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Beam dynamics of intense particle sources simulated with the help of TBCI-SF*

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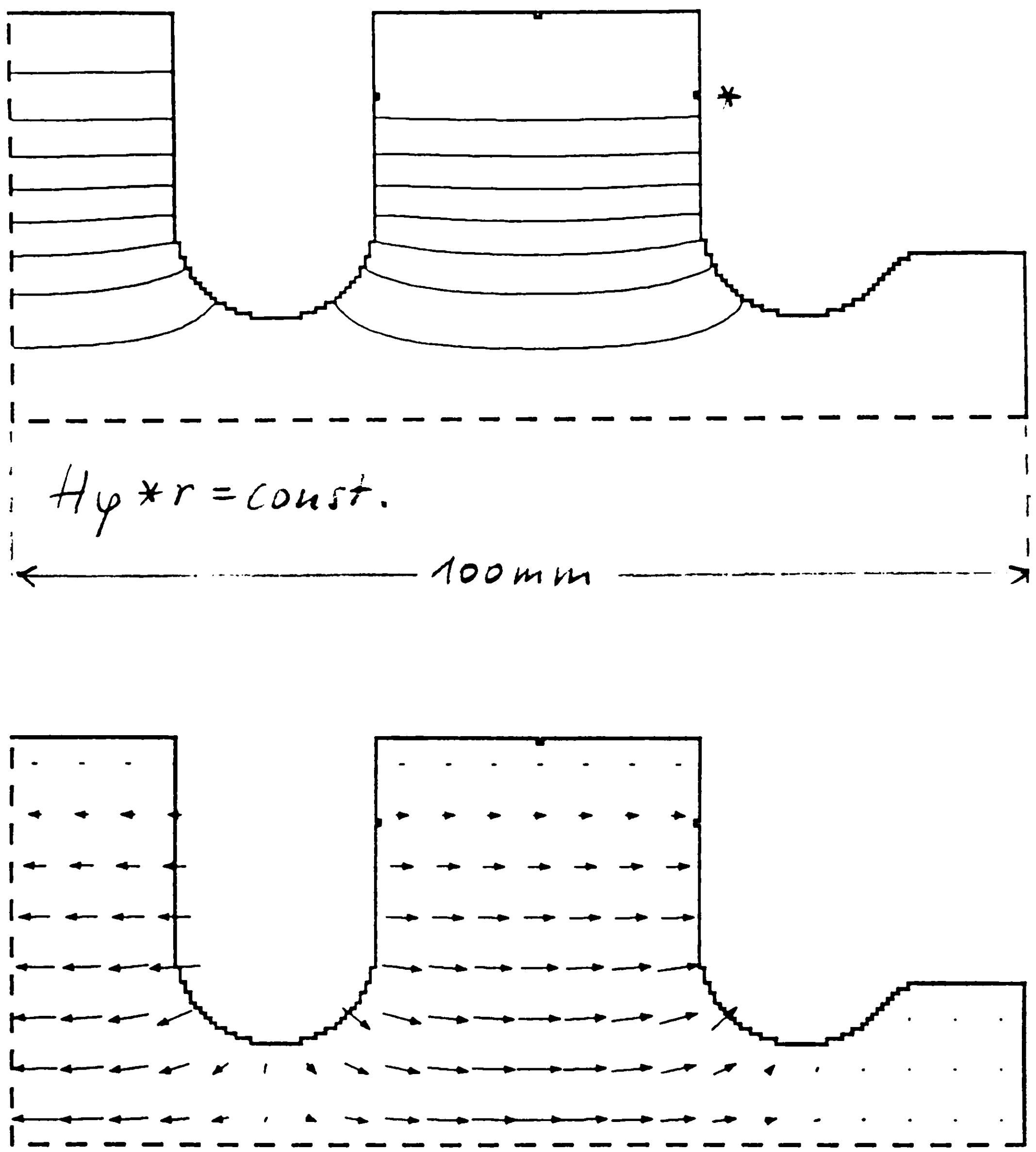
In the framework of the CLIC Test Facility (CTF) [1] a RF gun, very similar to the one designed at BNL [2], is under study.

