Status of 3D Simulations for OBLA Phase I and II

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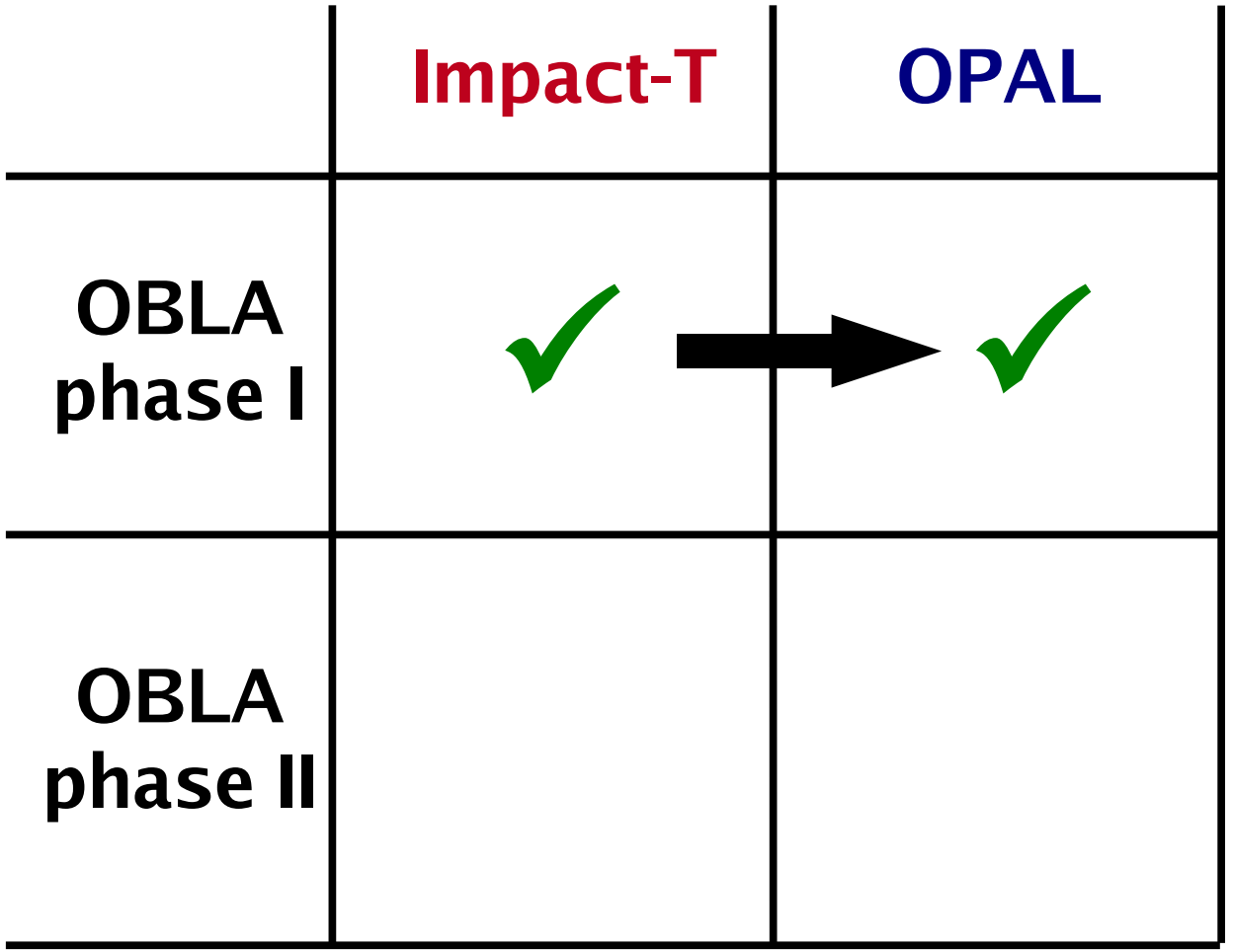
Outline

