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Measurement of Photoelectron Yield in KEKB LER

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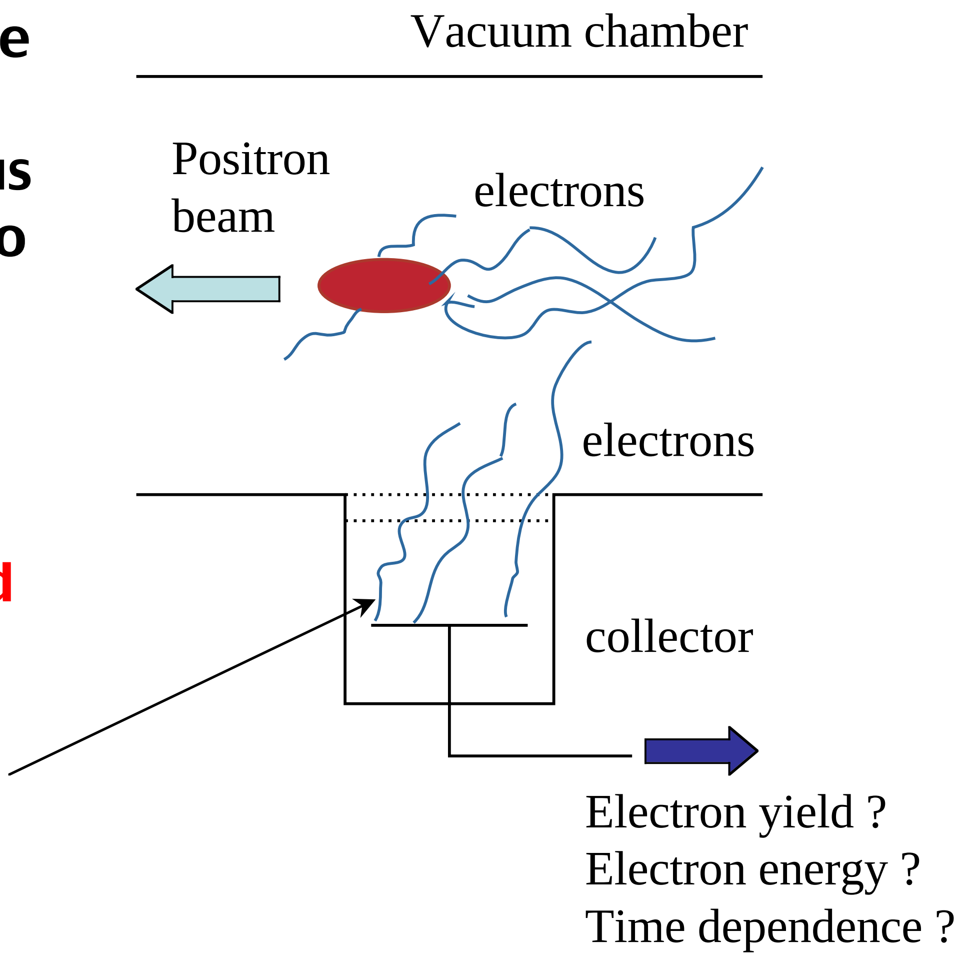
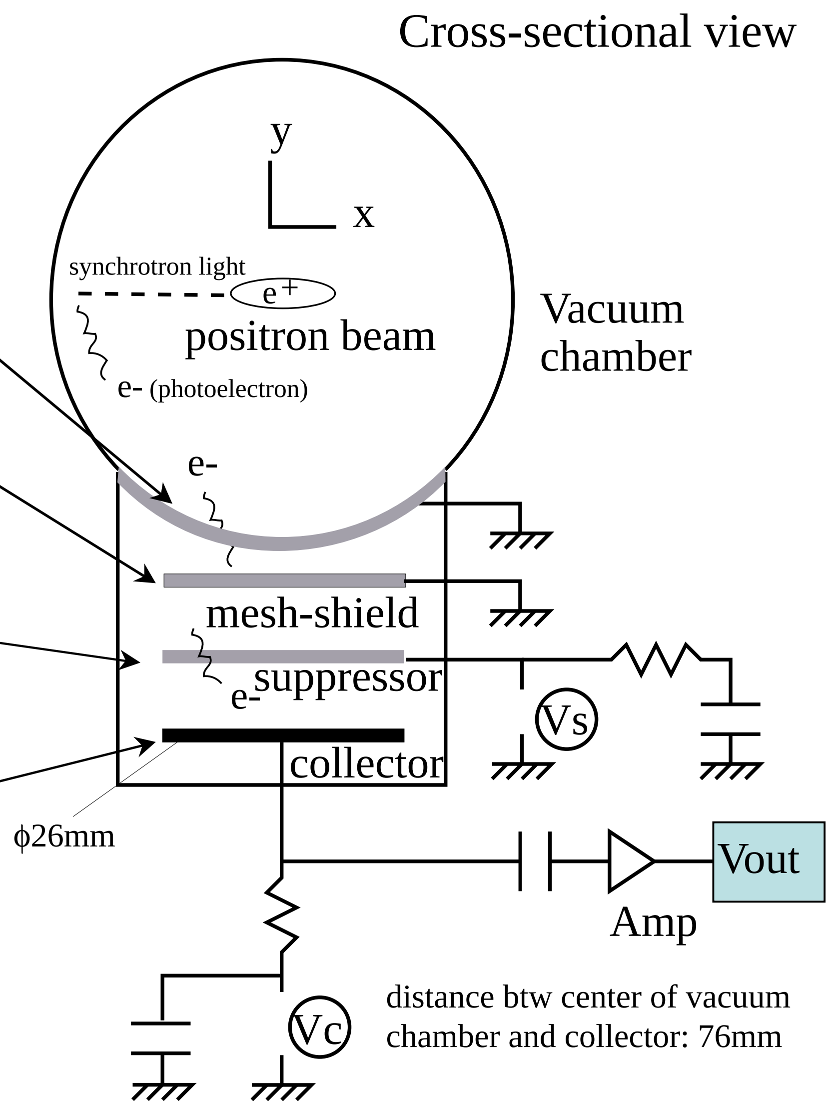
Introduction

- **Photoelectron effects cause beam blow-up in the positron ring is very serious for high current machine to achieve higher luminosity.**
- **What we can measure is photoelectrons reach at the collector.**
  Not photoelectrons around the beam !
- **These measurements can give the information for simulations**



