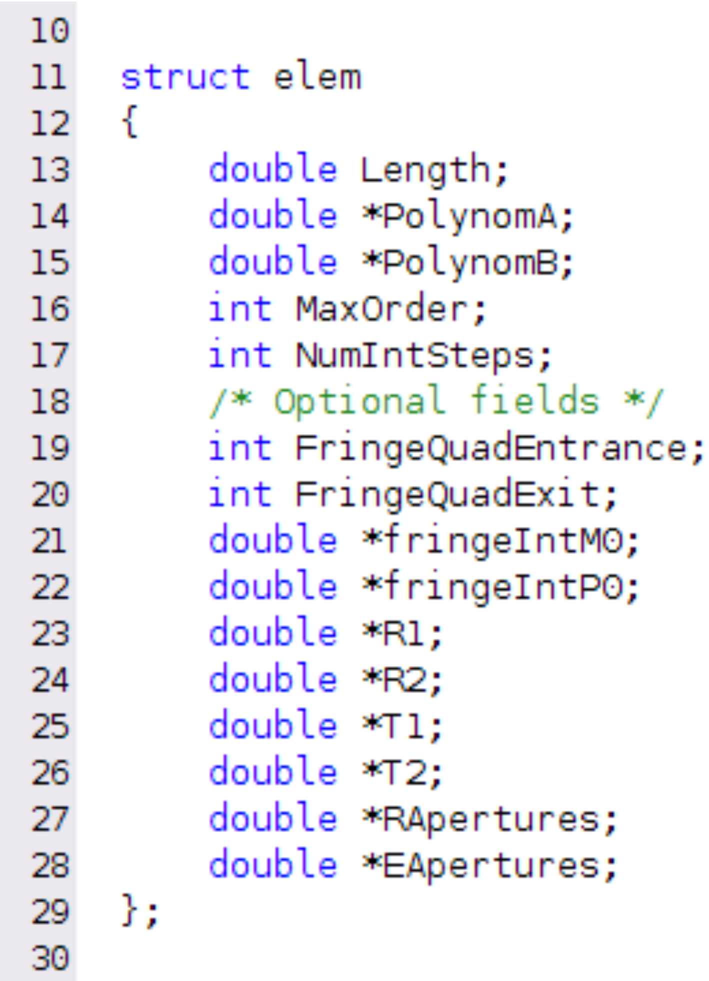
The tracking results in being about 20% faster.

The turn number is passed to all the integrators through the parameter structure.



```
struct parameters
{
  int nturn;
  double RingLength;
  double T0;
};
```

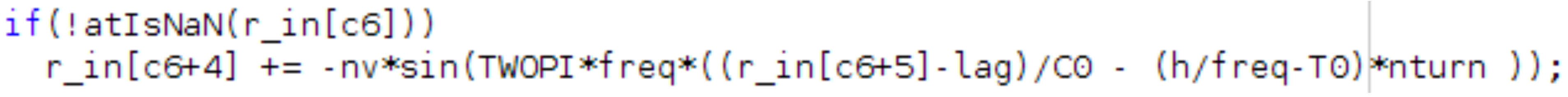
Element structure for StrMPoleSymplectic4Pass



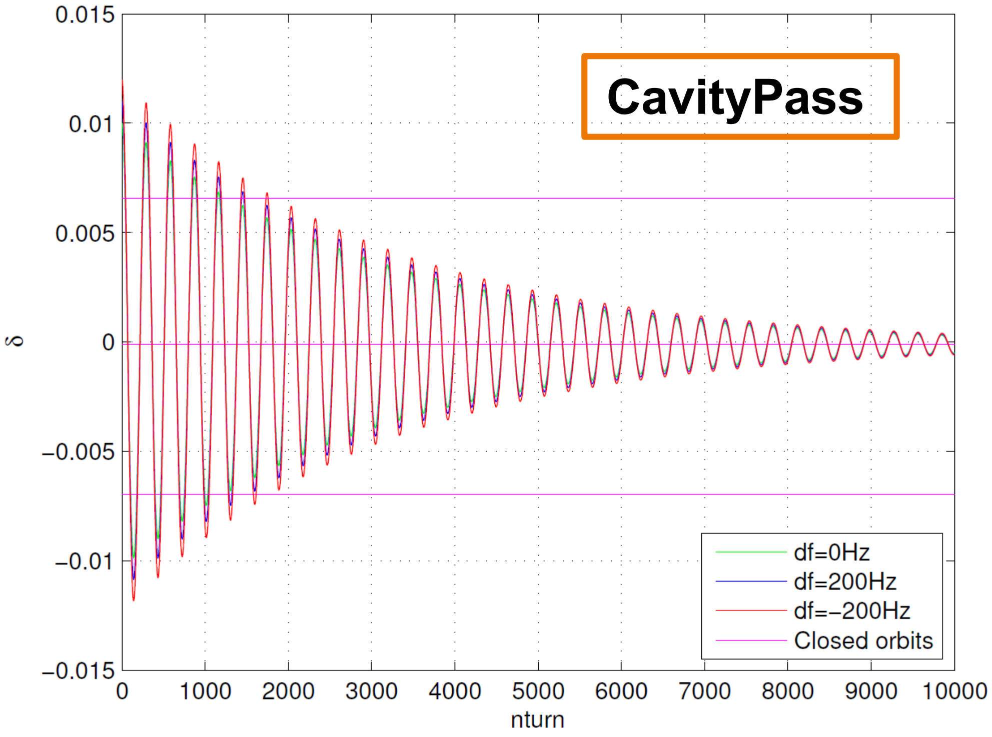
```

struct elem
{
    double Length;
    double *PolynomA;
    double *PolynomB;
    int MaxOrder;
    int NumIntSteps;
    /* Optional fields */
    int FringeQuadEntrance;
    int FringeQuadExit;
    double *fringeIntM0;
    double *fringeIntP0;
    double *R1;
    double *R2;
    double *T1;
    double *T2;
    double *RApertures;
    double *EApertures;
};

