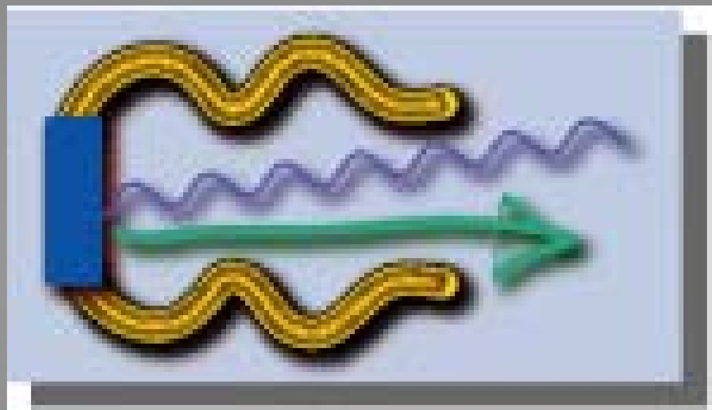
PHIN JRA

Charge production with Photo-injectors



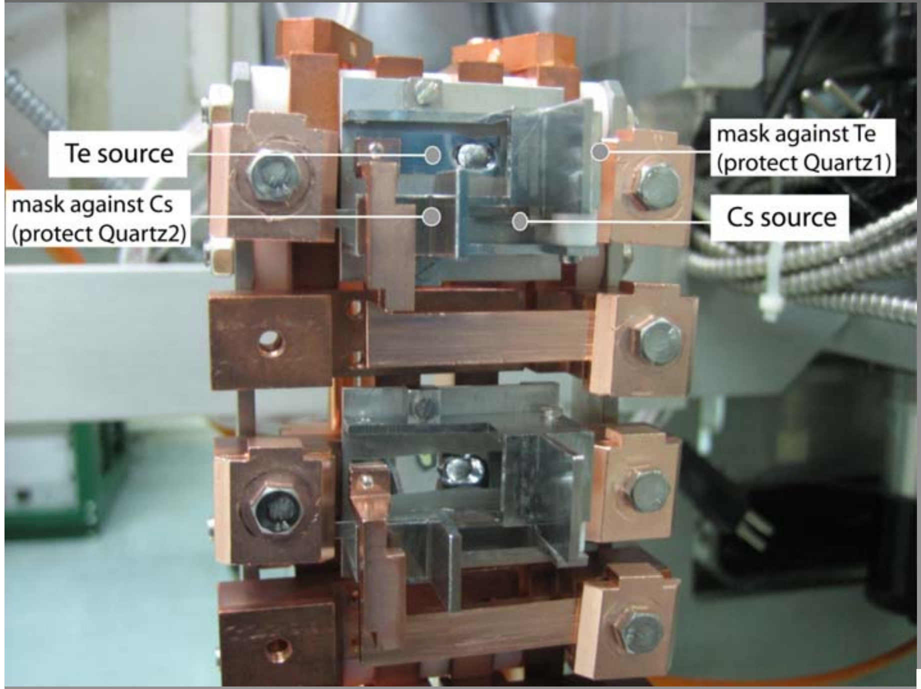
Andrea Ghigo

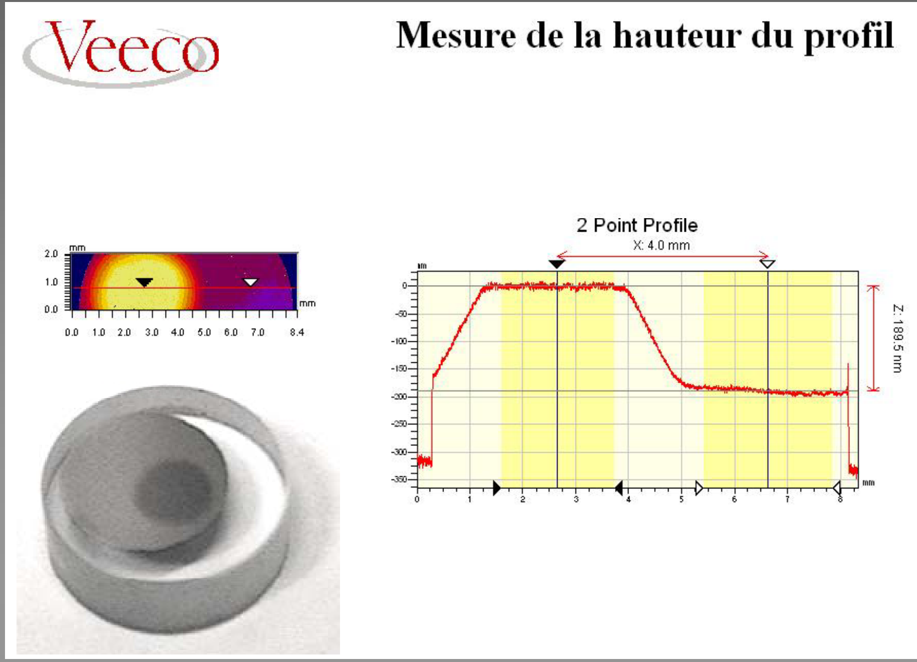
CARE Collaboration Meeting

CERN 31 October 2007

Institute	Acronym	Country	Coordinator	PHIN Scientific Contact	Associated to
CCLRC Rutheford Appletone Lab. (22)	CCLRC-RAL	UK	P. Norton	G.Hirst	
CERN Geneva (19)	CERN	CH	H. Haseroth	R.Losito	
CNRS-IN2P3 Orsay (3)	CNRS-LAL	F	T. Garvey ??	G. Bienvenu	CNRS
CNRS Lab. Optique Appl. Palaiseau (3)	CNRS-LOA	F	T. Garvey ??	V. Malka	CNRS
ForschungsZentrum ELBE (10)	FZR-ELBE	D	J. Teichert	J. Teichert	
INFN-Lab. Nazionali di Frascati (11)	INFN-LNF	I	S. Guiducci	A. Ghigo	INFN
INFN- Milan (11)	INFN-MI	I	C. Pagani	I. Boscolo	INFN
Twente University- Enschede (13)	TEU	NL	J.W.J. Verschuur	P.Van der Slot	

CERN Photo-cathode preparation



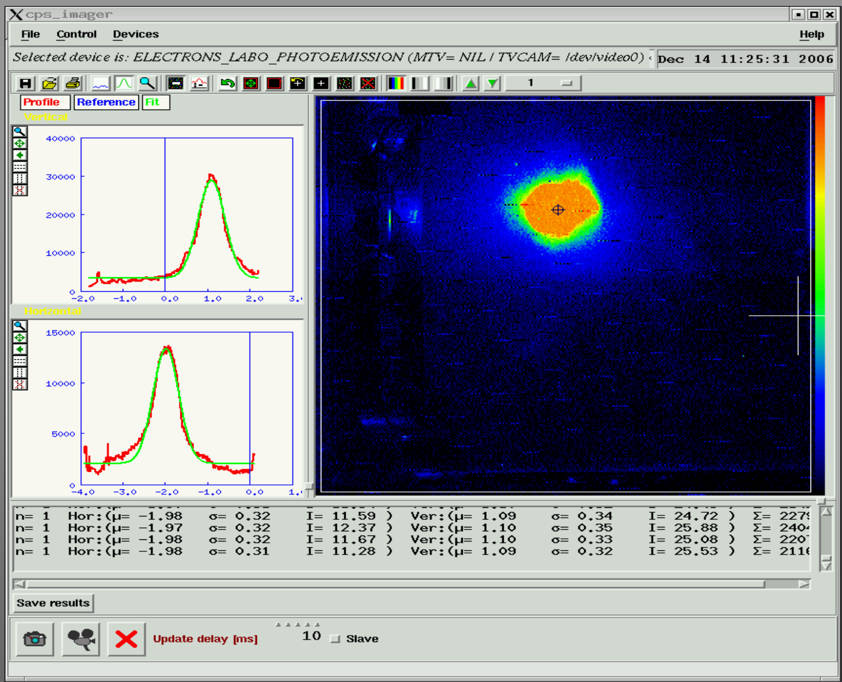


- **Co-Deposition setup evaluated**
- **Te absolute thickness calibration**
- **Calibration of quartz measurements**

Profilometer VEECO DEKTAK 6M

Electron beam in DC gun, from Cs_2Te photocathode

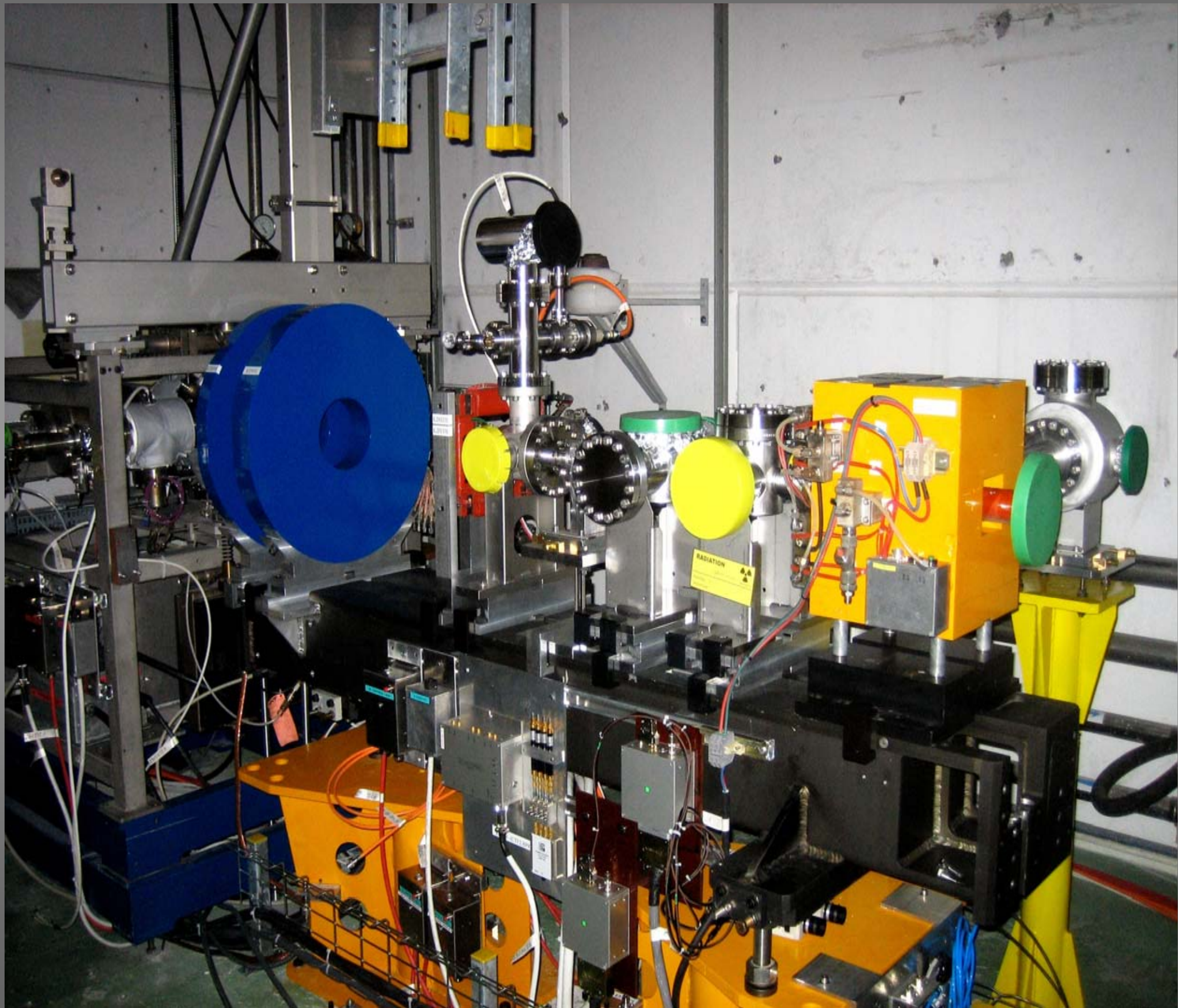
- co-evaporation technique:
  - simultaneous evaporation of Cs and Te onto Cu substrate
  - observation of film growth with two independent deposition monitors
- transfer of cathode into DC gun (under high vacuum)
  - 80 kV DC gun operation,
  - laser 266 nm, pulse width 5 ns, repetition rate 10 Hz
  - e-current measured with wall current monitor
  - quantum efficiency measured: 6%



