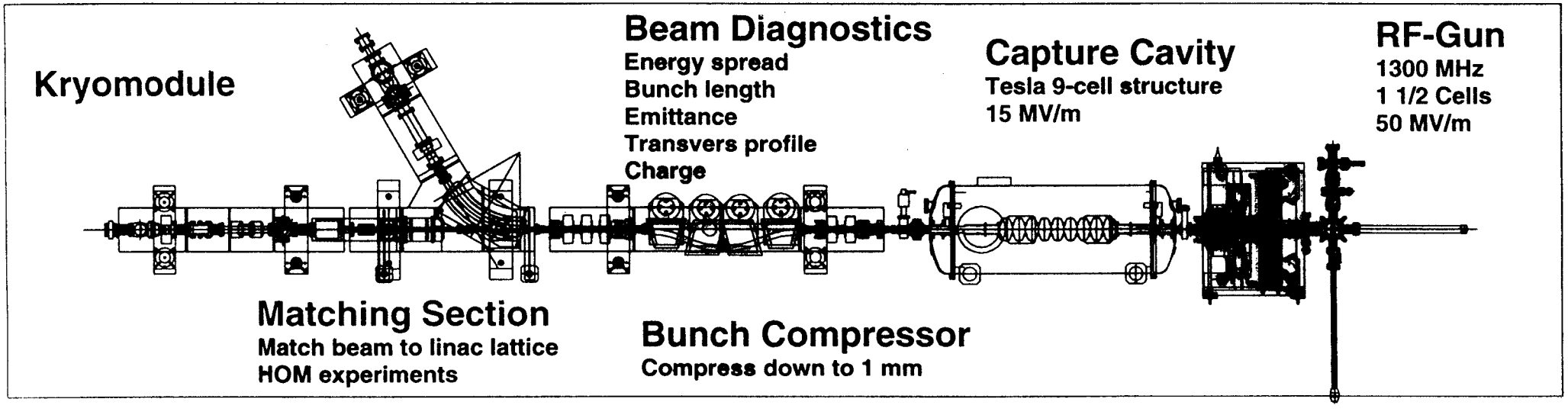
TTF Injector operation July to October 99

Klaus Floettmann

Argonne, Nov. 99

TTF Injector II

Train of 800 electron bunches, train length = 0.8 ms
Repetition rate 10 Hz
Bunch charge = 8 nC
Bunch length = 1 mm
Energy = 20 MeV
Emittance (x,y) = 20 π mm mrad