```

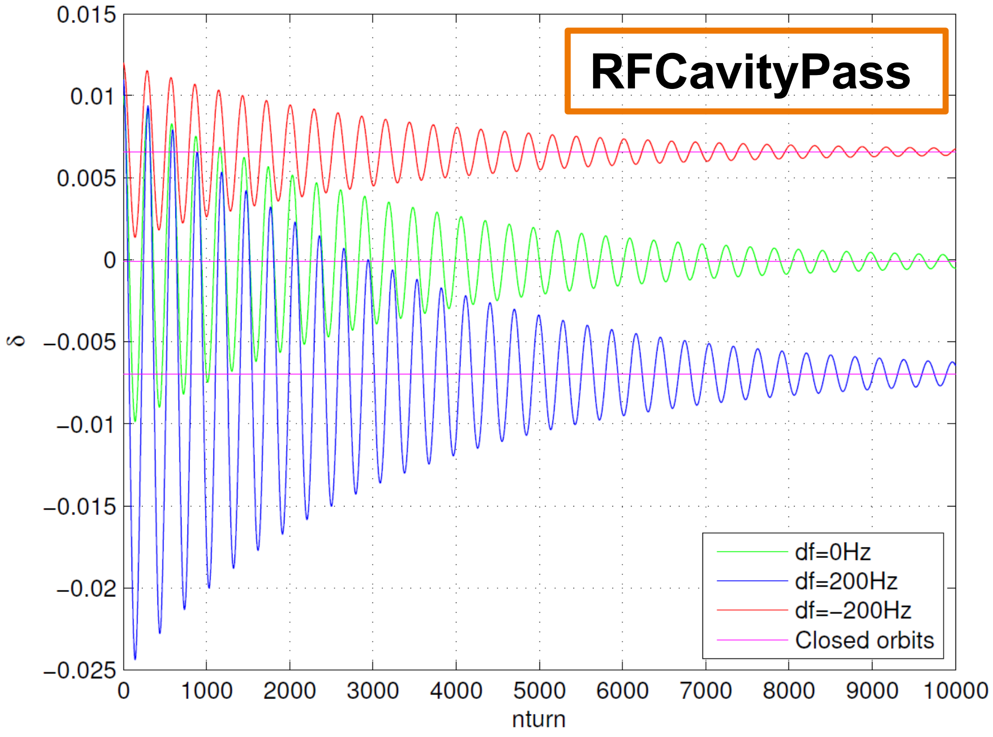
TURN NUMBER AND RFCAVITYPASS

With the turn number, the cavity passmethod can be improved. With the new RFCavityPass, changing the RF frequency we change the closed orbit.



```
if(!atIsNaN(r_in[c6]))
  r_in[c6+4] += -nv*sin(TWOPI*freq*((r_in[c6+5]-lag)/C0 - (h/freq-T0)*nturn ));
```



