

# PITZ cathodes: QE measurements and cathode history

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Workshop on High QE Photocathodes for RF  
Guns

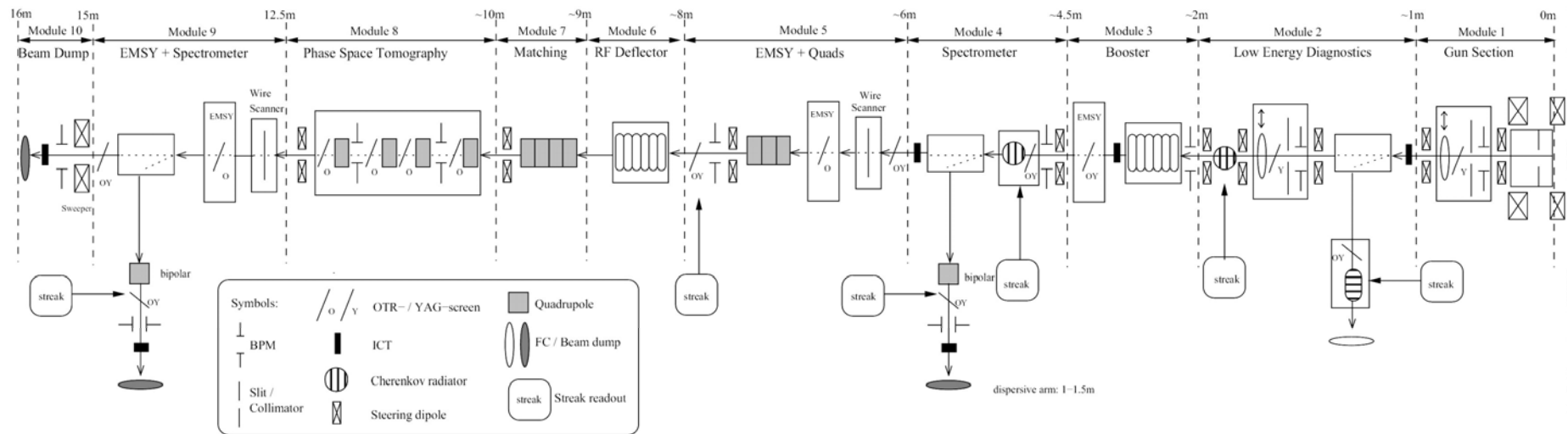
Milano, 04-06/10/2006

# Outline

1. Introduction
2. QE measurement
3. Cathode history
4. Summary - Outlook

# 1. Introduction

## PITZ2 schematics



## ■ PITZ: Photoinjector Test Facility

- ❑ Test and optimize rf guns for FELs → TTF, FLASH, XFEL
- ❑ Warm 1.5 cell L-band cavity
- ❑ Diagnostics section
- ❑ Cs<sub>2</sub>Te cathodes produced in LASA Milano

# 1. Introduction

## ■ RF:

- 3.5MW 1.3GHz
- 5MW klystron
- About 40MV/m in gun
- → about momentum of electrons 4.0MeV/c

Rf-phase: relative timing between rf and  
Laser : 360 deg corr. To 1/1GHz

## ■ Laser:

- Developed:I.Will et al. (MBI)
- Nd:YLF, oscillator , several stages
- O(10)micro Joules
- 20 ps long. flat top
- 27m long laser beam line

# 1. Introduction

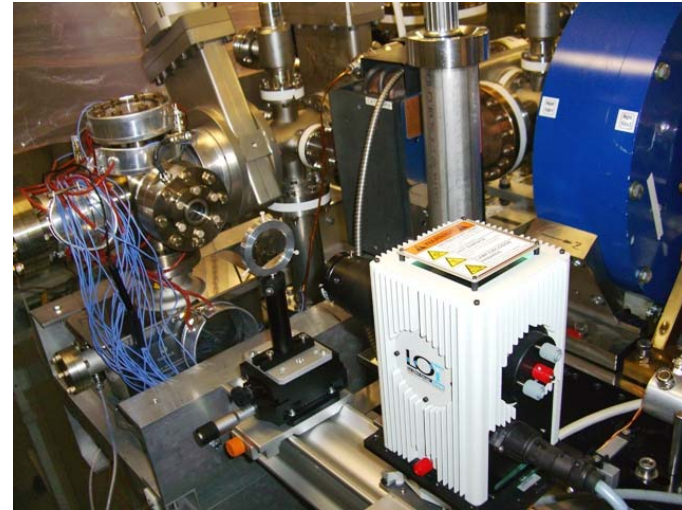
- The quantum efficiency for cathode #58.1 was measured by two methods:
  - using the gun, laser and rf
  - Using a cw hydrogen lamp
- Cathode history: Exposure and integrated rf energy of 4 Cs<sub>2</sub>Te and 4 Mo cathodes will be presented