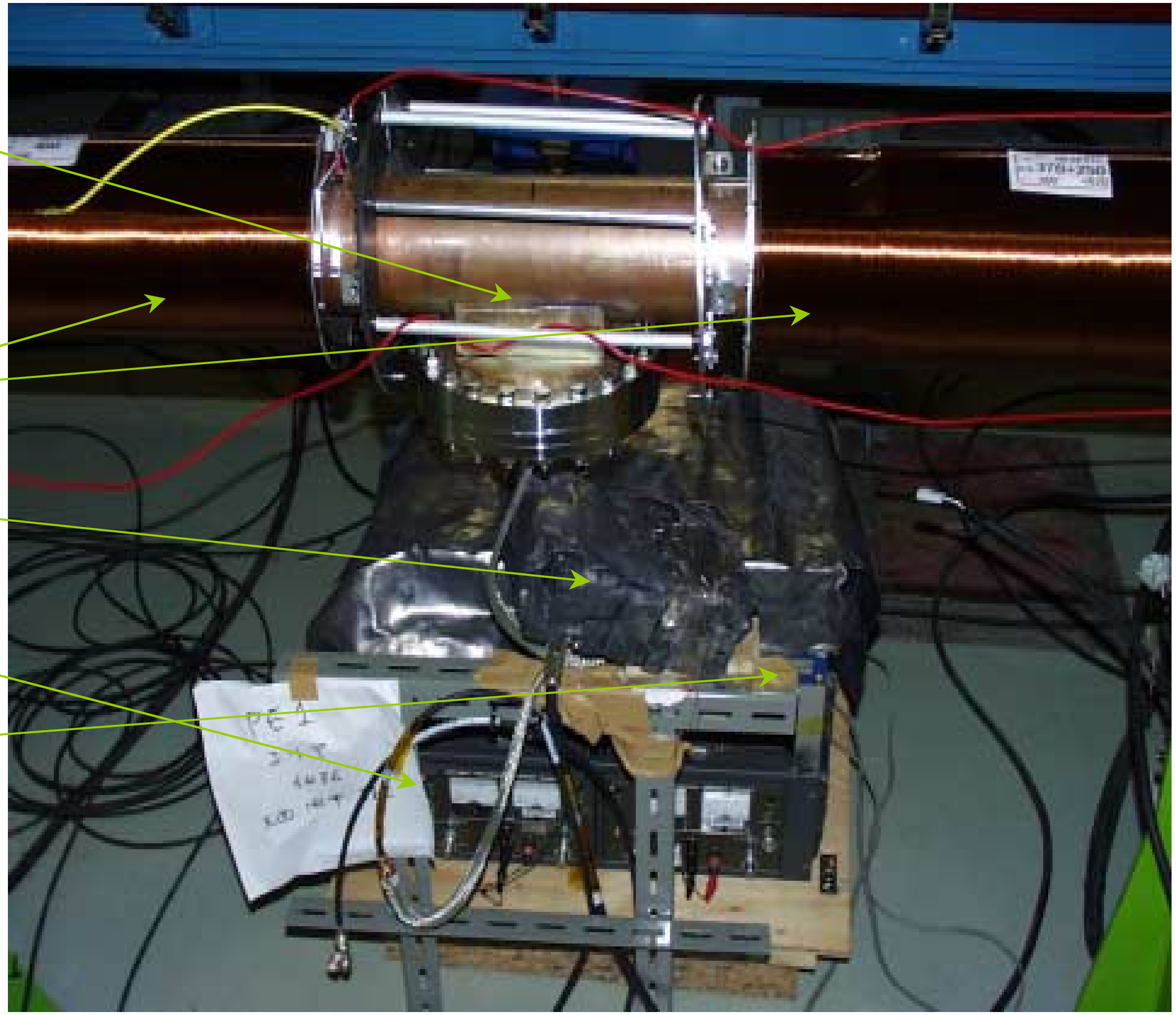
Photoelectron Detector

- **Special vacuum chamber (ϕ94mm) with shield grid (mesh)**
- **Additional shield grid(mesh) in front of suppressor and collector**
- **Suppressor can be used for energy scan of photoelectrons by applying bias voltage(Vs).**
- **Collector(ϕ26mm) is connected to readout electronics. Bias voltage(Vc) can be applied. Distance from chamber center is 76 mm.**



