# OPAL Status – 1.1.5

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for the OPAL development team

On felsim:

```
module load opal-1.1.5
```

On Horizon (CSCS):

```
export PATH=~adelmann/bin:$PATH
```

# New Features -1

## Thermal Emittance
- based on the discussions at dedicated FELSI-Meeting in Dec. 2009

```
==>help, Distribution;
   +1 help, Distribution;
OPAL >
OPAL > The DISTRIBUTION statement defines data for the 6D particle distr.
Attributes:
OPAL >  string DISTRIBUTION    Distribution type: … GUNGAUSSFLATTOPTH
OPAL >  real            ELASER          Laser energy (eV)
OPAL >  real            SIGLASER        Sigma of (uniform) laser spot size (m)
OPAL >  real            W               Workfunction of material (eV)
OPAL >  real            FE              Fermi energy (eV)
OPAL >  real            AG              Acceleration Gradient (MV/m
```

# New Features 2 - Short Range Wakefields

Short Range Wakefields

- SLAC-PUB-4169 (K.L.F Bane)
- our implementation passes analytic tests
- read in wake-potential from file

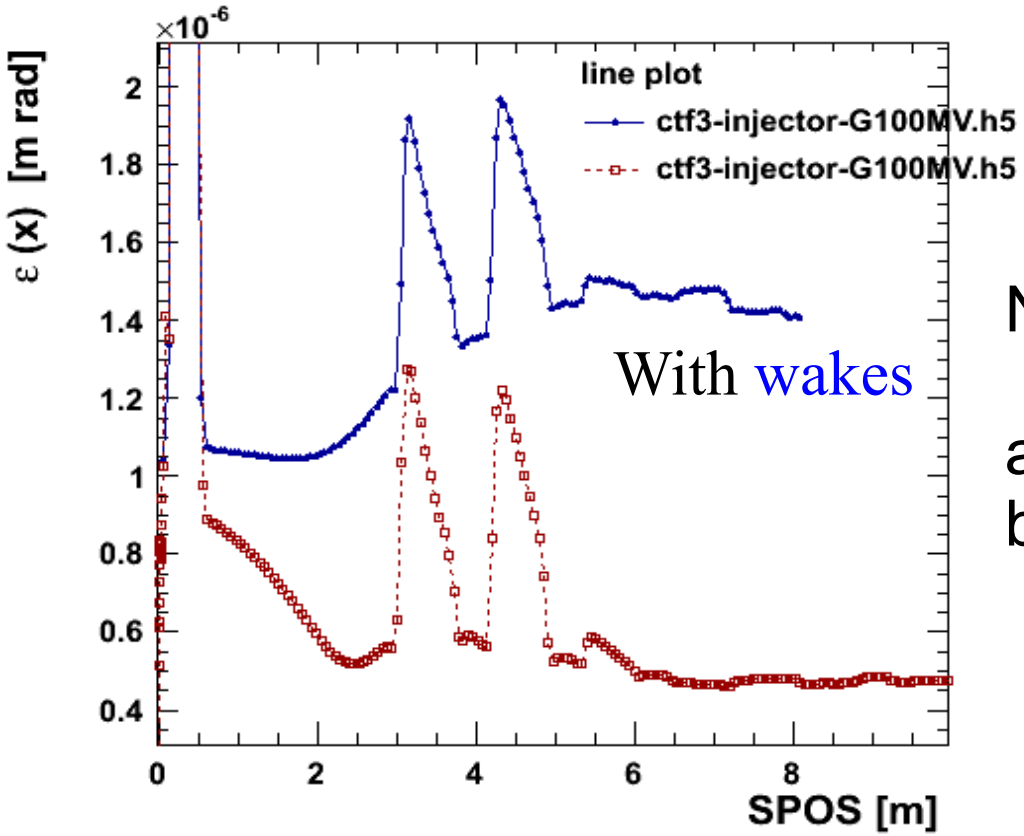
```
TWWAKE: Wake,TYPE="TRANSV-SHORT-RANGE", NBIN=32, CONST_LENGTH=false, CONDUCT="AC",
             Z0=376.991118, FORM="ROUND",RADIUS=0.00931,
            SIGMA=6.45337e7, TAU=2.70187e-14;
```

```
FINSB01_RAC: TravelingWave, L = 4.6, VOLT = 18.0, FMAPFN = "FINSB-RAC.T7",
                            ELEMEDGE = 2.95, NUMCELLS = 132, MODE = 1/3, ACCURACY = 39,
                            FREQ = 2997.924, LAG = -61.651178784 / 360.0, WAKEF=TWWAKE;
```