## 2. QE measurements

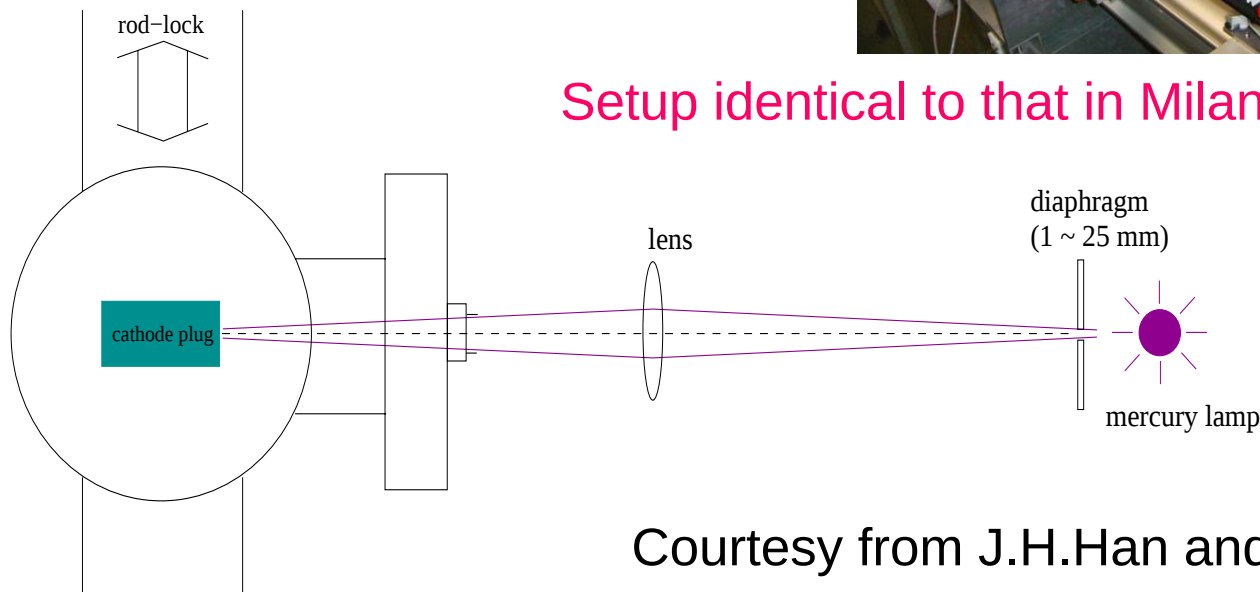
- The quantum efficiency for cathode #58.1 was measured by two methods:
  - using the gun, laser and rf
  - Using a cw hydrogen lamp

## 2.1. QE measurement with cw light source in the PITZ tunnel

- **Setup:**
  - ❑ **Hg lamp**
  - ❑ **254 nm bandpass filter**
  - ❑ **Lens**
  - ❑ **Photometer**
  - ❑ **Picoamperemeter**



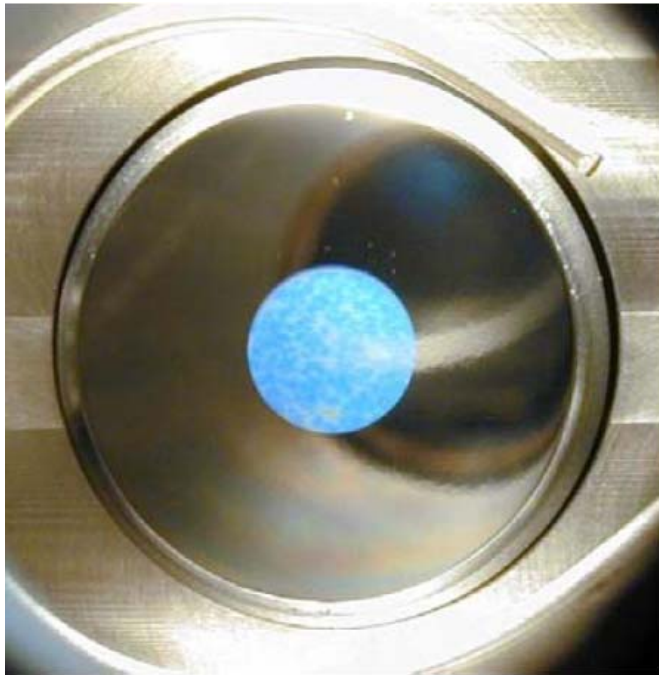
Setup identical to that in Milan and Hamburg