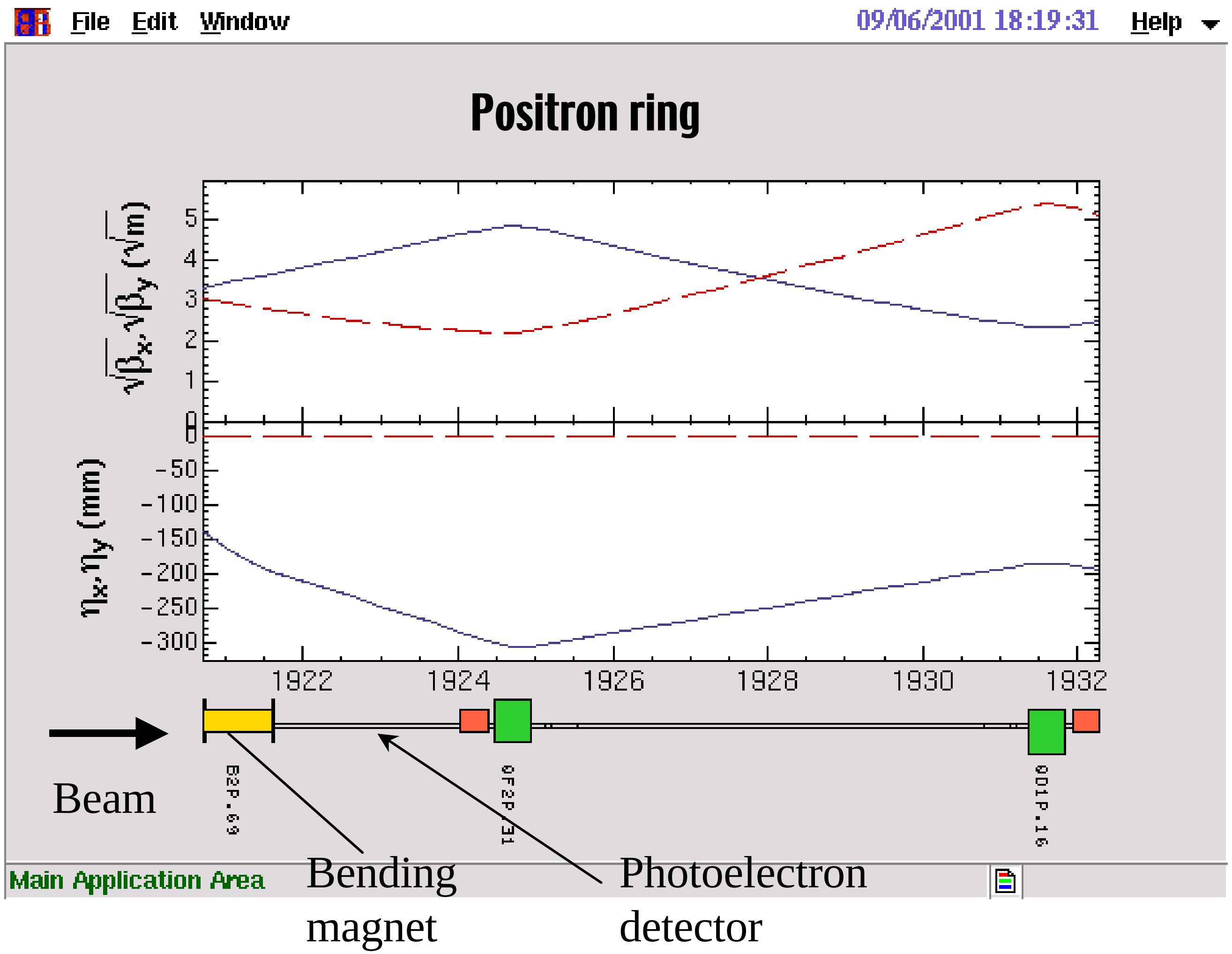
Photoelectron Detector

- **Special vacuum chamber with photoelectron detector**
- **Solenoid coils**
- **Amplifier**
- **Power supply for the amplifier**
- **Cooling fan is used to keep temperature of power supply constant.**

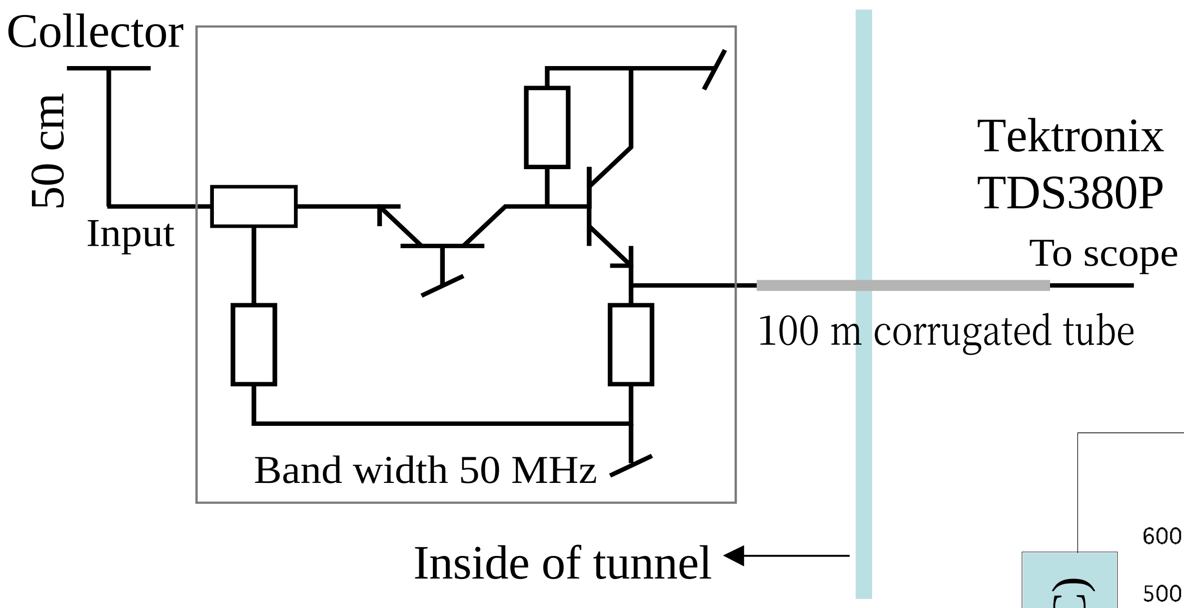


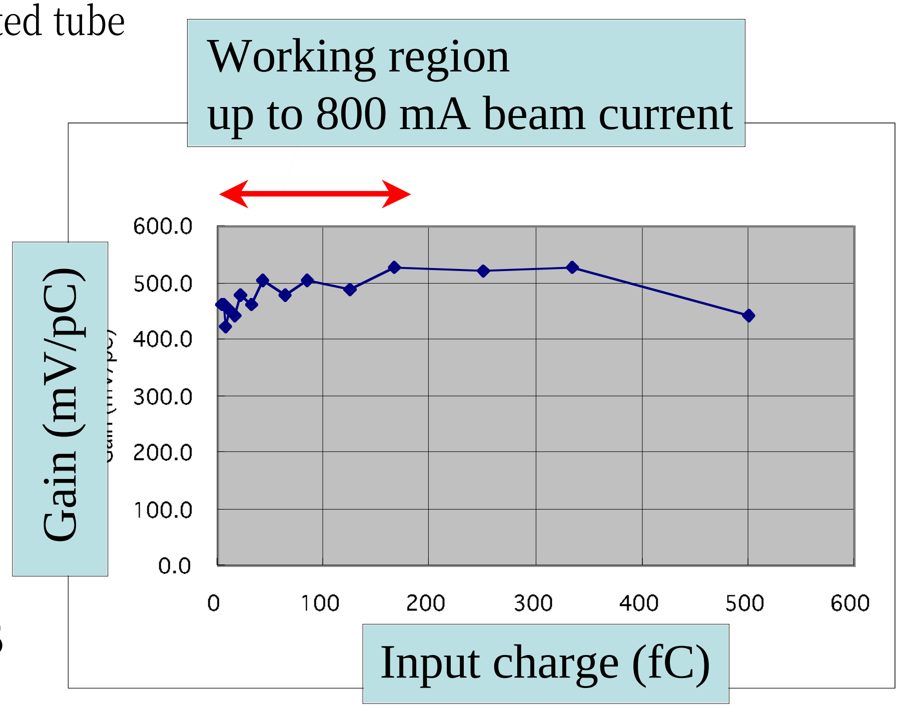
Location of Photoelectron Detector

- **Photoelectron detector is located at 1.5 m downstream of a bending magnet.**
- **Bending radius: 16.3 m**