Laser

262 nm (UV)
≈5 μJ/pulse → 8 nC/bunch
800 pulses/train (1 MHz)
10 Hz rep. rate

Cathode System

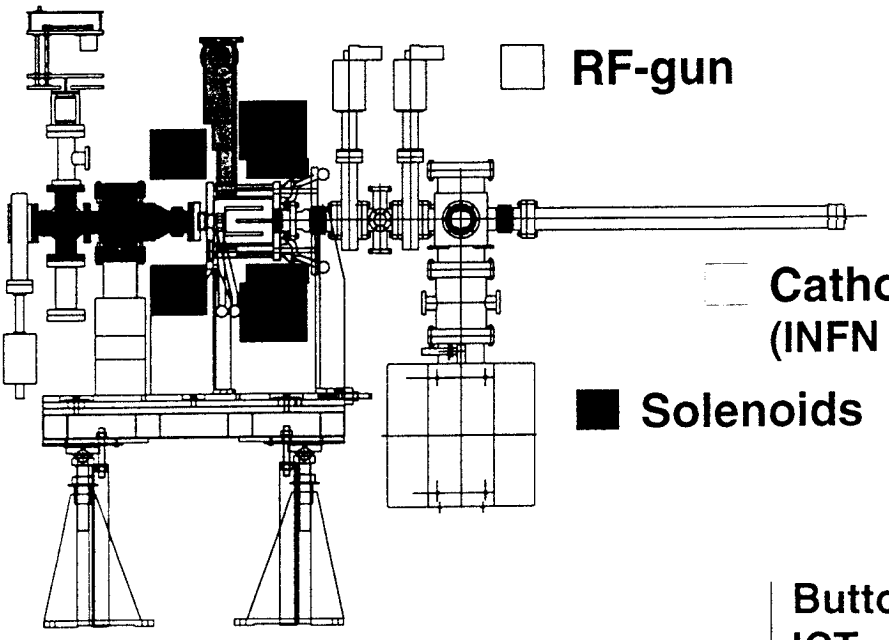
Material: Cs2Te
QE > 1 %

S. Schreiber
8.Nov.1997

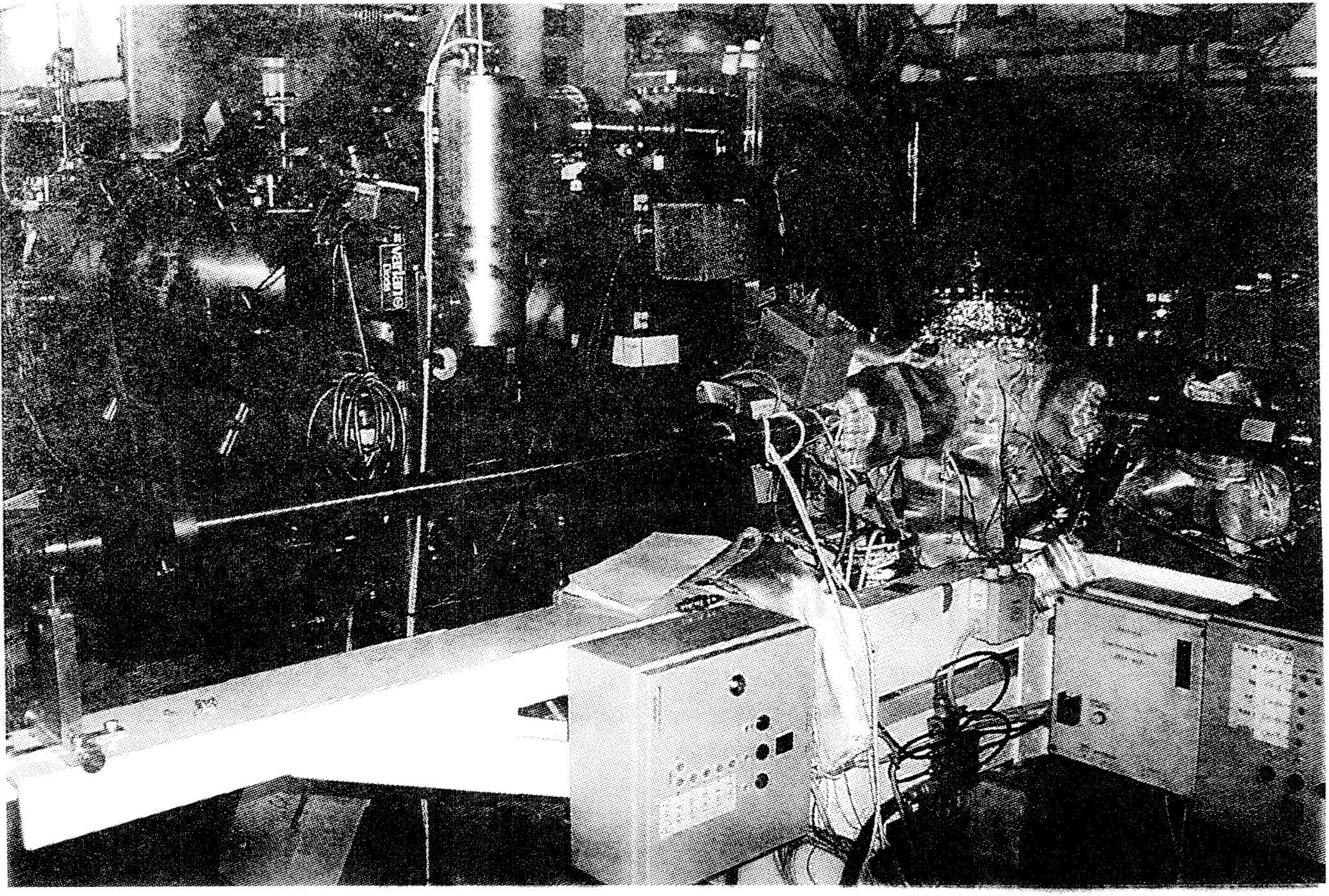
TTF RF-Gun

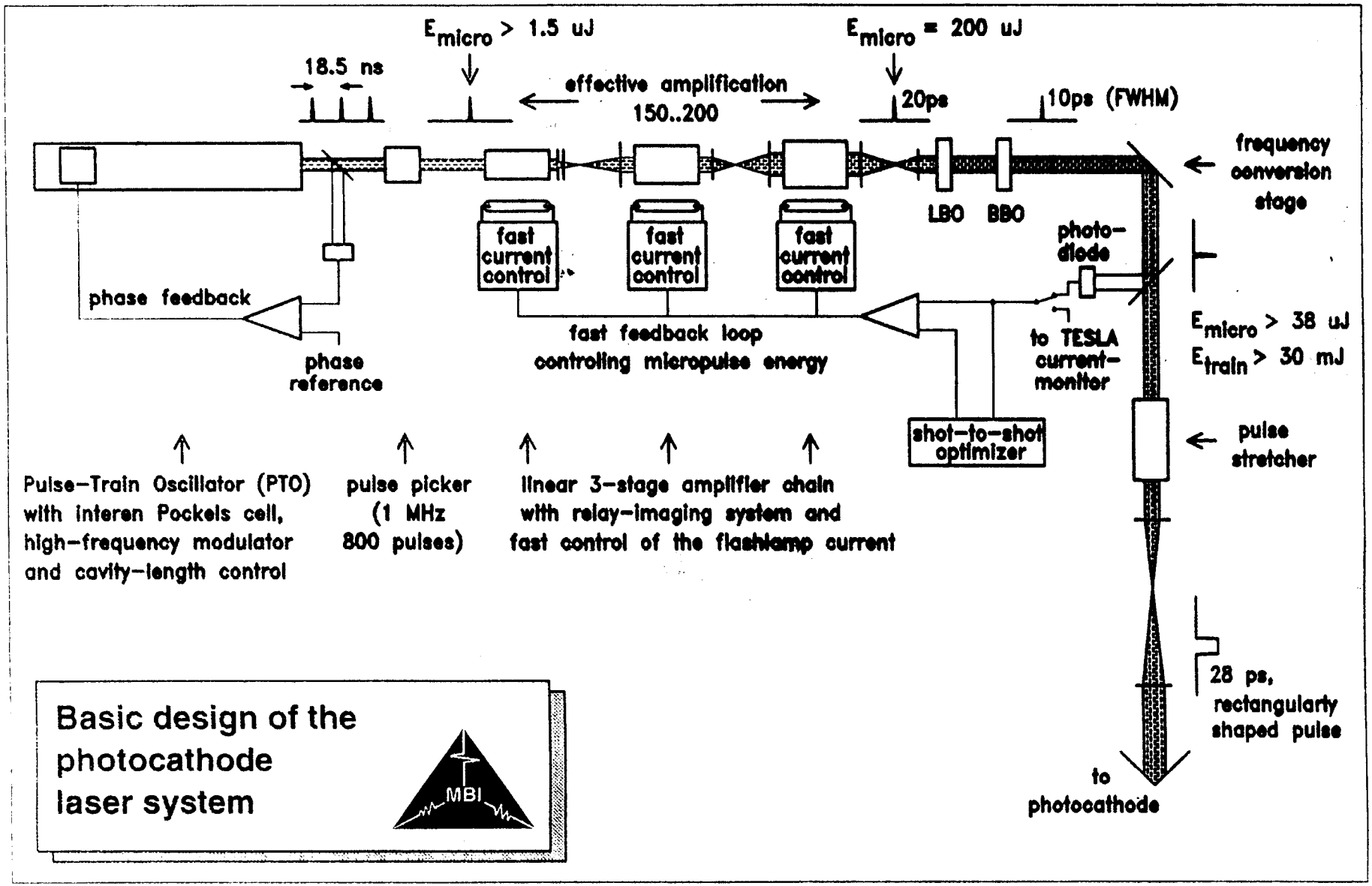
Fermilab
(E. Colby, H. Edwards et al)

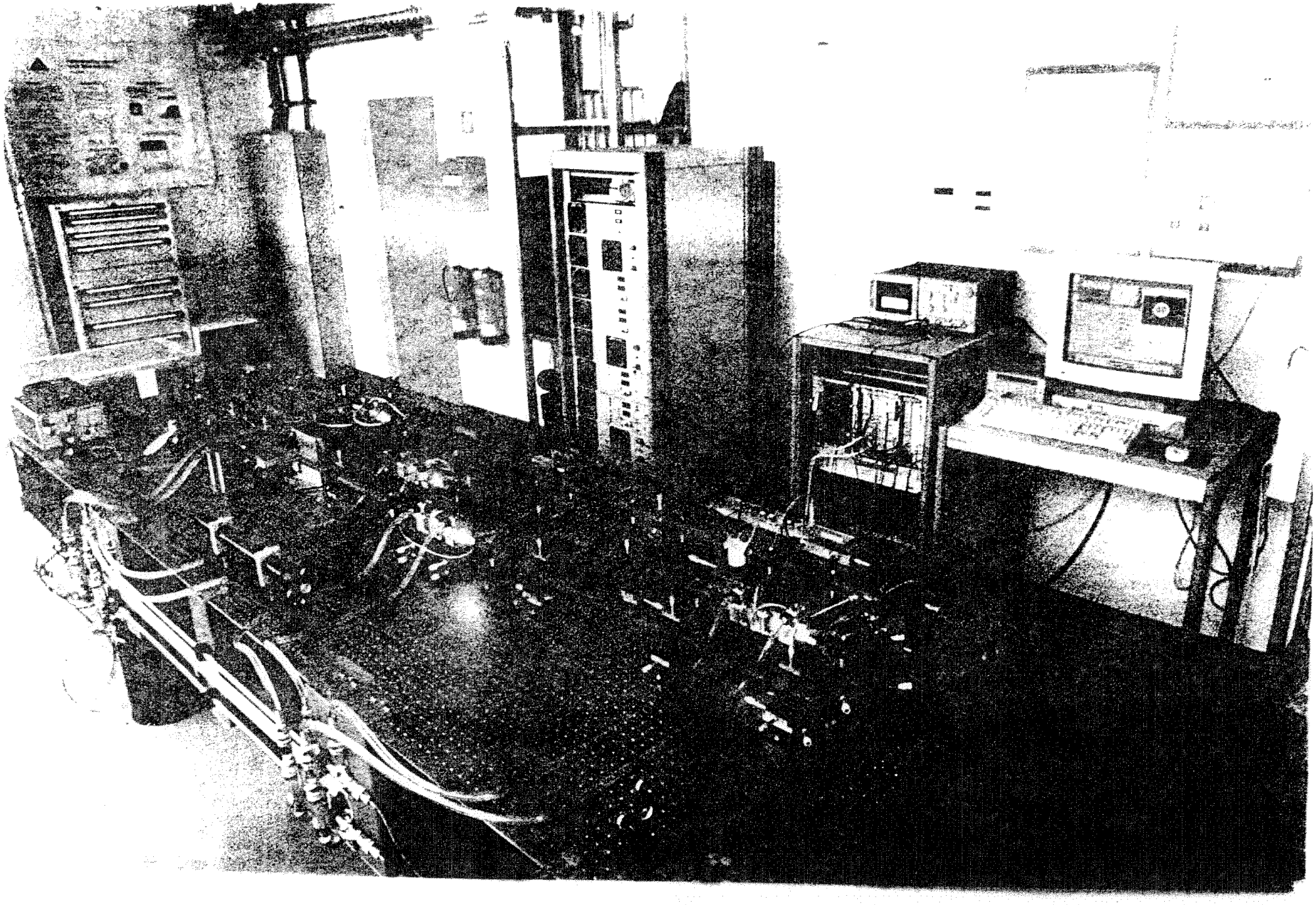
- 1 1/2 cell rf gun, 1.3 GHz
- Laser driven with a Cs_2Te cathode
- High bunch charge: Q = 8 nC
  Long bunch train: 800 bunches within 0.8 ms
  High peak current: I = 1 kA
  Repetition rate: 10 Hz
  Mean RF power: 50 kW
- Emittance compensation (with solenoids):
  - transverse emittance: 15 mm mrad
  - long. emittance: 100 deg keV