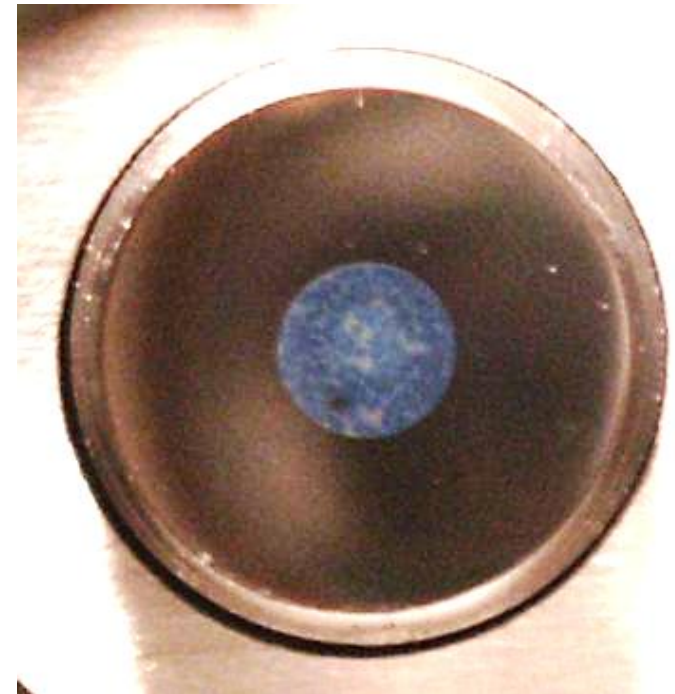
Courtesy from J.H.Han and J.Roensch

## 2.1. QE measurement with cw light source in the PITZ tunnel

**Cathode: #58.1 (Cs<sub>2</sub>Te) used in PITZ operation 2005 - 2006**



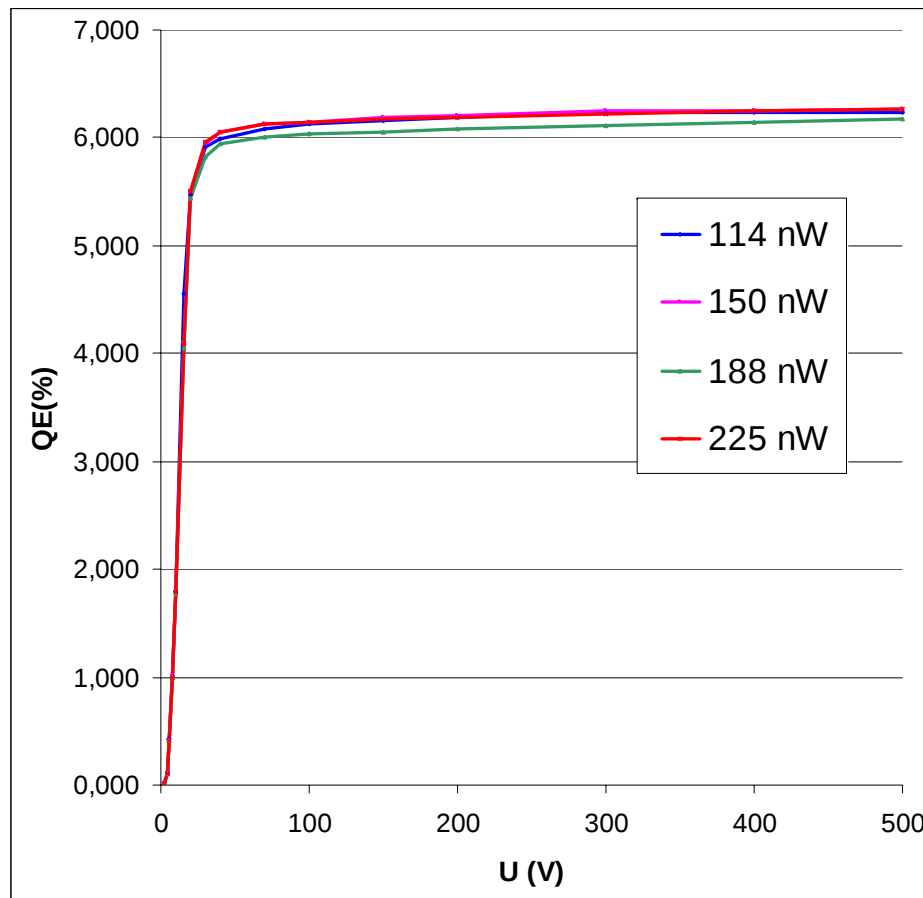
- **About august 2005  
(almost fresh)**