	Impact-T	OPAL
OBLA phase I	✓	
OBLA phase II		

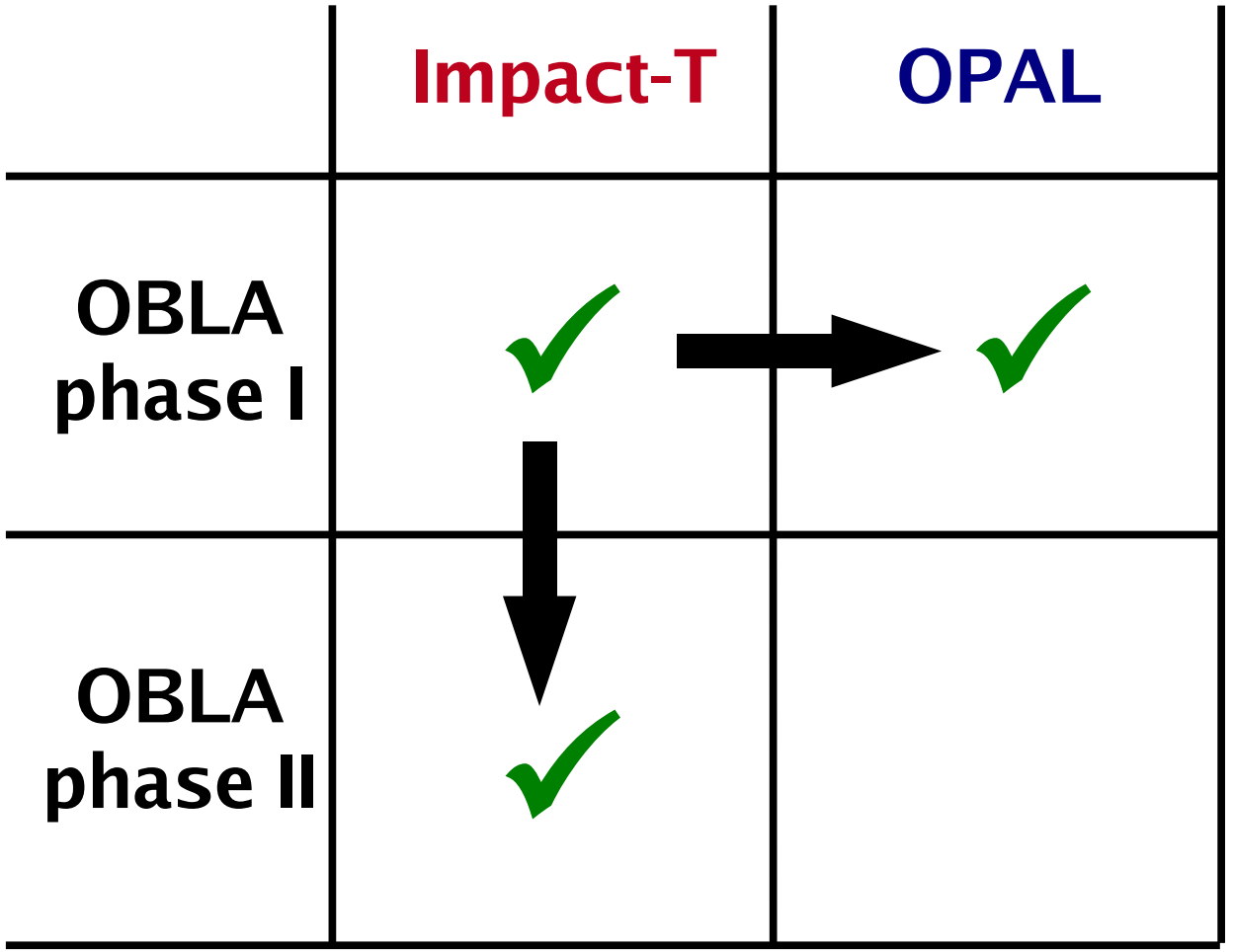
- Long time ago, see http://amas.web.psi.ch/projects/fel/obla

Outline



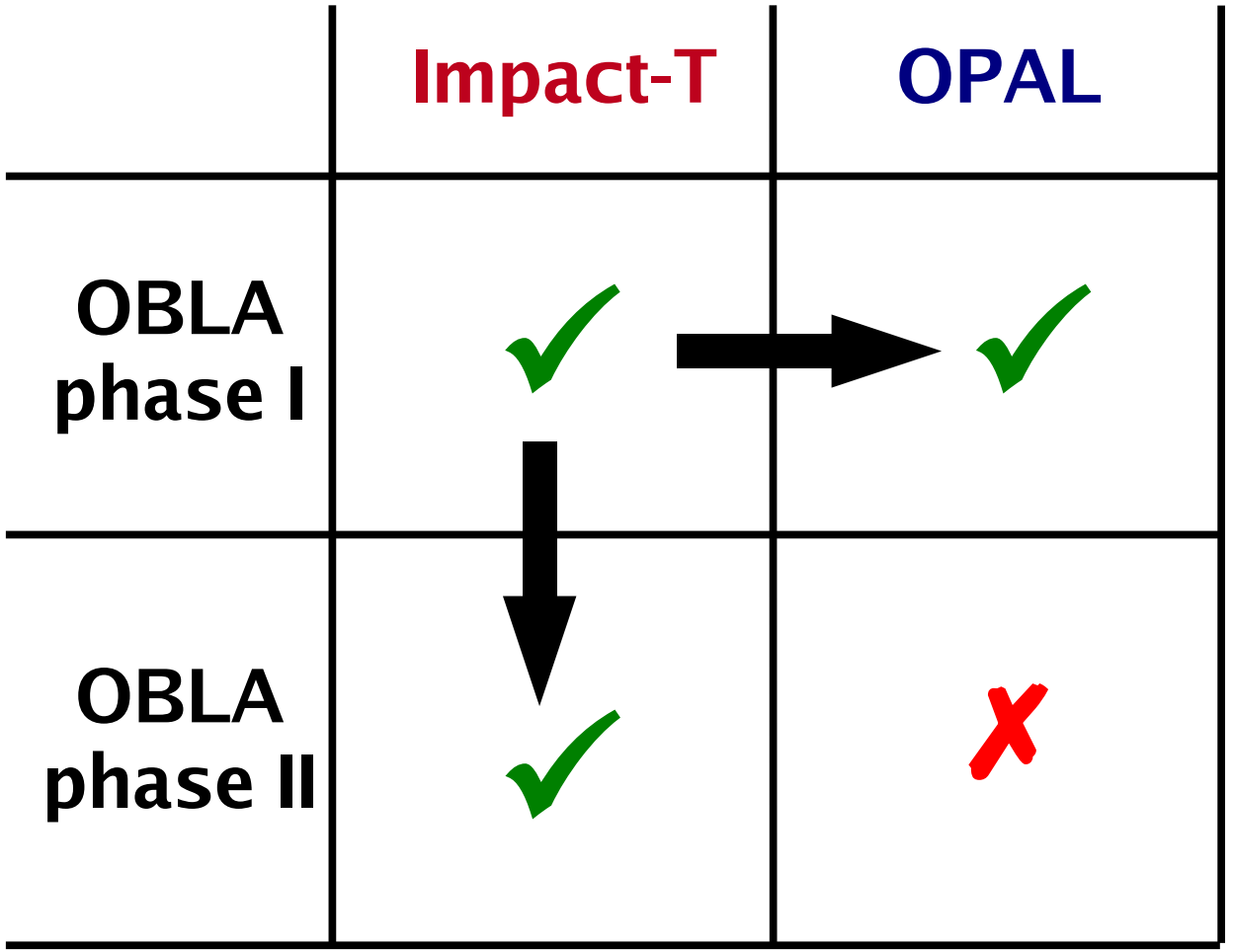
- New input file for gun (thanks Andreas)
- Restart after gun (requires separate input file...)
- Identical field maps (T7 files)
- No problems