Electronics

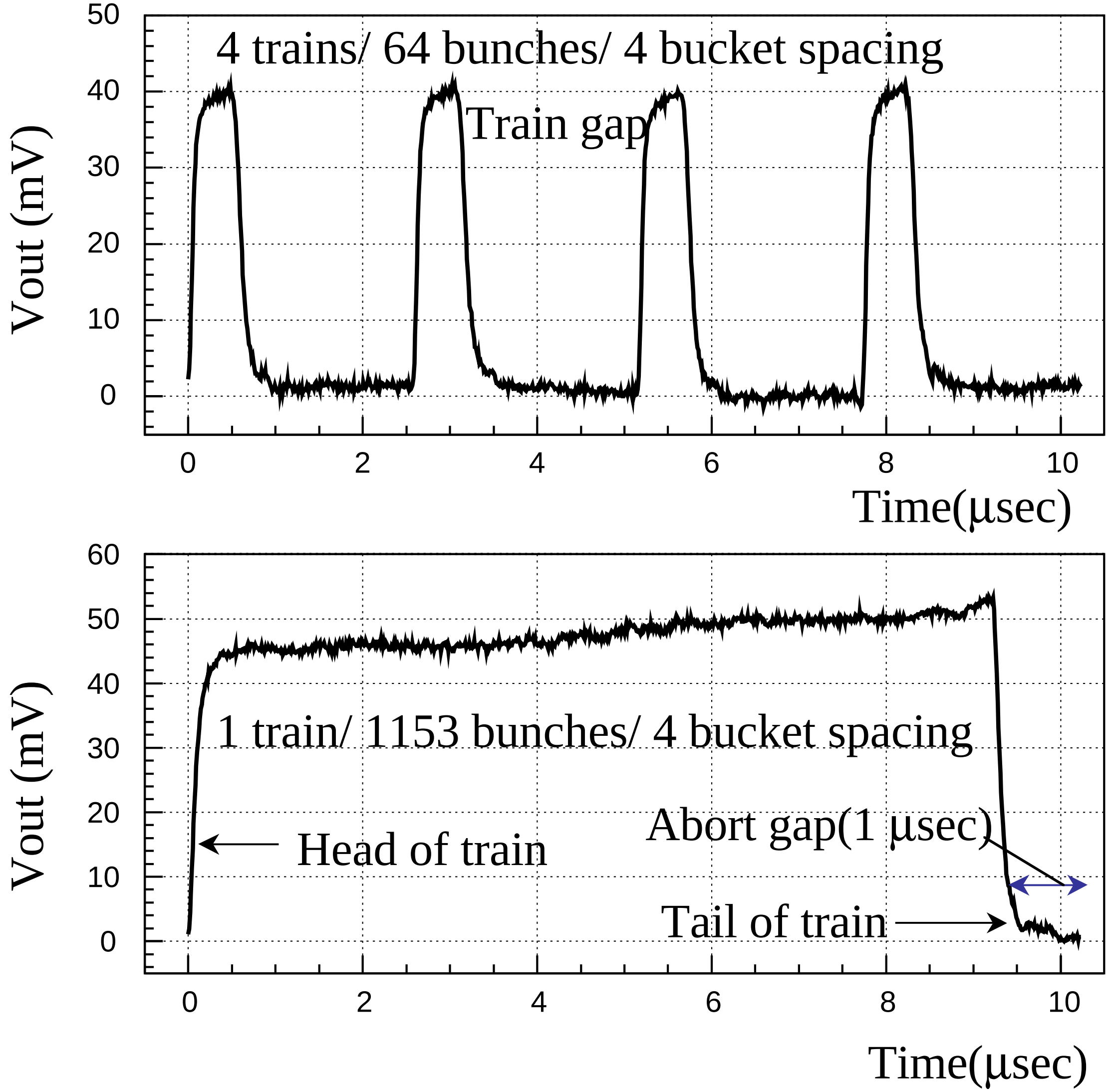




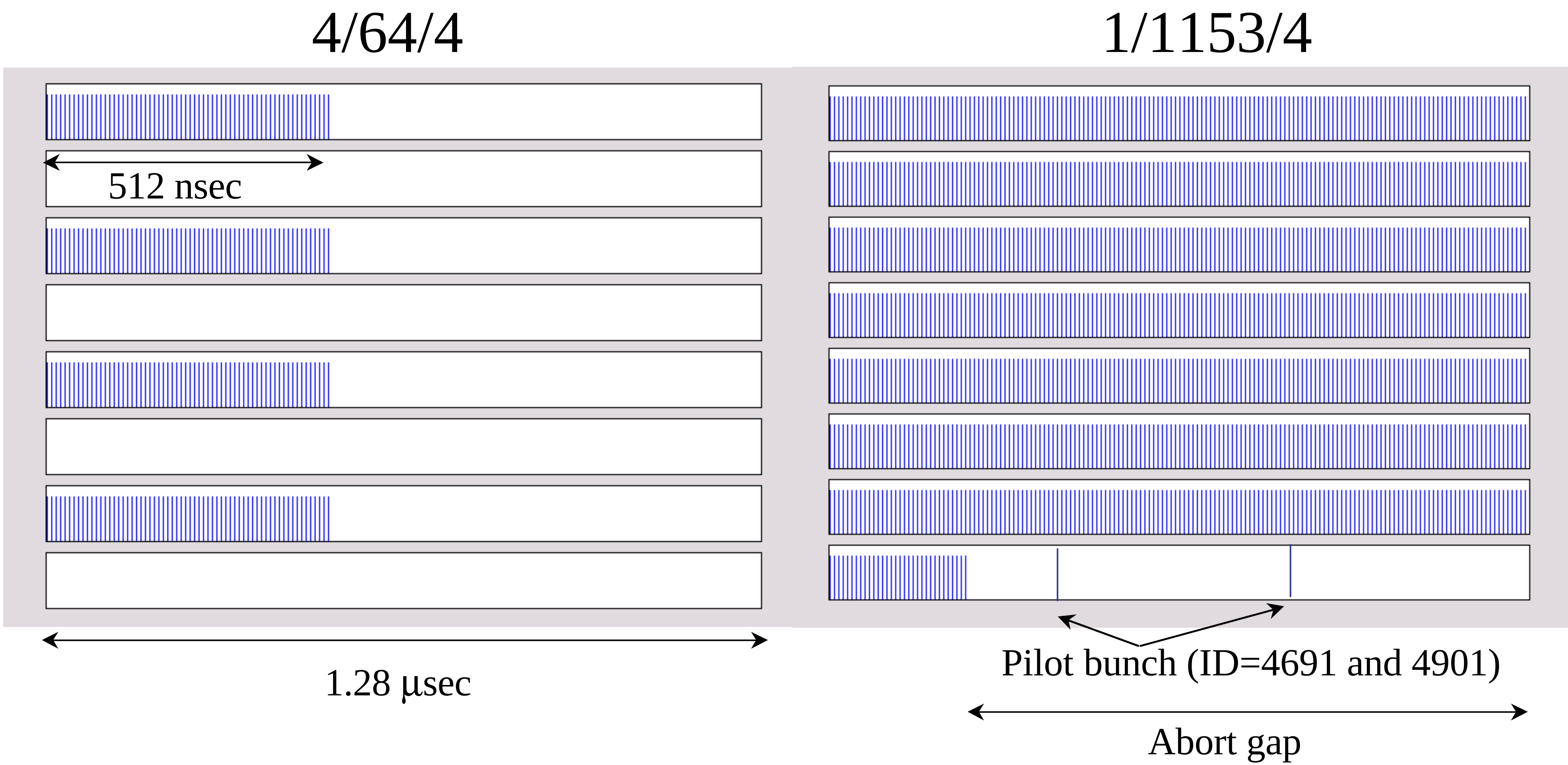
- **Current amp. (Radeka amp.)**
- **Gain: 500 mV/pC**
- **Rise time: 3～5 nsec**
- **Drifting of the amplifier gain is less than 2% for one year operation.**
- **This measurement is AC. (⟺ DC)**