**09/28/2006**

Courtesy from J.H.Han and J.Roensch

## 2.1. QE measurement with cw light source in the PITZ tunnel



- **04/11/2005 10.5%**
- **08/28/2005 3.1%**
- **09/28/2006 6.2%**
- **Possible explanation for non-matching result: calibration of light sensor**

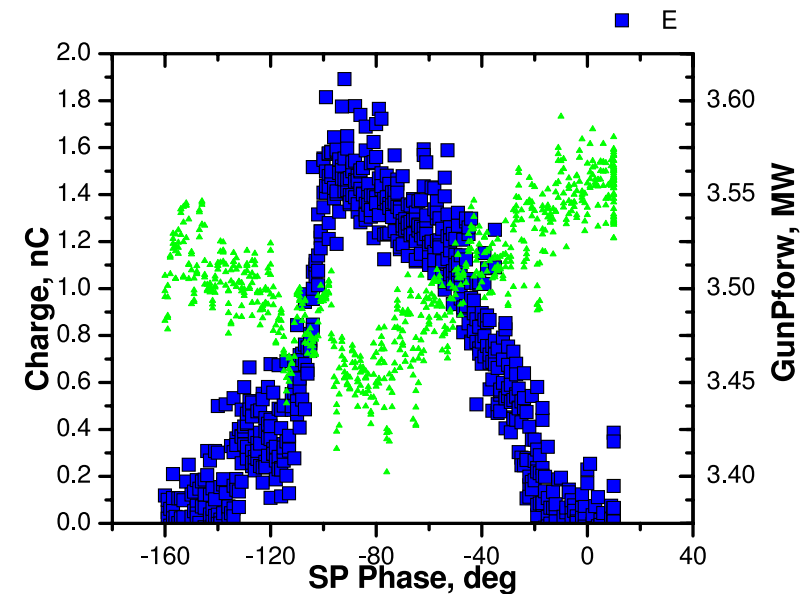
Courtesy from J.H.Han and J.Roensch

## 2.2. QE measurement using cathode in gun, laser and rf

- For different laser pulse energies the maximum charge vs. phase was estimated in phase scans
- For these different laser power settings the laser power was measured at the laser table and at the laser entrance window near to the gun
- From these measurements the transmission factor was calculated for the laser beam line for the used diaphragm (2mm diameter)
- The QE was calculated
- Cathode #58.1

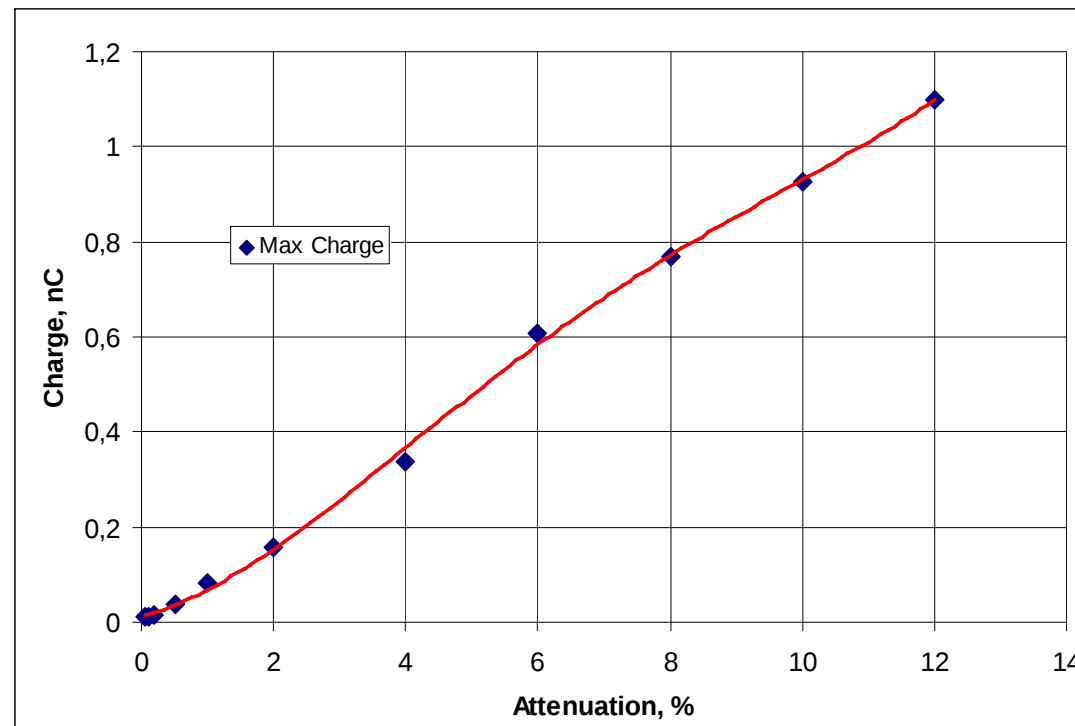
## 2.2. QE measurement with laser and rf

