Test of Diamond screen at PITZ

2 Parts

-Difference between YAG and Diamond screen

-High Load Test (9.6.2011n)

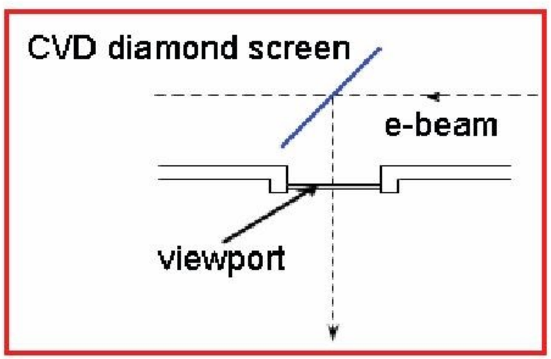
HJG,02082011

Test of Diamond screen at PITZ

S. Rimjaem, Workshop on Scintillating Screen Applications in Beam Diagnostics, GSI, Darmstadt, February 15th, 2011

Chemical Vapour Deposition (CVD) Diamond Screen

thickness	100 μm
diameter	30 mm
Incident angle	45°
High thermal conductivity	5 times higher than Cu
Emission wavelengths	415 – 478 nm



Reference: M. Degenhard, "CVD Diamond Screens for Beamline Diagnosis at PETRA III"

Diamond:

polykristalline with special doping

Why Diamond:

Excellent Thermal Conductivity
- can withstand large heat-load

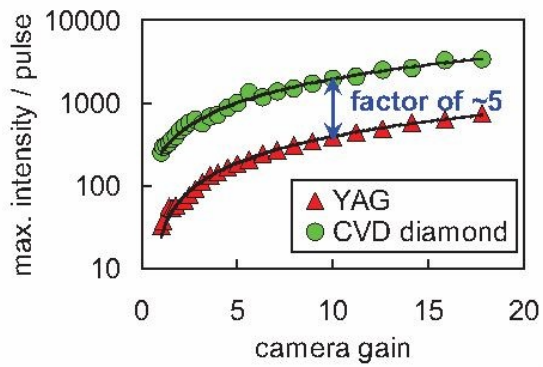
Excellent Vacuum Properties

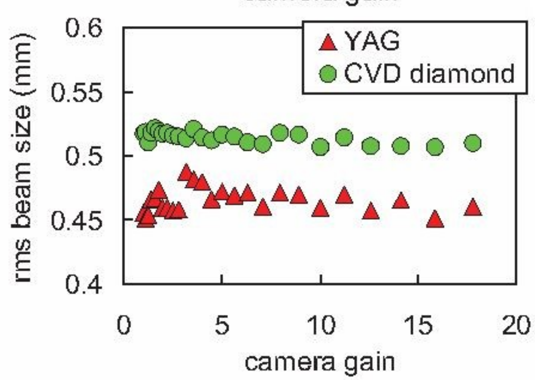
Excellent Mechanical Stability

HJG,02082011

Test of Diamond screen at PITZ

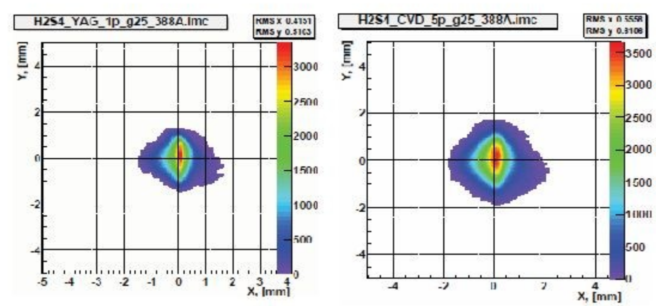
YAG and CVD diamond screens: no. of pulses & camera gain





$<\sigma_{xy}>_{CVD} - <\sigma_{xy}>_{YAG} \sim 168\ \mu m$

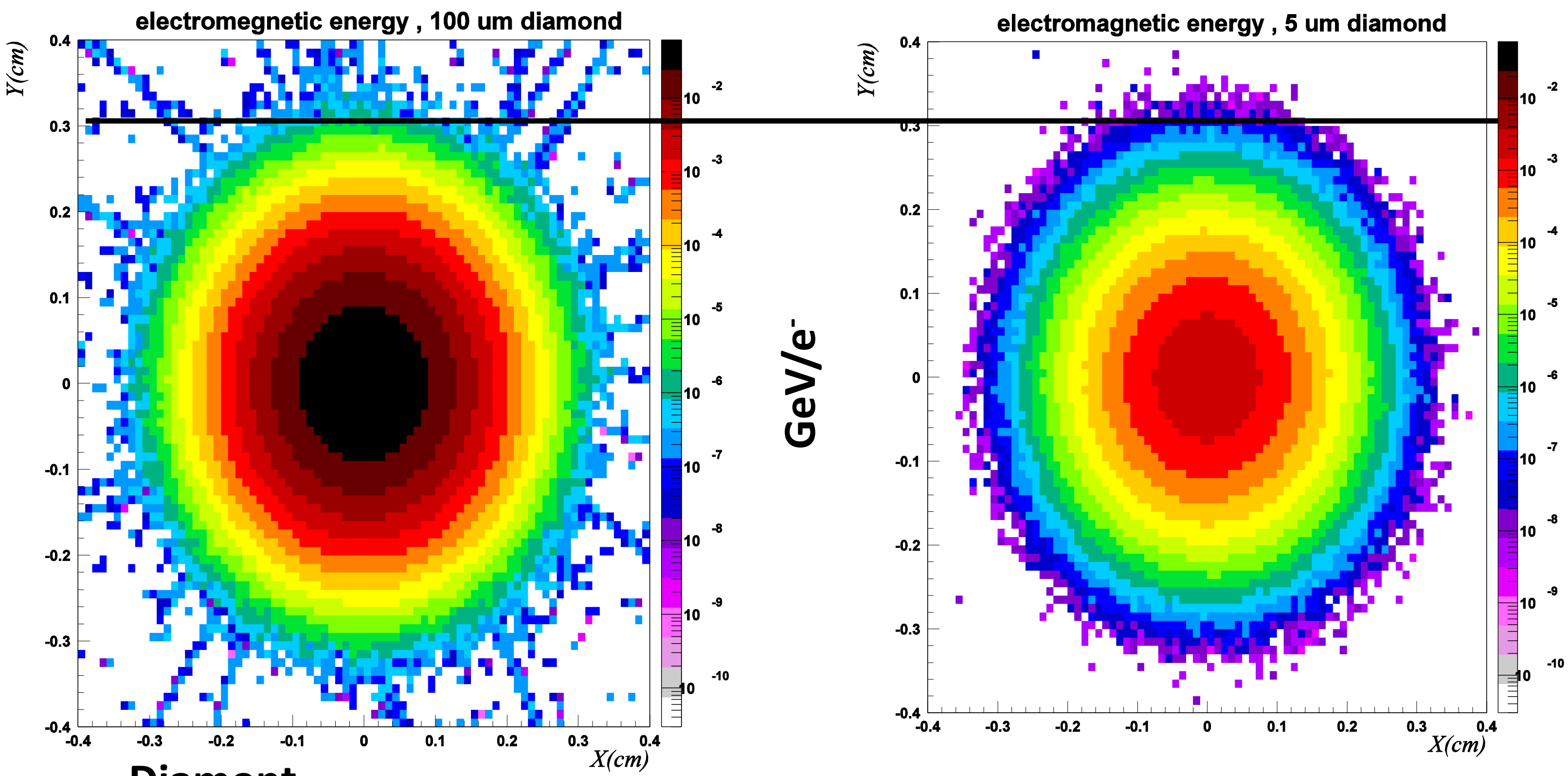
- Fixed parameters:
  - omentum ~24.8 MeV/c
  - No. of bunches / train: YAG (1 bunch), CVD diamond (5 bunches / train)
- Vary parameters:
  - Camera gain
  - Focusing (adjusted solenoid current to have the same beam area)