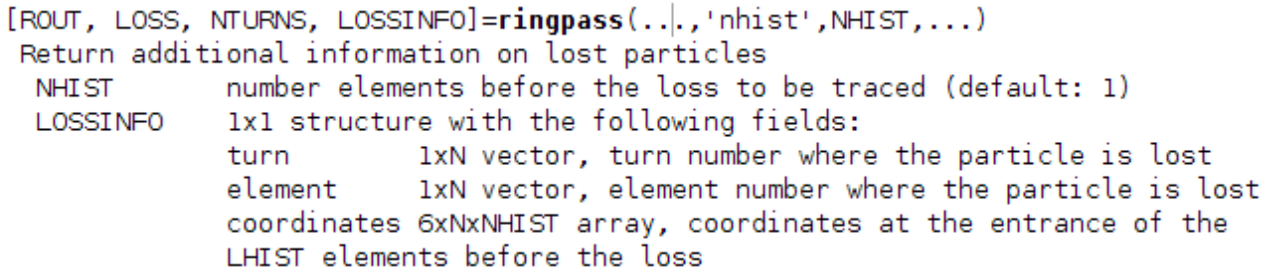


PHYSICAL APERTURES AND BEAM LOSSES

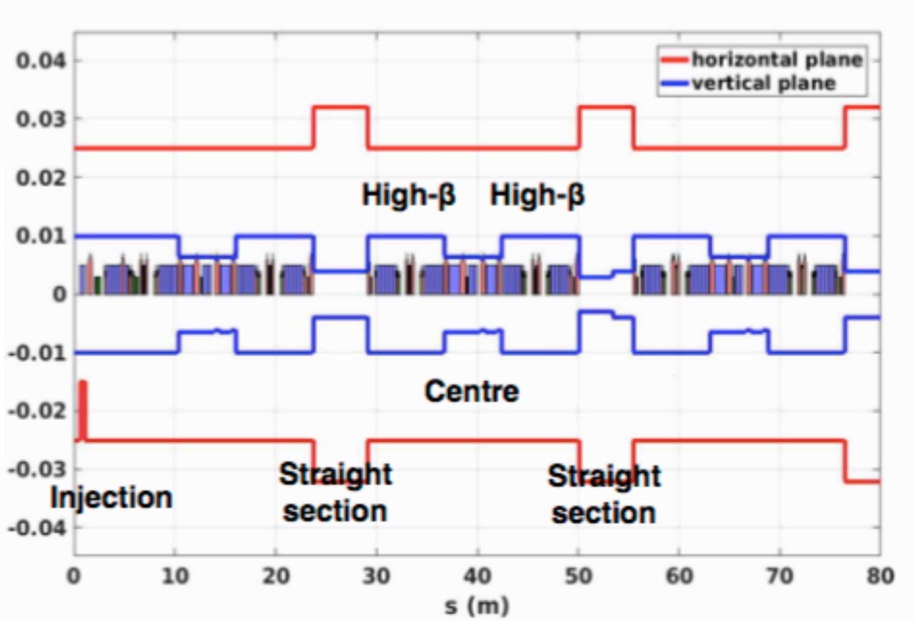
Most of the pass methods have two additional optional fields: RApertures and EApertures, for rectangular and elliptical physical apertures.

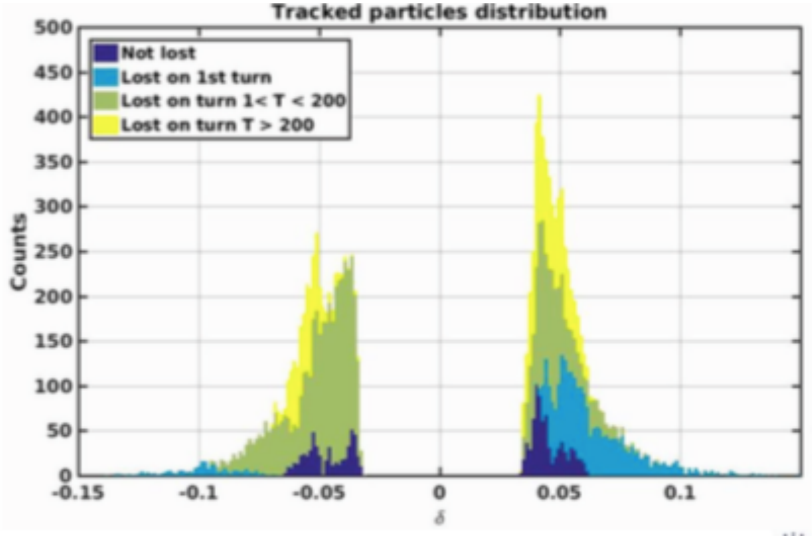
RApertures=[xlim -xlim ylim -ylim];

EApertures=[xlim ylim];



```
[ROUT, LOSS, NTURNS, LOSSINFO]=ringpass(...,'nhist',NHIST,...)
 Return additional information on lost particles
  NHIST       number elements before the loss to be traced (default: 1)
  LOSSINFO    1x1 structure with the following fields:
              turn        1xN vector, turn number where the particle is lost
              element     1xN vector, element number where the particle is lost
              coordinates 6xNxNHIST array, coordinates at the entrance of the
              LHIST elements before the loss
```