S. Schreiber
6-Nov-1997




E_{micro} > 1.5 uJ
E_{micro} = 200 uJ
18.5 ns
effective amplification
150..200
20ps
10ps (FWHM)
frequency conversion stage
LBO
BBO
photo-diode
fast current control
fast current control
fast current control
phase feedback
phase reference
fast feedback loop controling micropulse energy
to TESLA current-monitor
E_{micro} > 38 uJ
E_{train} > 30 mJ
shot-to-shot optimizer
pulse stretcher
Pulse-Train Oscillator (PTO) with interen Pockels cell, high-frequency modulator and cavity-length control
pulse picker (1 MHz 800 pulses)
linear 3-stage amplifier chain with relay-imaging system and fast control of the flashlamp current
28 ps, rectangularly shaped pulse
to photocathode
Basic design of the photocathode laser system
MBI



Strategy for the run:

Stick to parameters found in March

rf power	2.2MW ≡ 35 MV/m on the cathode
emission phase	50° – 60°
spot size of the laser	1.5 mm for Q = 1 nC
on the cathode	3.0 mm for Q = 8 nC
laser pulse length	$\sigma \approx 7.0$ ps
primary Solenoid	165 A ≡ 0.092 T
secondary solenoid	90 A ≡ 0.077 T

Start-up:

Fast and smooth without major problems!

Subsystems:

* RF controls: New DSP control in operation. Requires 100μs rf pulses, improves stability of amplitude and phase, but bad for dark current.

* Laser: Damaged pockels cell exchanged before run to improve spot uniformity.

* Cathodes: Cathode of March run in operation until last week.

Development of quantum efficiency and dark current

Date	QE	dark current
Feb new cathode with polished surface	~ 6 %	15 μA
July	0.6 %	70 μA
Sep	0.6 %	800 μA
Oct	0.5 %	1200 μA

Last weeks measurements (after three weeks without gun operation):