Please consult the online manual for more details concerning parameters

# New Features 2 - Short Range Wakefields cont.

(old) CTF 3 version (Yujong/S. Russel Dec 2008) up to 160 MeV




Note:

a) not optimized with wakes
b) the purpose is to show/test the wake calculations

# New Feature 3 - SA-AMG PCG

Iterative Space-Charge Solver (SA-AMG PCG)

- improving approximation of space-charge forces by taking into account realistic beam pipe boundaries
- currently support for cylindrical shaped beam pipes
- in the (near) future: support arbitrary domains specified in STEP / H5FED files

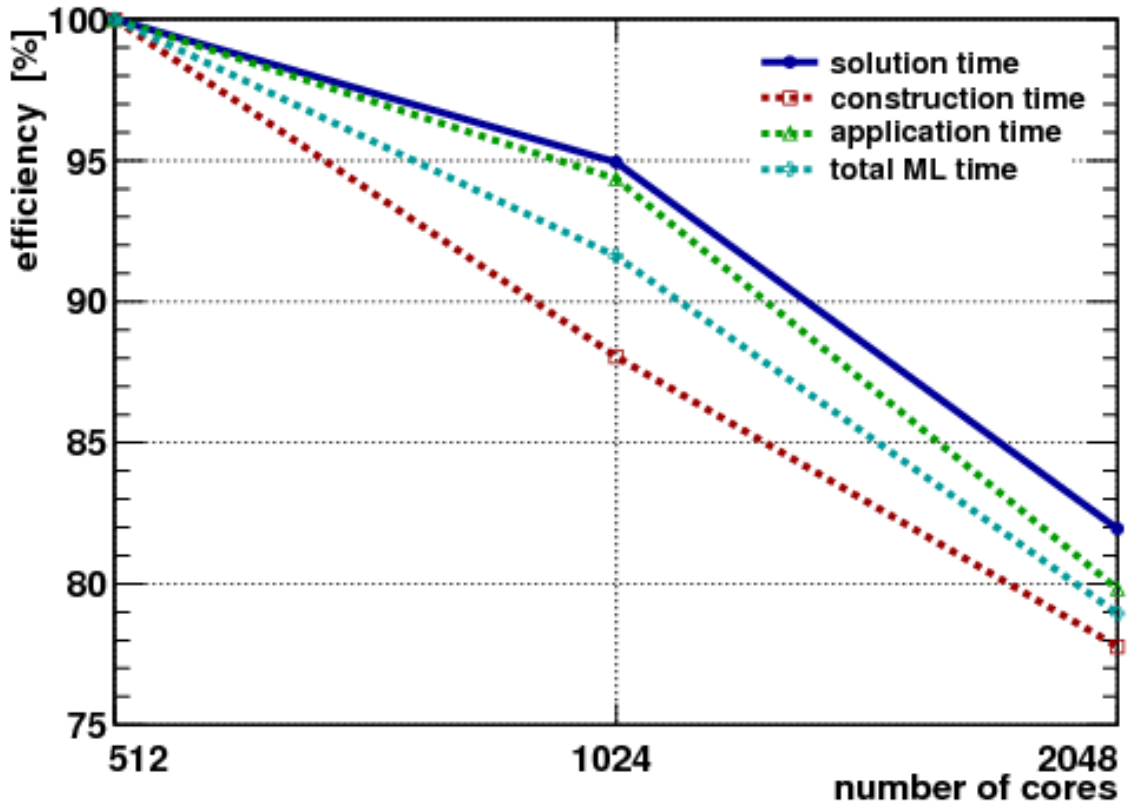
```
GME: GEOMETRY,    LENGTH=1, S=0.0, A=0.001, B=0.001;

Fs: FIELDSOLVER, FSTYPE=MG, MX=32, MY=32, MT=64, PARFFTX=false, PARFFTY=false,
                 PARFFTT=true, BCFFTX=open, BCFFTY=open, BCFFTT=open, BBOXINCR=3,
                 GEOMETRY="GME", ITSOLVER="CG", INTERPL="linear", TOL=1e-6,
                 MAXITERS=100;
```