Measurement of Photoelectron Yield

- **Pick-up output voltage(Vout) as a function of time**
- **Single shot**
- **Filling pattern:**
  - **4/64/4 (180 mA)**
  - **1/1153/4 (660 mA)**
  - **1 bucket spacing is 2 nsec.**
- **Revolution is about 10 μsec.**
- **Abort gap with no bunch is 1 μsec.**

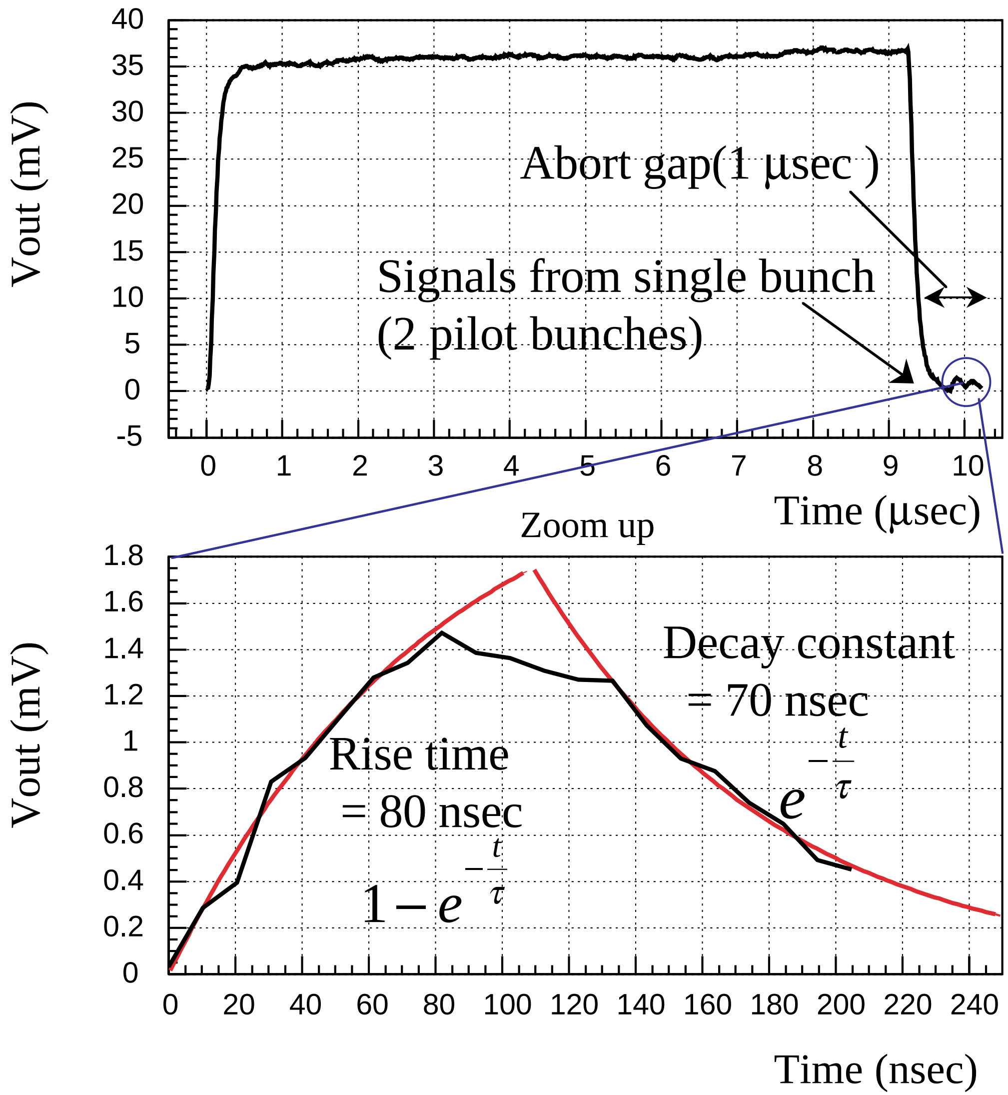


Filling patterns

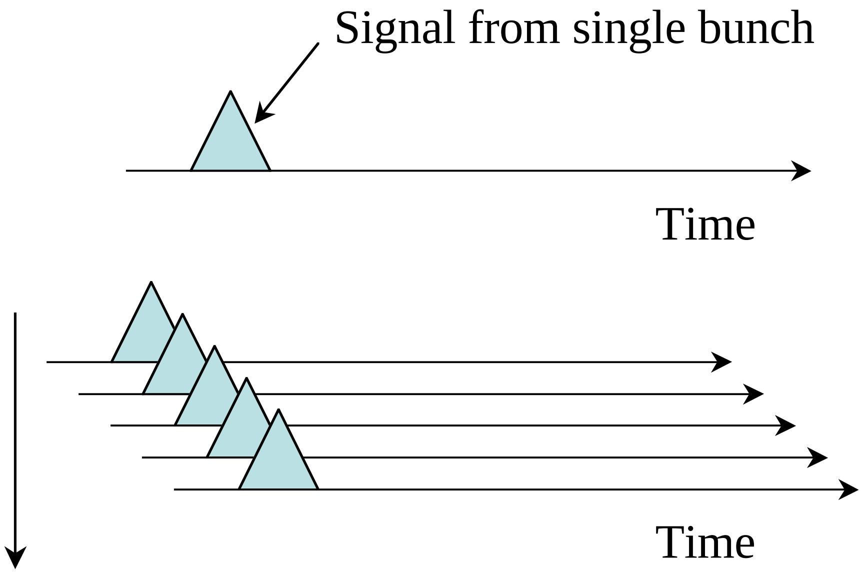


Measurement of Photoelectron Yield (cont'd)

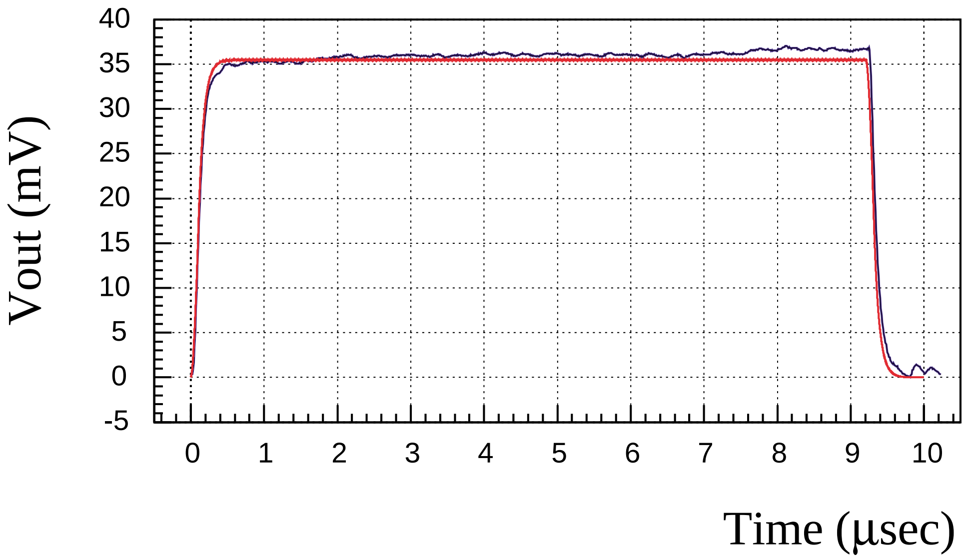
