OPAL Status

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History and Motivation

- OPAL (Object Oriented Parallel Accelerator Library) combines: CLASSIC, MAD9, uses IPPL, H5Part and FixPo, IMPACT-T ideas.
  - OPAL doc: http://amas.web.psi.ch/docs/opal/user-guide-html/
  - More docs: http://amas.web.psi.ch/docs/index.html
- OPAL is a MAD language based particle (envelope) tracker including 3D space charge.
- OPAL comes in different flavors:
  - **OPAL-t (tracking with time as independent variable)**
  - OPAL-Cycl (cyclotron tracking module part of an Ph.D. project)
  - OPAL-Map (equivalent to Mad9p)
  - OPAL-FETD Ph.D. Project(s)

Why replace IMPACT-T ?

```
8 8
2.0e-12 20000 1
6 1000000 1 0 1 1 0.01
64 64 64 1 0.015 0.015 10.01
17 0 0 100 1.0e-11
0.0012 0.0012 0.0  1. 1. 0.0 0.
0.0012 0.0012 0.0  1. 1. 0.0 0.
2.96753035036325e-06 0.0 0.0  1.0 1.0 -2.96753035036325e-06 0.0019784
2.856 1.0 0.511005e+06  -1.0 2856.0e6 0.0
0.125985 10 20 105 0.0 57.1946046422954 2856.0e6 115.0 1.0 0.15 0.0 0.0 0.0 0.0 0.0 0.0 /
1.0 10 20 105 0.0 0.0 2856.0e6 34.86 2.0 0.15 0.0 0.0 0.0 0.0 0.0 0.0001 /
2.0 10 20 105 1.0 0.0 2856.0e6 34.86 3.0 0.15 0.0 0.0 0.0 0.0 0.0 0.0001 /
!0.0 1 45 -2 1.42 1.0 0.4777e-8 /
!0.0 1 55 -3 1.42 1.0 0.4777e-8 /
0.052464 10 20 105 1.42 25.5e6 2856.0e6 119 4.0 0.15 0.0 0.0 0.0 0.0 0.0 0.0 /
2.937928 10 20 105 1.472464 29430178.7820912 2856.0e6 148.9504449 5.0 0.15 0.0 0.0 0.0 0.0 0.0 0.0 /
2.937928 10 20 105 1.472464 29430178.7820912 2856.0e6 209.0 6.0 0.15 0.0 0.0 0.0 0.0 0.0 0.0 /
0.05246 10 20 105 4.410392 25.5e6 2856.0e6 119 7.0 0.15 0.0 0.0 0.0 0.0 0.0 0.0 /
0.537148 10 20 0 4.462852 0.15 /
```