- **YAG: <x> = 18.17 mm, <y> = 12.71 mm**
- **CVD diamond: <x> = 15.90 mm, <y> = 12.59 mm**

Test of Diamond screen at PITZ

FLUKA simulation of a diamont radiator, assumtion: EDEPO ~ fluorescence



Diamont

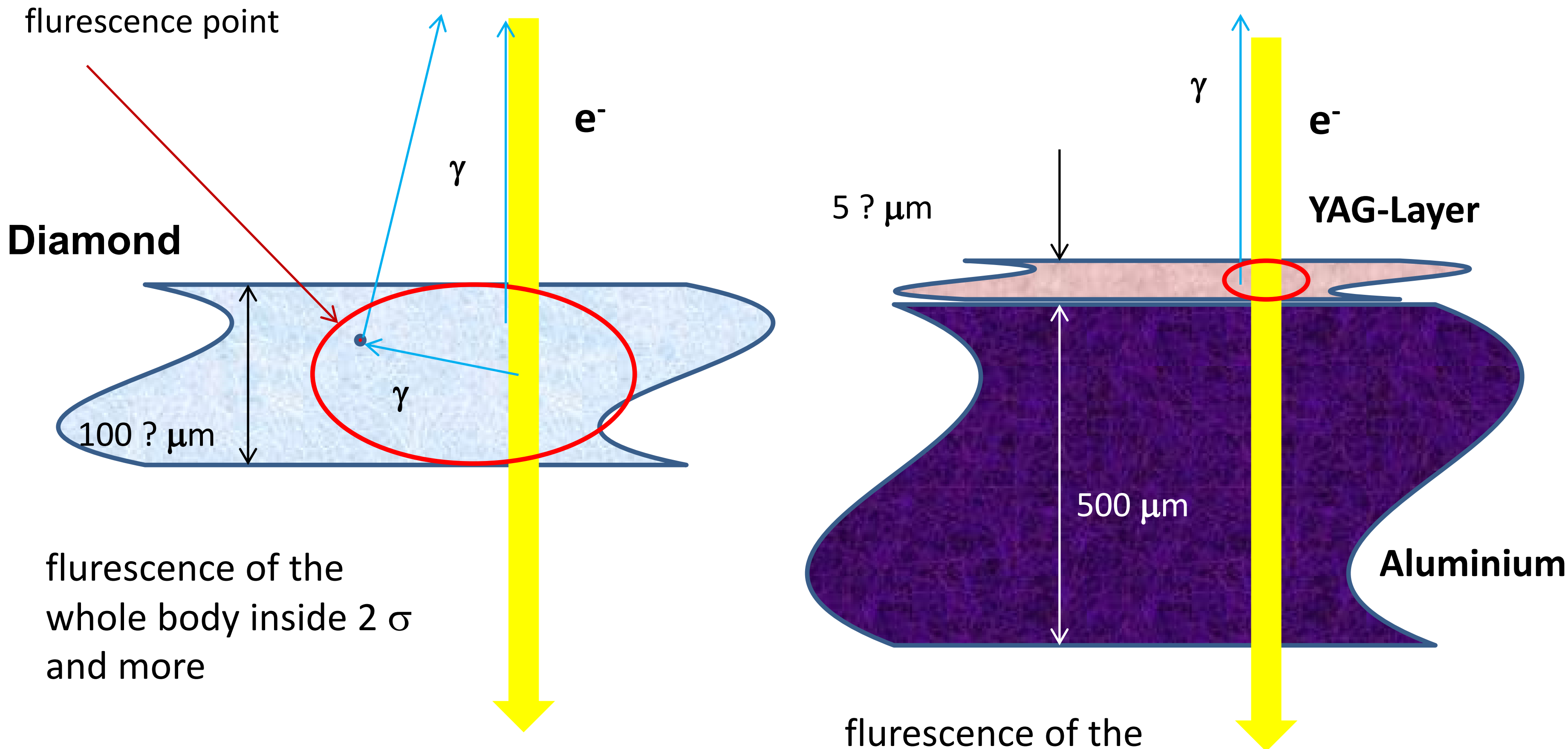
almost transparent for γs
(visible and Röntgen)

$RMS_{Diamond}$ > RMS_{YAG} ;

comparison of a 5 ? µm with a 100 ? µm radiator ????

HJG,02082011

Test of Diamond screen at PITZ



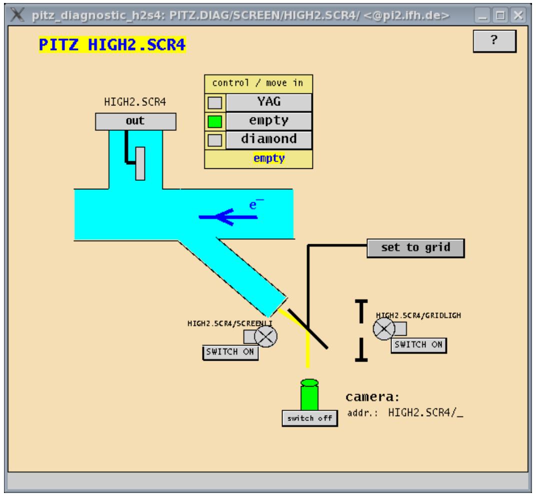
flurescence of the whole body inside 2 σ and more