- **Isolated bunches (*pilot bunch*) can be put in the abort gap.**
- **Signal from photoelectrons due to synchrotron light emitted from single bunch.**
- **Decay constant is 70 nsec.**
- **Decay time constant is needed to extract photoelectron current.**



Measurement of Photoelectron Yield (cont'd)



Pile up contributions
from 1153 bunches (8 nsec spacing)

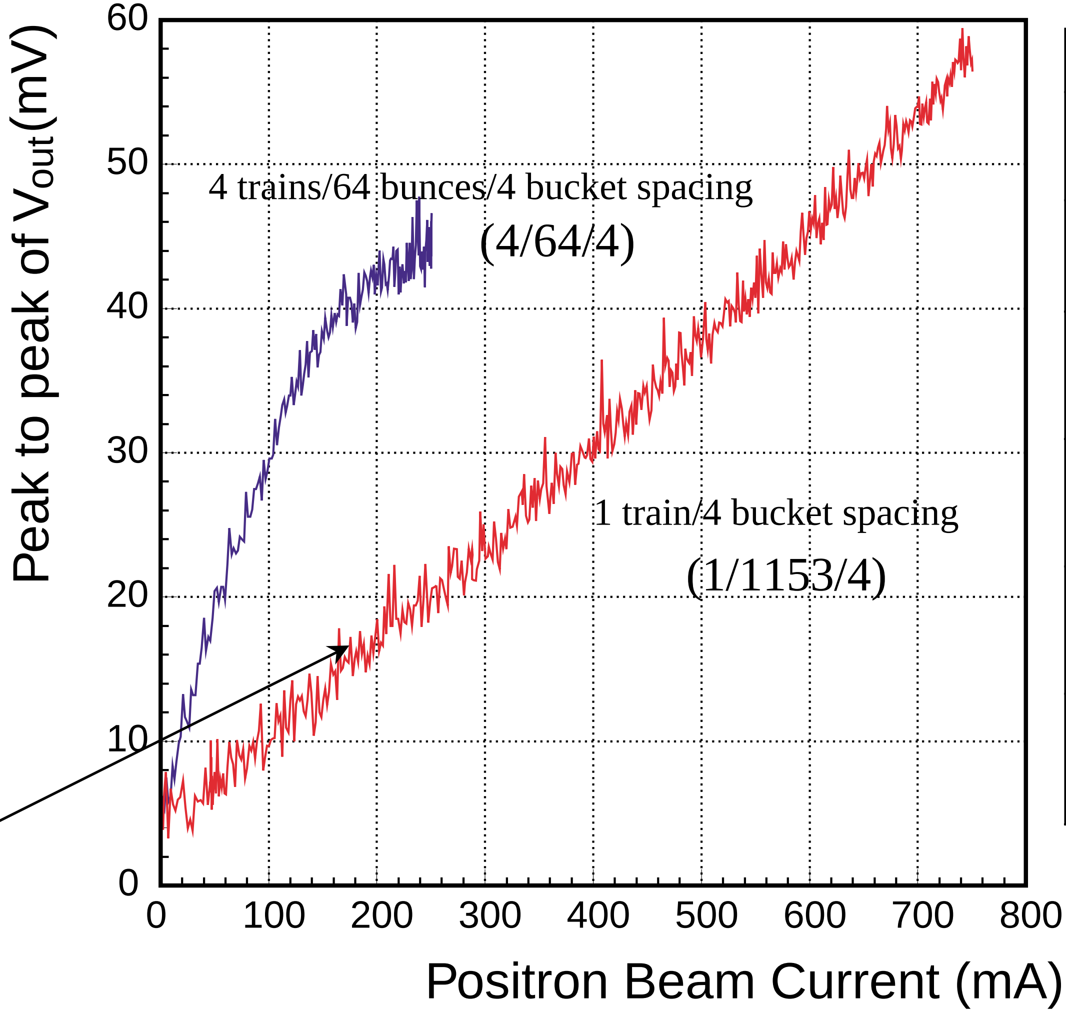


Blue… measured output voltage
Red… pile up of single pulse (x1.2)