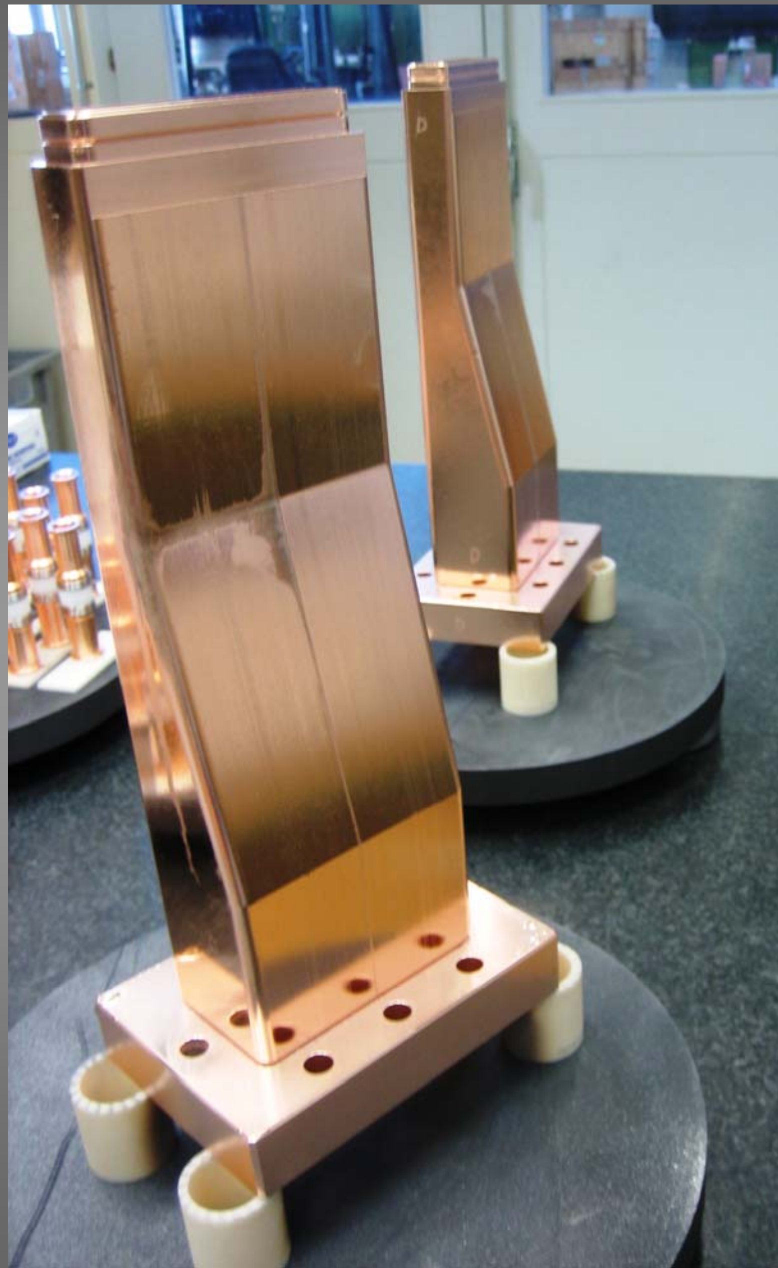
e-beam on scintillation screen

photocathode No. 166
(Dec. 2006)