Please consult the online manual for more details concerning parameters

# New Feature 3 - SA-AMG PCG cont.

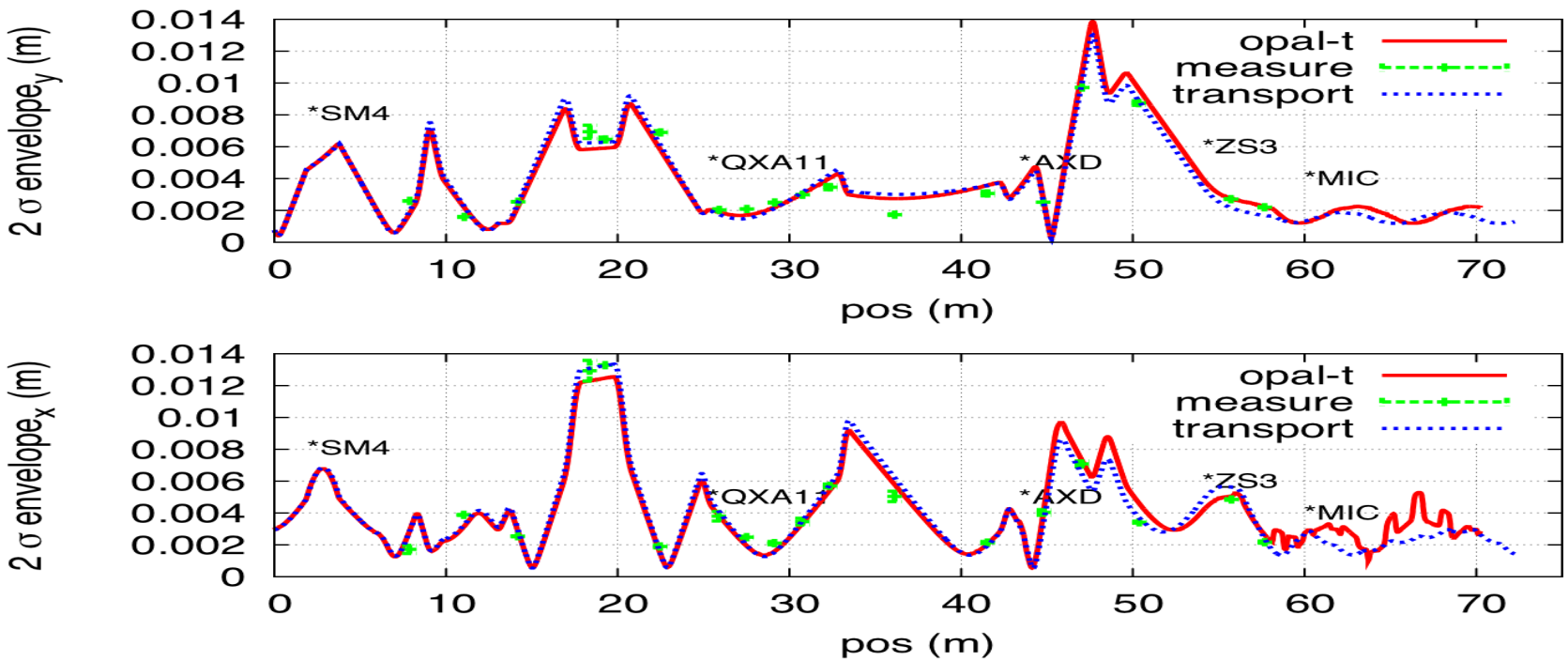
Iterative Space-Charge Solver: Parallel Efficiency on a $1024^3$ grid