flurescence of the YAG-layer

HJG,02082011

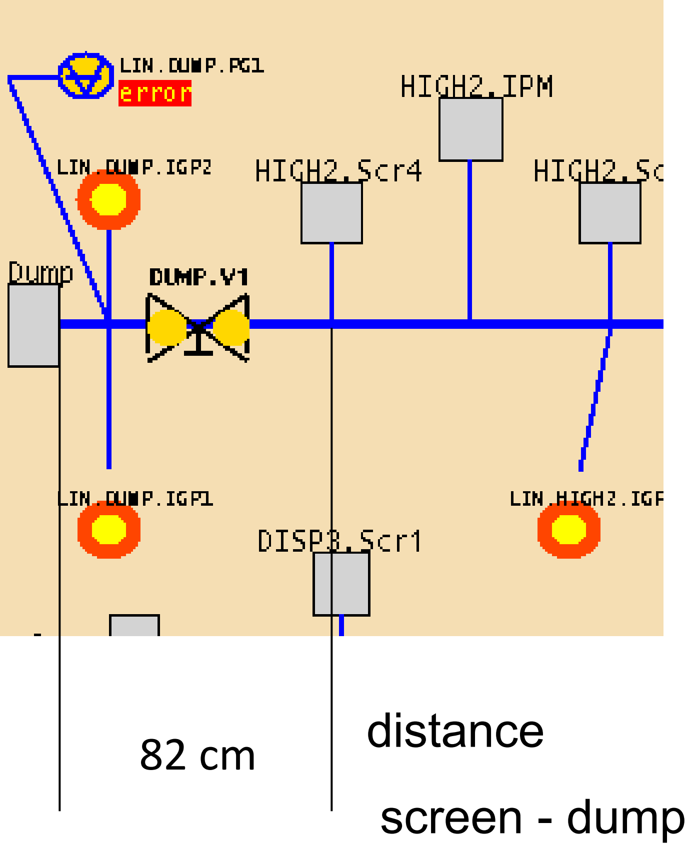
Test of Diamond screen at PITZ

High power test of Diamond and YAG screen



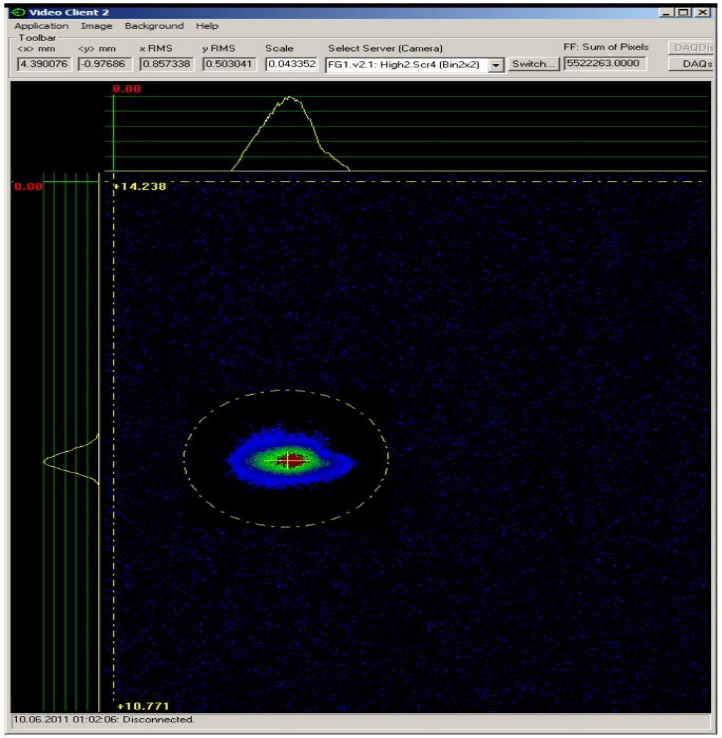
Adjust to 1 nC at H1,ICT1
Focus on D /YAG screen
Incraese NOP

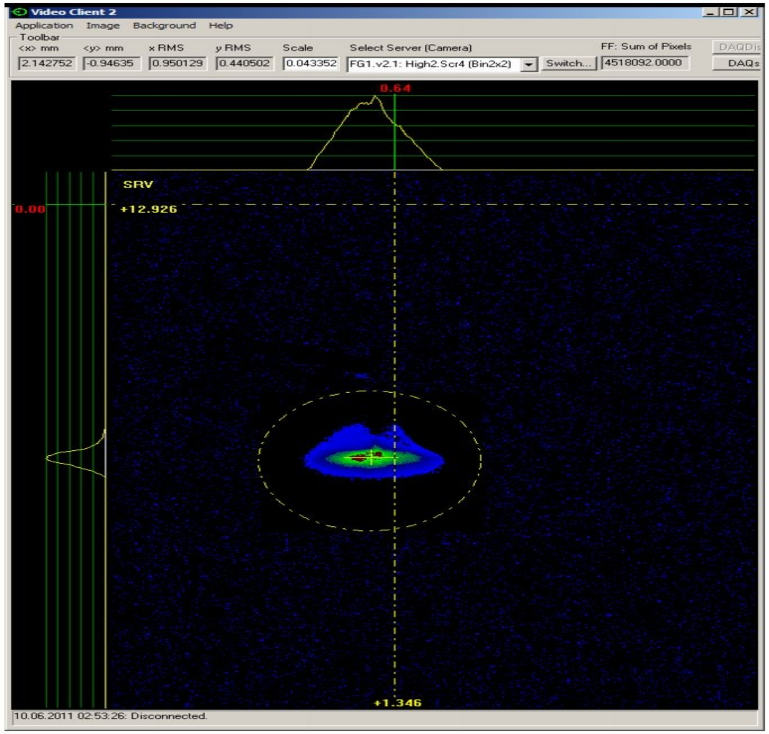
Observe pressure in IGP1,IGP2,IGP3
Observe beam spot on screen