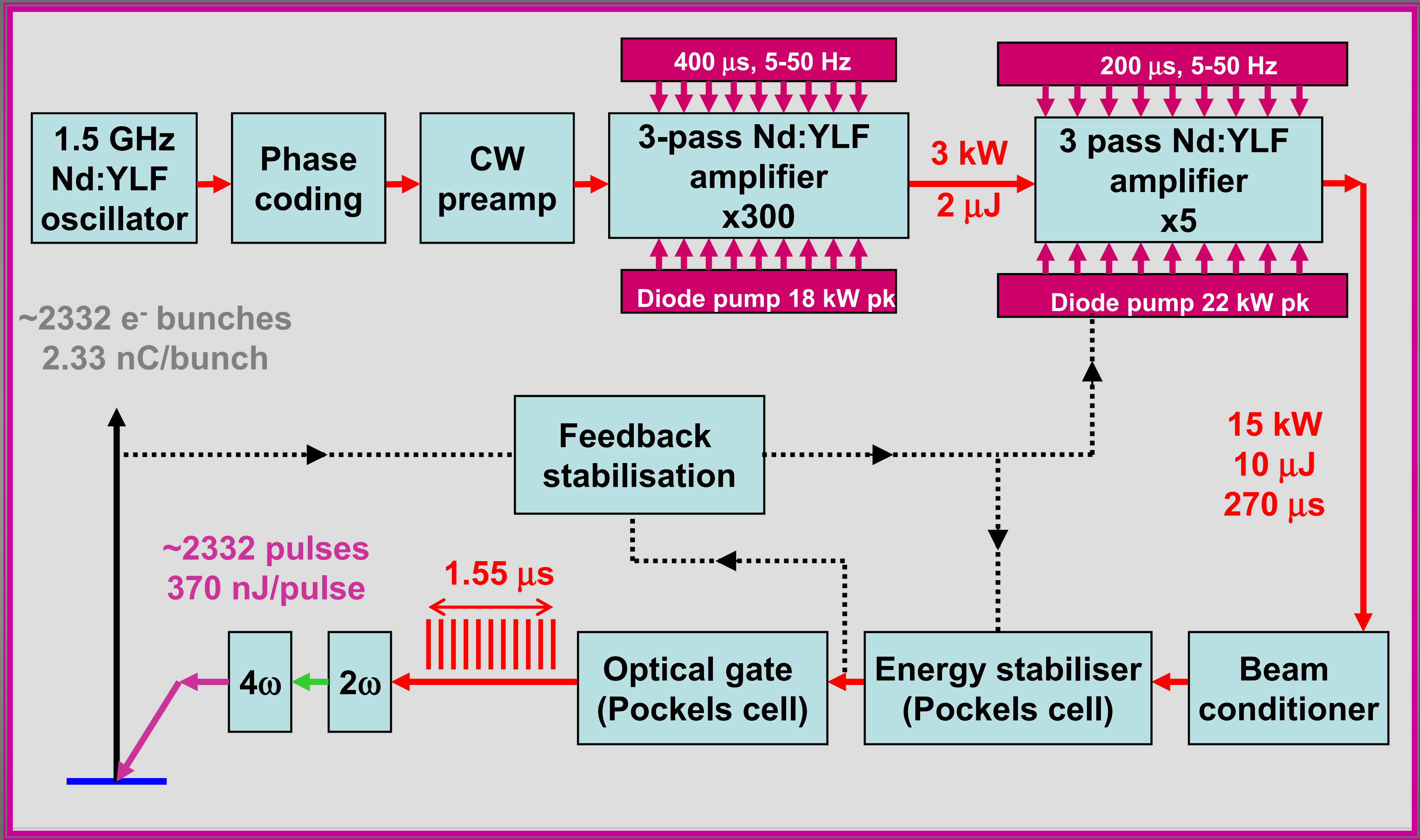
CERN CTF3 Photoinjector installation



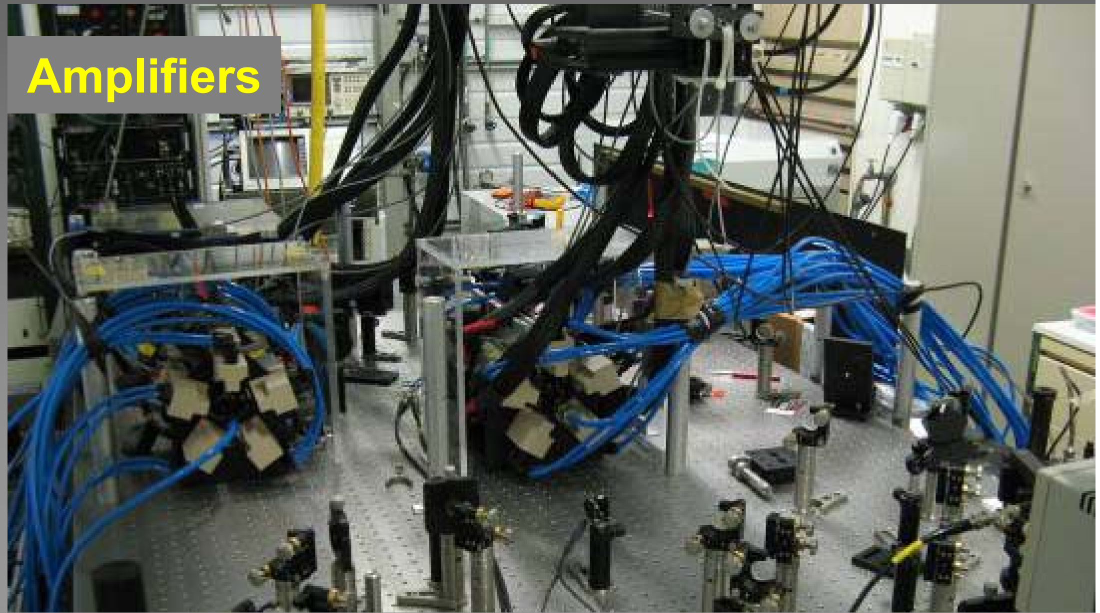
LAL-CERN RF Gun

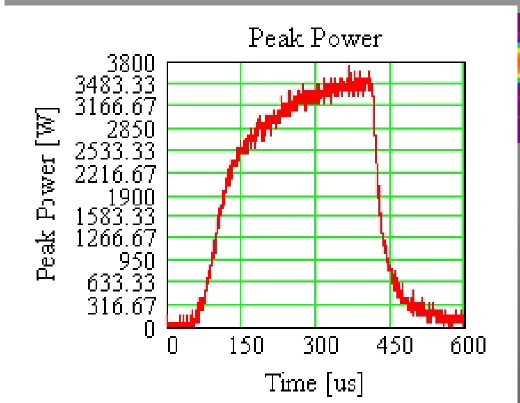


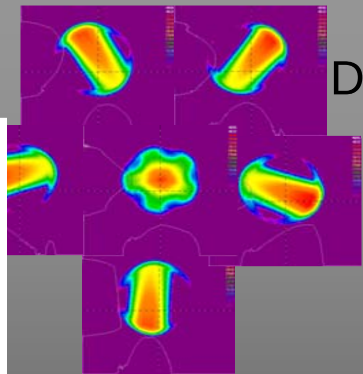
CCLRC/RAL CTF3 Laser system schematic



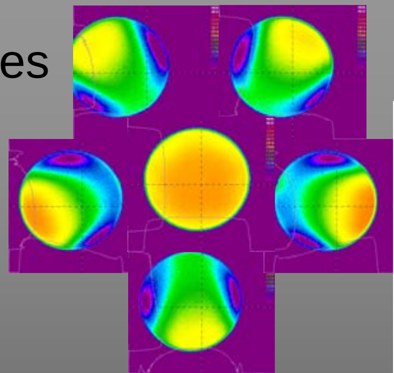
CTF3 Laser System

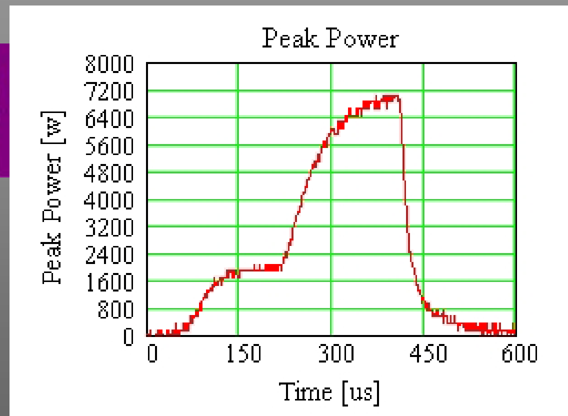


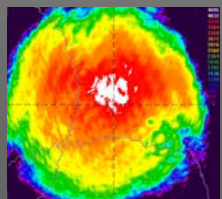




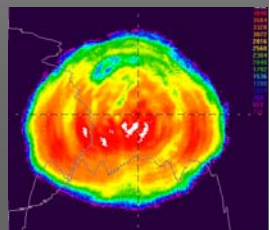
Diodes



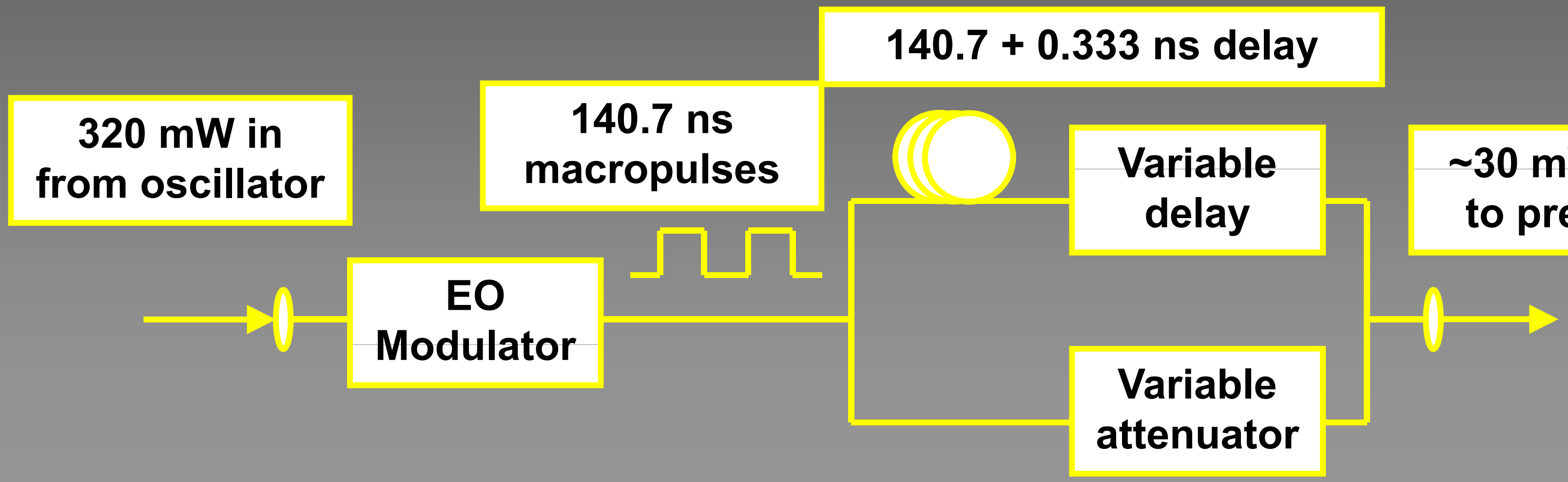




Laser profiles

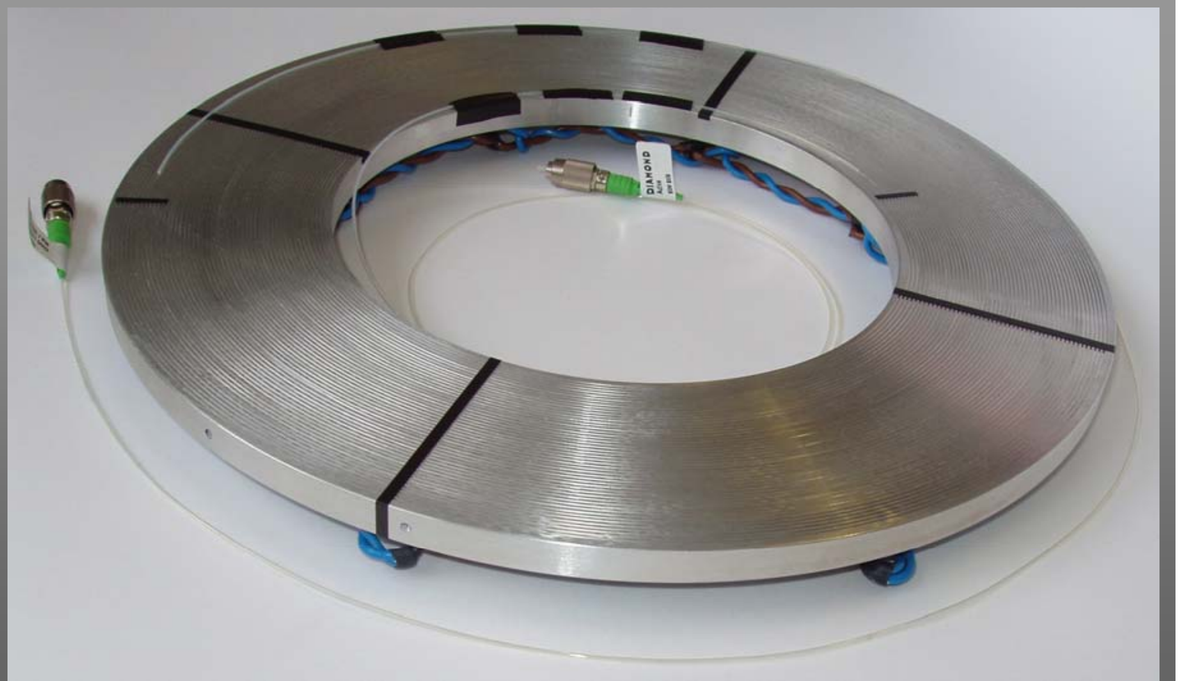


Pulse phase coding



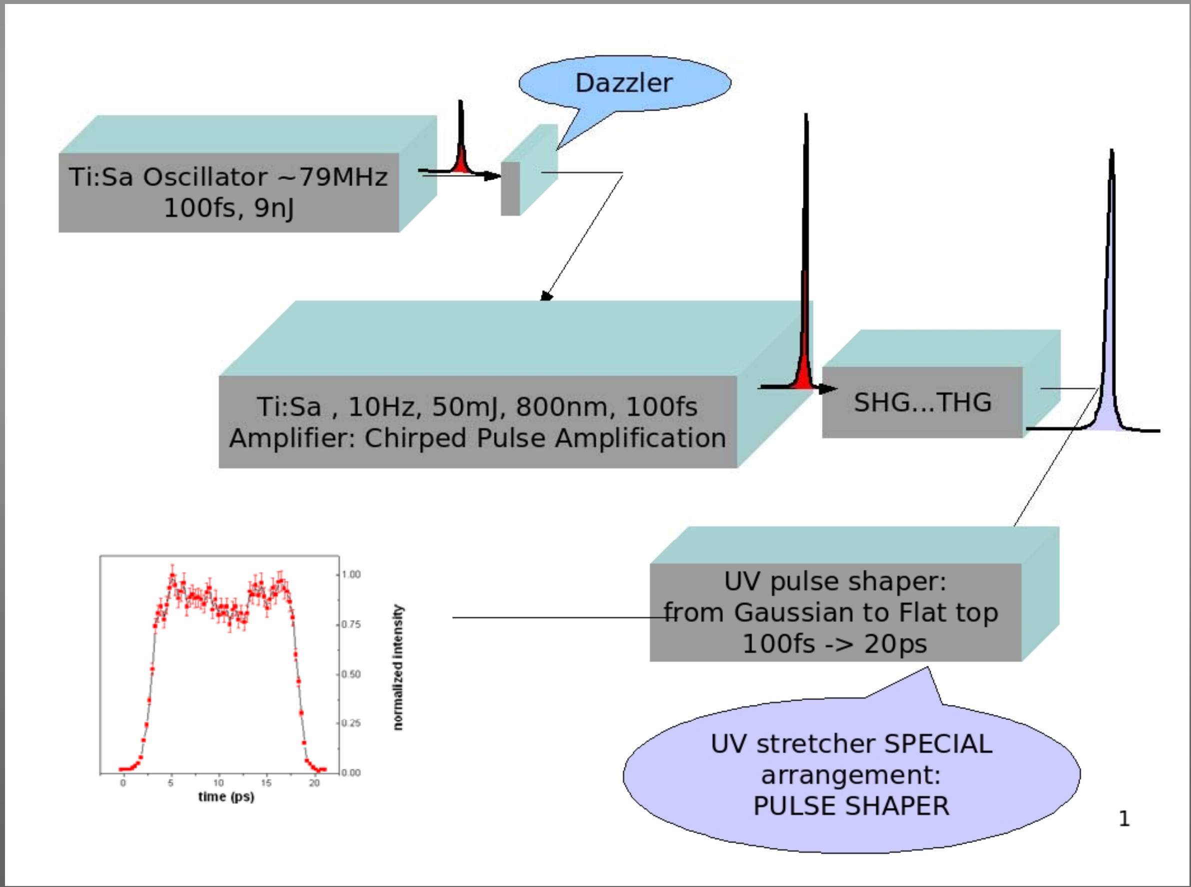
- Fibre modulation, based on telecoms technology, is fast but lossy and limited in average power
- Measurements on the High Q system suggest 10dB loss before the preamp

  results in <3dB output reduction
- Delay can be adjusted by varying the fibre temperature (~0.5ps/°C)
- Attenuation can be controlled by varying the fibre bending losses

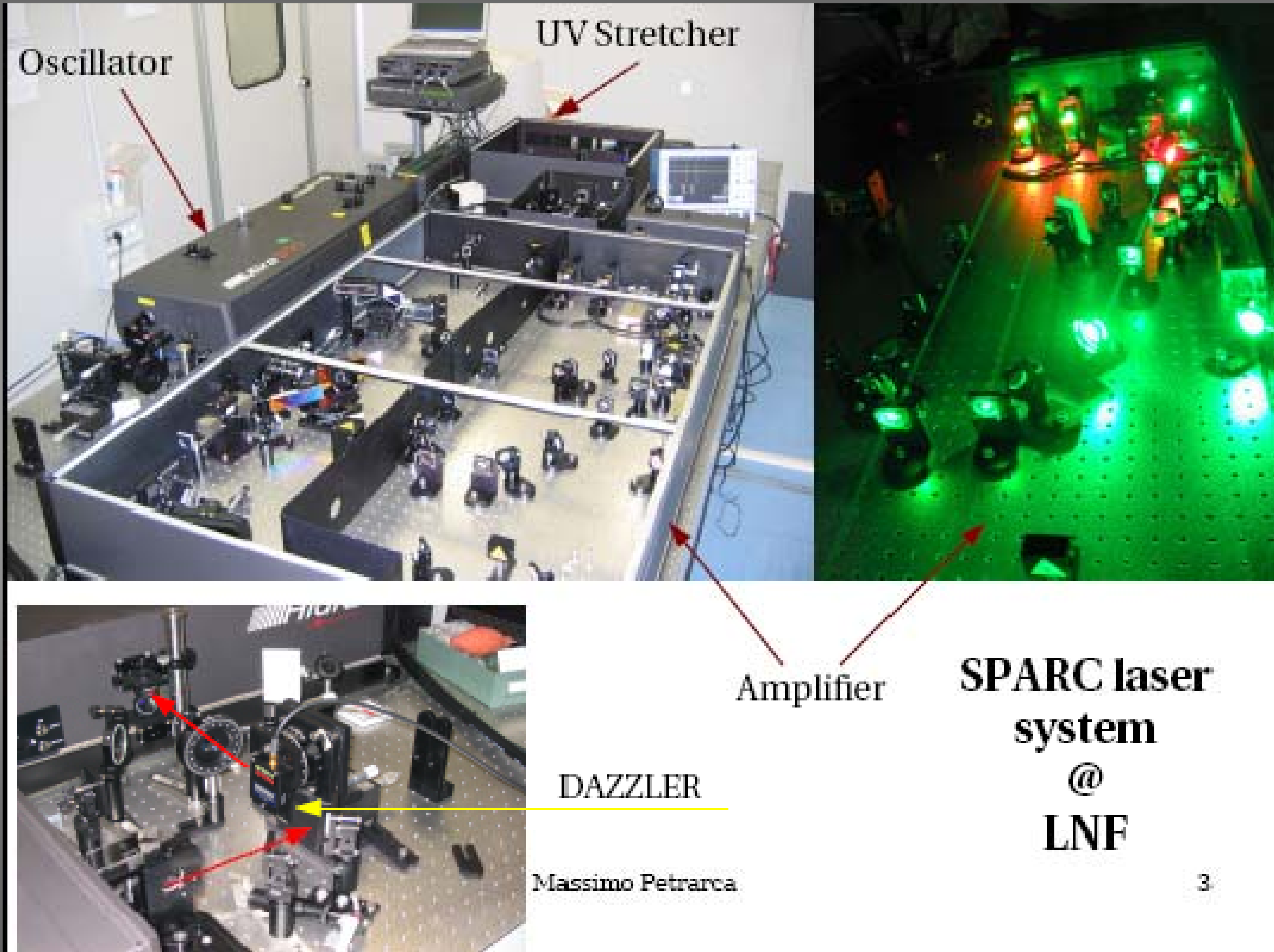


INFN-SPARC laser system

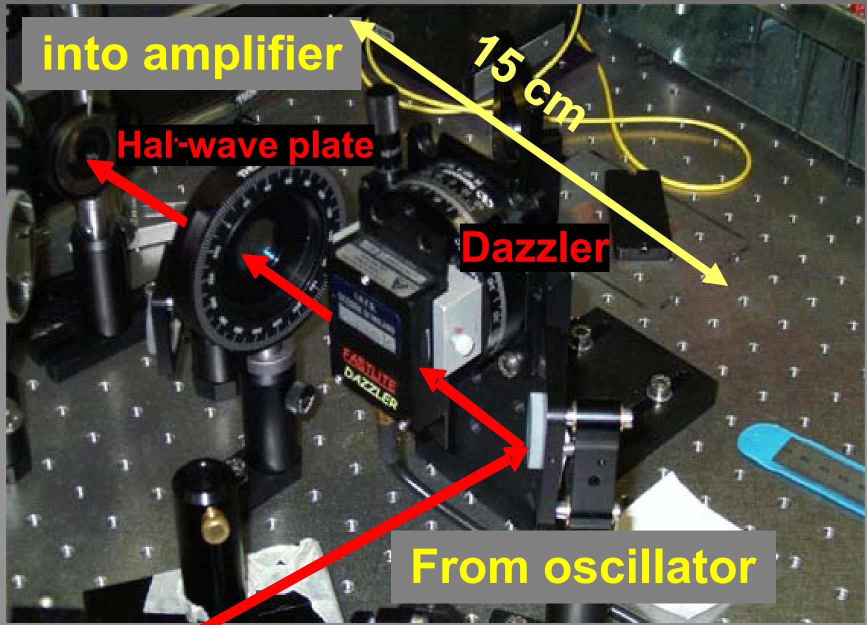
A Ti:Sa TW-class laser is used to drive the SPARC RF-gun.
The flat top pulse shape is achieved using two steps:
- the Dazzler or LC-SLM for Amplitude and phase modulation in IR before the amplifier
- UV pulse shaper for amplitude modulation to get shorter rise time