# New Feature 4 – SBEND

72 MeV (p) line modeling (WIP, Y. Bi):

**Measurement** 30.4.2009
I=0.496 [mA]

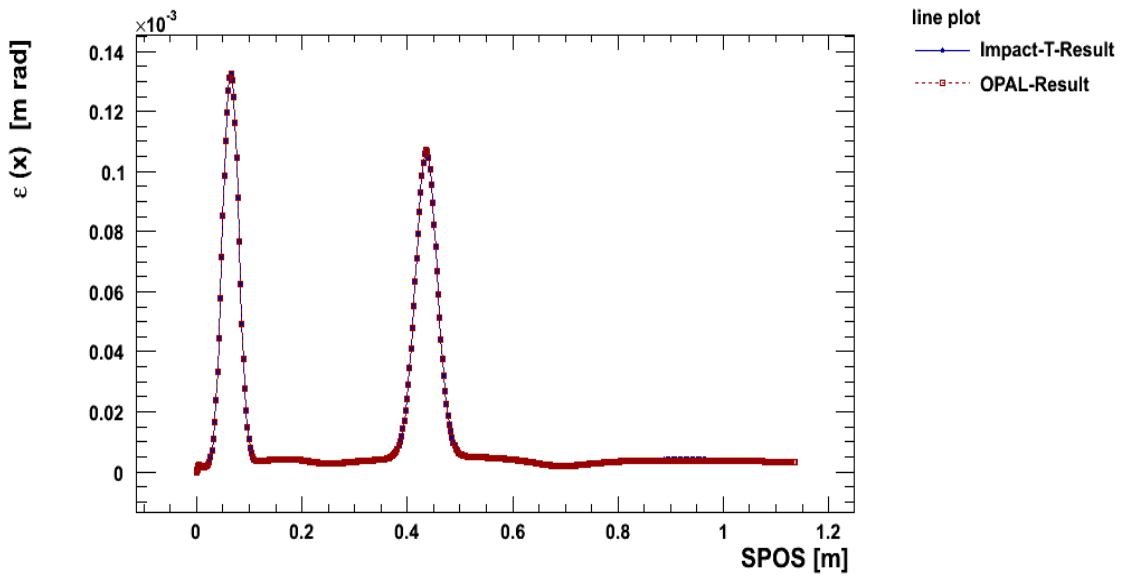


# Recap Validation Strategy

## Inductive reasoning

### - IMPACT-T (PARMELA) & LCLS

SLAC-PUB-11665 &
Phys. Rev. ST Accel. Beams 9, 044204 (2006).



# Validation Strategy - cont

Jointly with LANL (ICAP paper planed, S. Russel)

- PITZ Gun
- Parmela & OPAL code comparison
- Martlie/Impact & OPAL comparison
- LCLS ?

+ OPAL/ASTRA - OBLA
+ PHIN (Cern CLIC) ??