Outline



- Same gun
- New lattice and field-maps afterwards
- No problems

Outline



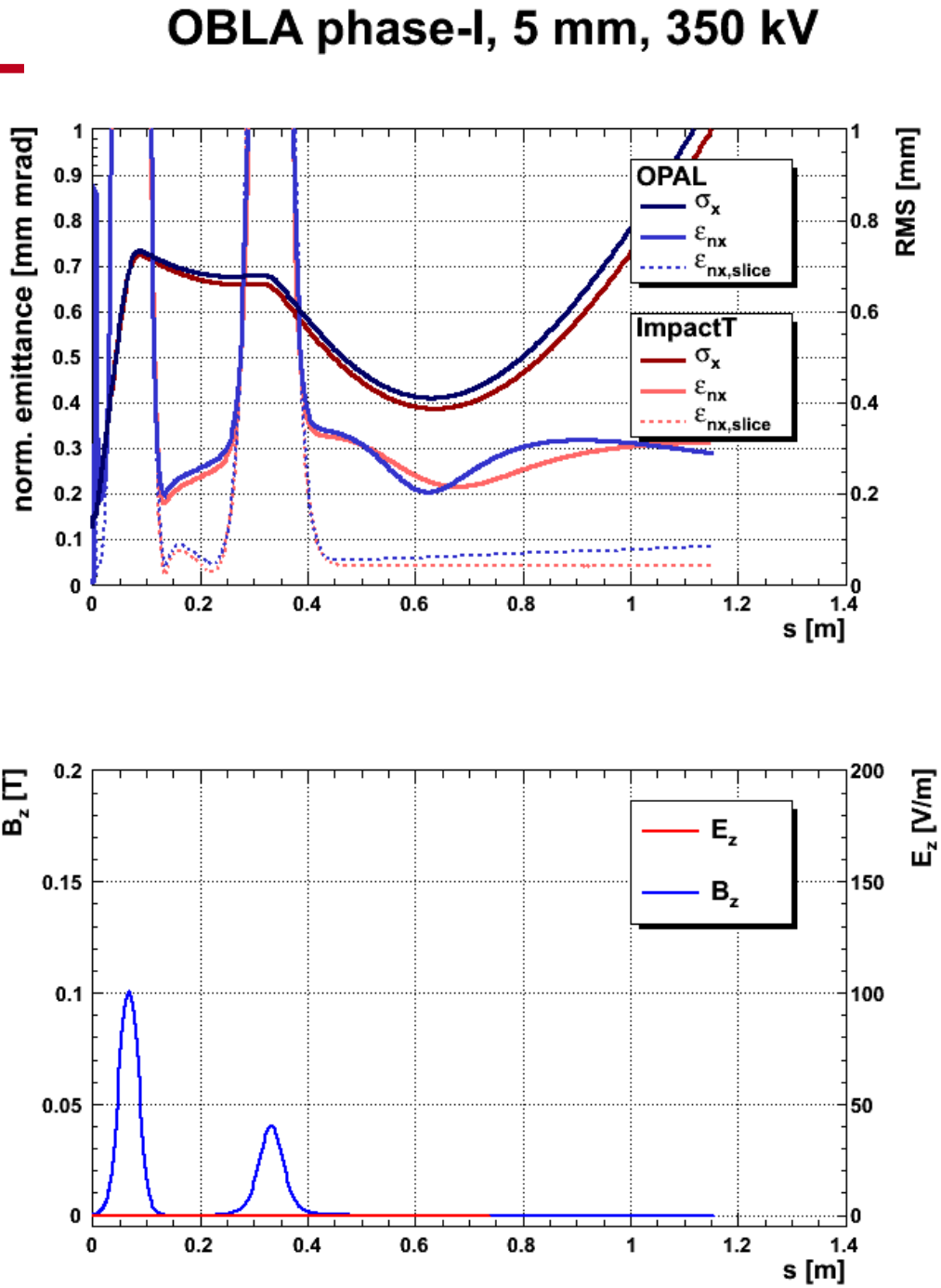
- Not yet
- No problem expected (but important test for OPAL)