HJG,02082011

Test of Diamond screen at PITZ





Diamond: NOP 4, gain 25

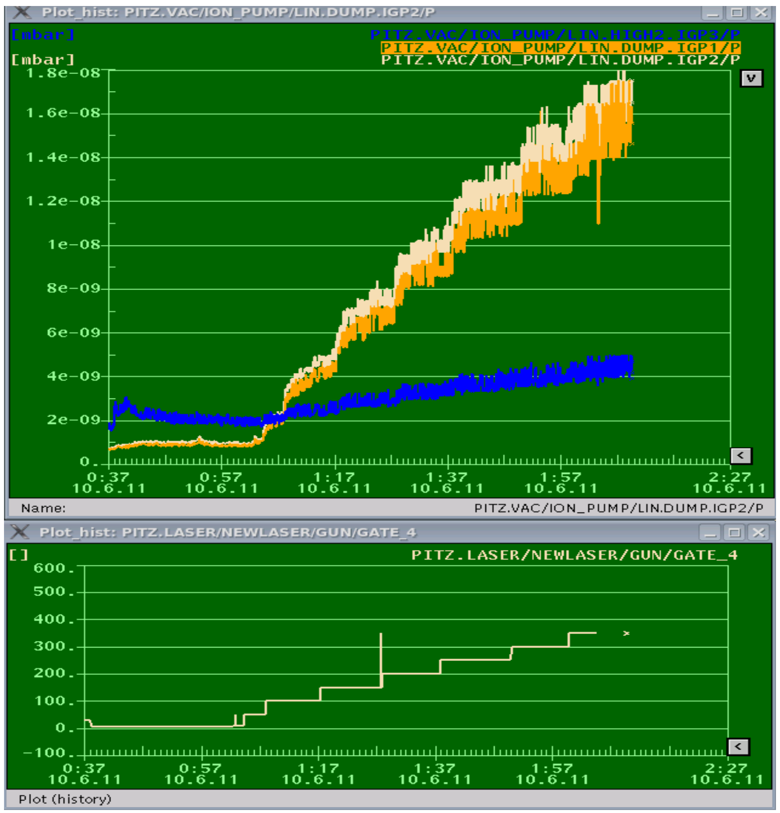
YAG (Aluminium): NOP 1, gain 18

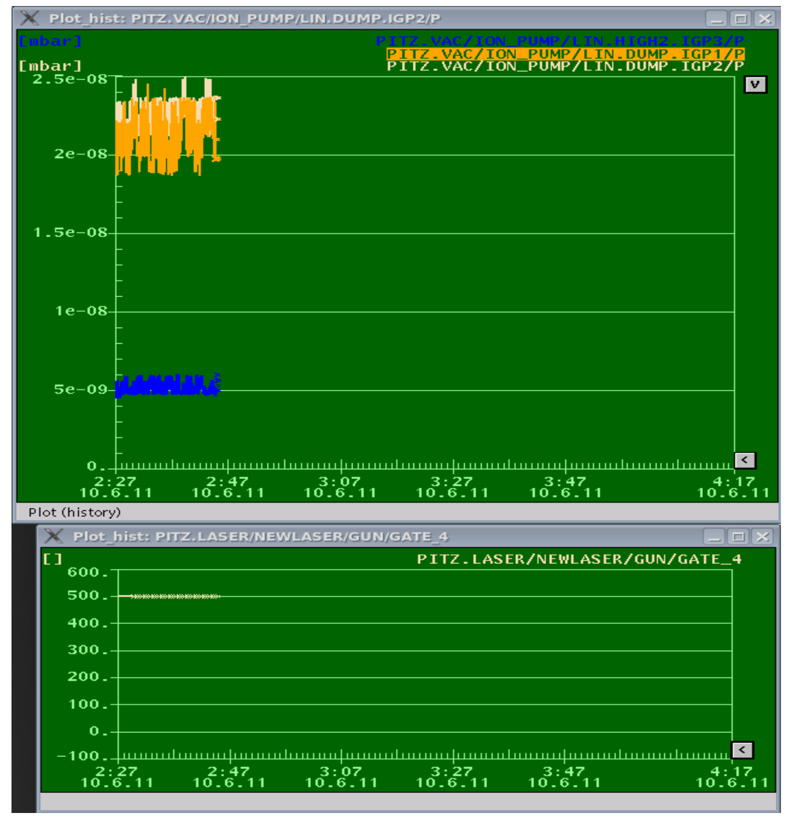
RMS ~ 0.7 mm

HJG,02082011

Test of Diamond screen at PITZ

Diamond- Screen

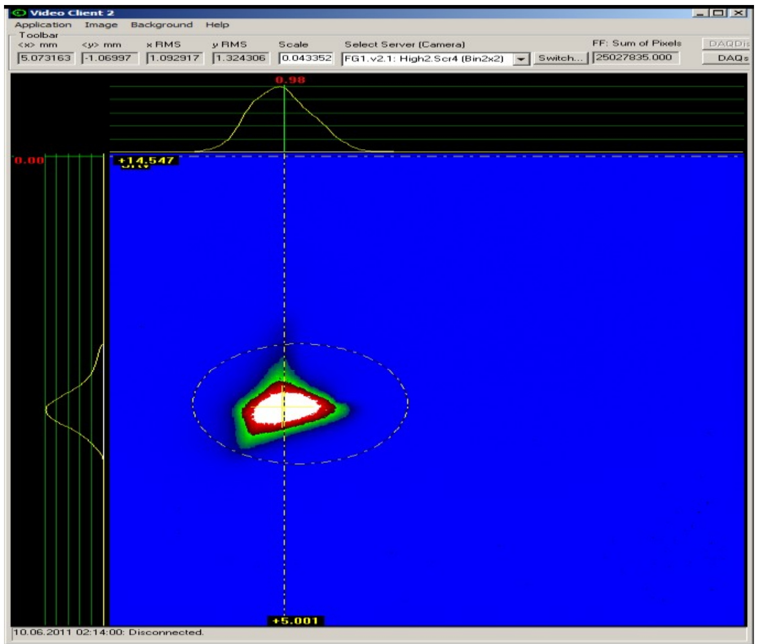


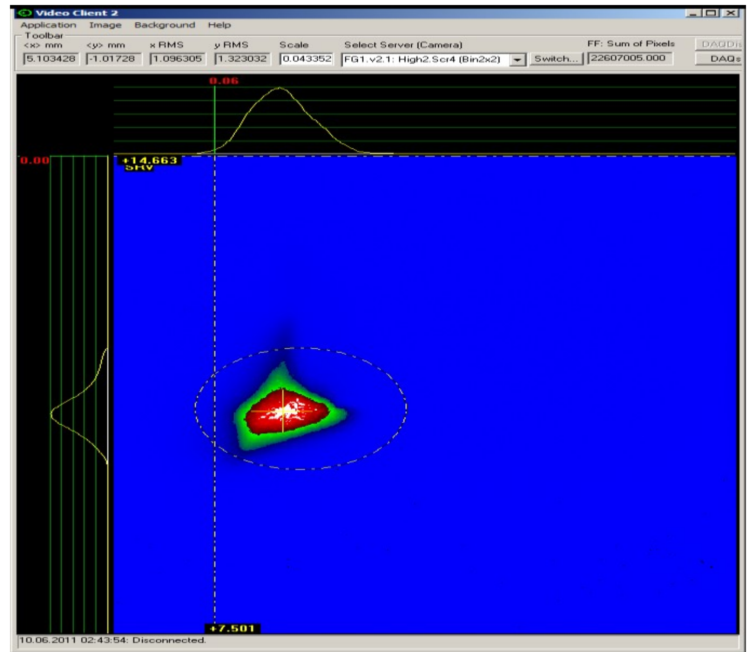


stable vacuum at NOP=500 for > 30 mins

HJG,02082011

Test of Diamond screen at PITZ





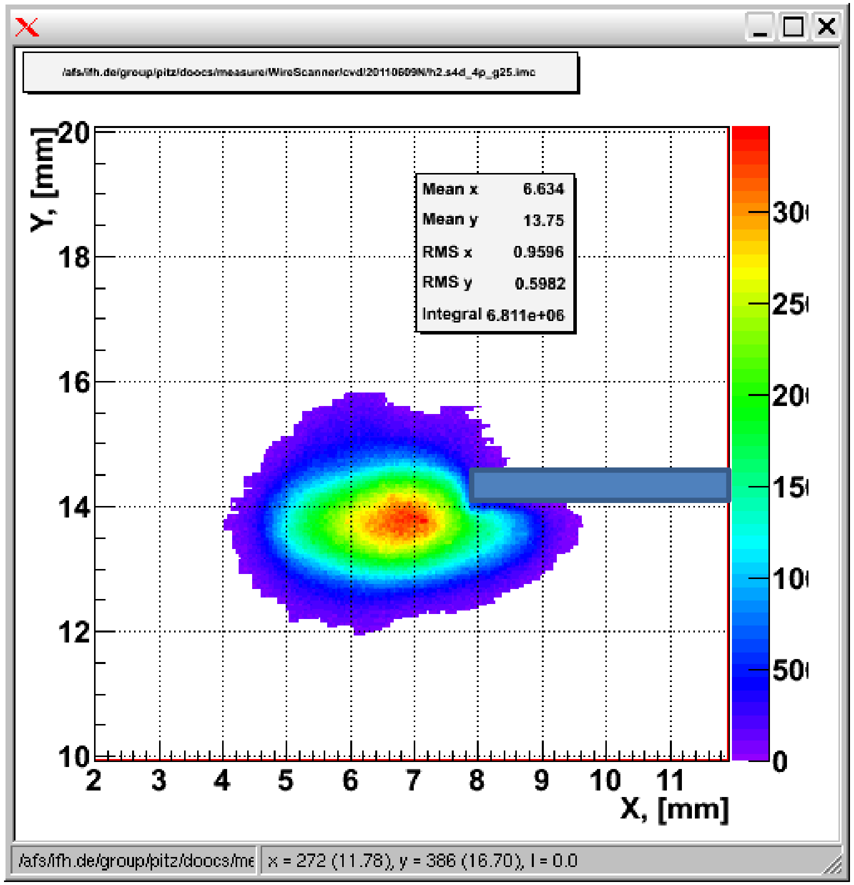
Beam-spot at start (NOP = 500)

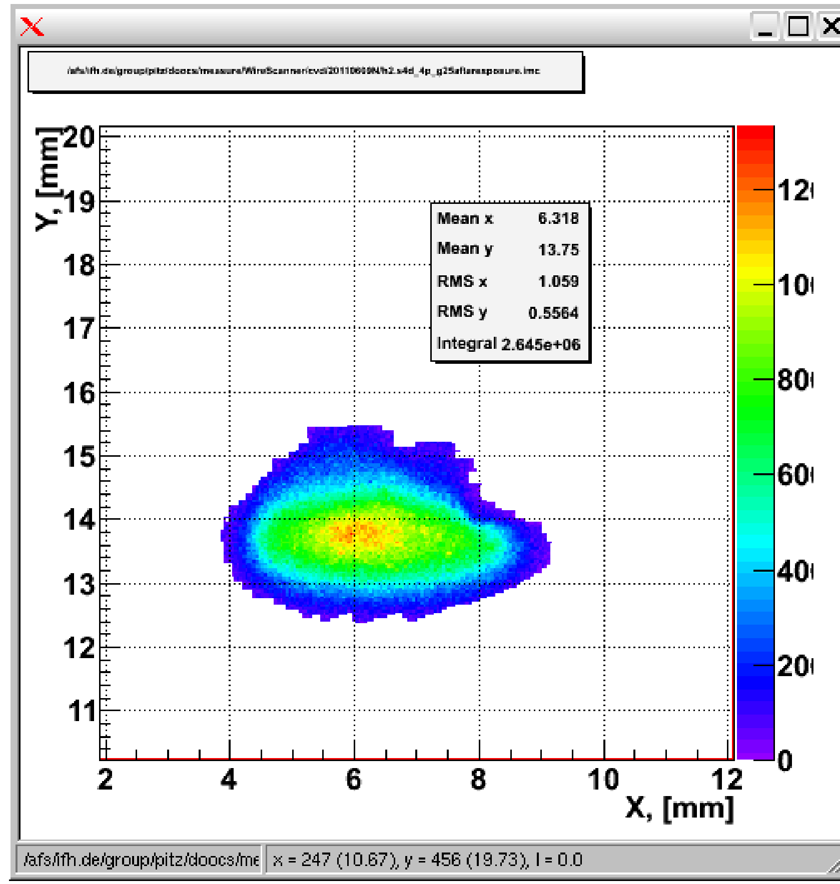
36 min later (10.8 10^6 NOP)