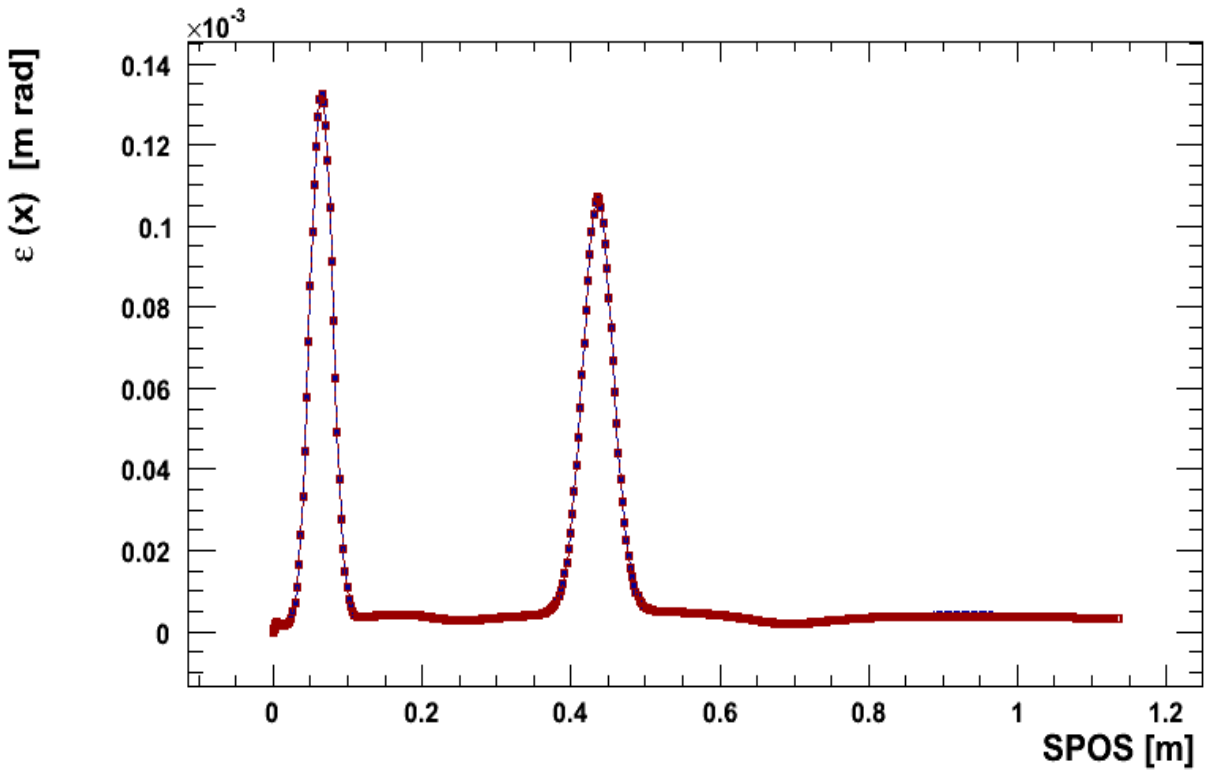
Much nicer with OPAL-t

```
Edes=1.0;
gamma=(Edes+PMASS)/PMASS;
beta=sqrt(1-(1/gamma^2));
gambet=gamma*beta;
P0 = gamma*beta*PMASS;
brho = (PMASS*1.0e9*gambet) / CLIGHT;


// L:        physical element lenght (real)
// KS:       field scaling factor (real)
// FMAPFN:   field file name (string)
// ELEMEDGE: physical start of the element on the floor (real)

sol0: Solenoid, L=0.001, KS=0.31250, FMAPFN="1T2.T7",
       ELEMEDGE=0.0580;
...

rf1: RFCavity, L=0.01, VOLT=35.50, FMAPFN="1T3.T7",
      ELEMEDGE=0.129, TYPE="STANDING", FREQ=1498.956,
      LAG=144.0/360.0;
...
lrf0: RFCavity, L=0.0253, VOLT=14.750, FMAPFN="INLB-02.Ez",
      ELEMEDGE=2.73066, TYPE="TRAVELING", NUMCELLS=40,
      MODE=1/3, ACCURACY=39, FREQ=1498.956, LAG=0.3;
...
l1:   Line = (sol0,rf1,rf2,sol1,sol2,sol3,sol4,sol5,sol6,sol7,sol8,lrf0);
```

```
Dist1:DISTRIBUTION, DISTRIBUTION=gauss,
sigmax=  1.0e-03, sigmapx=1.0e-4, corrx=0.5,
sigmay=  2.0e-03, sigmapy=1.0e-4, corry=-0.5,
sigmat=  3.0e-03, sigmapt=1.0e-4, corrt=0.0;

Fs1:FIELDSOLVER, FSTYPE=FFT, MX=64, MY=64, MT=64,
                 PARFFTX=true, PARFFTY=true, PARFFTT=false,
                 BCFFTX=open, BCFFTY=open, BCFFTT=open;

beam1: BEAM, PARTICLE=ELECTRON, pc=P0, FIELDSOLVER=FFT,
           SPACECHARGE=true, NPART=1e4, MAXSTEPS=36000,
           DT=1.0e-12;

track,line=l1, beam=beam1;
 run, method = "PARALLEL-T", beam=beam1,
       fieldsolver=Fs1, distribution=Dist1;
endtrack;
```

- Overall state of the art design
- Scalable (x 1000-cores Mad9p experience)
- OPAL-t reduces the amount of “scripting”
- MAD-Language
- Error studies will be much easier
- Optimizer included in OPAL