OBLA “500 keV”

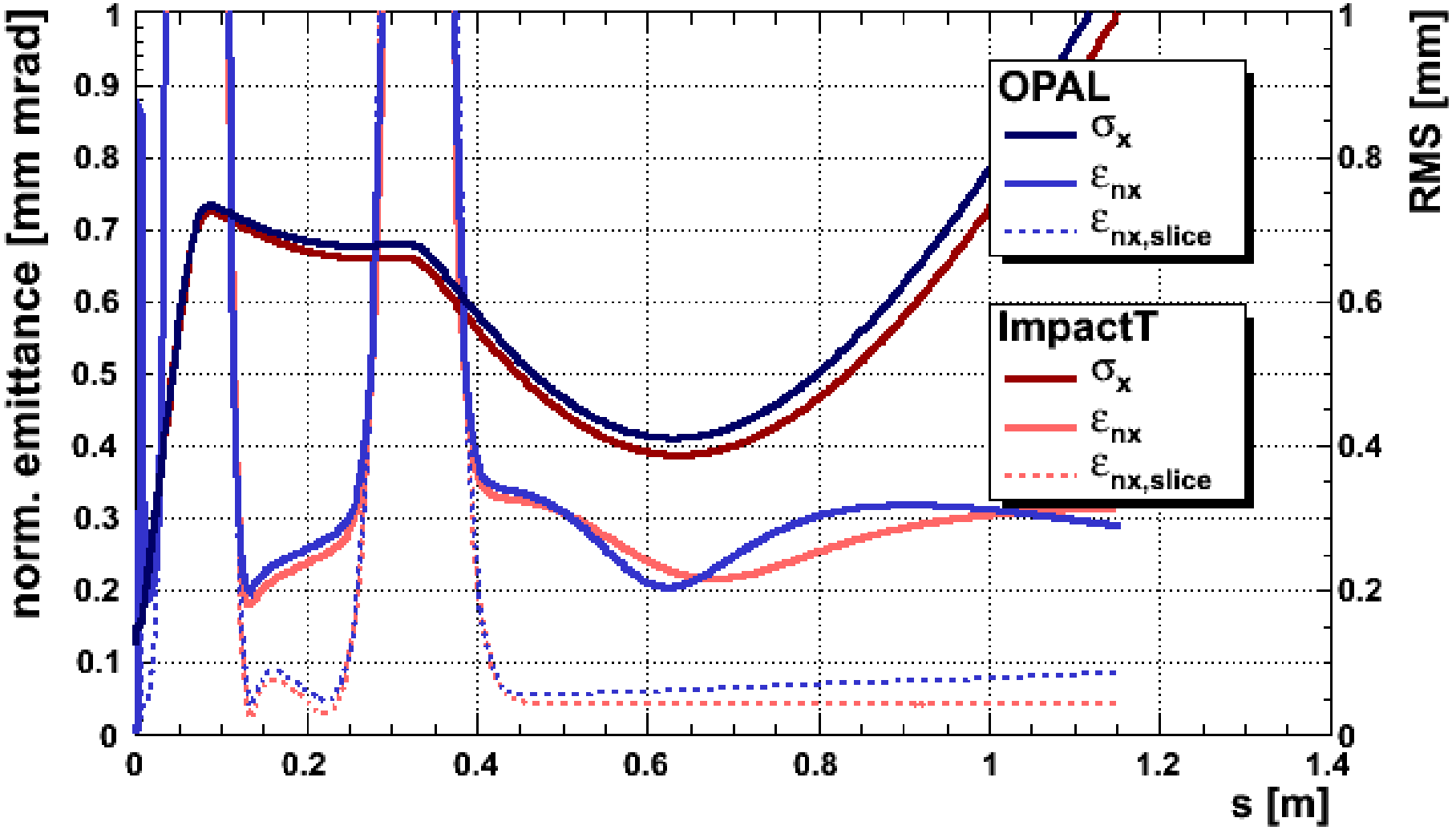
- All simulations until now in Impact-T
  - See http://amas.web.psi.ch/projects/fel/obla/
- Works fine, but serious limitations when it comes to modeling the initial distribution at the cathode.
  - Intricate emission mechanism, only really understood by Ji
- Move on to OPAL, version 1.0.0 now available on merlin cluster
- Mutual benefits:
  - OPAL gives us the freedom needed to simulate **any** gun.
  - OBLA is an excellent real-world test bed for OPAL
    - I am not involved in the development of OPAL: a true user with dumb questions and outlandish requests.