Altogether 19.6 10^6 NOP in 104 min at ~ 1 nC

HJG,02082011

Test of Diamond screen at PITZ





Diamond: at start

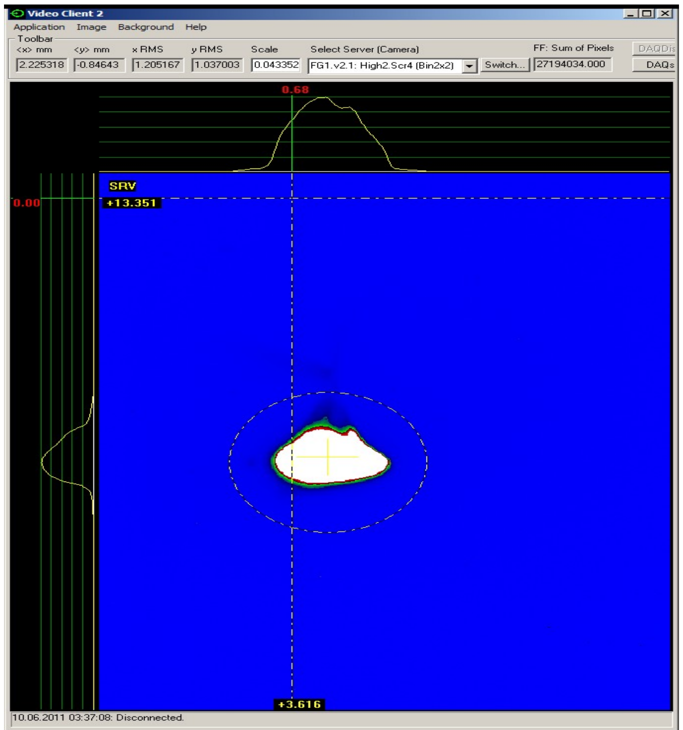
after 104 min (19.6 10^6 NOP)

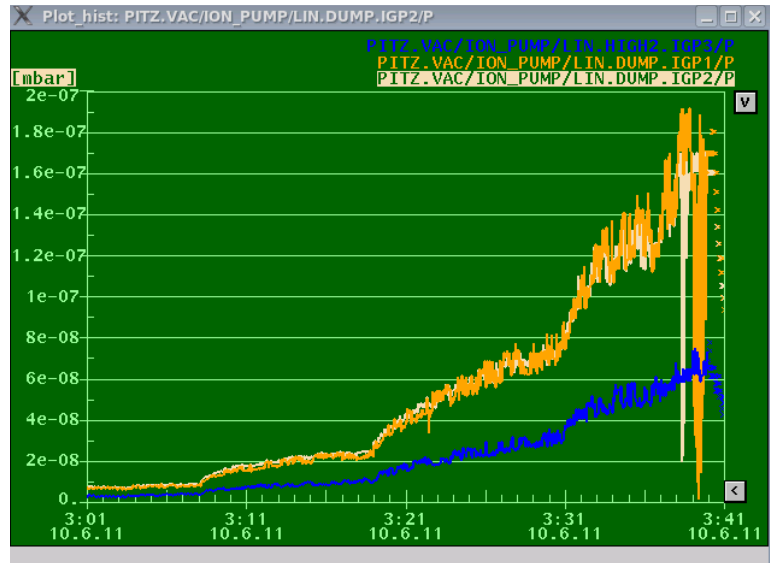
HJG,02082011

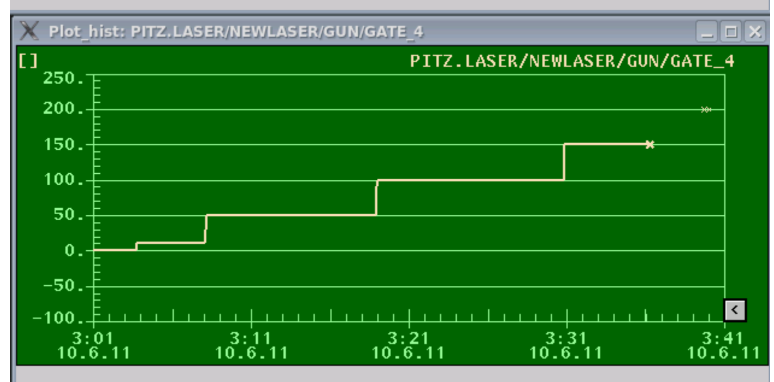
Intensity drops to 38 % , but only in the last 5 mins.