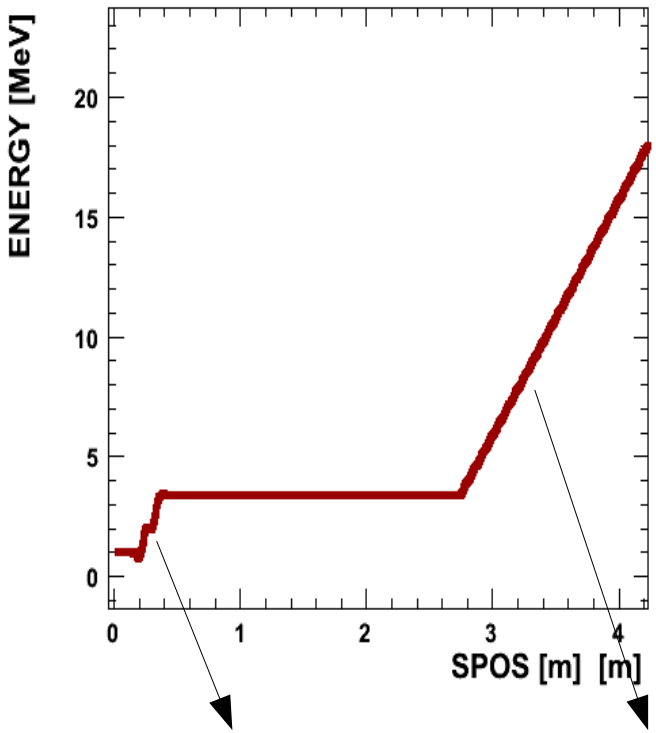
OPAL-t Validation – OBLA

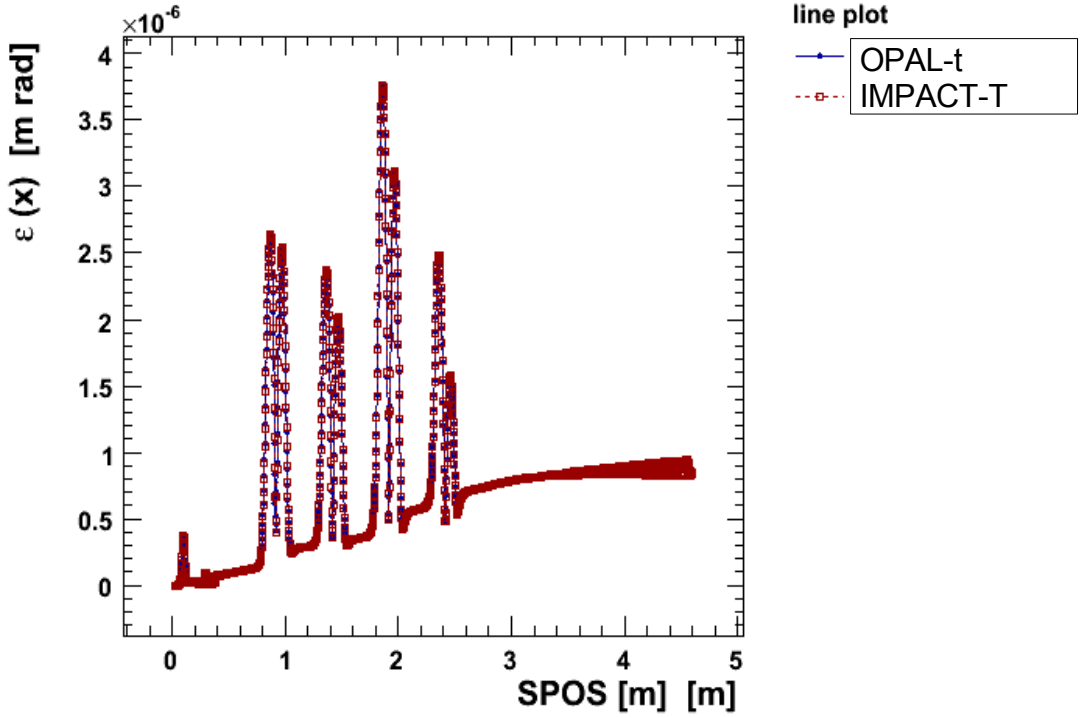


- OBLA post gun
- With space charge

Implementation and tested by Yves Ineichen (summer student 2007)

OPAL-t Validation - Acceleration





Standing wave Traveling wave

Implementation and tested by Yves Ineichen (summer student 2007)

Next Steps

- OPAL-t Model ready this year for
  - OBLA including gun
  - 250 MeV injector
- 1D CSR model
- Wake field model (a la K. Bane)
- Space charge solver with boundaries (master thesis Yves Ineichen)
- OPAL-t hands-on seminar early 2008!