# Quality Assurance – Daily Regression Tests

## Build Tests

| Name | Revision | Status |
|---|---|---|
| classic | r8031 | |
| OPAL | r8031 | |

## Regression Tests

### Simulation: BC1-1

Description: One dipole with 1D csr, no space charge is considered

| Variable | Mode | Required Accuracy | Delta | Status |
|---|---|---|---|---|
| rms_x | last | 1e-15 | 2.24508713098e-16 | |
| rms_y | last | 1e-15 | 2.19445556917e-18 | |
| rms_z | last | 1e-15 | 0.0 | |
| rms emmitance | last | 1e-15 | [1.1881000000003863e-20, 2.450249999999814e-27, 1.4212900000000301e-19] | |

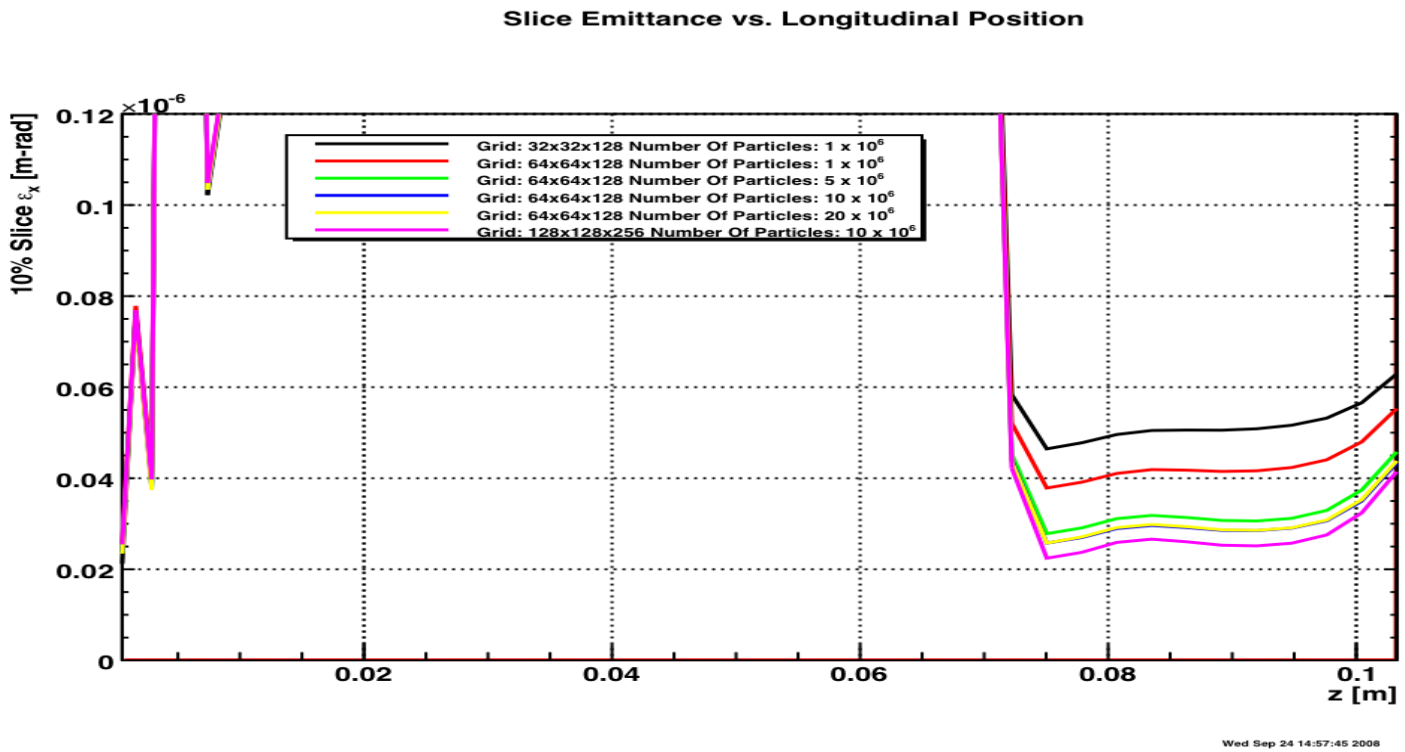
### Simulation: Scan

Description: Parameter scans with OPAL. The third run is used for comparison!