Test of Diamond screen at PITZ

YAG-Screen



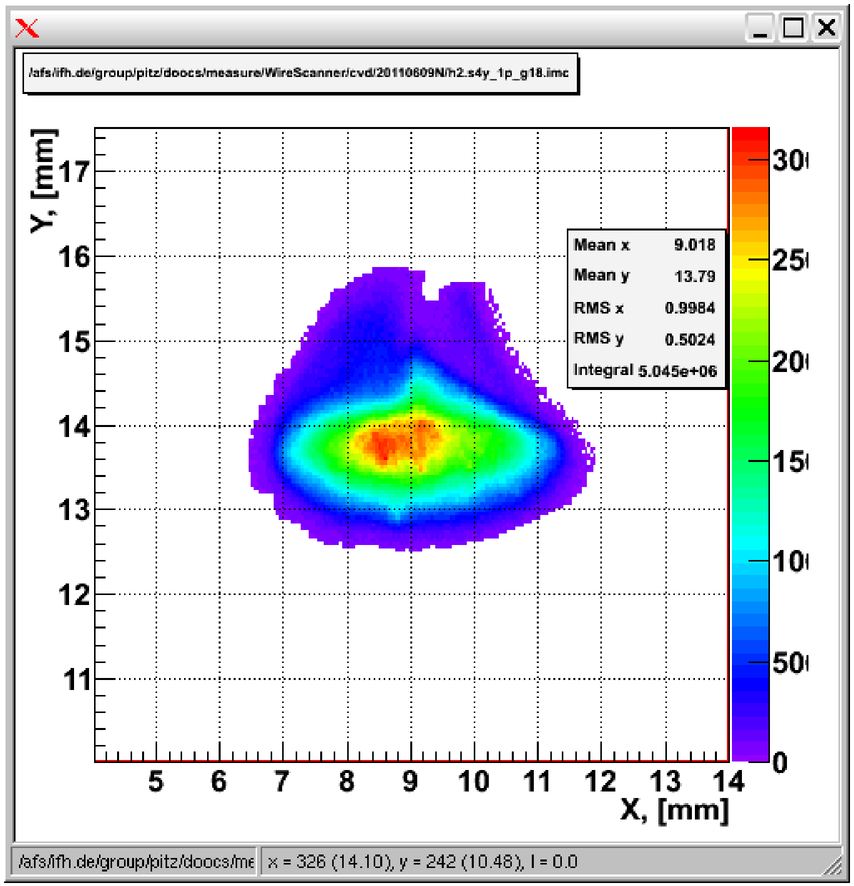


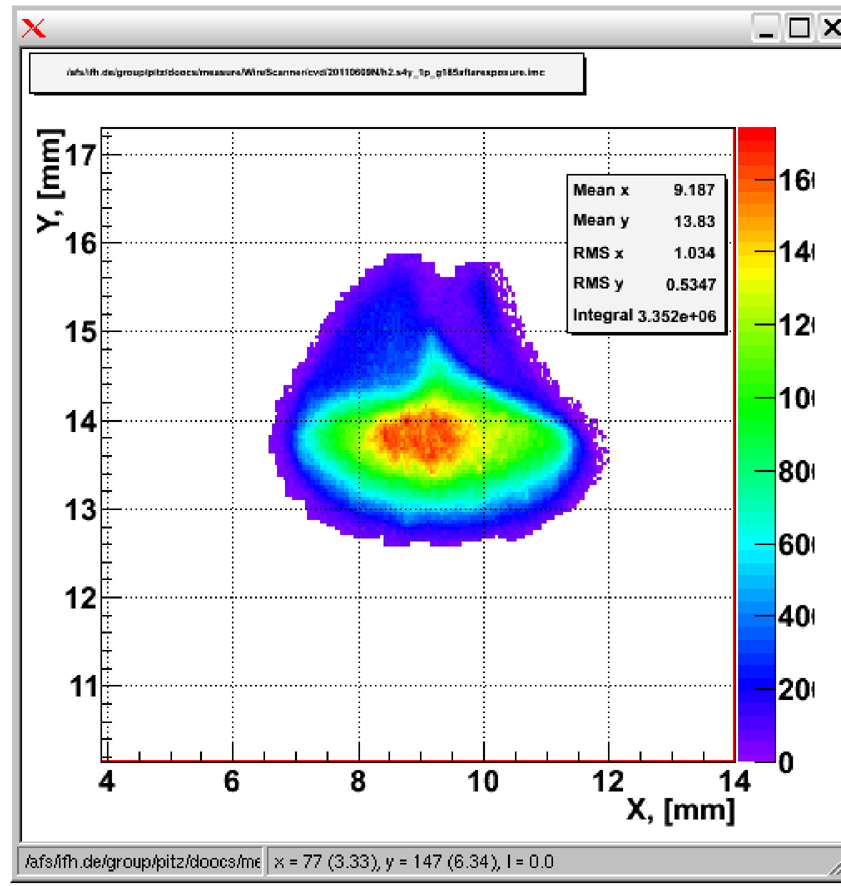


unstable vacuum behaviour at NOP = 200
we interrupt the test

HJG,02082011

Test of Diamond screen at PITZ



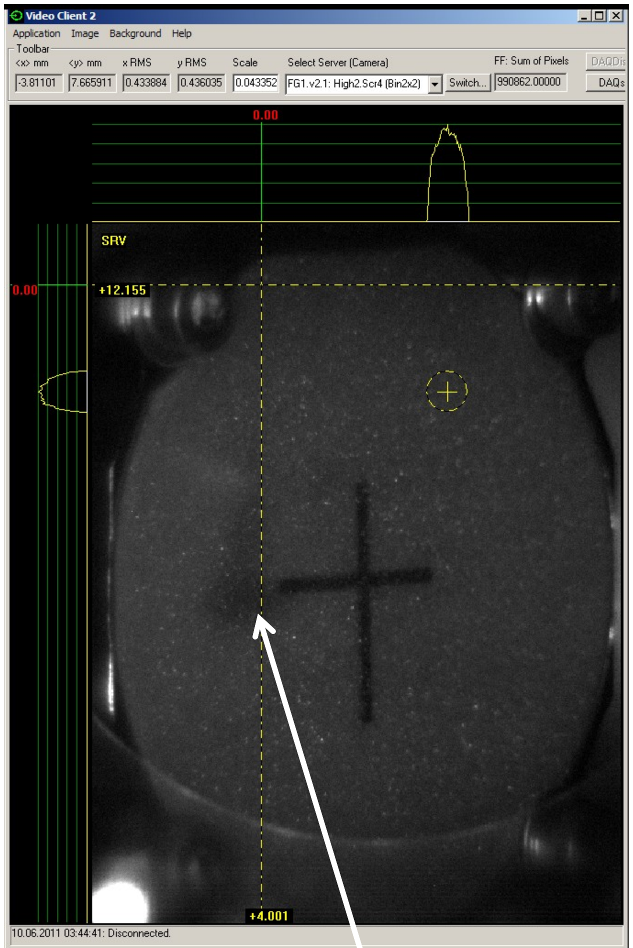


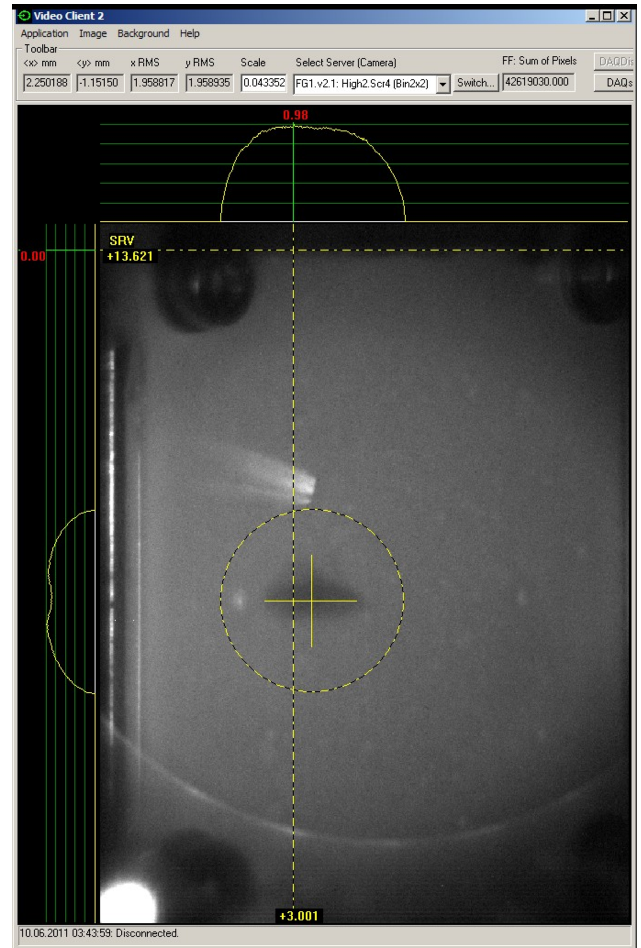
YAG : at start

after 32 min (19.3 10^3 NOP)
interrupt: vacuum bad

HJG,02082011

Test of Diamond screen at PITZ



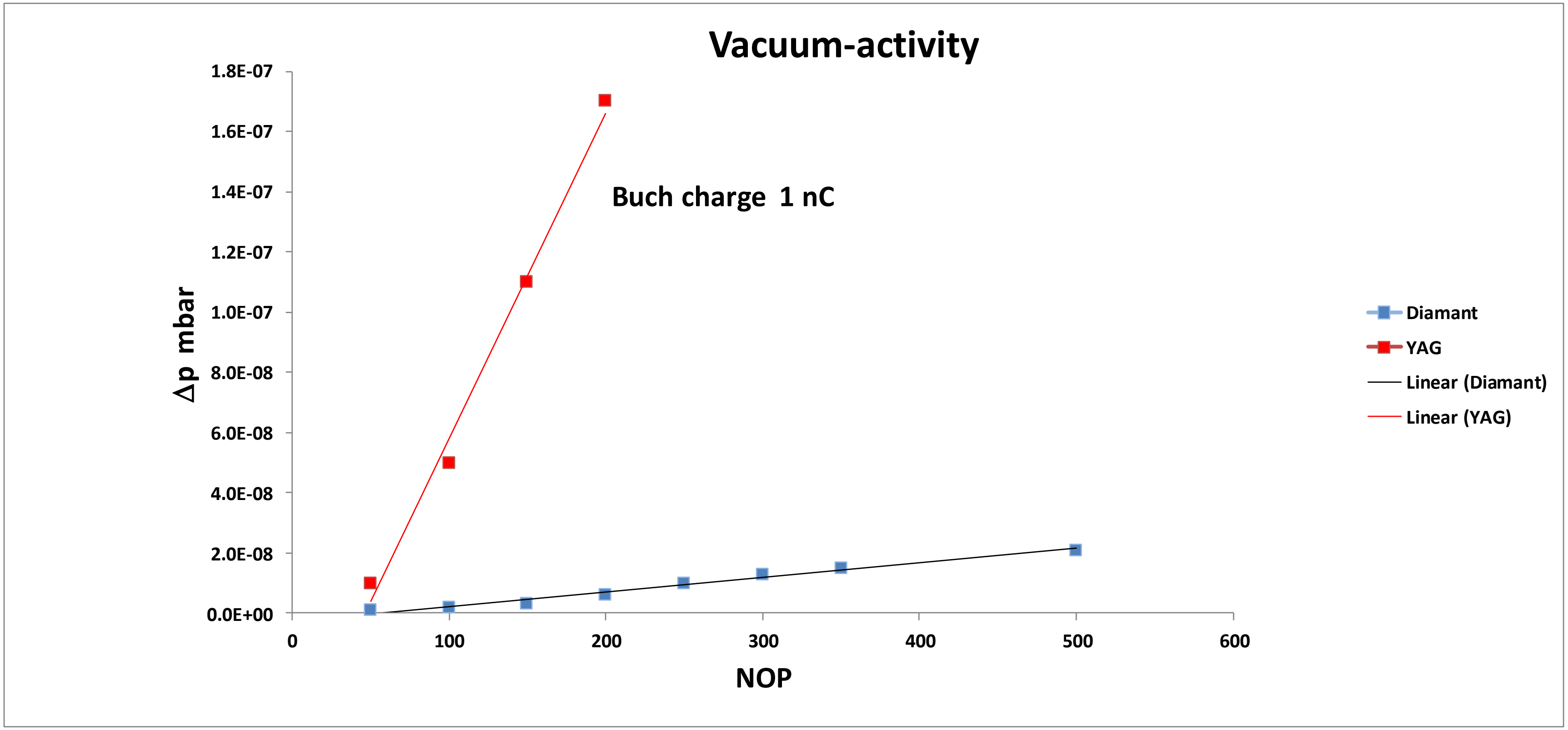


diamond: at 1500 ^{o}C it sublimates to graphite

YAG

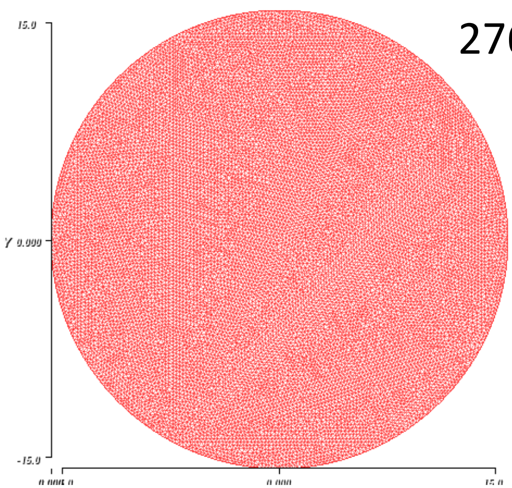