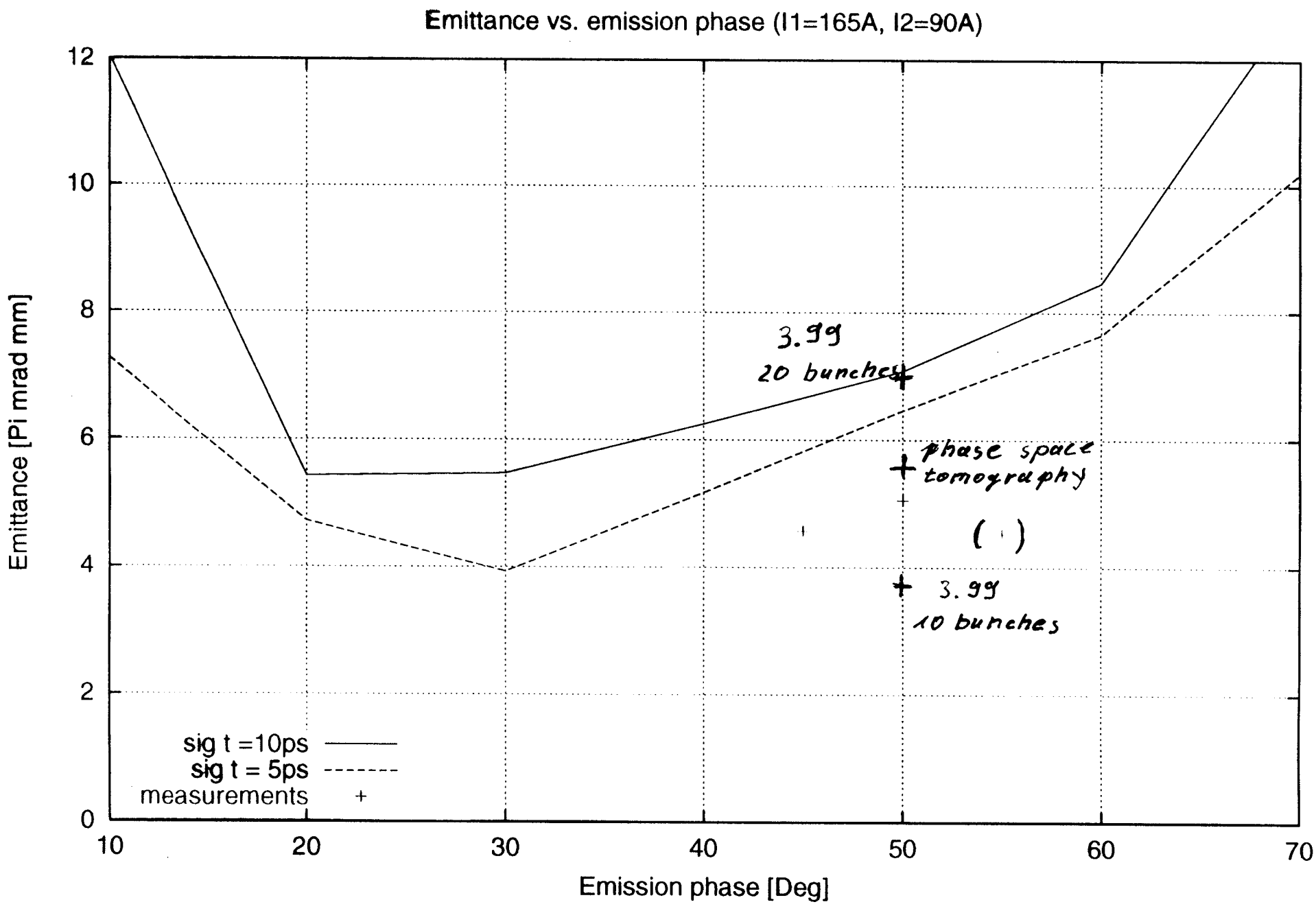
At start-up the dark current of 400 μA increases within ~1 h to 700 μA. After firing the TSP's the dark current was reduced to 150 μA. Due to problems with the klystron the further development with time was not observed. The cathode was changed. With the new cathode a dark current of 160 μA was measured.

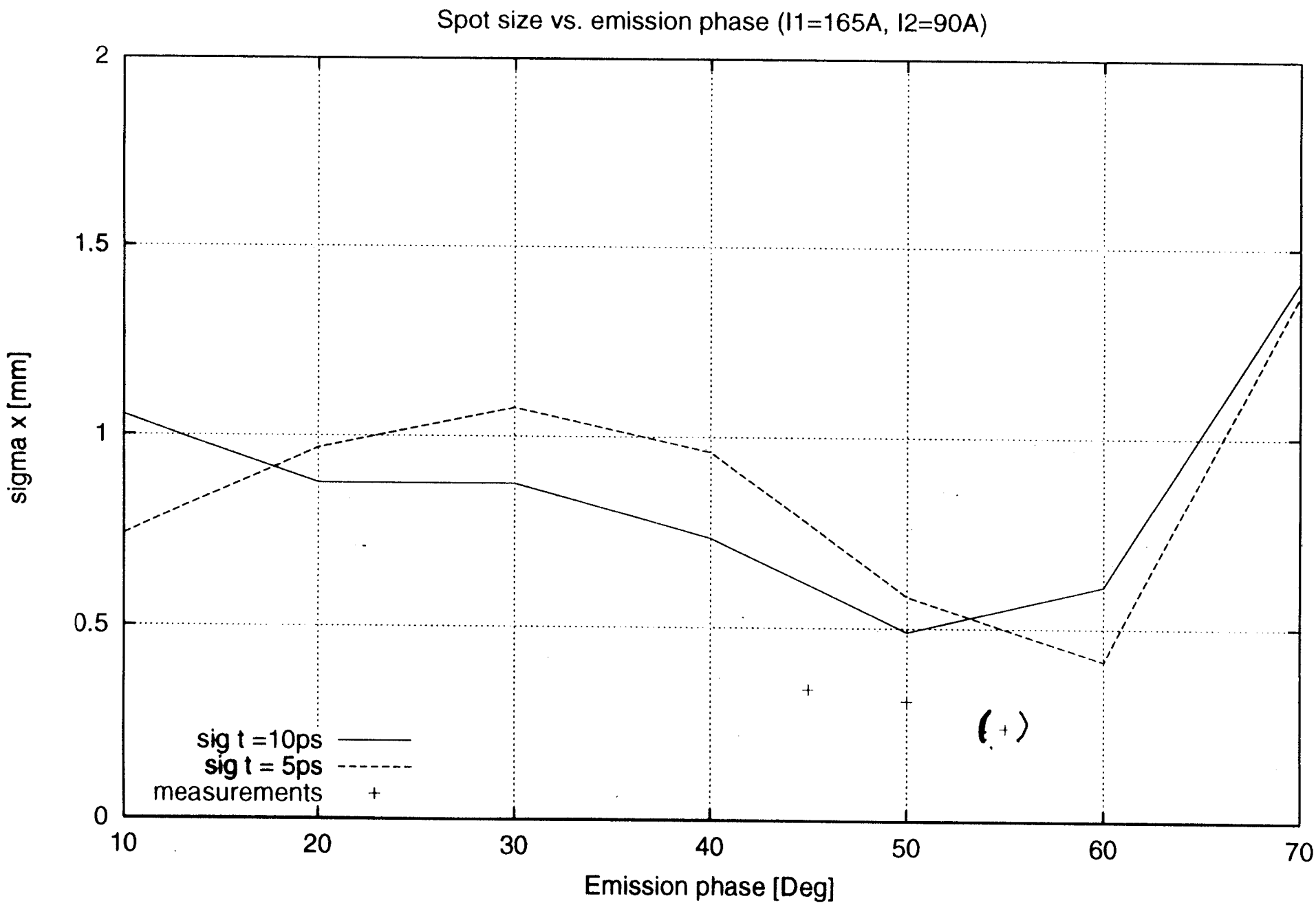
Emittance measurements with the pepper pot