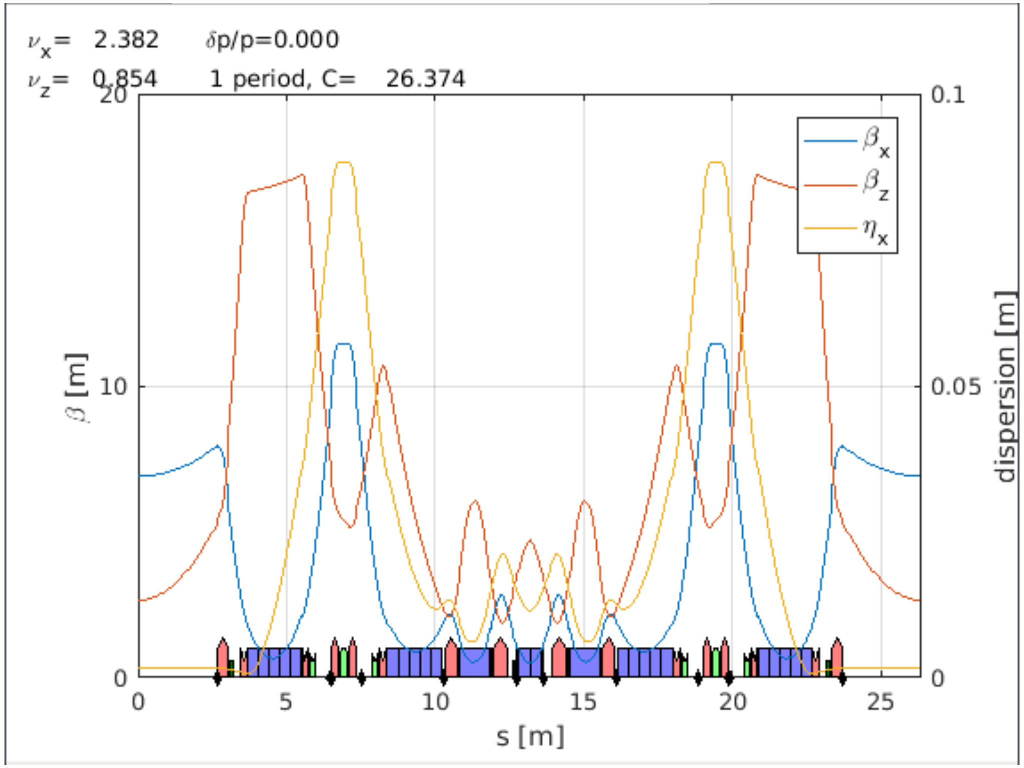




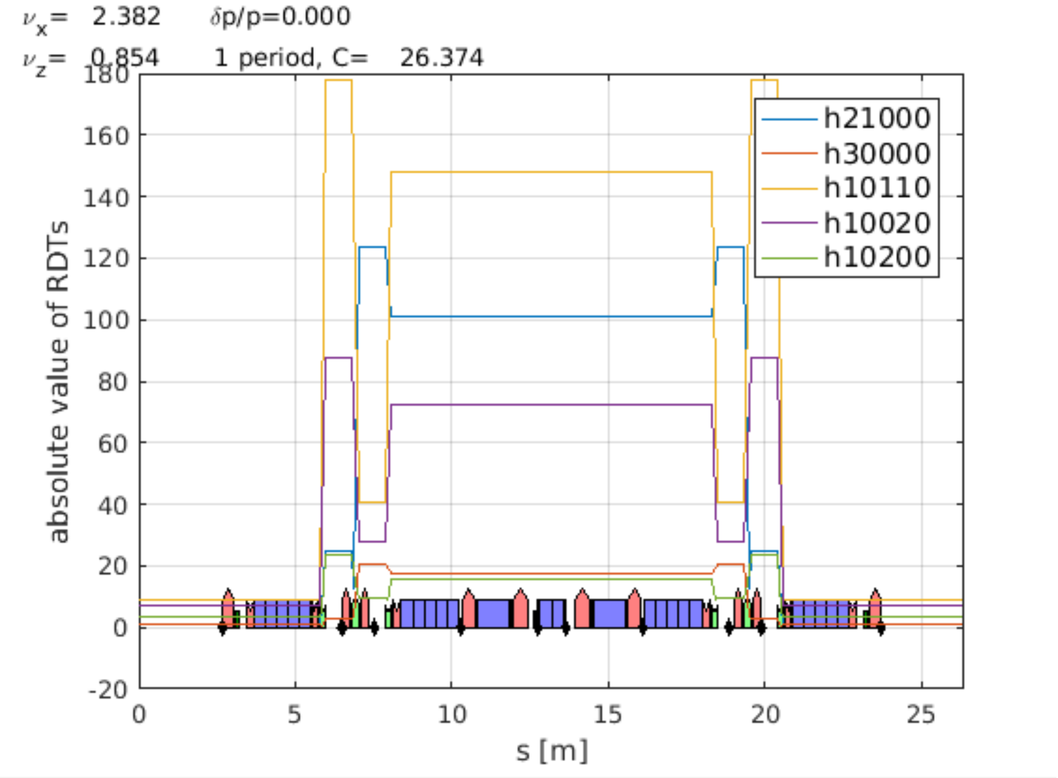
See R. Versteegen, “**Modeling of Beam Losses at ESRF**”, IPAC 15