Simulation of beam dynamics is done with the help of the Particle-In-Cell code TBCI-SF [3]. This code computes the particle motion and the electro-magnetic fields self-consistently for cylindrical geometries. It takes space-charge and wake-fields into account. RF fields are drawn from URMEL [4], static fields from PROFI [5].

The code has been provided by DESY (T. Weiland and his team) and PROFI Engineering, Darmstadt (W.R. Novender) and has been adapted to CERN central computer facilities by one of us (W.R.).

The resonator, oscillating in π-mode, is shown in figure 1. Some, by TBCI-SF calculated, parameters are compared with results obtained at BNL using the codes SUPERFISH and PARMELA (see table of comparison). Energy, dispersion, emittance growth due to RF and space charge as well as pulse width are worked out for different RF phases at start of the particles at the cathode (figure 2). This code can also become a valuable instrument in the simulation of beam dynamics for DC guns, pre-bunchers and bunchers.

* *TBCI-SF: Transverse Beam Cavity Interaction, Self-consistent*, Author: Petra Schuett



E field

TEXT: UR-RF-04 DATA 4/90, CRAY: FS-FM, 3 SYM.RINGS => E1/E2=1.004, ENDTLENV/PC= 2.1105 AT R/M= 0.0000 ; FRAME= 7
PLOT: E-FIELD AT PHI=0 ; ID: urmelaf 15/04/90 14:04:24 ; MODE:TM0- EE- 2 ; F/MHZ= 2968.2 ; F/FC= 0.4

* tuning rings

π- mode

Fig1 : fields in the cavity

RF GUN OF CTF, TABLE OF COMPARISON (BNL/CERN) ON CRAY REVISED 15/04/90

	BNL	CERN	
CHARGE Q	1	1	NC
EZ(R=Z=0)	100	100	MV/M
EMAX/EZ(R=Z=0)	1.06 - 1.20	1.34	
EZMAX(CELL1)/ EZMAX(CELL2) AT R=0	1	1	
FREQUENCY PI MODE	2895	2968	MC/S
PI MODE - 0 MODE	1.9	1.84	MC/S
CAVITY Q	11800	11922	
CAVITY PEAK POWER	5.3 - 5.9	5.73	MW
RF PHASE PHI AT START	67	67	DEGREES
SPOTSIZE)) AT START	SIGMA = 3	RADIUS = 6	MM
BUNCH LENGTH)	SIGMA = 2	FULLWIDTH = 8	PS
BEAM ENERGY	4.65 - 4.93	4.47	MEV
ENERGY DISPERSION	SIGMA = .36	SIGMA =1.13	%
SPOTSIZE)) OUTLET	2*SIGMAR = 8.4	RMAX =11.0	MM
BUNCH LENGTH)	SIGMA = .6	SIGMA = .73	MM
ANGULAR DIVERGENCE	2*SIGMA = 56	MAX = 70	MRAD
EMITTANCE GROWTH EG	25.6	53.9	PI*MM*MRAD

BNL PARAMETERS ARE DRAWN FROM SEVERAL PUBLICATIONS, CERN AND BNL CAVITY DIFFER SLIGHTLY IN DIMENSIONS. AT START CTF PULSE RECTANGULAR IN TIME, WITH UNIFORM CHARGE DISTRIBUTION IN R. BNL DISTRIBUTIONS GAUSSIAN, CUT AT 2 SIGMA.