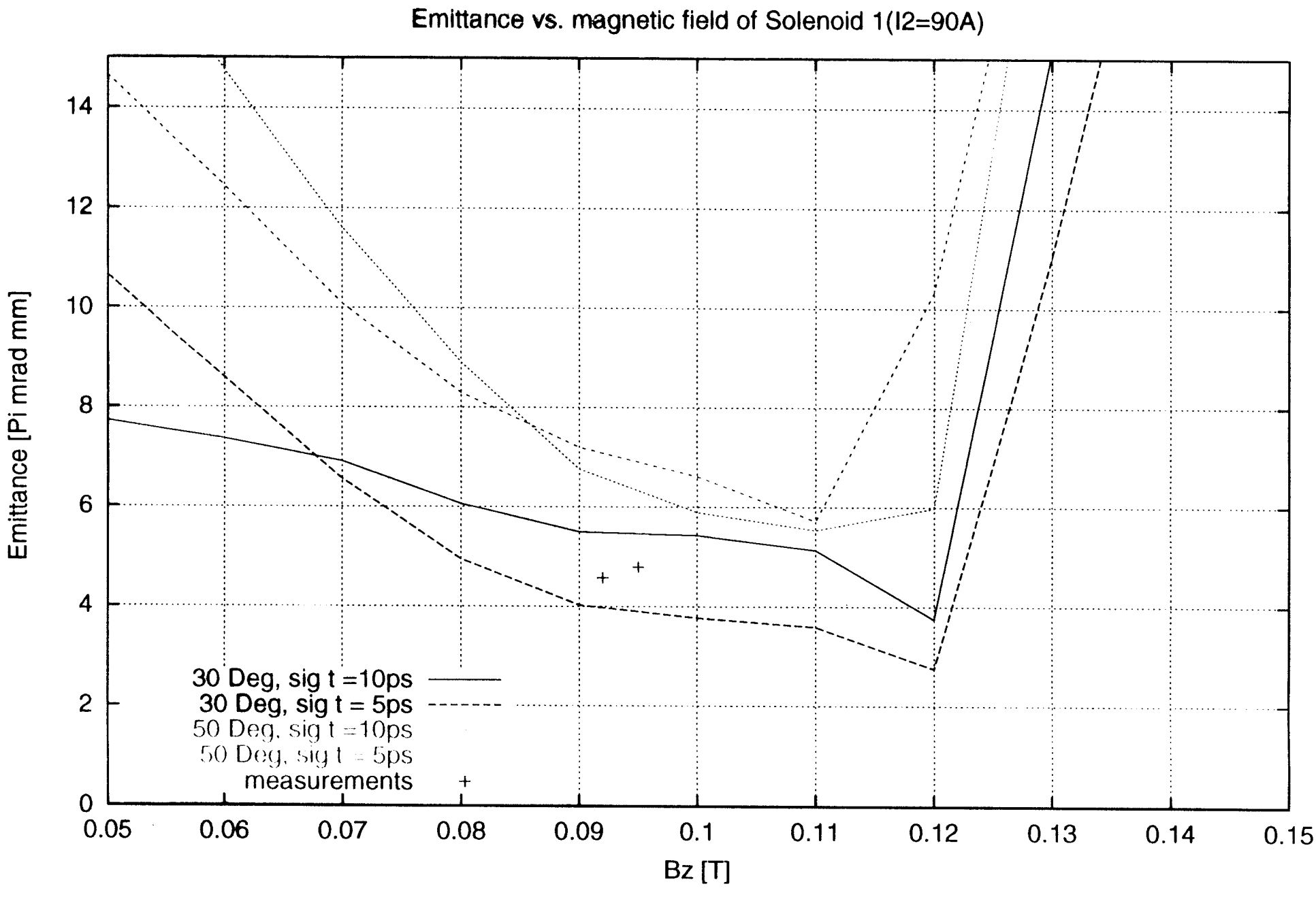
(Data analysis by Alessandro Cianchi, simulations by K. F.)