- Phase scan for laser attenuator 12%
- Rep.rate 10 Hz
- Rf pulse length 100 microseconds
- Rf power in gun: 3.5 MW
- 5 laser pulses
- Diaphragm: 2mm diameter
- Solenoid current: 320 A
- Current bucking coil : 0A

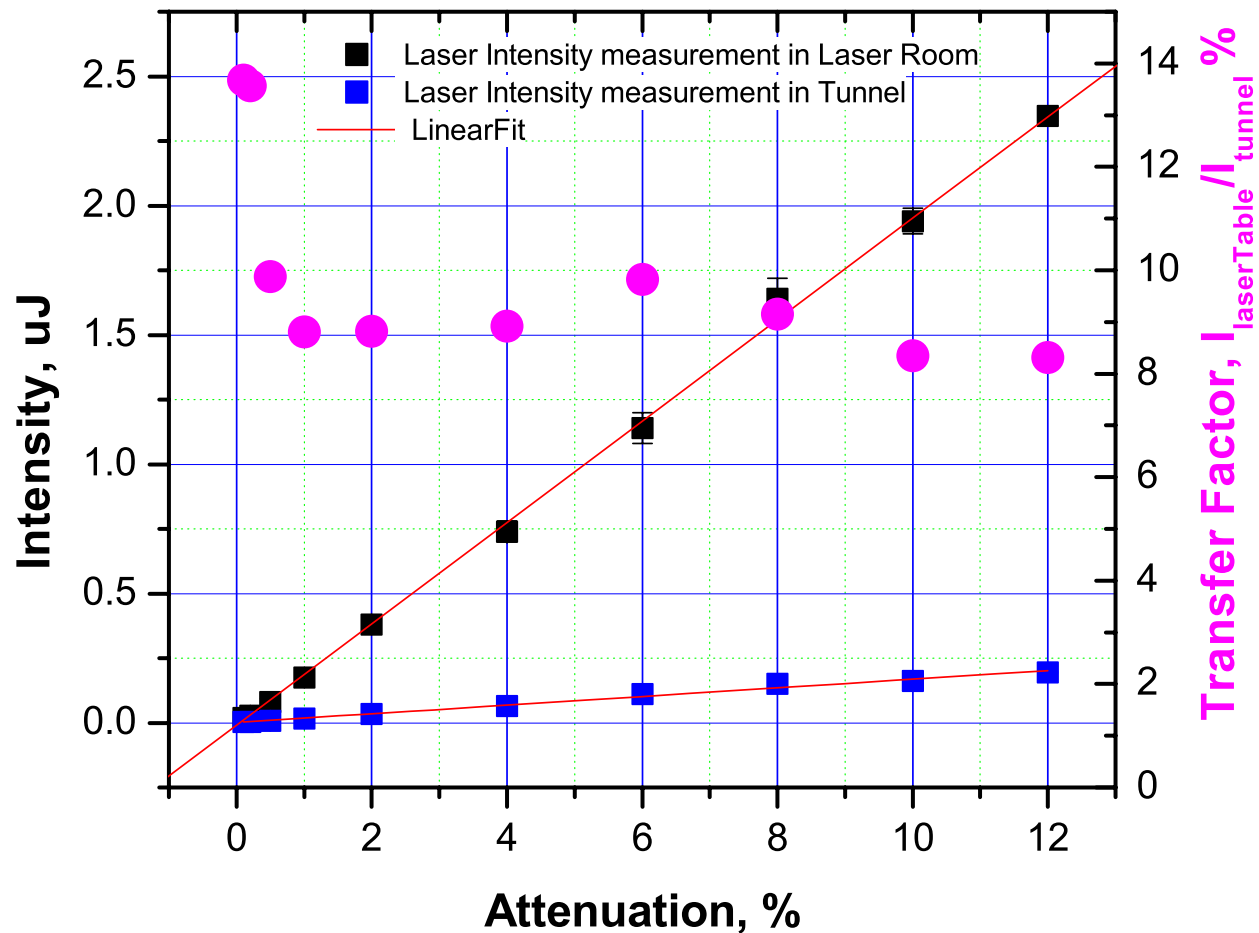