Impact-T vs OPAL

- Charge: 6 pC
- Cathode-anode: 5mm, 350 kV
- 50k macroparticles
- Mesh: 32 × 32 × 32
- Time step: 0.1 ps (gun), 1 ps (after)
- σ_t: 6.5 ps; $r_{x,y}$: 300 μm
- Emission process is not exactly the same, we must expect some difference
- Very satisfying agreement!
- Origin of increase in slice emittance in OPAL?



OBLA phase-I, 5 mm, 350 kV



Input file OPAL (gun)

```
Option, TFS=FALSE;
Option, ECHO=FALSE;
Option, PSDUMPFREQ=10;
Title,string="OBLA Gun";

Edes=1.0E-9;
gamma=(Edes+EMASS)/EMASS;
beta=sqrt(1-(1/gamma^2));
gambet=gamma*beta;
P0 = gamma*beta*EMASS;
brho = (EMASS*1.0e9*gambet) / CLIGHT;

value,{gamma,brho,Edes,beta,gambet};

SP1: Solenoid, L=1.20, ELEMEDGE=-0.5335, FMAPFN="1T2.T7", KS=1e-04;
SP2: Solenoid, L=1.20, ELEMEDGE=-0.399, FMAPFN="1T3.T7", KS=0.0;
SP3: Solenoid, L=1.20, ELEMEDGE=-0.269, FMAPFN="1T3.T7", KS=4e-05;

gun: RFCavity, L=0.011, VOLT=-71.596, FMAPFN="1T1.T7", ELEMEDGE=0.00,
     TYPE="STANDING", FREQ=1.0e-6;

l1:   Line = (gun,sp1,sp2,sp3);

qb=6.0E-12;
rf=1498.956e6;
v0=beta*CLIGHT;
lz  = 6.5E-12*v0;
value,{v0,lz};

Dist1:DISTRIBUTION, DISTRIBUTION=gungauss,
    sigmax=  0.00030, sigmapx=0.0, corrx=0.0,
    sigmay=  0.00030, sigmapy=0.0, corry=0.0,
    sigmat=  lz, sigmapt=1.0, corrt=0.0 , TEMISSION=3.9e-11, NBIN=39,
    DEBIN=1;
MINSTEPFORREBIN=1000;

Fs1:FIELDSOLVER, FSTYPE=FFT, MX=32, MY=32, MT=32,
         PARFFTX=true, PARFFTY=true, PARFFTT=false,
         BCFFTX=open, BCFFTY=open, BCFFTT=open,
         BBOXINCR=1, GREENSF=STANDARD;

beam1: BEAM, PARTICLE=ELECTRON, pc=P0, NPART=50000,
       BCURRENT=0.008993736, BFREQ=rf, CHARGE=-1;

Select, Line=l1;

track,line=l1, beam=beam1, MAXSTEPS=2000, DT=1.0e-13;
  run, method = "PARALLEL-T", beam=beam1, fieldsolver=Fs1,
       distribution=Dist1;
endtrack;
Stop;
Quit;
```

Input file Impact-T (gun)

- More compact, but harder to read

```
1 1 /
1.0e-13 2000 39 /
6  1282 1 0 1 1 0.02 /
32 32 32 1 0.003 0.003 0.05 /
23 0 0 390 3.9e-11 /
0.00030 0.0 0.0 1.0 1.0 0.0 0.0 /
0.00030 0.0 0.0 1.0 1.0 0.0 0.0 /
3.84493391959e-06 0.0 0.0 1.0 1.0 -1.15348017588e-05
0.00197835937429 /
0.000230608615385  1.0  0.511005e+06   -1.0    1498.956e6  0.0
0.0 10 20 -5 0.0 0.0 0.0 /
0.0 1 1    -7 0.0 0.0 0.015 0.0 /
0.011 10 20 112 0.000 -6.9986e-05 1.0E-6 0.0 1.0 0.0253 0.0 0.0
0.0 0.0 0.0 /
0.024 10 20 0 0.0 0.105 /
1.200 10 20 3 -0.5335 1e-04 2.0 0.005 0.0 0.0 0.0 0.0 0.0 /
1.200 10 20 3 -0.274 0.000000 3.0 0.005 0.0 0.0 0.0 0.0 0.0 /
1.200 10 20 3 -0.054 0.000000 3.0 0.005 0.0 0.0 0.0 0.0 0.0 /
```

Python scripts to run simulations

- A set of python scripts have been set up (and committed to the svn repository) to run the full OBLA-I and -II simulation in either Impact-T or OPAL.
- Example: the comparison shown before was run with

```
runOBLAWithGun.py SP1B=100 SP3B=40 GAP=5 VGAP=350
```

(for Impact-T)

```
runOBLAWithGun.py -OPAL SP1B=100 SP3B=40 GAP=5 VGAP=350 CORES=4
```

(for OPAL, parallel!)