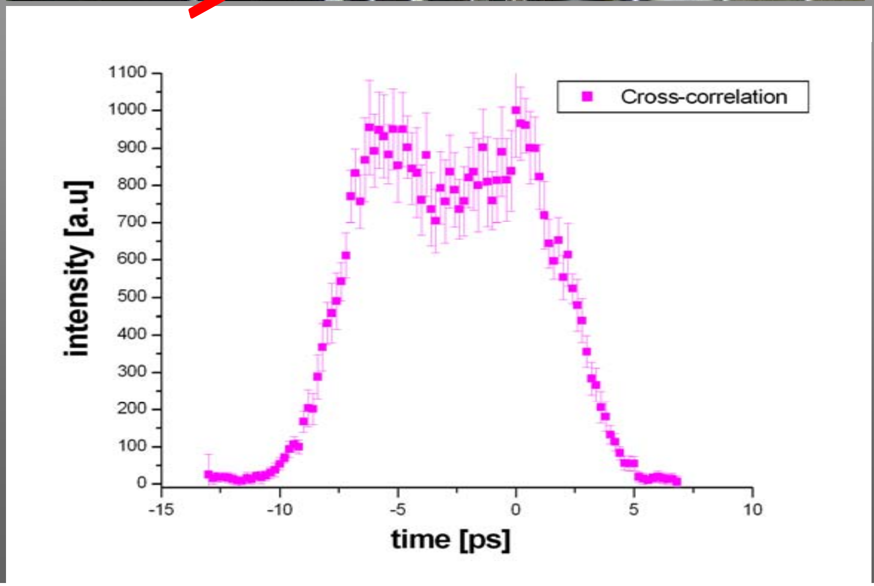


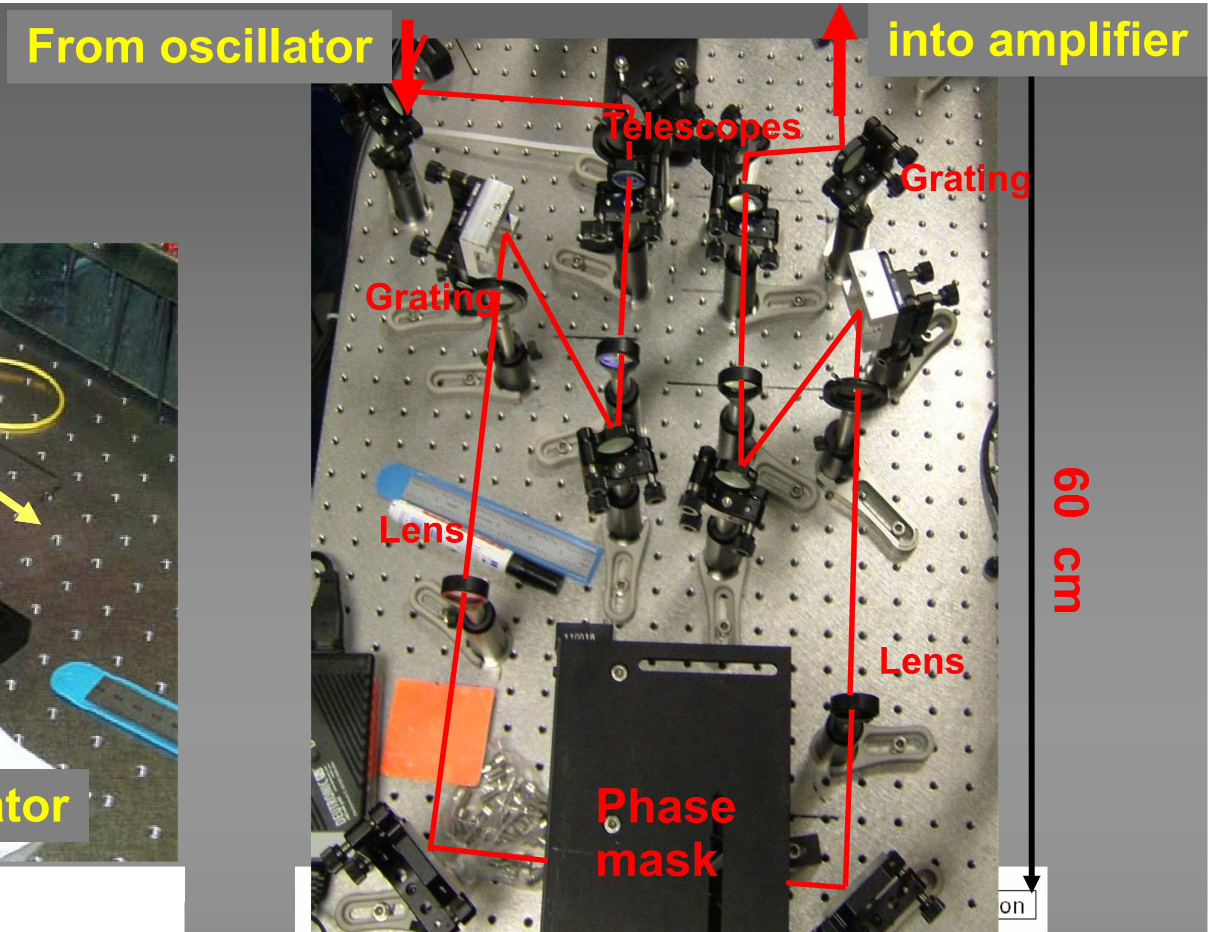
Longitudinal Pulse Shaping

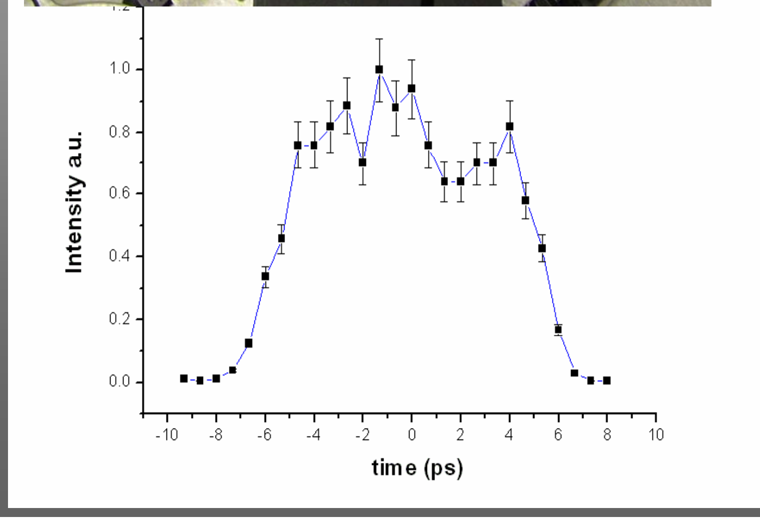


Dazzler & LC-SLM
INFN LNF& Mi





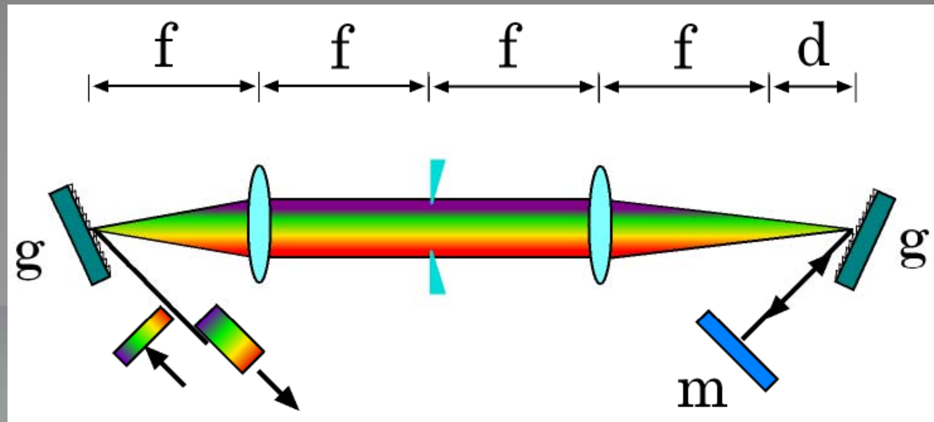


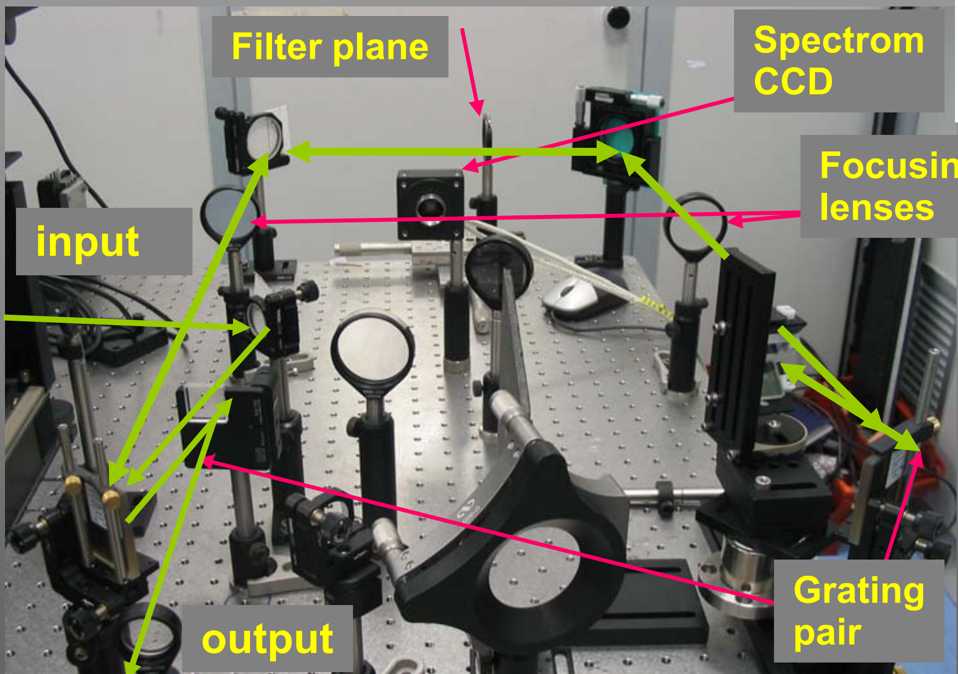


Shaping device + custom UV pulse shaper

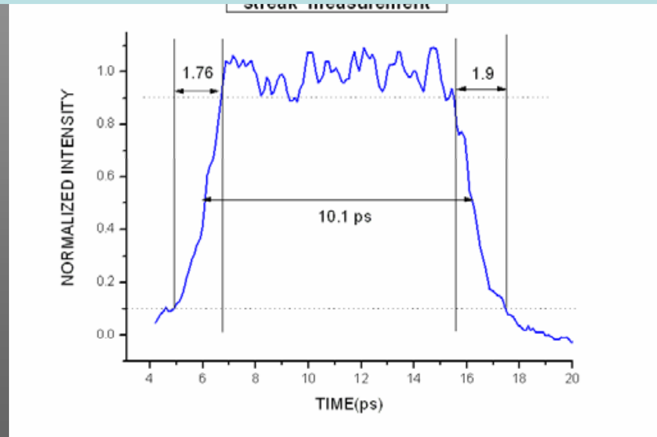
-The UV stretcher was designed to lengthen the laser pulse up to 20 ps.

-In the Fourier plane an amplitude filter, such as an iris, can be applied to cut the tails of an almost square spectrum produced by the DAZZLER or LC-SLM