## 2.2. QE measurement with laser and rf

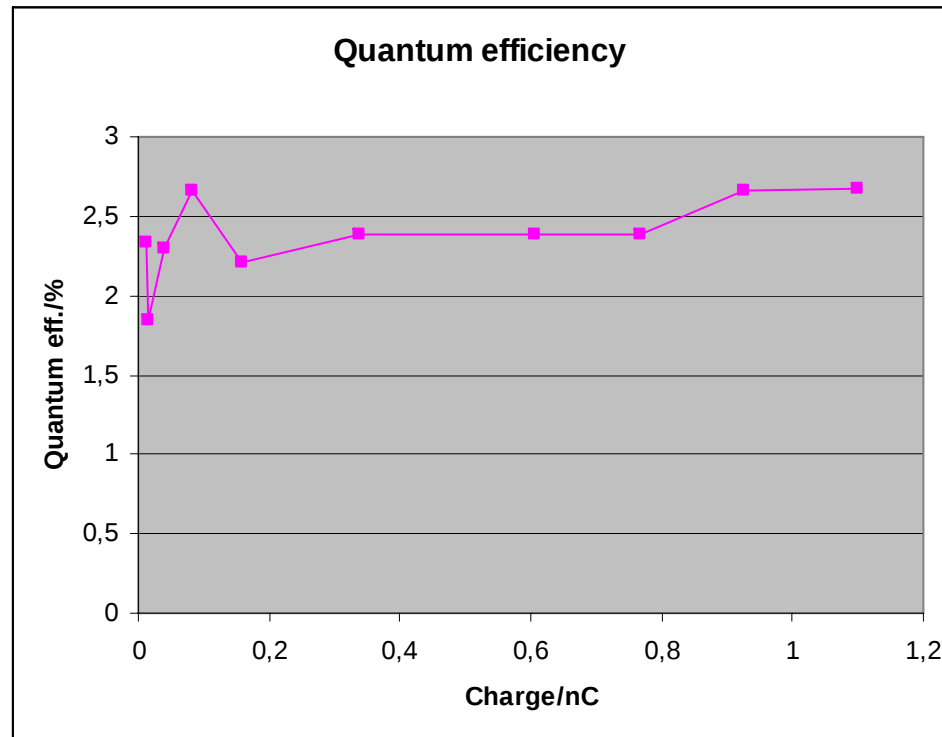
- Maximum charge measured in phase scans for different laser pulse energy (laser attenuator)



## 2.2. QE measurement with laser and rf

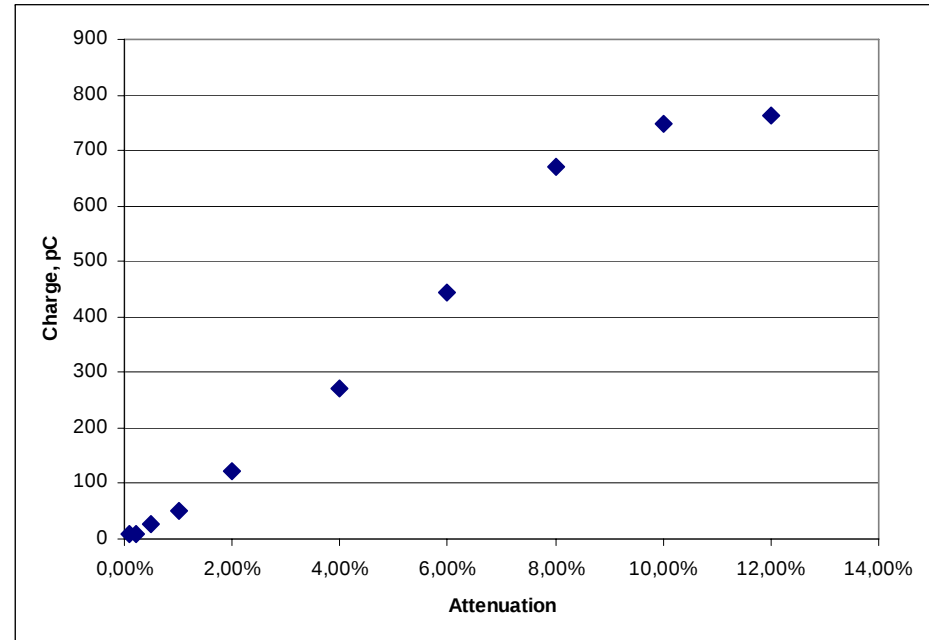
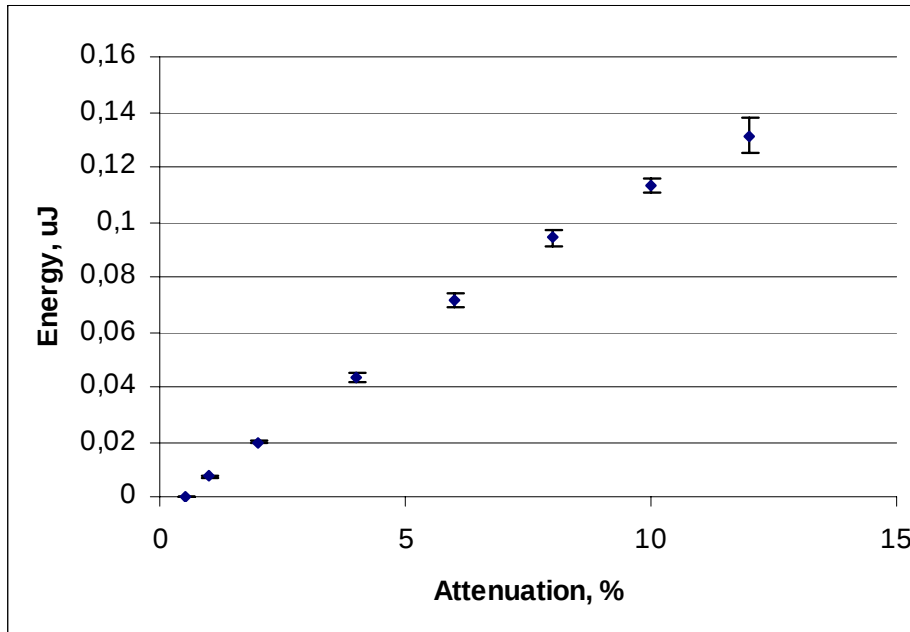