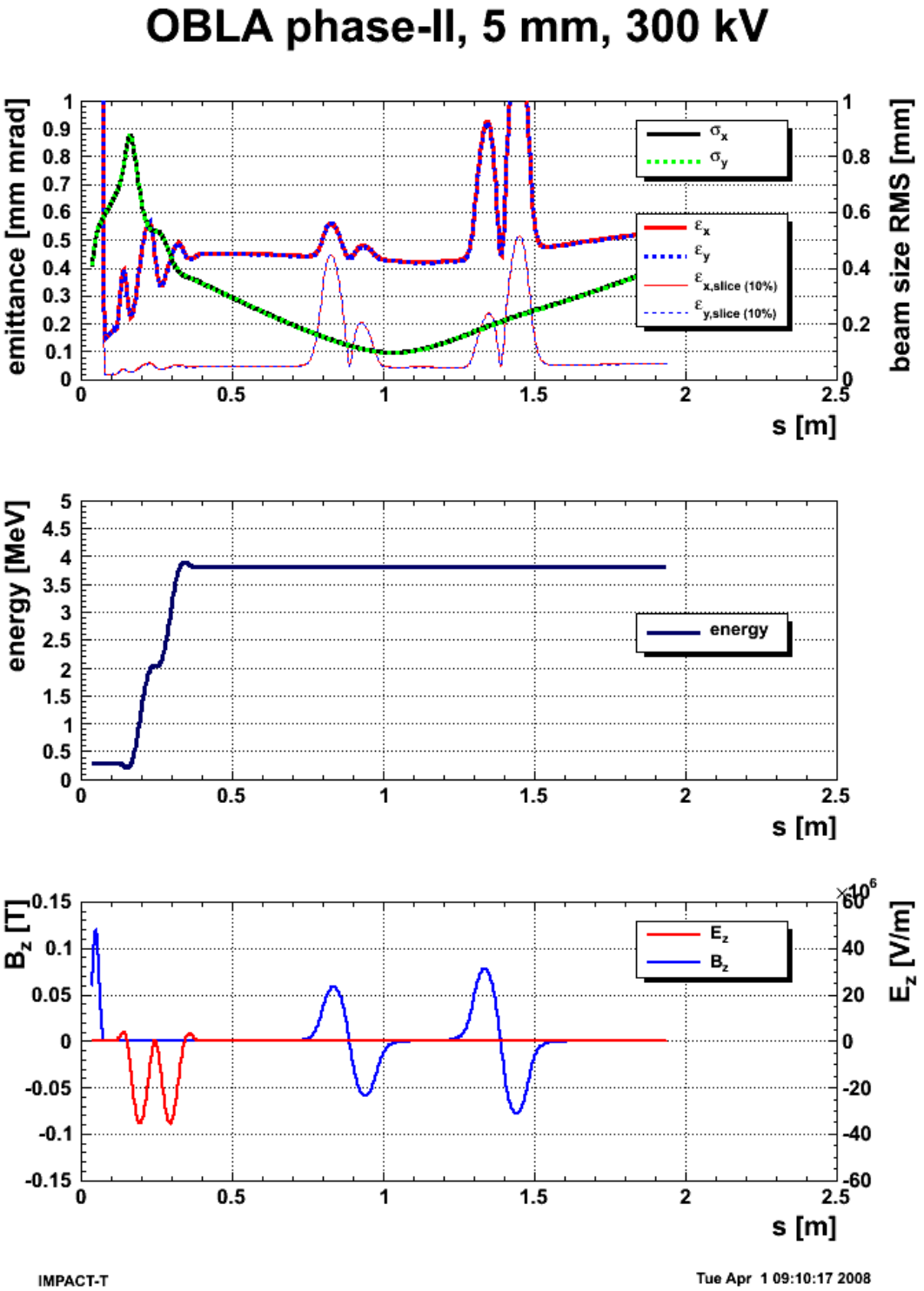
- The script creates a directory, simulates the gun, then the remaining beamline.
- Some ~50 parameters can be set via the command line (the order does not matter), parameters not set will be at some default values.
- Anyone with an account on merlin can run this simulation right away!

OBLA “4 MeV”