ATPLOT

`atplot(arc)`

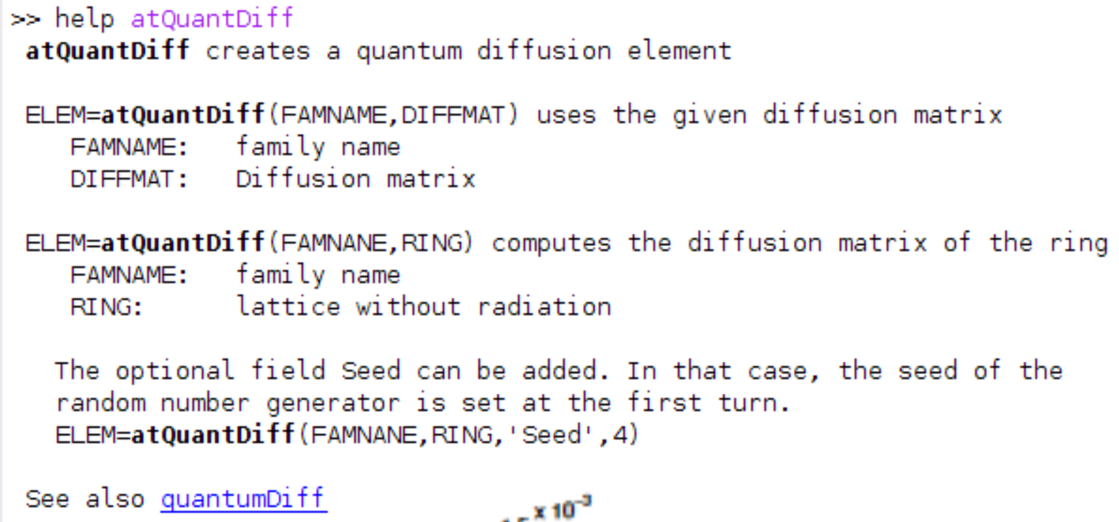


`atplot(arc,@plotRDT)`

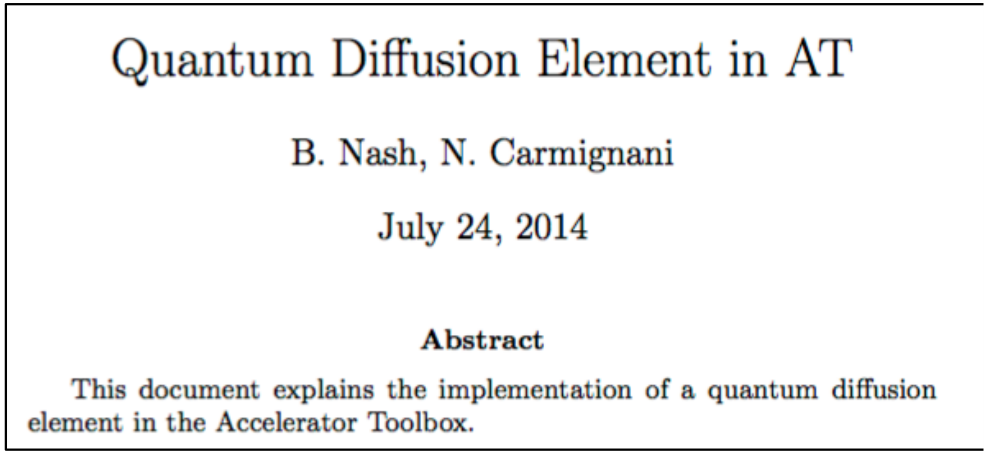


Further examples of plotting functions: curly H, beam sizes, closed orbit, physical apertures, W functions, second order dispersion

QUANTUM DIFFUSION



```
>> help atQuantDiff
 atQuantDiff creates a quantum diffusion element

 ELEM=atQuantDiff(FAMNAME,DIFFMAT) uses the given diffusion matrix
    FAMNAME:   family name
    DIFFMAT:   Diffusion matrix

 ELEM=atQuantDiff(FAMNANE,RING) computes the diffusion matrix of the ring
    FAMNAME:   family name
    RING:      lattice without radiation

   The optional field Seed can be added. In that case, the seed of the
   random number generator is set at the first turn.
   ELEM=atQuantDiff(FAMNANE,RING,'Seed',4)

 See also quantumDiff
```



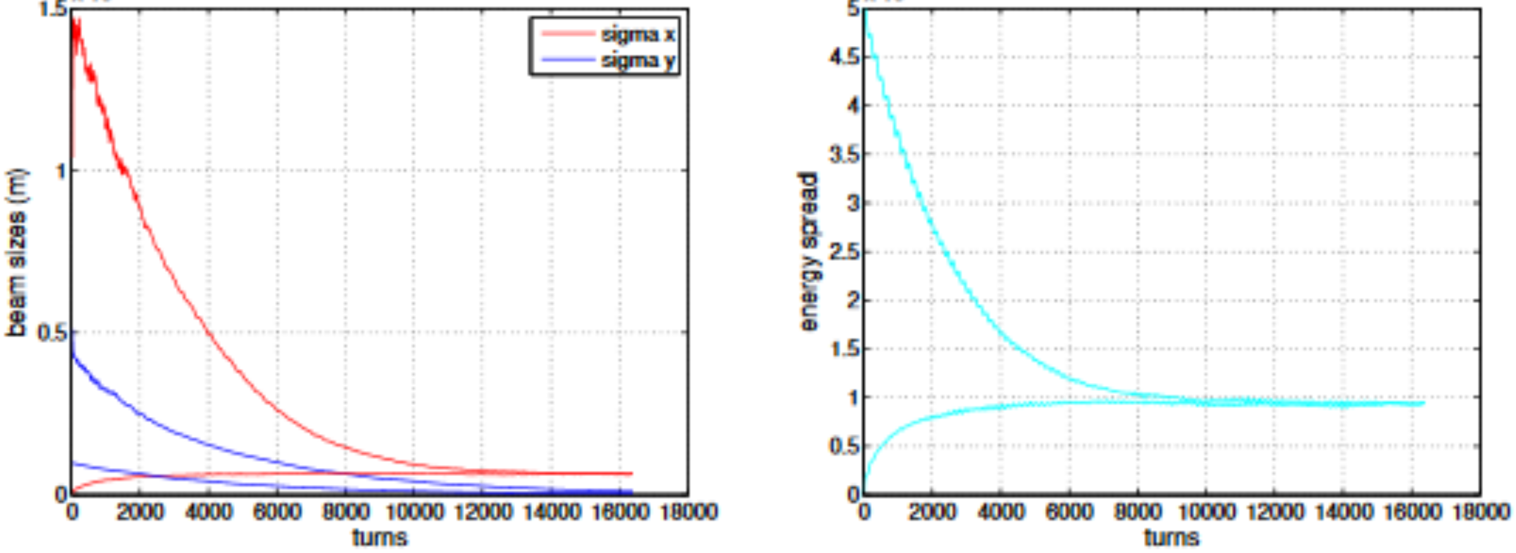
Quantum Diffusion Element in AT

B. Nash, N. Carmignani

July 24, 2014

Abstract

This document explains the implementation of a quantum diffusion element in the Accelerator Toolbox.