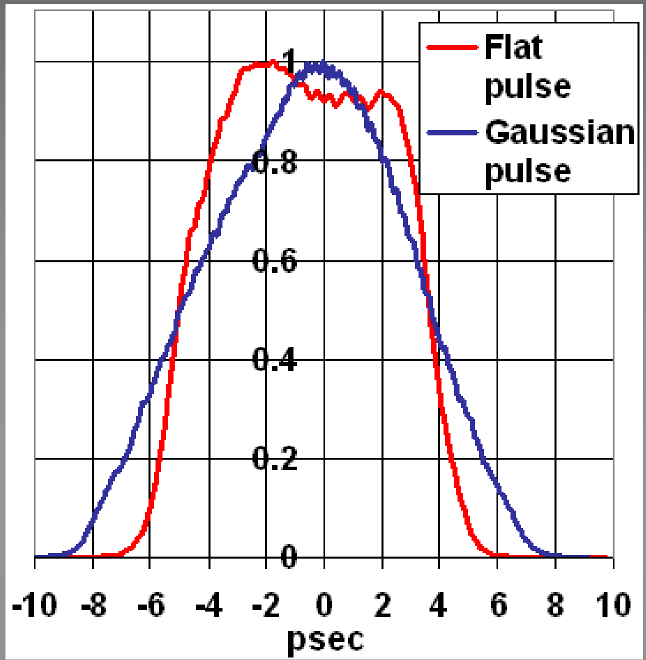


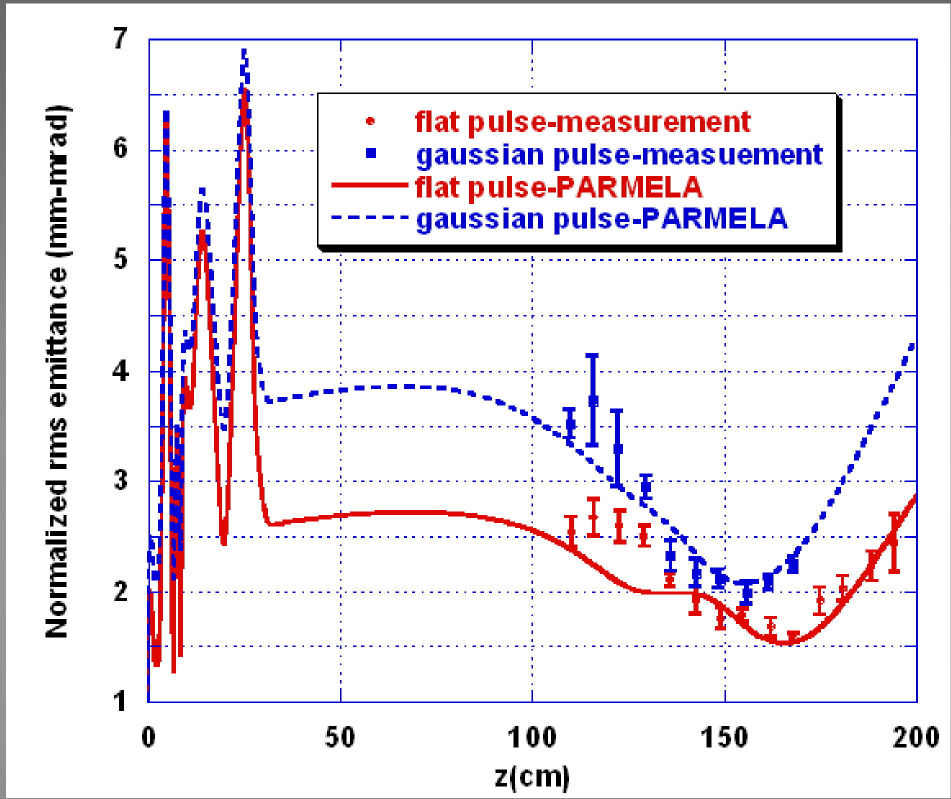


Hamamatsu FESCA 200 measurements



Flat top vs gaussian pulse shape on electron beam emittance





DAZZLER

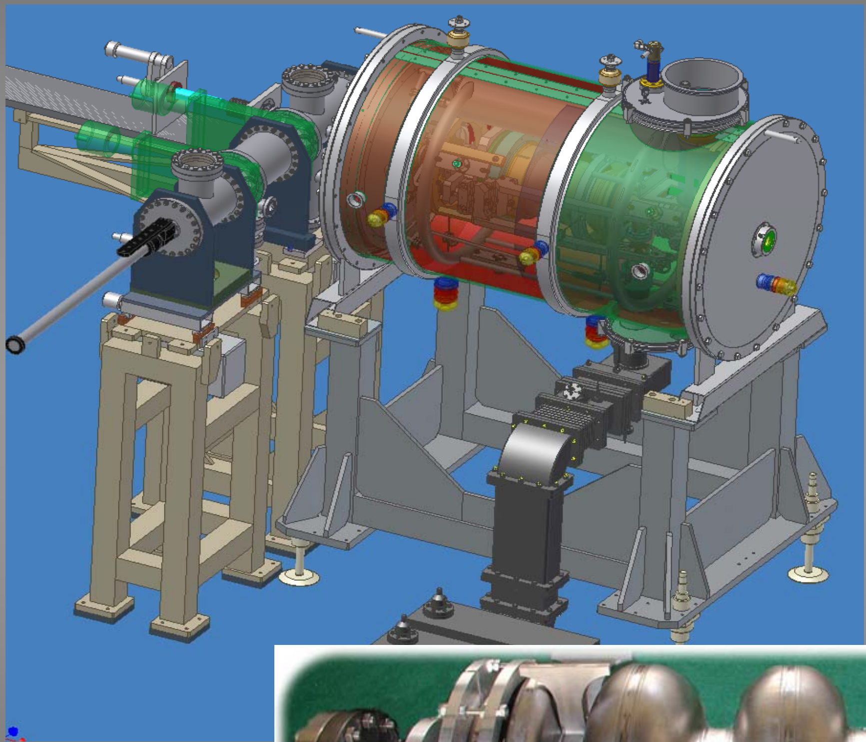
- Compact
- Easy alignment
- Contemporary phase and amplitude modulation
- Losses within 50%
- Resolution = 0.3 nm
- Slow optimization

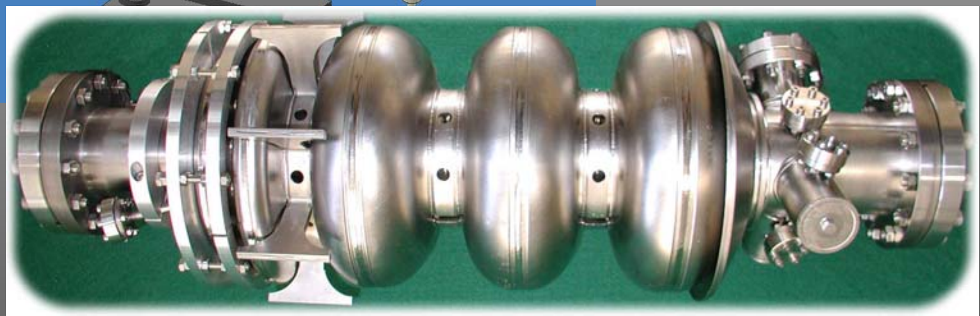
LC-SLM

- Not-compact
- Tricky alignment
- Phase or amplitude modulation
- Losses within 50%
- Resolution better than 0.1 nm
- Fast optimization

Development of a SCRF Photoinjector

high brightness & high average current

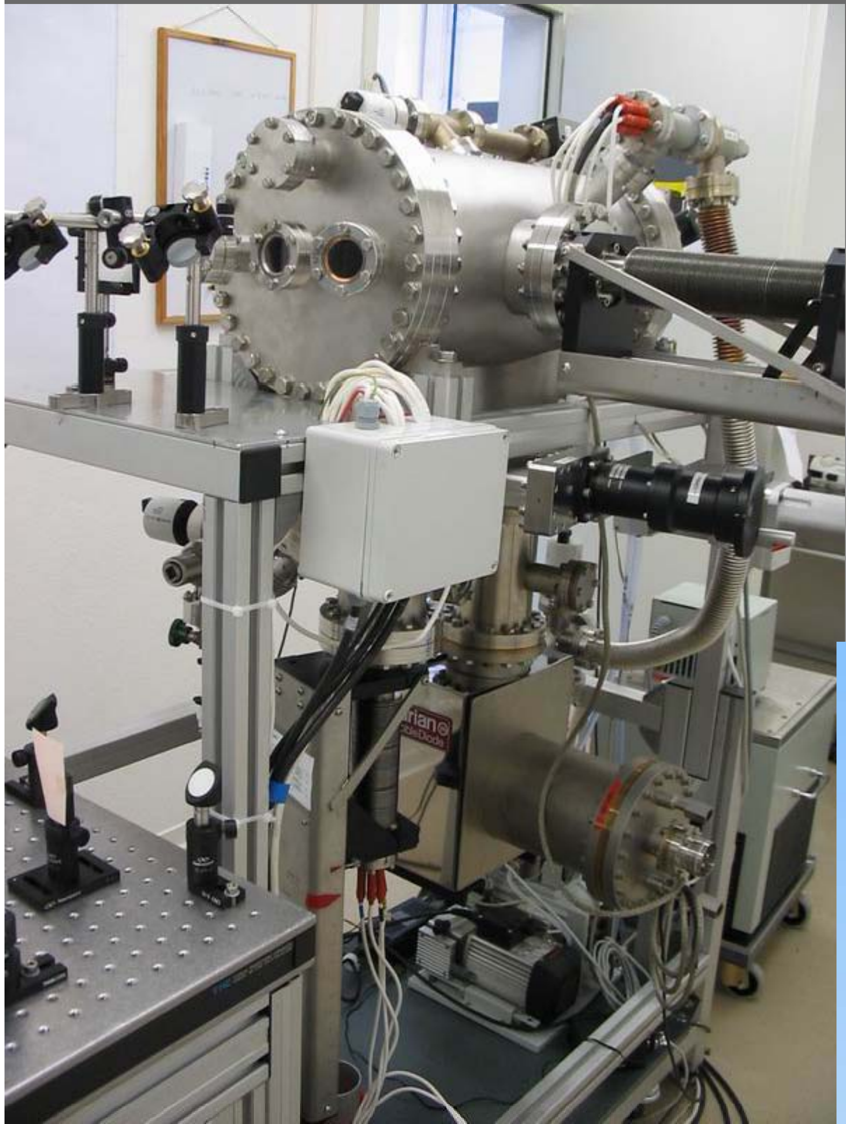




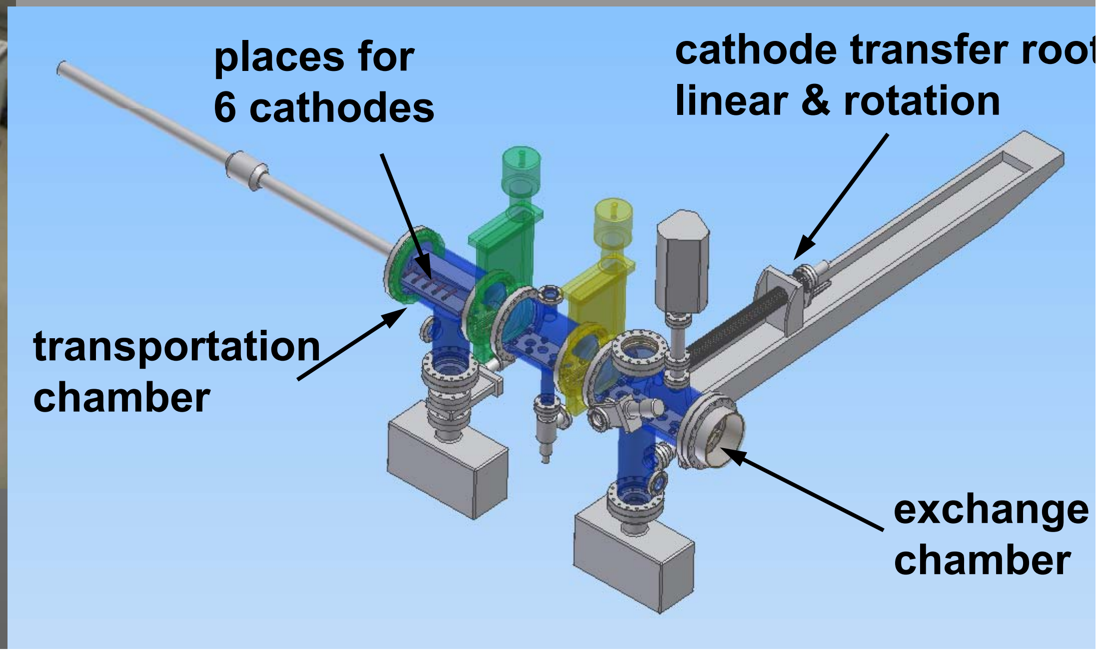
Supported by EU
within CARE/PHIN
and the German BMBF
with DESY, BESSY, MBI

Bundesministerium
für Bildung
und Forschung

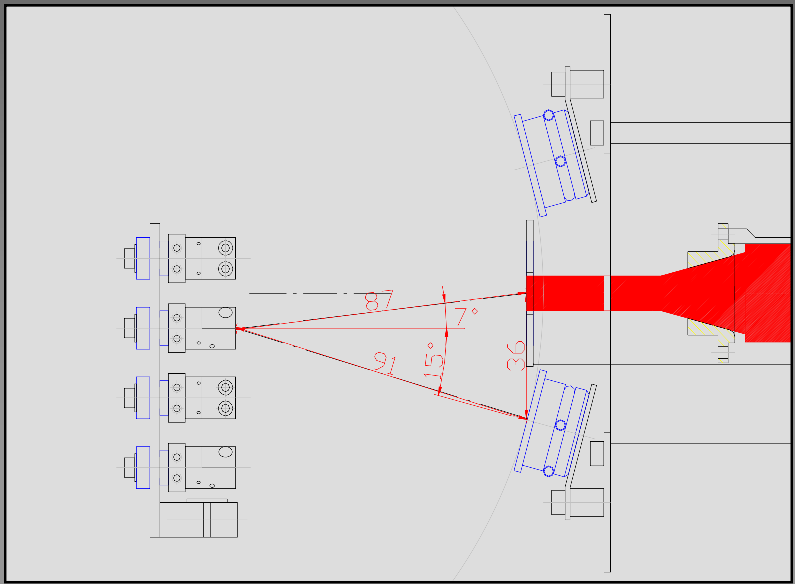
Preparation Chamber for the Photo Cathodes

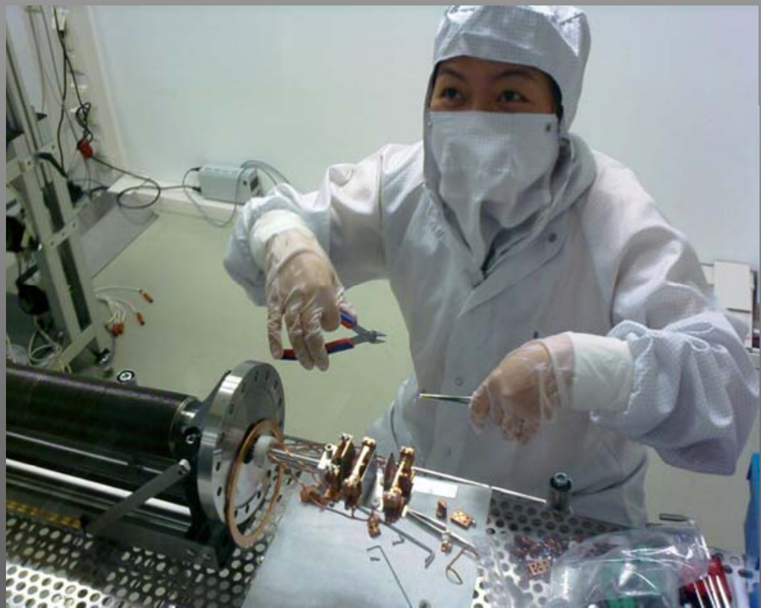


- New clean room (Class 1000), independent from gun
- Ultra high vacuum (P < 10^{-9} mbar)
- Measurement of Q.E.
  - 262nm laser
  - Q.E. during deposition
  - life time
  - distribution scan
- Controlled by computer