## 2.2. QE measurement with laser and rf



- Result: ~ 2.5 % (Faraday cup)
- Correction: FC=> ICT: 3.33%
- Error about 10% of this value for  $Q > 0.2$  nC

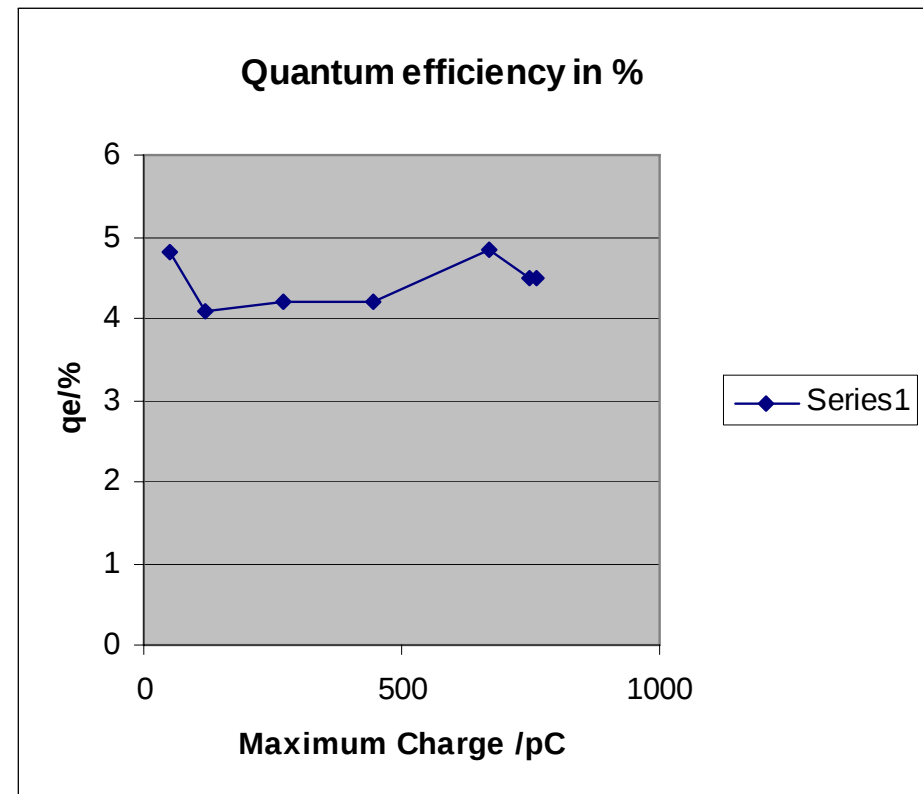
## 2.2. QE measurement with laser and rf