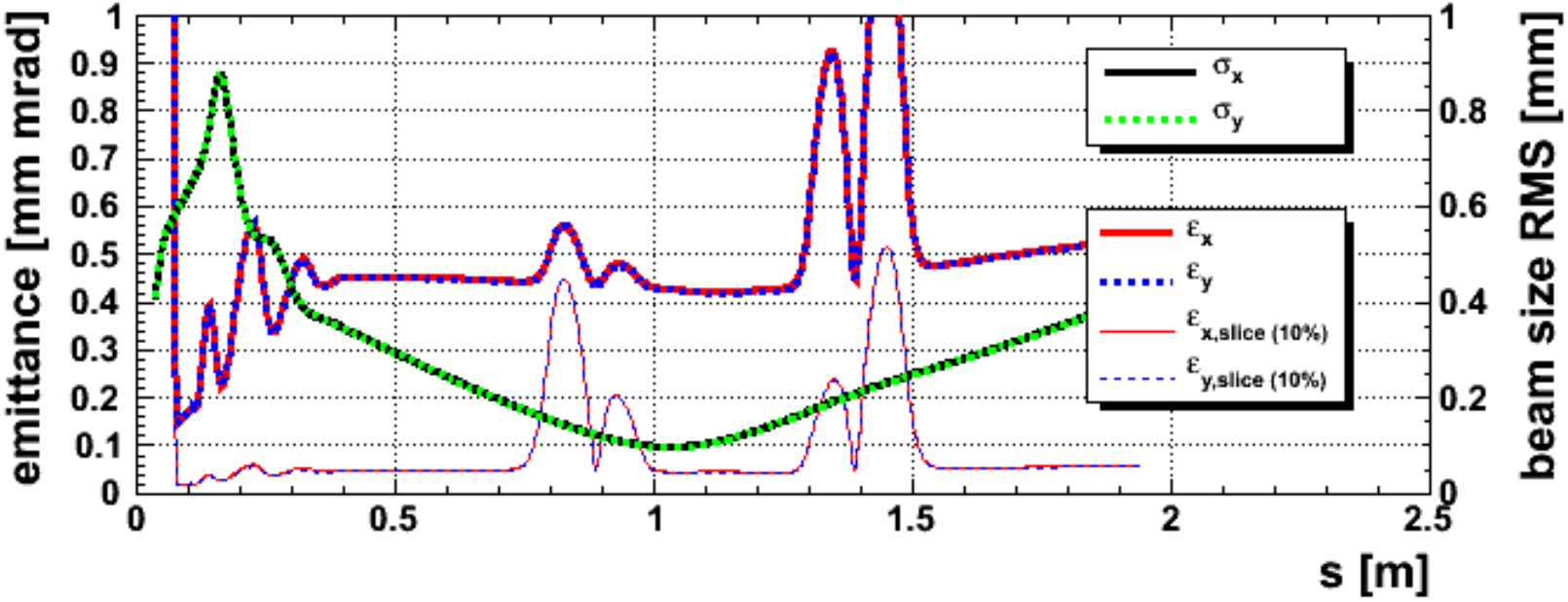
- Try first in Impact-T, move to OPAL once everything looks reasonable.
- Lattice (device positions and lengths): for now stick to Kevin's note FEL-LK-002-01 (complemented by private communication with Kevin):
  - **Pulsed solenoid:** center 40 mm from anode
  - **Cavity:** center of first cell 185 mm from anode
  - **First double solenoid:** 880 mm from anode
  - **Second double solenoid:** 1380 mm from anode
- New reference will be FEL-BR06-003 (but not released yet?)
- Field maps: for the time being use Steve Russell's files (3D injector simulation), later update them one by one.
- Adjust field map positions until fields are in the right position.
- Only fundamental mode in cavity (OBLA 2008), phase on-crest.
- **`runOBLA2WithGun.py PSLB=120 SL10B=60 SL20B=80 GAP=5 VGAP=300`**

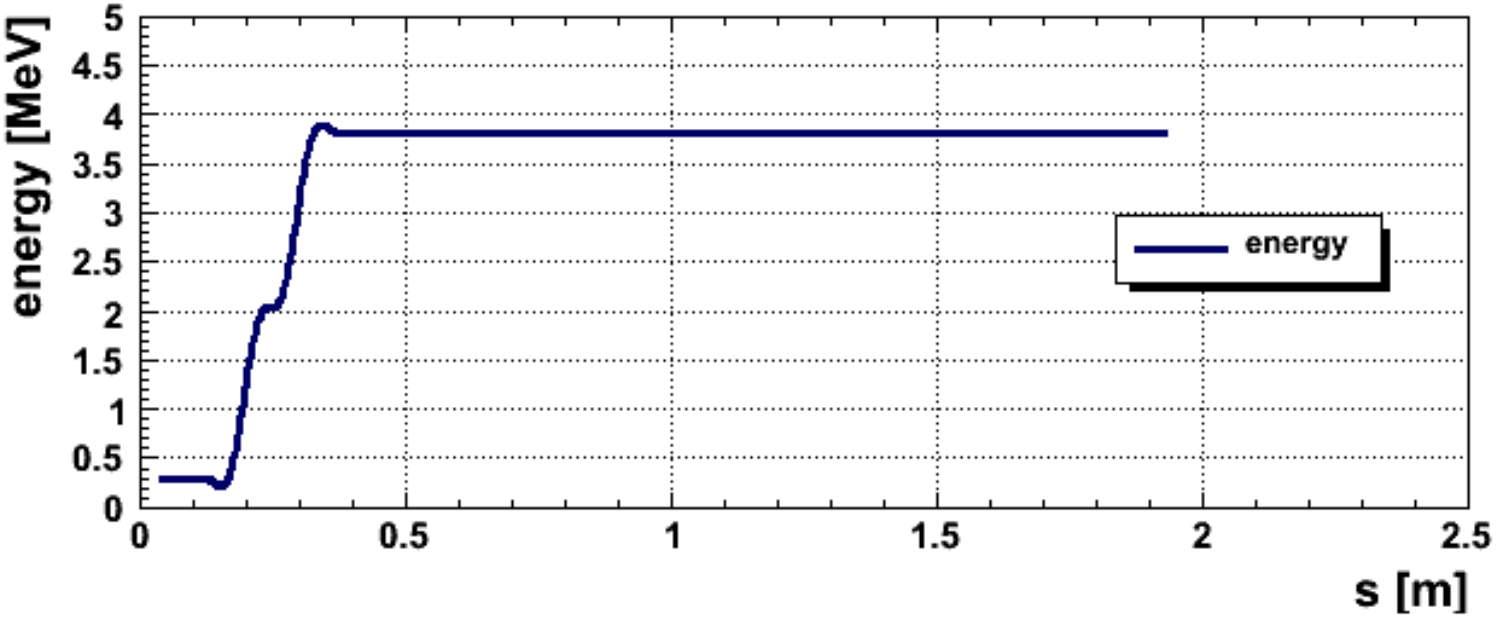
OBLA 4 MeV (Impact-T)