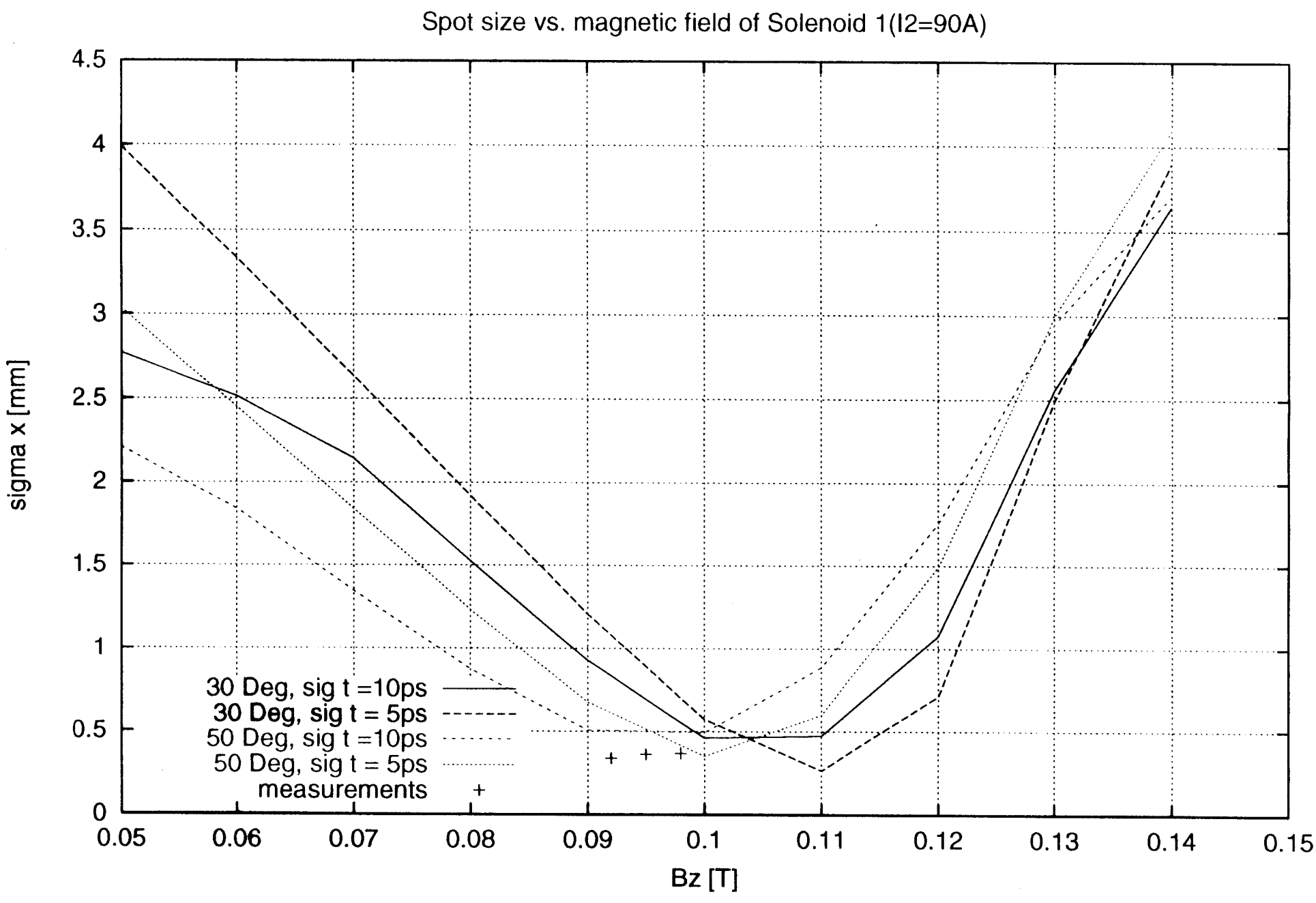
Problems:

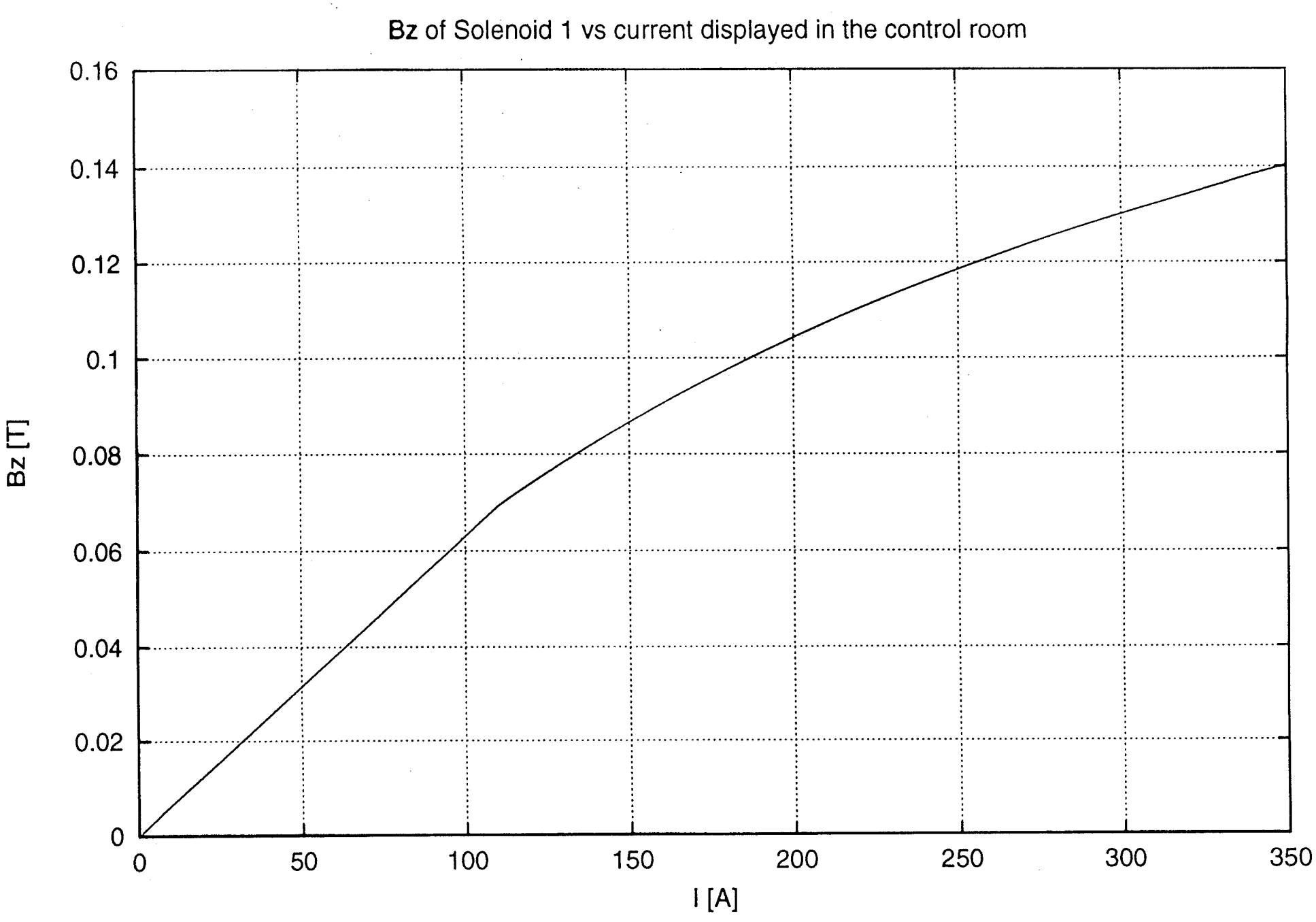
* limited time (one evening only)
* instable rf phase
* cracks on the OTR screen No.4
* too low photon intensity, need different screen or intensified camera


Emittance vs. emission phase (I1=165A, I2=90A)
Emittance [Pi mrad mm]
Emission phase [Deg]
12
10
8
6
4
2
0
10
20
30
40
50
60
70
3.99
20 bunches
phase space
tomography
( )
3.99
10 bunches
sig t =10ps
sig t = 5ps
measurements


Spot size vs. emission phase (I1=165A, I2=90A)
sigma x [mm]
Emission phase [Deg]
sig t =10ps
sig t = 5ps
measurements
0
0.5
1
1.5
2
10
20
30
40
50
60
70


Emittance vs. magnetic field of Solenoid 1(I2=90A)
Emittance [Pi mrad mm]
Bz [T]
0
2
4
6
8
10
12
14
0.05
0.06
0.07
0.08
0.09
0.1
0.11
0.12
0.13
0.14
0.15
30 Deg, sig t =10ps
30 Deg, sig t = 5ps
50 Deg, sig t =10ps
50 Deg, sig t = 5ps
measurements


Spot size vs. magnetic field of Solenoid 1(I2=90A)
sigma x [mm]
Bz [T]
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0.05
0.06
0.07
0.08
0.09
0.1
0.11
0.12
0.13
0.14
0.15
30 Deg, sig t =10ps
30 Deg, sig t = 5ps
50 Deg, sig t =10ps
50 Deg, sig t = 5ps
measurements


Bz of Solenoid 1 vs current displayed in the control room
Bz [T]
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
50
100
150
200
250
300
350
I [A]