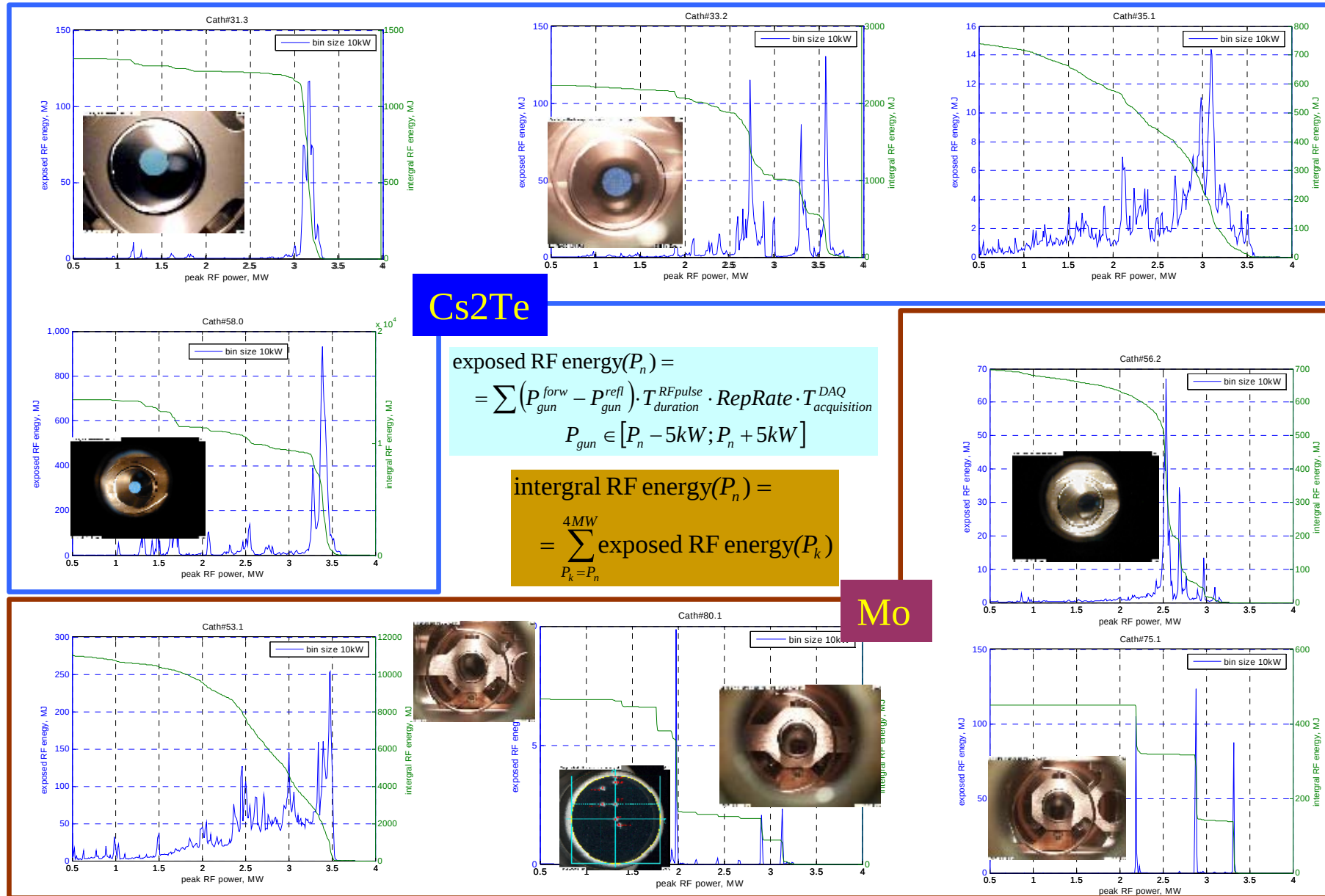
## 2.2. QE measurement with laser and rf

### ■ Second measurement:

- ❑ Correction FC → ICT (factor 1.33) done
- ❑ Mean value  $qe$ : 4.38%
- ❑ Comparable to previous measurement within 14% error for mean value



### 3. History of photocathodes at PITZ: exposed rf energy



# 3. History of photocathodes at PITZ

## CS<sub>2</sub>Te-Cathodes

| Cathode number | Integrated rf energy/MW |
|----------------|-------------------------|
| 31.3           | 1300                    |
| 33.2           | 2200                    |
| 35.1           | 730                     |
| 58.1           | 14,000                  |

## Mo-Cathodes

| Cathode number | Integrated rf energy/MW |
|----------------|-------------------------|
| 53.1           | 11,000                  |
| 80.1           | 28                      |
| 75.1           | 450                     |
| 56.2           | 700                     |

# 5. Summary and outlook

- The QE of cathode #58.1 was measured:
  - With cw Hg lamp: 6.2% (not consistent with prev. meas.)
  - With rf and laser: 3.33 % and 4.38% corrected to ICT
- Exposed rf energy and integrated rf energy were plotted for 4 Cs<sub>2</sub>Te cathodes and 4 Mo-cathodes as well.
  - Maximum values of integr. rf energy is 14GJ.

# Acknowledgement

- Contributions from and/or common work with:
  - G.Asova
  - H.H. Han
  - J.Ivanisenko
  - M.Krasilnikov
  - J.Roensch
  - J.Baehr

## 2.2. QE measurement with laser and rf