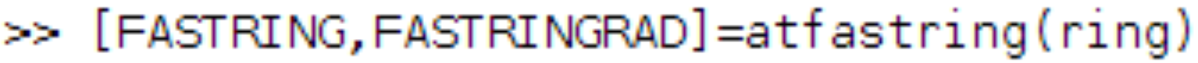
(a)

(b)

ATFASTRING

atfastring creates a lattice with only a few elements:

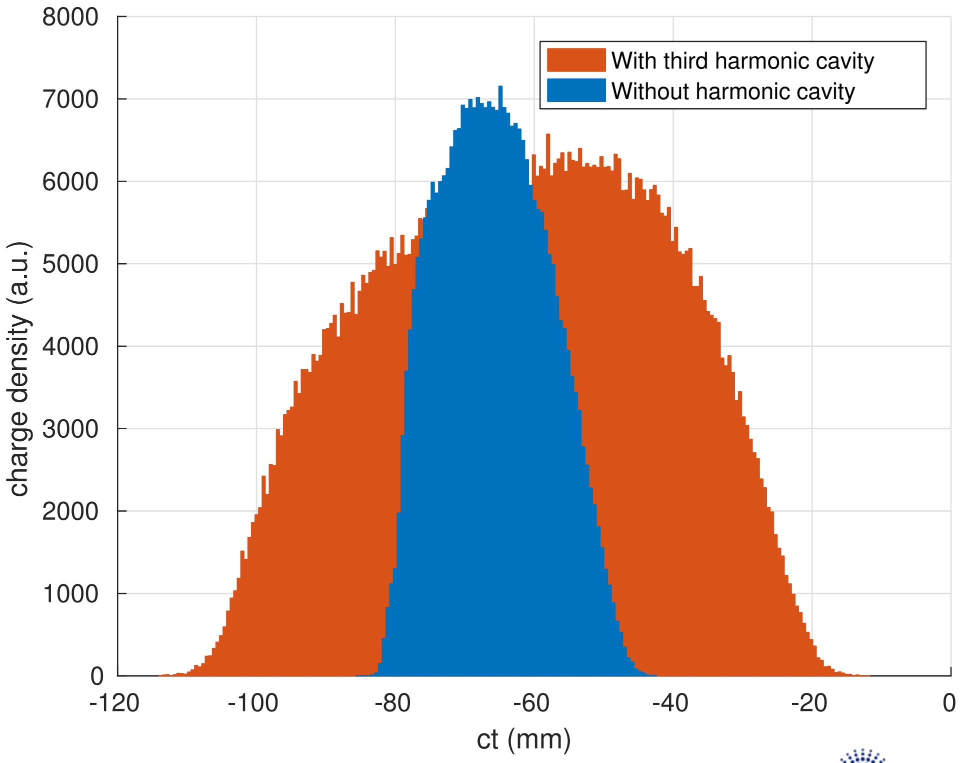
- **Linear matrix;**
- **Nonlinear element (chromaticity and detuning with amplitude);**
- **RF cavity;**
- **Quantum diffusion.**



```
>> [FASTRING,FASTRINGRAD]=atfastring(ring)
```

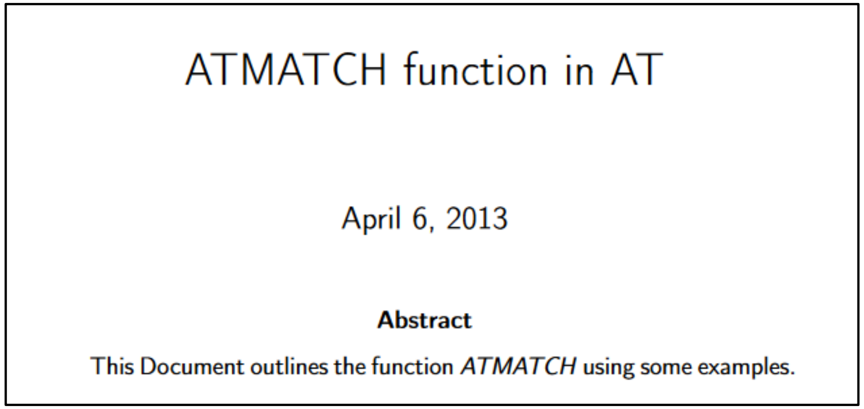
The fast ring can be used for impedance studies and for harmonic cavity studies.

Simulation done with the atfastring
300000 particles
200000 turns



ATMATCH

AT has now a function for general matching, written by Simone Liuzzo: atmatch



ATMATCH function in AT

April 6, 2013

Abstract

This Document outlines the function *ATMATCH* using some examples.