- Charge: 6 pC
- Cathode-anode: 5mm, 300 kV
- 50k macroparticles
- Mesh: 32 × 32 × 32
- Time step: 0.1 ps (gun), 1 ps (after)
- σ_t: 6.5 ps; $r_{x,y}$: 300 μm
- A first look – not yet optimized in any way.

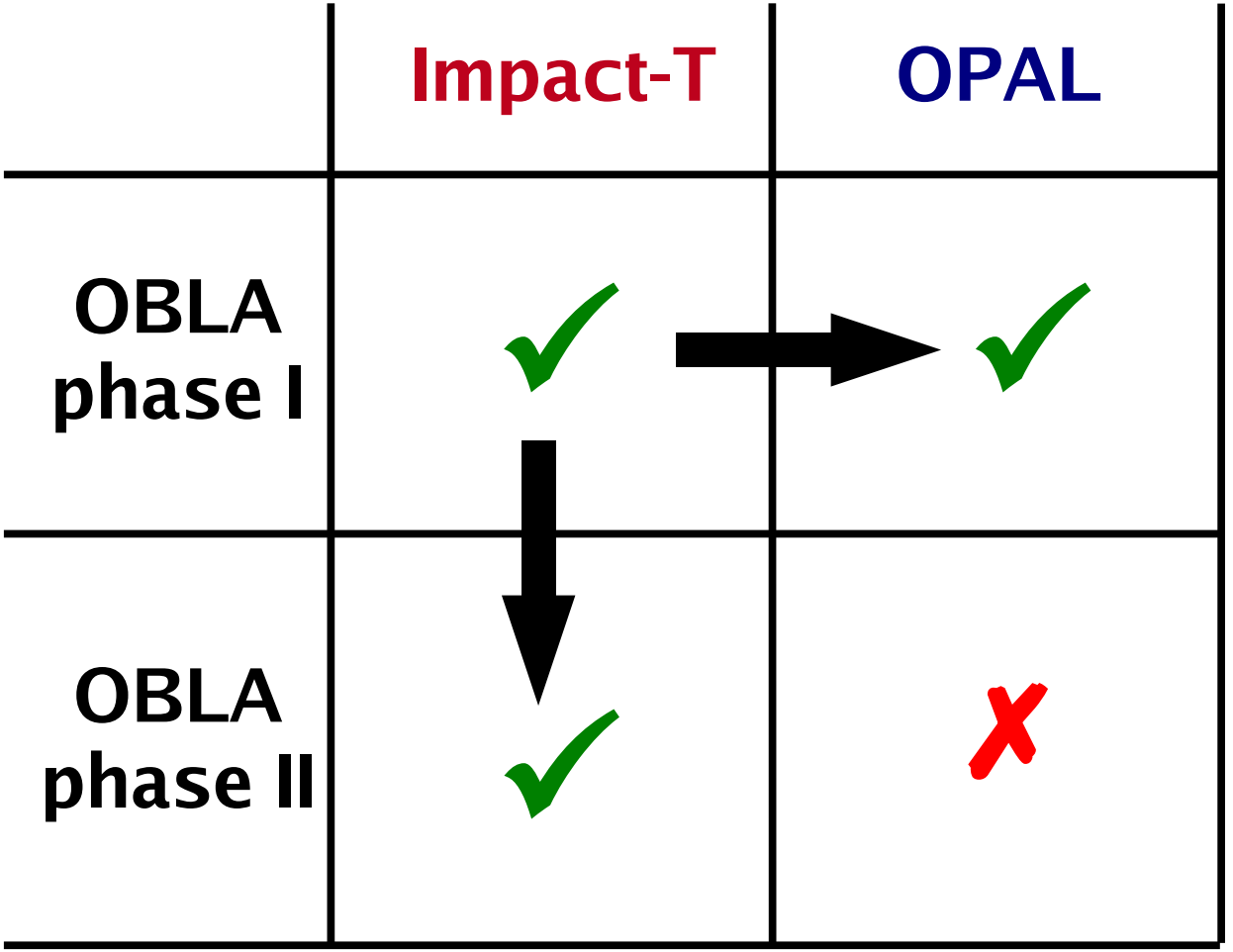


OBLA phase-II, 5 mm, 300 kV





Conclusion



- Work in progress!