| Variable | Mode | Required Accuracy | Delta | Status |
|---|---|---|---|---|
| rms_x | last | 1e-15 | 0.0 | |
| rms_y | last | 1e-15 | 0.0 | |
| rms_z | last | 1e-15 | 0.0 | |
| rms emmitance | last | 1e-15 | [0.0, 0.0, 0.0] | |
| Emean | last | 1e-15 | 0.0 | |

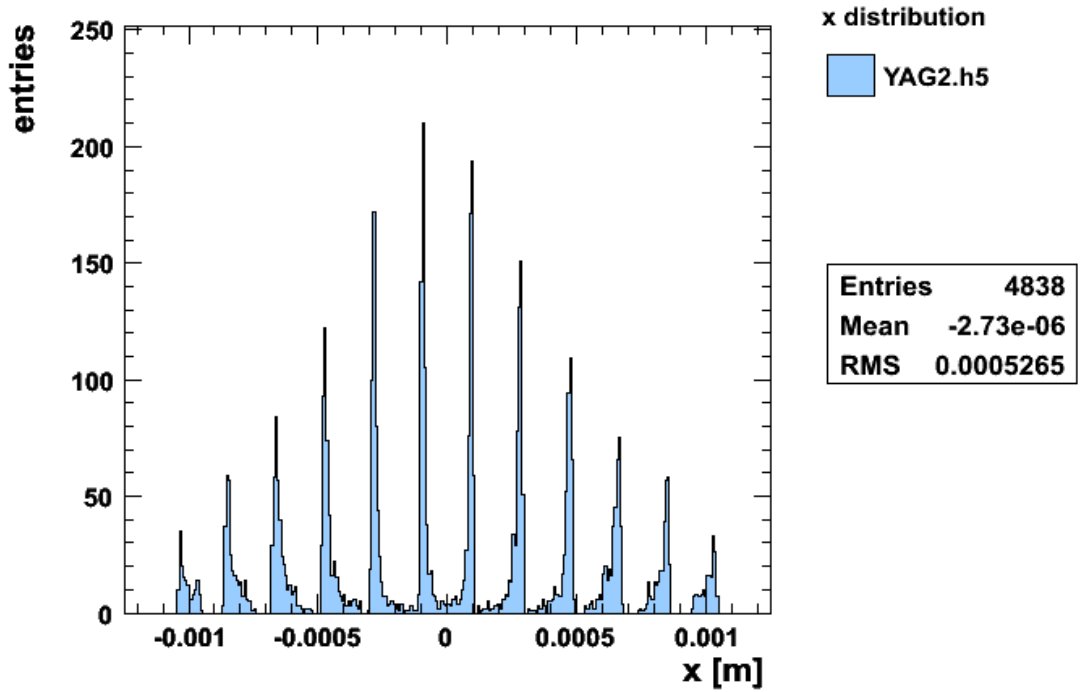
# Fun & useful things to do with OPAL

- Capability to perform S2E simulation with
  convergent #Particles & #Gridpoints
  → first step towards realistic µB-I simulations



# Fun & useful things to do with OPAL cont.

Pepperpot & good statistics → compare model w. reality



# Summary – XFEL related

OPAL in its latest version 1.1.5 is ready for:

- OBLA simulations and comparison w. measurements
- S2E 3D 250 MeV Injector simulation
  (but NO ONE is doing it !)

# Summary – XFEL related cont.

- OPAL is a unique combination of
  - + "Level of detail" (1D CRS, 3D SC, Wakefields, #particle >, etc)
  - + easy to use (MAD-language, post processing H5PartROOT)
  - + parallel performance

- Active nat. & international development team
  - + full self consistent simulations (M. Wittberger & Ch. Kraus)
  - + multi objective optimization (Y. Ineichen)
  - + secondary effects on collimators & SBEND (Y.Bi)
  - + benchmarking & LANL-XFEL design (S.Russel)
  - + PAC 2009, TU3PBC05, (J. Yang)