Evaporators and thickness monitors

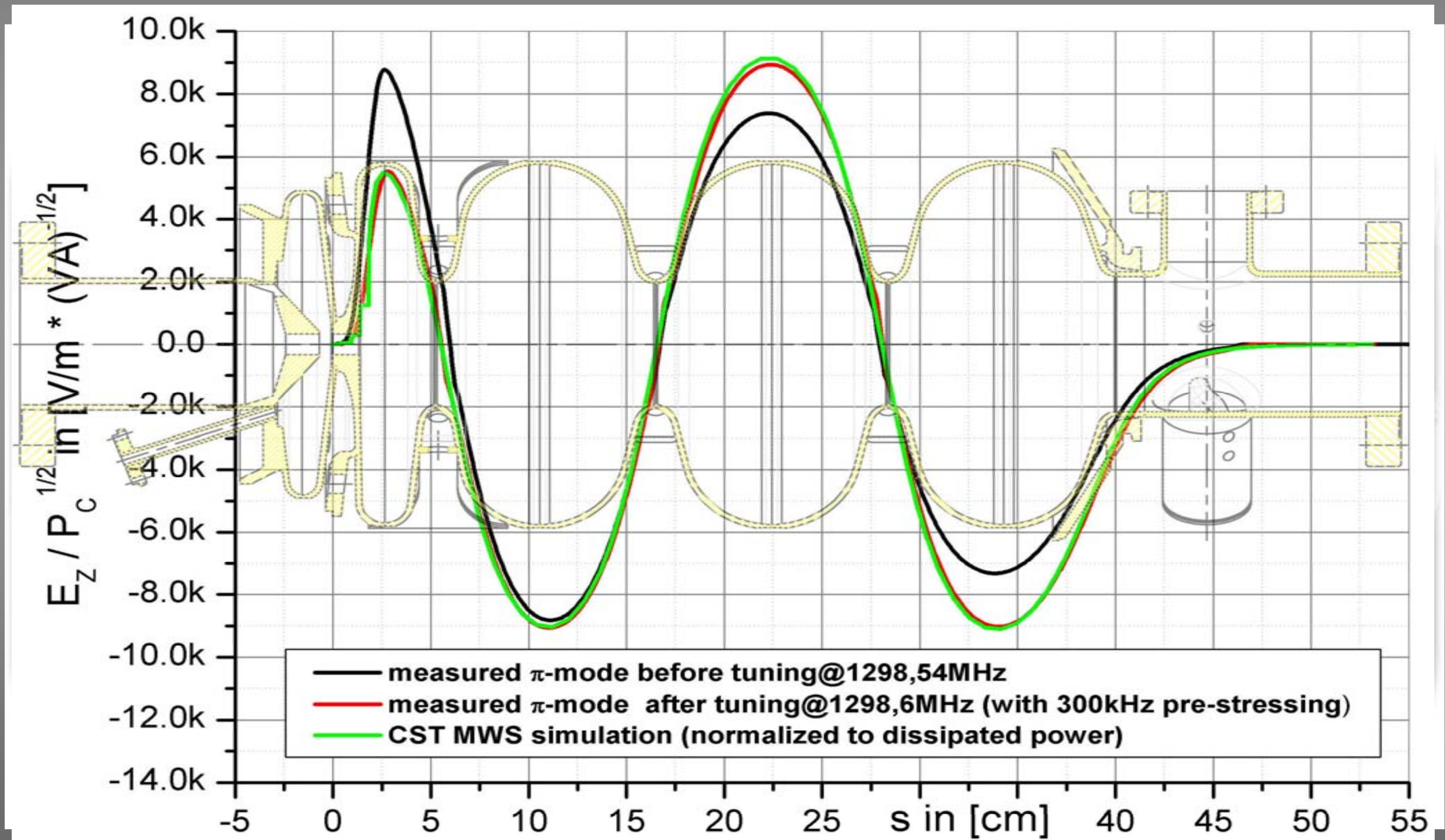




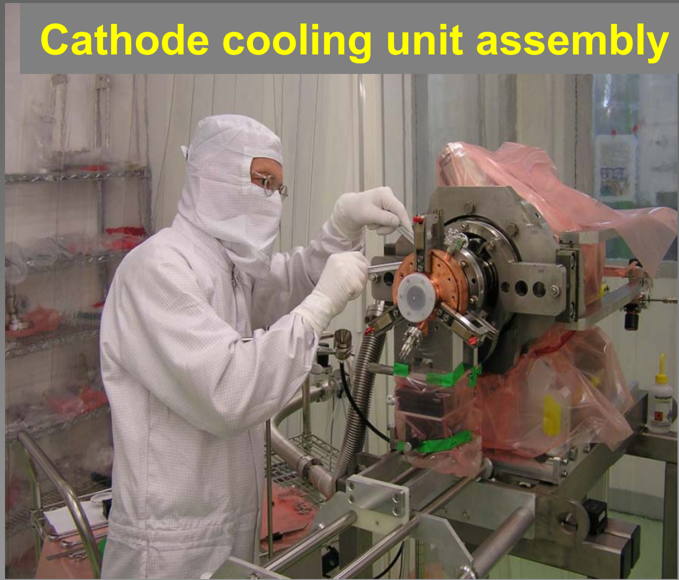
- Evaporators
  - 87 mm from the cathode
  - four boats, easy to change
  - Cesium source SAES Getters
- manually manipulated
  - monitored in a precision of 5μm
- two rate / thickness monitor
  - precise of 0.01 Å/s, 0.01Å
  - 36mm away from the cathode
  - calibrated before experiment

Cavity Treatment

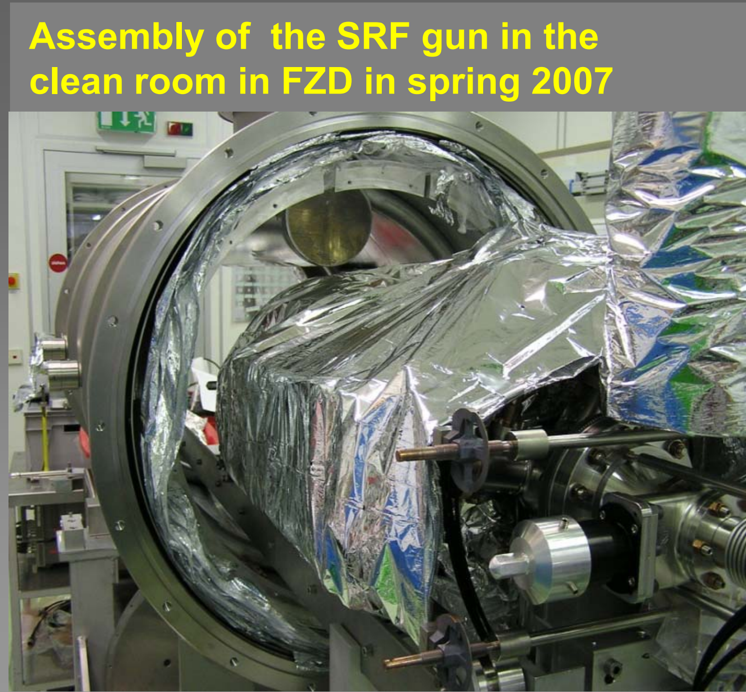
Tuning TM_{010} π-mode to calculated profile (+0.6 -1 +1 -1) by using tuning plates matched to cell shape (push / pull cells)



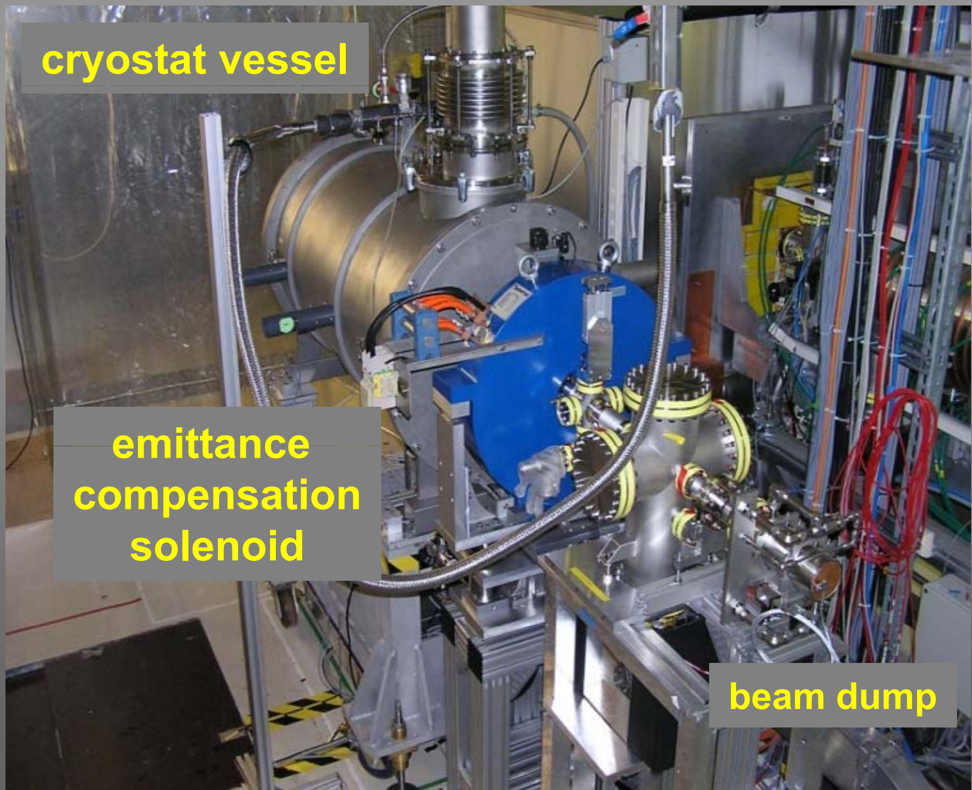
FZD-SC Photo-Injector installation



Cathode cooling unit assembly



Assembly of the SRF gun in the clean room in FZD in spring 2007



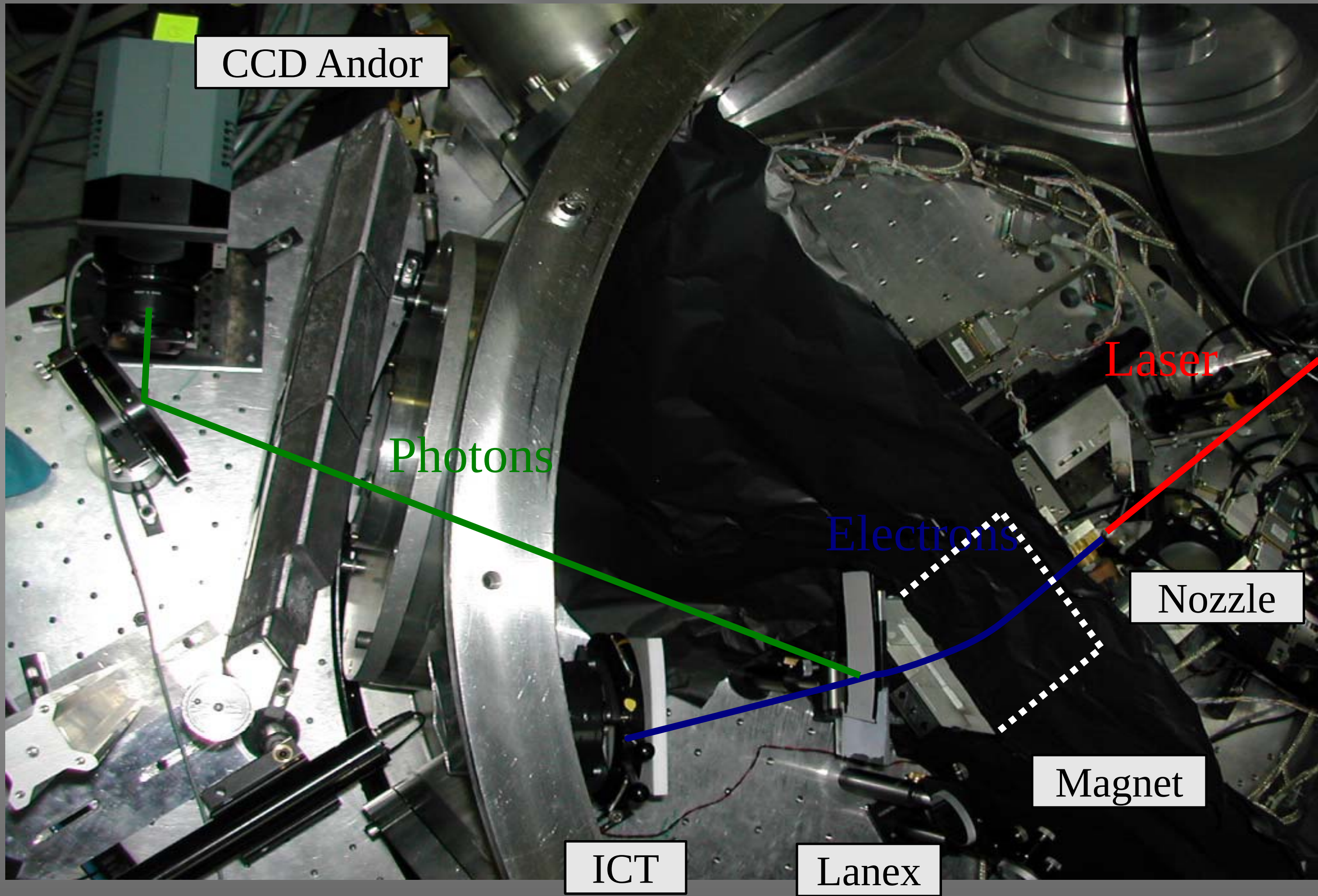
cryostat vessel

emittance compensation solenoid

beam dump

Helium supply tube assembly

LOA Plasma Photoinjector:

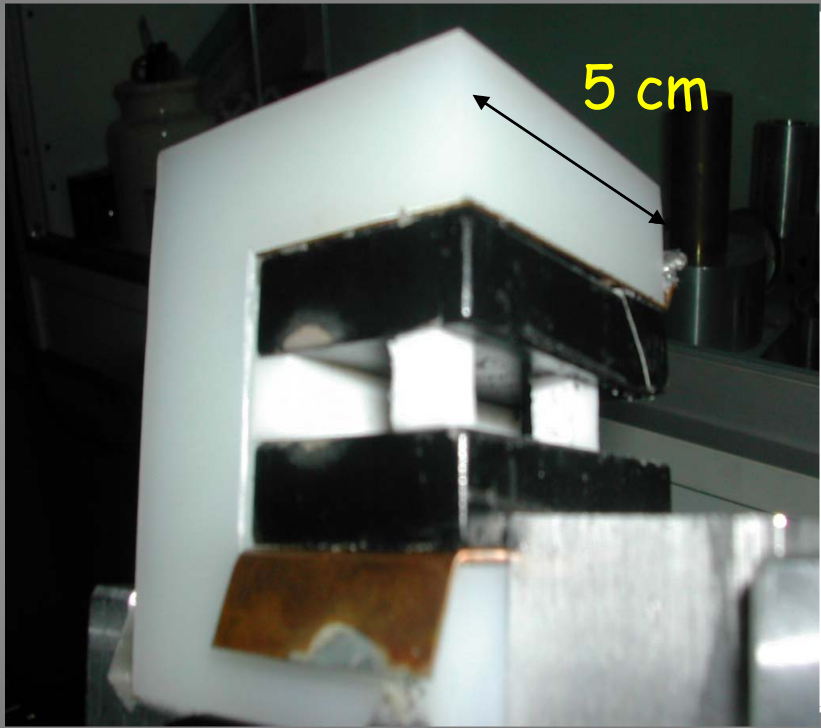


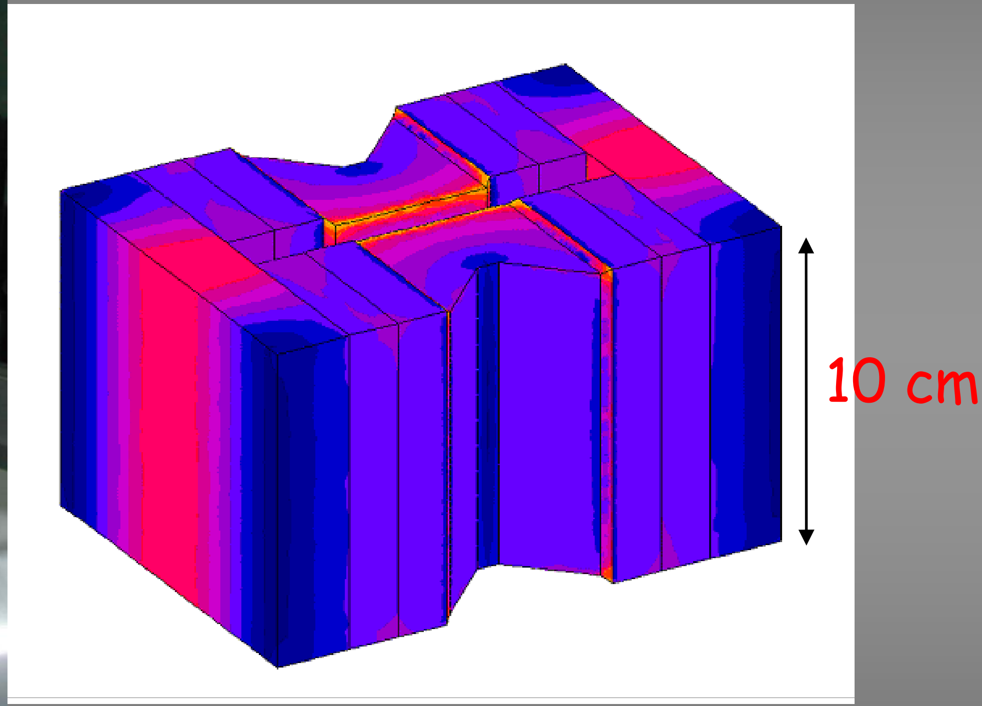
Experimental setup for energy – energy spread measurements

Comparison of the two spectrometer magnets

B=0.41 T

B=1 T



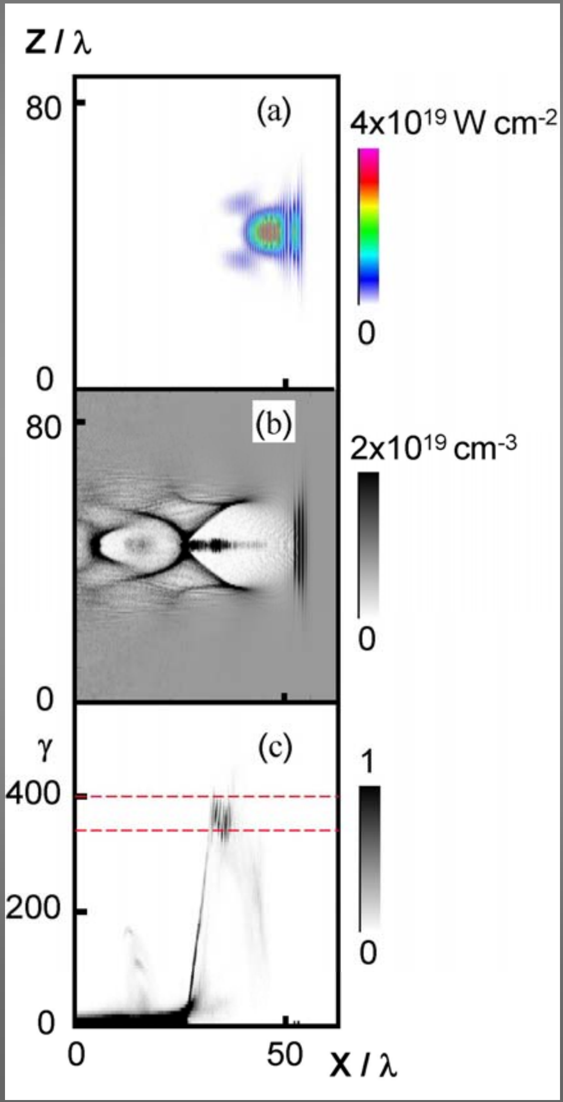


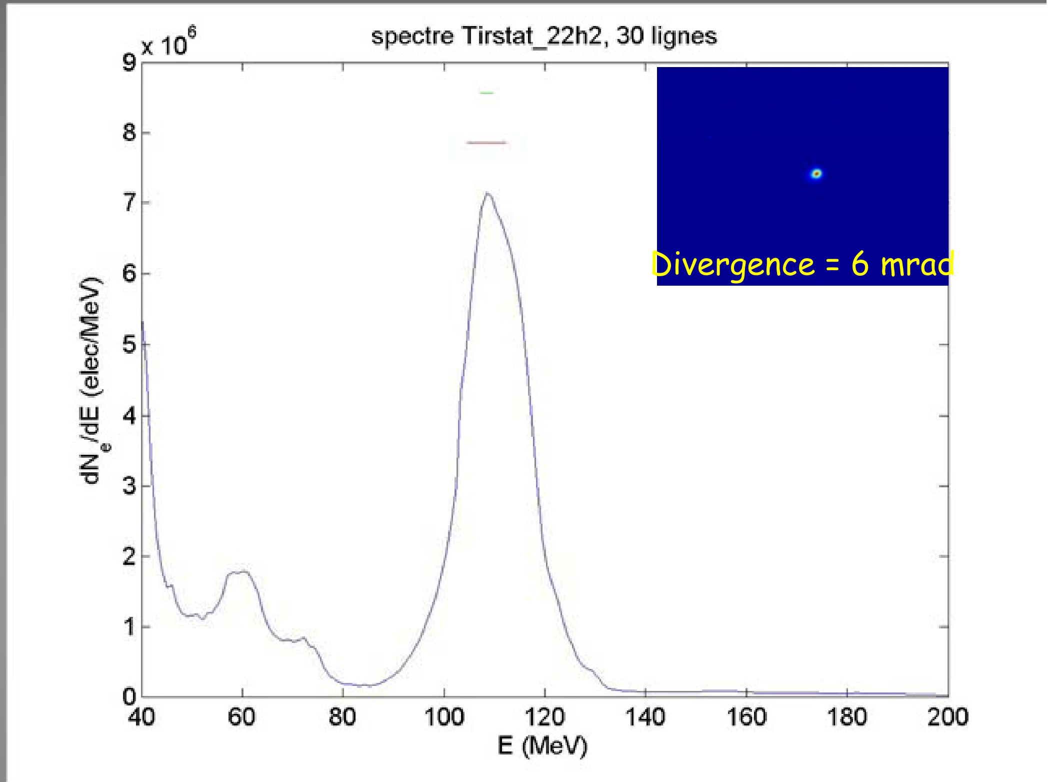
Previous Magnet
home made, up to 100 MeV