- **Photoelectron yield as a function of time can be reproduced by calculation from a signal shape.**

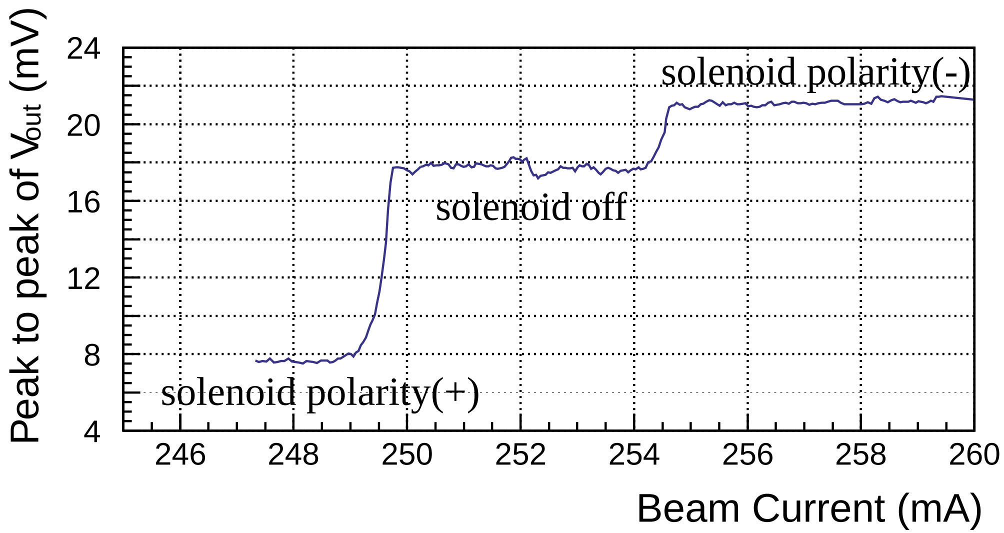
Measurement of Photoelectron Yield (cont'd)

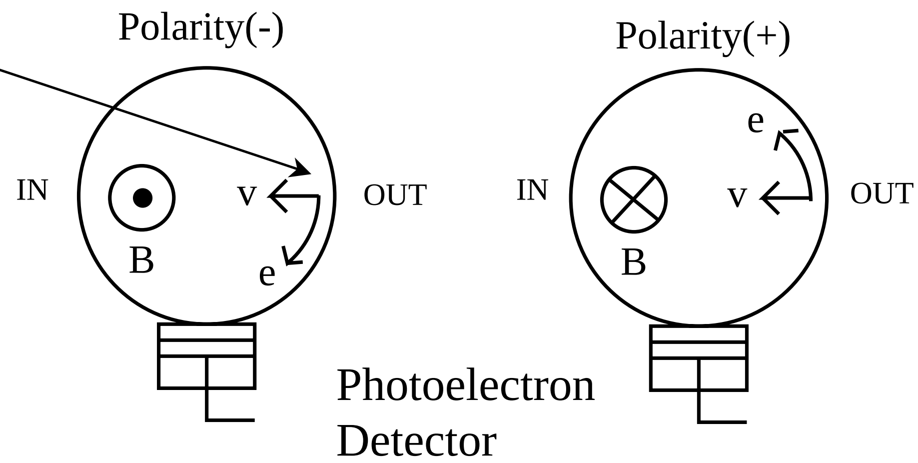
- **Peak-to-peak voltage of output signal(Vout) as a function of beam current**
- **Single shot**
- **Suppressor bias: 0 V**
- **Collector bias: 0 V**
- **Photoelectron yield: 1 μA at 550 mA beam current for 1/1153/4 filling pattern**
- **Photoelectron/beam current: 1.8 nA/mA**



Photoelectron Yield and Solenoid field

- **Effect of the polarity of solenoid field**
- **Pick-up voltage clearly depends on the polarity.**
- **Signal from pick-up is caused by photoelectrons.**
- **Synchrotron light hits the outer wall and photoelectrons are emitted.**
- **Trajectories of photoelectrons are different between + and – polarity of solenoid field.**