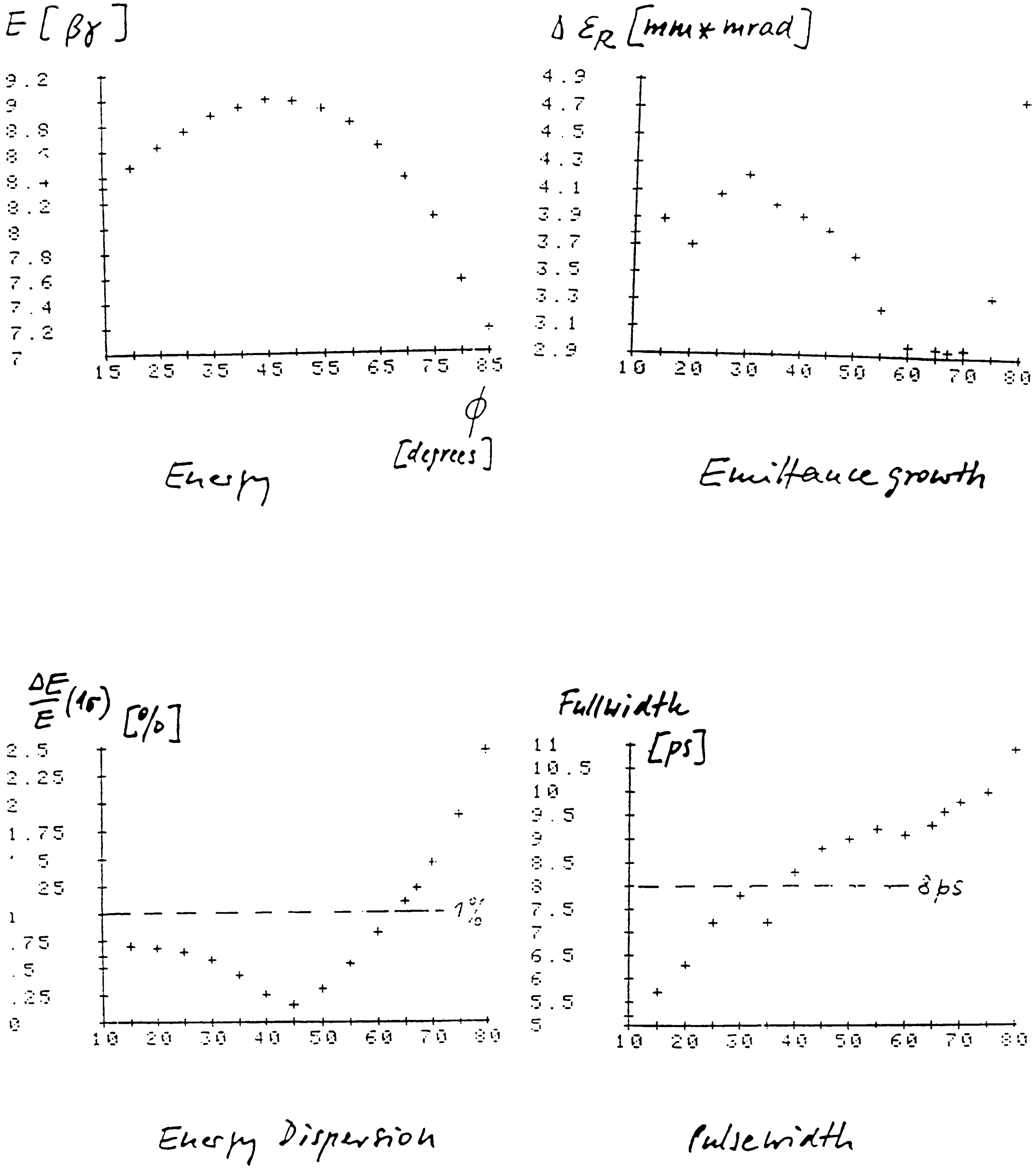
PHI = PHI OF CENTRE PARTICLE. AT PHI = 90 DEG., EZ = 100 MV/M.

SPOTSIZE, BUNCHLENGTH, DIVERGENCE AND EMITTANCE GROWTH ARE IN OUR CASE CALCULATED W.R.T. MACROPARTICLES (RINGS), AT <Z> = 96.9 MM

EMITTANCE GROWTH EG = SQR (E*E TOTAL - E*E CATHODE), E = EMITTANCE

EG = 4*EG(BNL) = 2*BETA*GAMMA*EG(TBCISF)

EG(TBCISF) = SQR (<R*R><R`*R`> - <R*R`><R*R`>)



1 nC, 100 MV/m, pulsewidth at start 8ps (parabolic) spotsize ϕ 12 mm, uniform chargedensity

FIG 2: Beam Parameters as function of RF phase ϕ

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