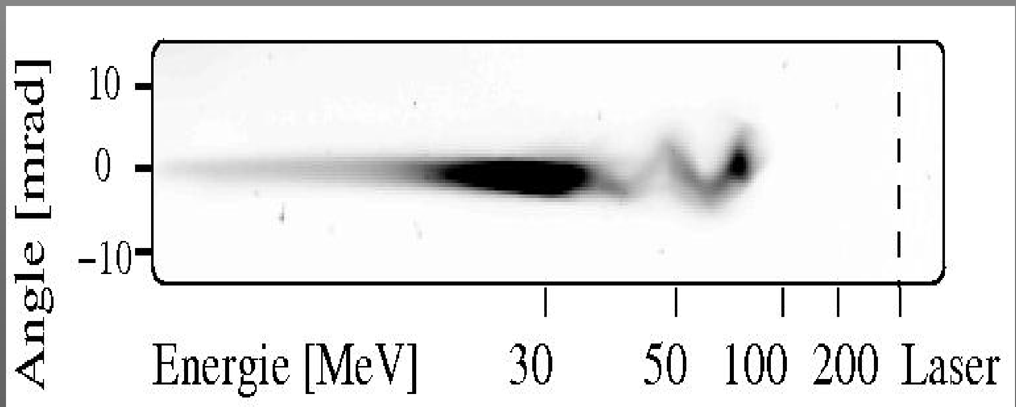
Design of a new magnet
up to 400 MeV

Energy distribution improvements: The Bubble regime

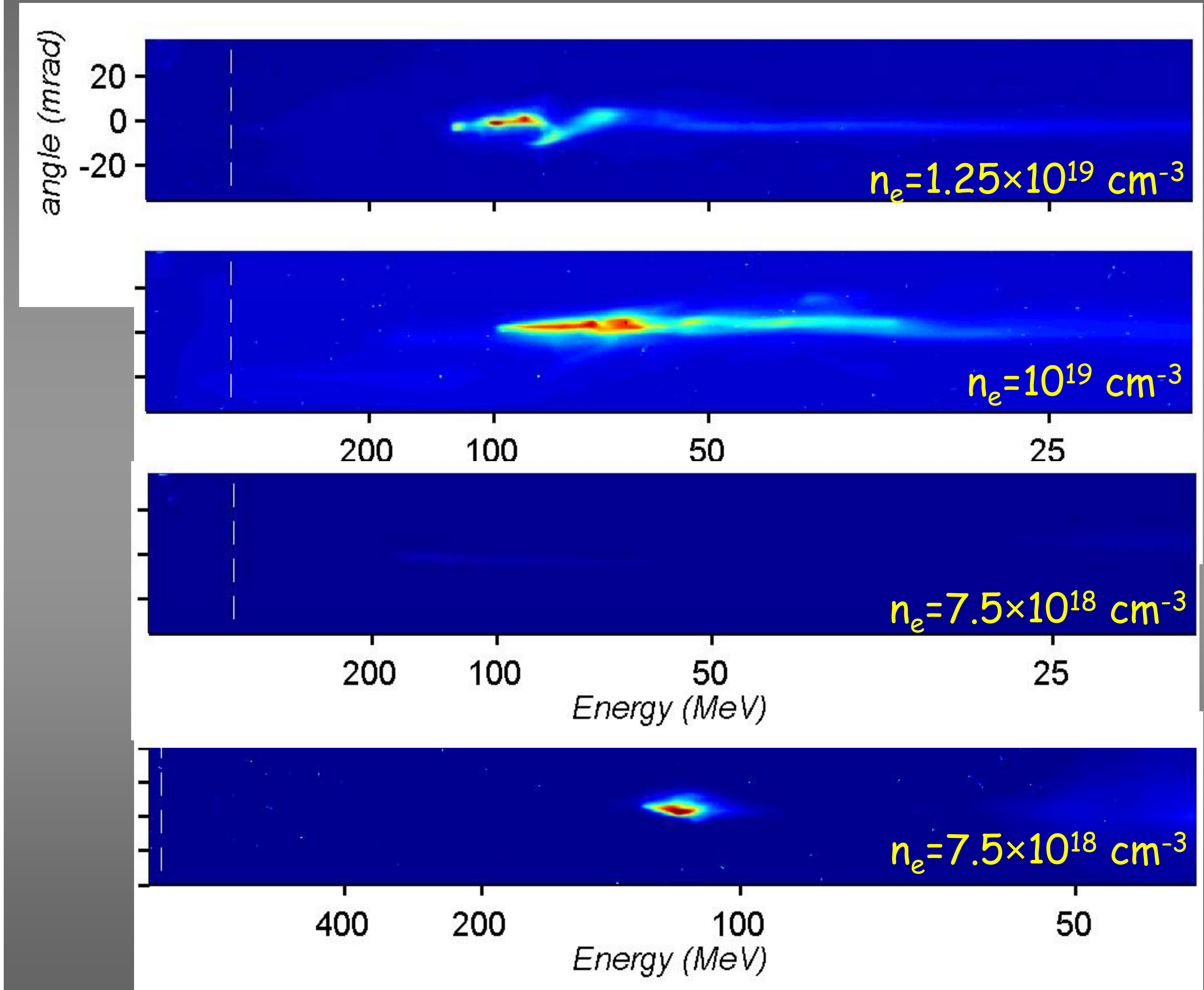
Charge in the peak : 200-300 pC

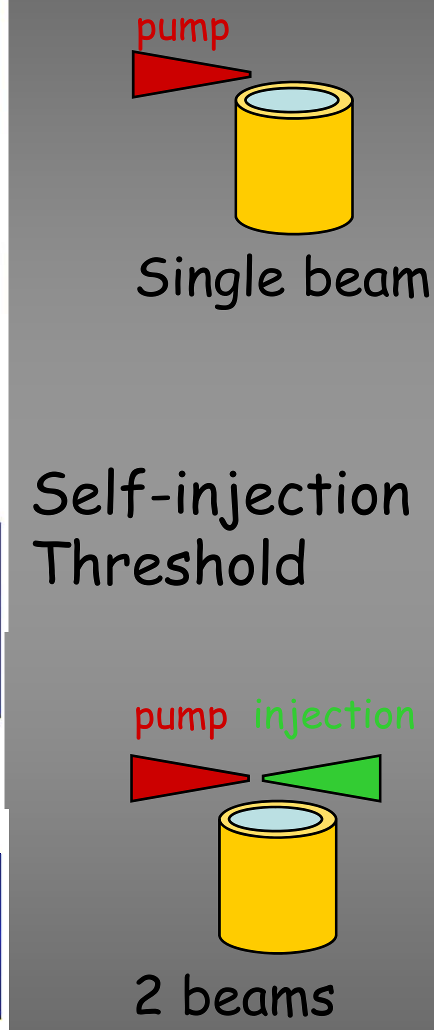






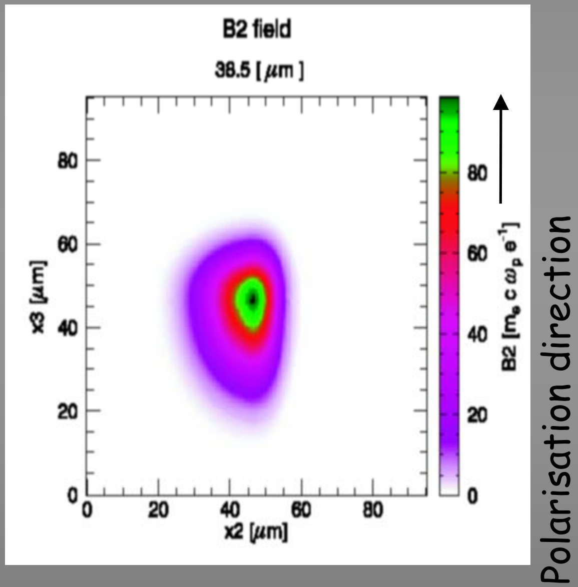
From self-injection to external injection



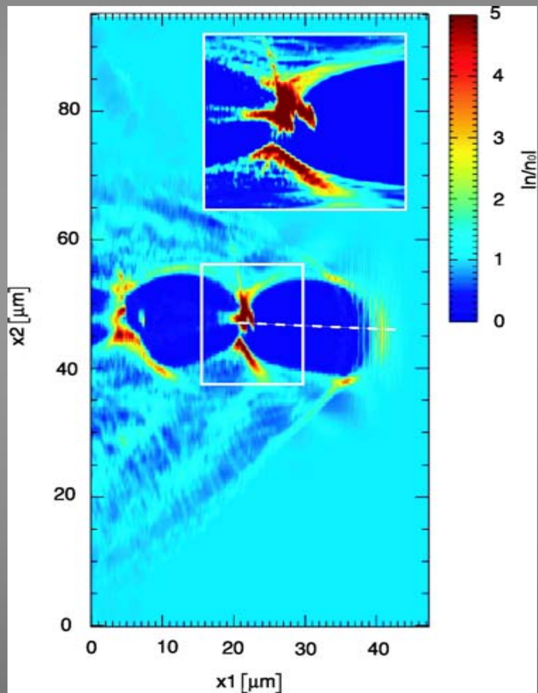


Off axis injection due to laser intensity asymetry

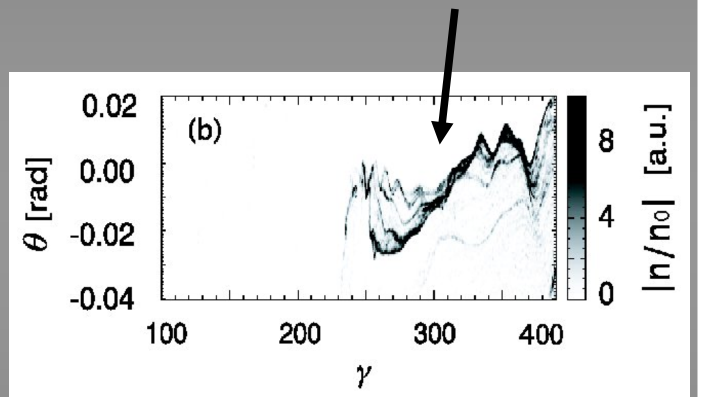
Laser asymmetry → Cavity asymmetry → Off axe injection



Initial laser intensity profile

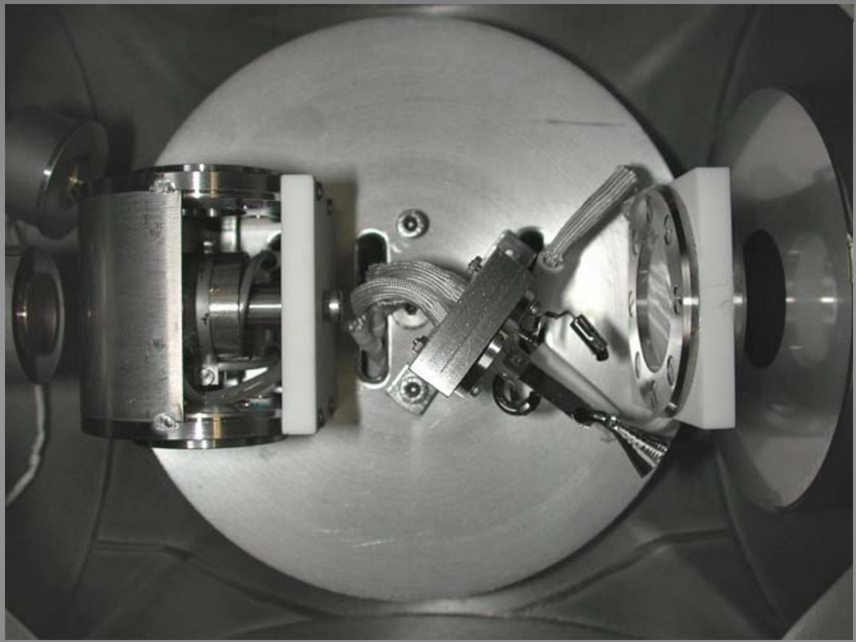


Density profile after 190 um of propagation



Electron angle versus energy

Mg Photocathode Preparation & Diagnostics @Twente University

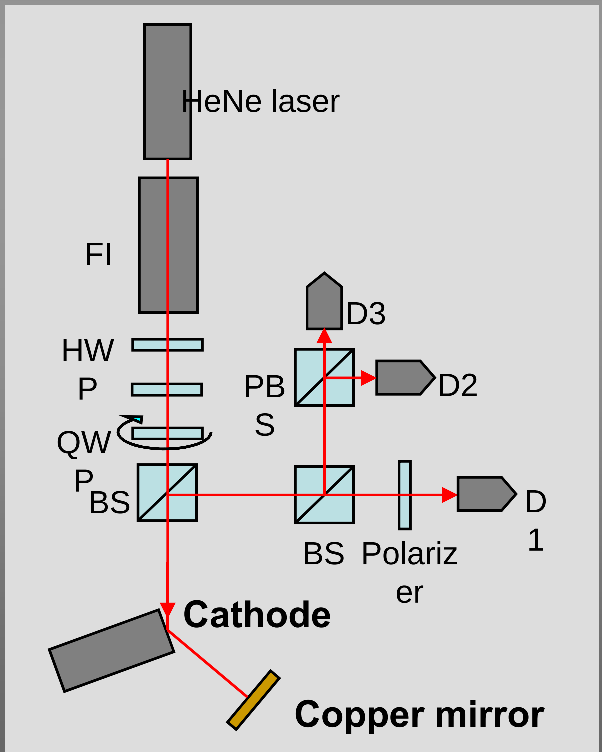


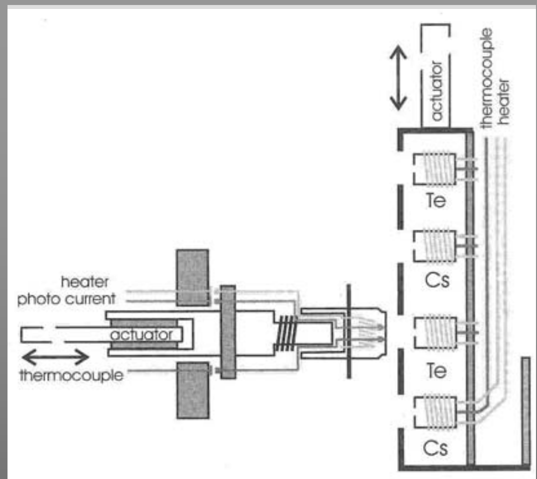
Mg preparation chamber interior
- Copper photocathode (left)
- Microbalance
- magnesium deposition setup
- CEM (turned) and wire meshes

- Preparation chamber for magnesium photocathodes completed
- Diagnostics for deposition rate (Microbalance) and charge emission (Channeltron Electron Multiplier) installed
- Electron multiplier tested in combination with fs IR pulses on copper => CEM saturated at all incident intensities
- Replacement diagnostics implemented based on wire mesh collector in combination with a capacitor => charge emission per fs IR pulse measurable
- Test in progress for Cu cathodes.

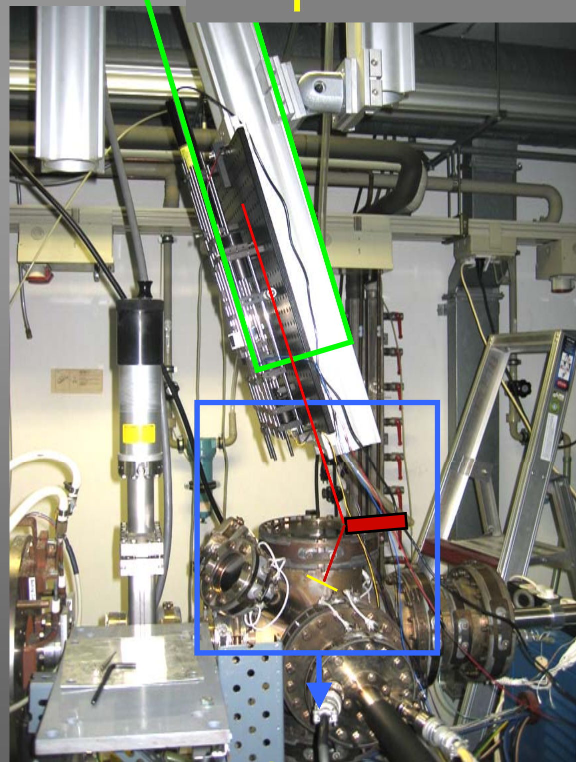
Preparation chamber & Ellipsometry on Cs_2Te Photocathodes

- To study the deposition process
- Optical method: photocathode stays inside, measurement device outside
- Real-time measurements register steps in the deposition process





Ellipsometer



Preparation Chamber