HJG,02082011

Test of Diamond screen at PITZ



HJG,02082011

Test of Diamond screen at PITZ



27636 Triangles

Simplification:

- Slab (z=0)
- Q = 1 nC (constant)
- C,λ = constant ($\neq$ f(T))
- No heat conduction between bunches
- No heat radiation
- Temp.-jump 1 train
  (NOP= 500, σ ~ 0.76 mm): 84.9 °C

- Solve heat PDE
  on a mesh (FEM):

$$\partial_t T(x,t) = k\Delta T(x,t)$$

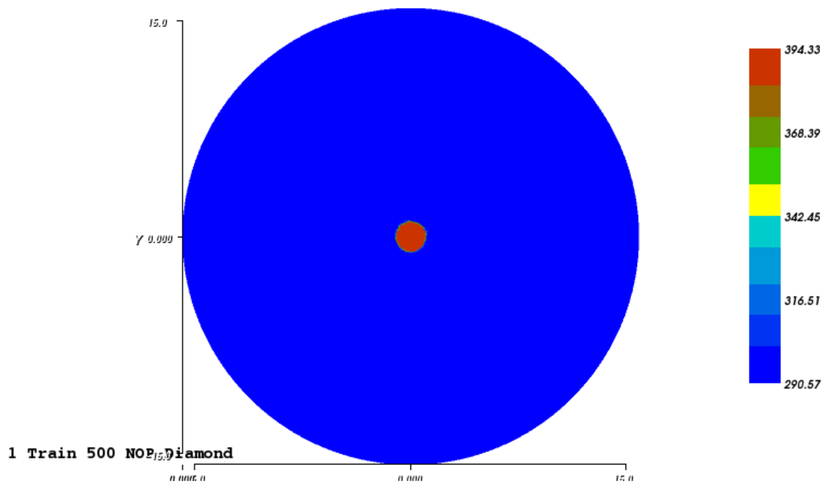
$$k = \lambda/(\rho * C)$$

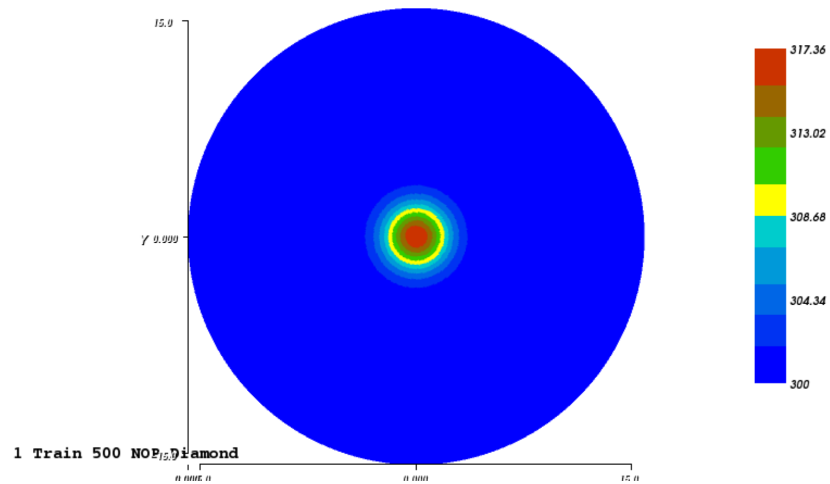
λ = thermal conductivity
C = thermal capacity
ρ = density