Matching an orbit bump with atmatch

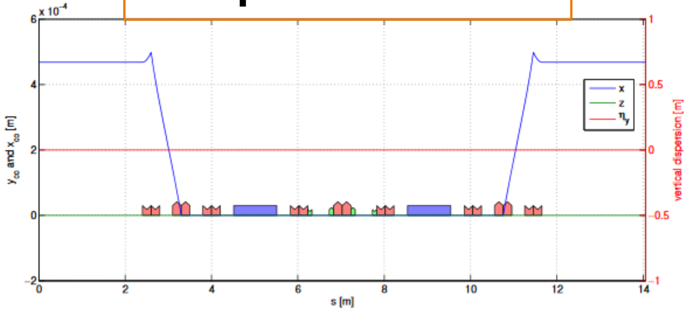
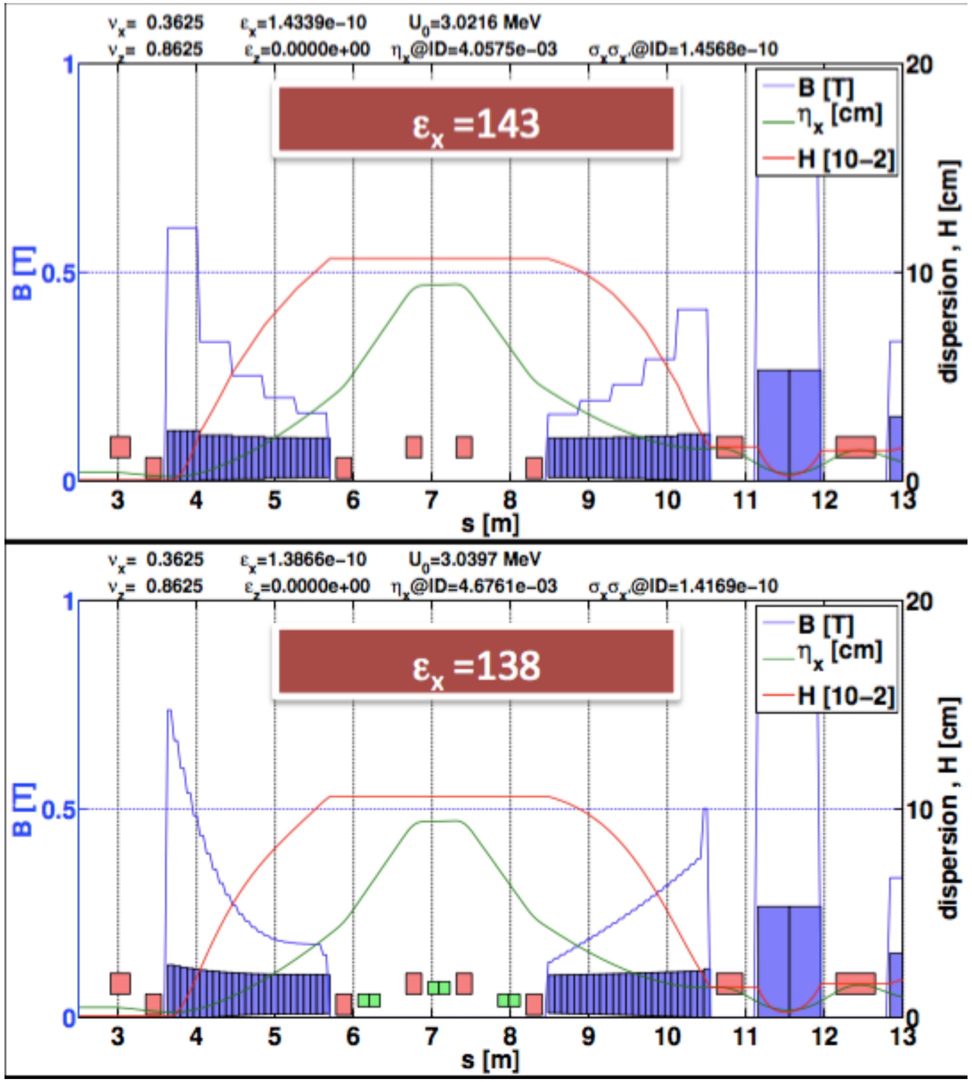


Figure 3: Bump in DBA cell.

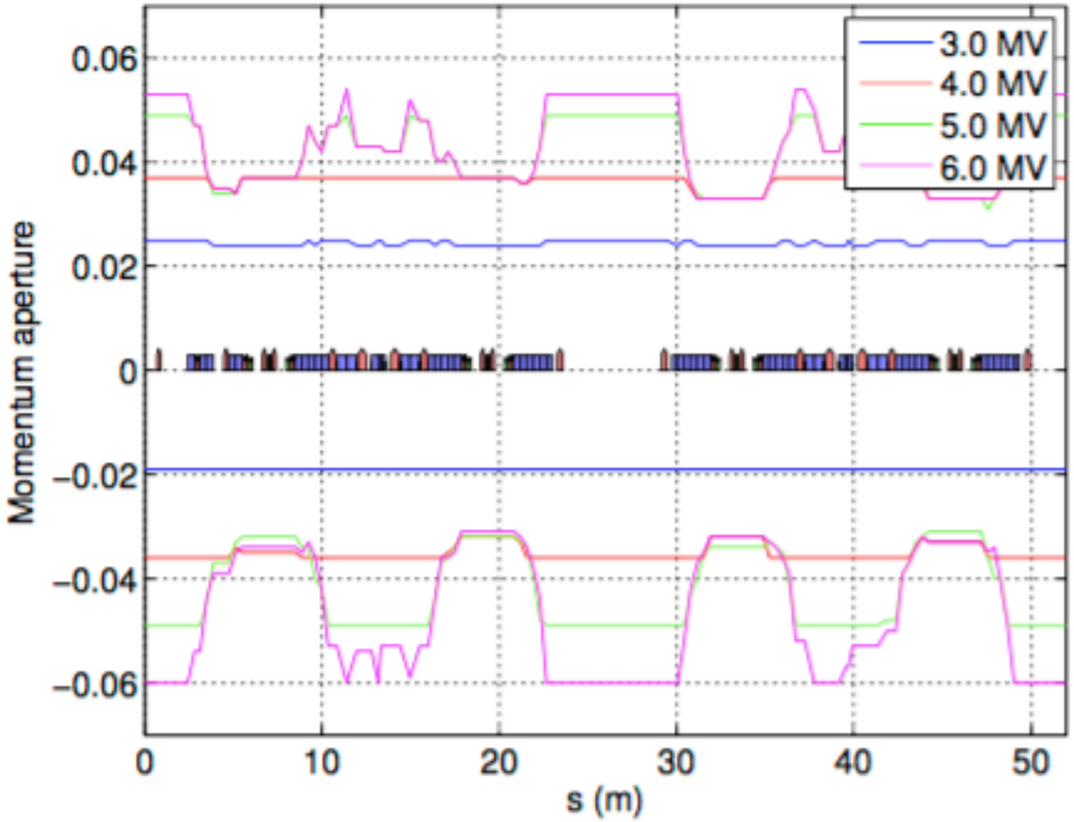
Matching of longitudinal gradient dipoles