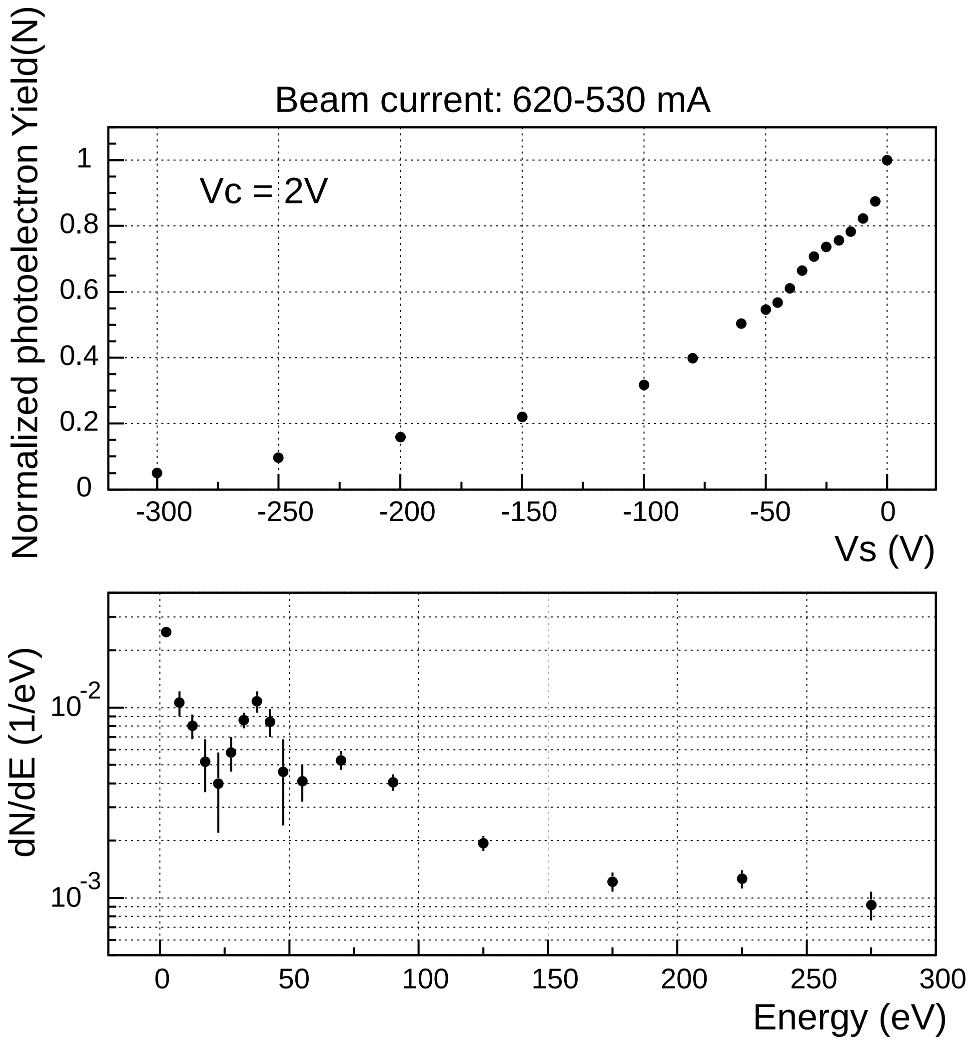




Cross section of vacuum chamber

Energy Spectra of Photoelectrons

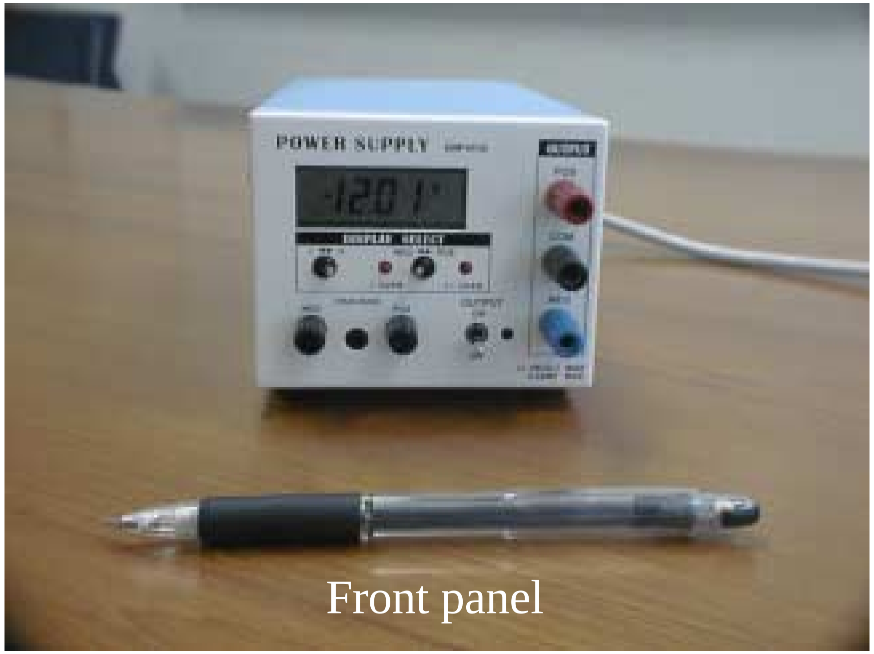
- **Beam current:**
  - **620～530 mA**
- **Filling pattern:**
  - **1/1153/4**
- **Collector bias: +2 V**
  - **To make measurement of electron yield stable.**
- **Suppressor bias:**
  - **0～ –300 V**
- **Large excess was found at 35 eV (Or large dips can be found at 25 and 50 eV?).**



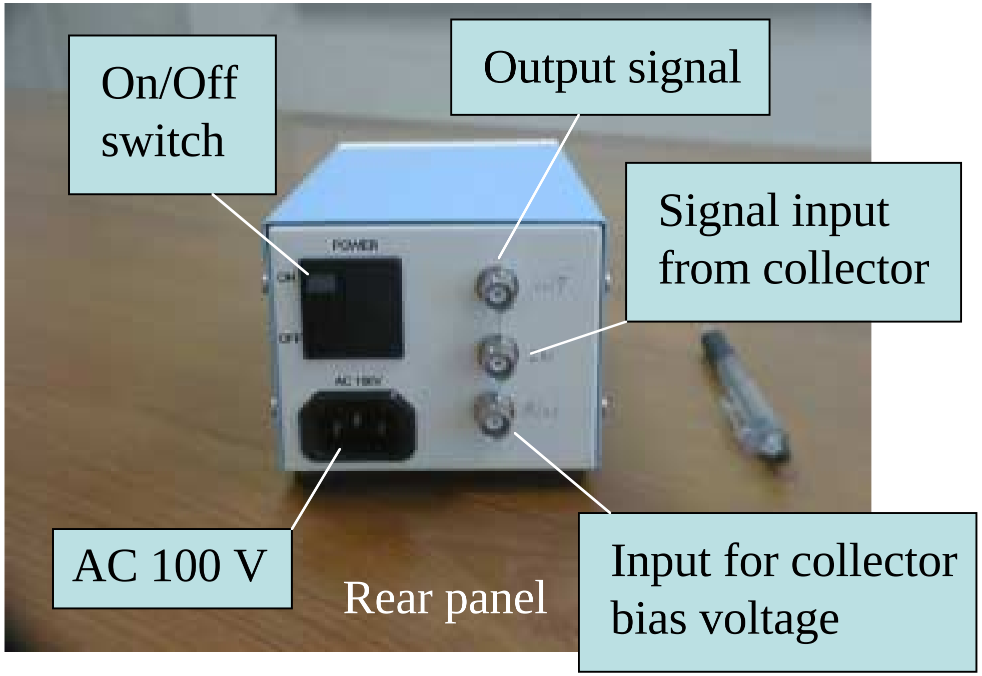
Summary

- We have developed photoelectron detector and readout electronics.
- Signals from photoelectrons were observed as a function of time.
- We measured photoelectron yield. (Need to consider detector acceptance and solenoid field.)
- Energy spectra of photoelectrons:
  - Large excess was observed at 35 eV.

Summary (cont'd)



Front panel



Rear panel

- **Latest version of readout electronics (T. Murakami)**
- **Amplifier with power supply (combined type)**
- **Readout system is much smaller than prototype and easy to take.**
- **Price is $200. (depends on number of productions)**