- FreeFEM++
  free avialable PDE solver
  www.freefem.org

HJG,02082011

Test of Diamond screen at PITZ





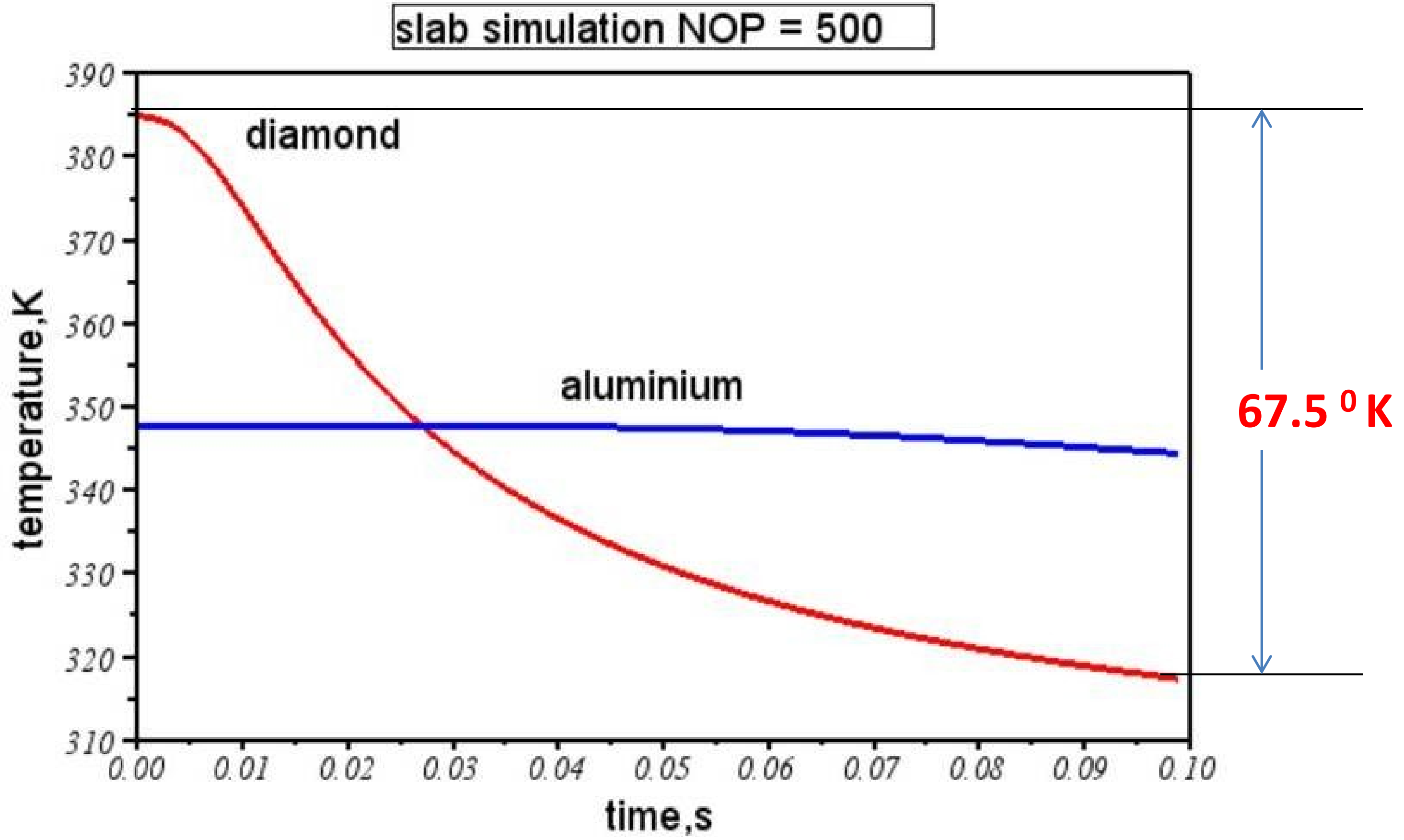
Simulation with 500 NOP/train and 1 nC

Within 0.1 s (the arrivel of the next train) the temperature in the center of the beam-spot cools down by **67.5** ^{o}K
(in reality this value must be much bigger)

For aluminium this value is 3.3 ^{o}K !

HJG,02082011

Test of Diamond screen at PITZ



Diamond: λ = 20 W/cmK , C = 0.51 J/gK
Aluminium: λ = 2.35 W/cmK , C = 0.91 J/gK

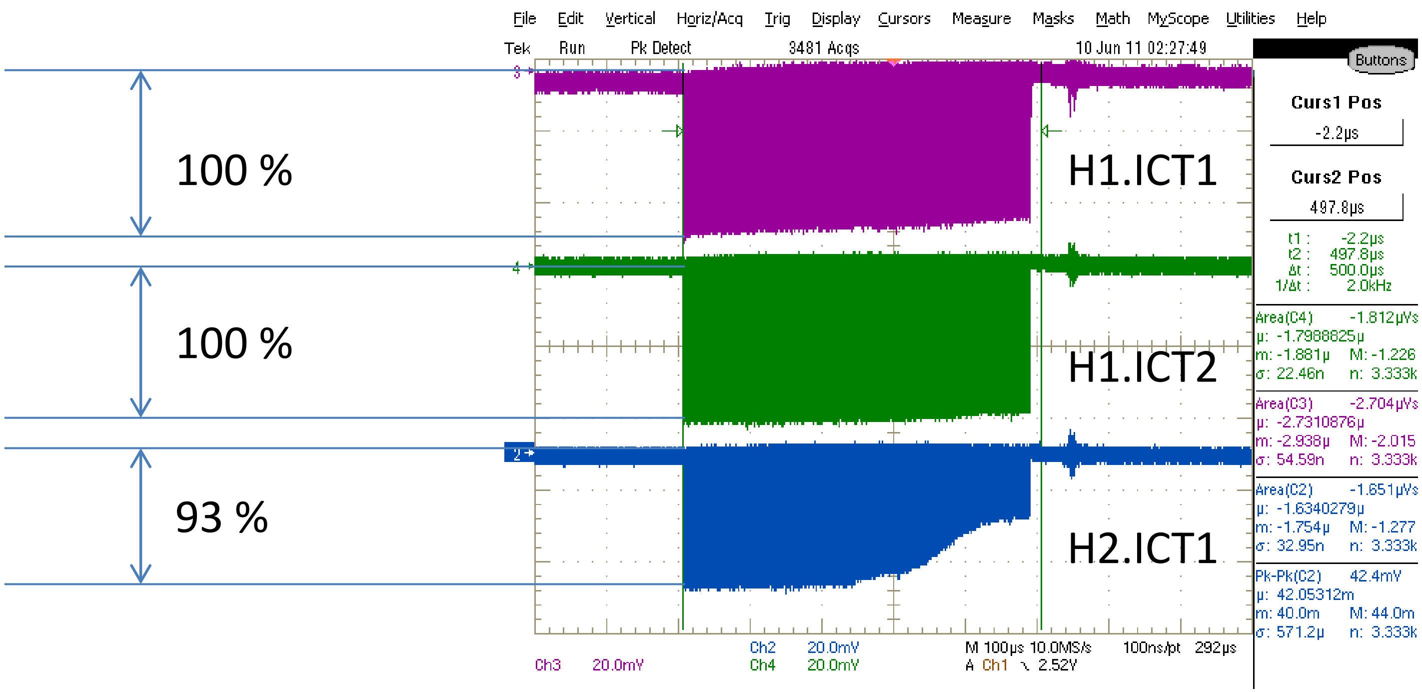
HJG,02082011

Test of Diamond screen at PITZ

- measure we really at 1 nC ?

➢ No , charge loss in high2 section.
  (may be ~ 800 pC)

Test of Diamond screen at PITZ



- ~ 7 % charge loss up to the H2-section (already measured 04.05.2011 A, see logbook)
- loss of signal bigger than 300 NOP (~ 50 %)

HJG,02082011

Test of Diamond screen at PITZ

- Different RMS-size and intensity between YAG and Diamond can be explained.
- The flurescence of Diamond screen is to strong at large NOP.
- Thinner Diamond screen (foil 20 μm) can solve problems probably.
- Diamond is much more stable against heat-load.
- Diamond shows an execlent vacuum behaviour.
- At 1500^{o}C Diamond becomes Graphite.