TOUSCHEK LIFETIME

Momentum acceptance

The function TouschekPiwinskiLifetime computes the Touschek lifetime for a lattice, given the momentum acceptance

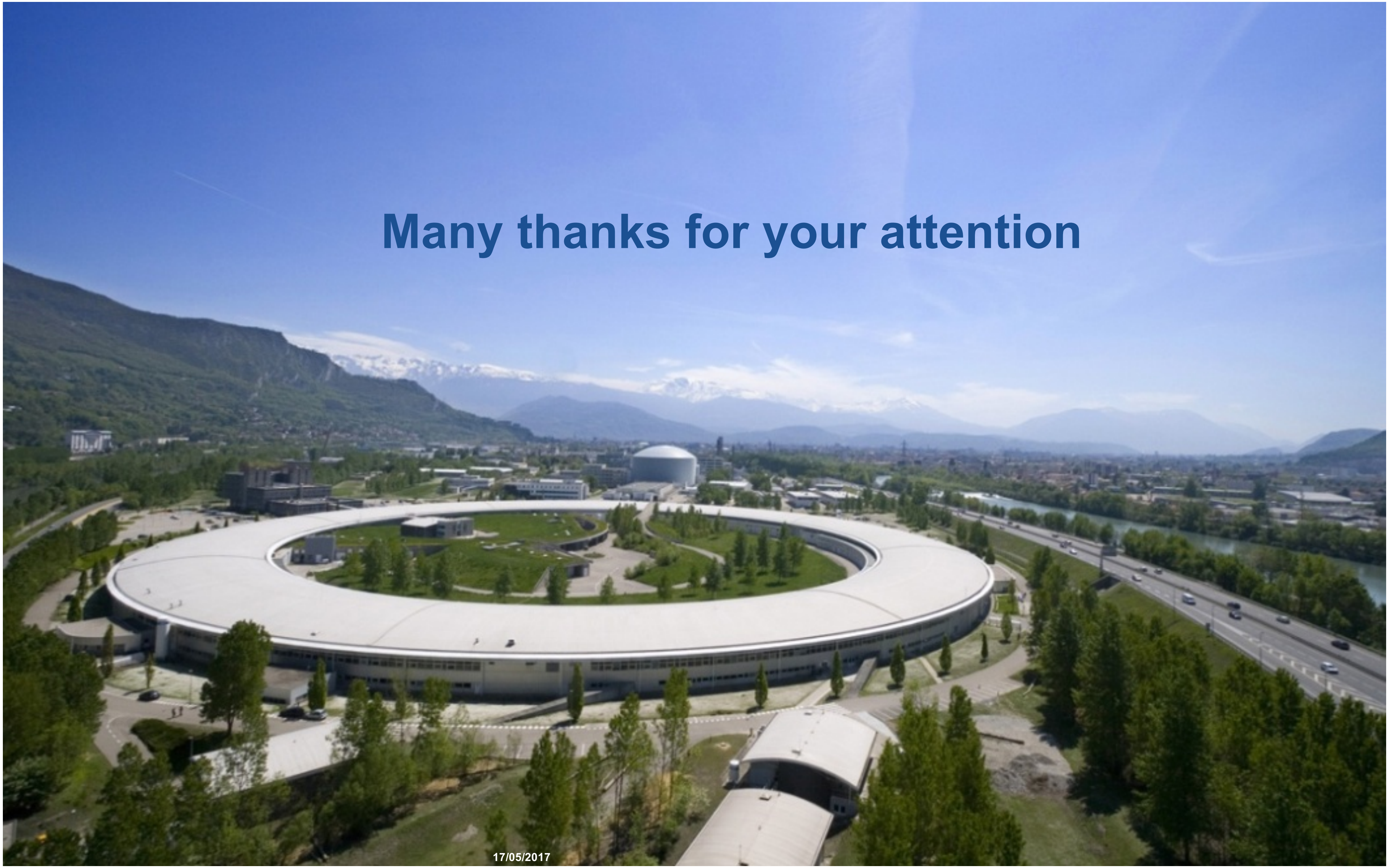


CONCLUSION

The version of AT in the sourceforge repository has many new features:

- physical apertures and losses information;
- atplot;
- quantum diffusion;
- atfastring;
- atmatch;
- Touschek lifetime;

It is backwards compatible, it is compatible with the python AT and it is 20% faster!



Many thanks for your attention