The Summary Of Test Beam In 2004~2005's Run

Test Beam group,IHEP,CAS

Presented by ZOU Xiang

June 1,2005,Beijing

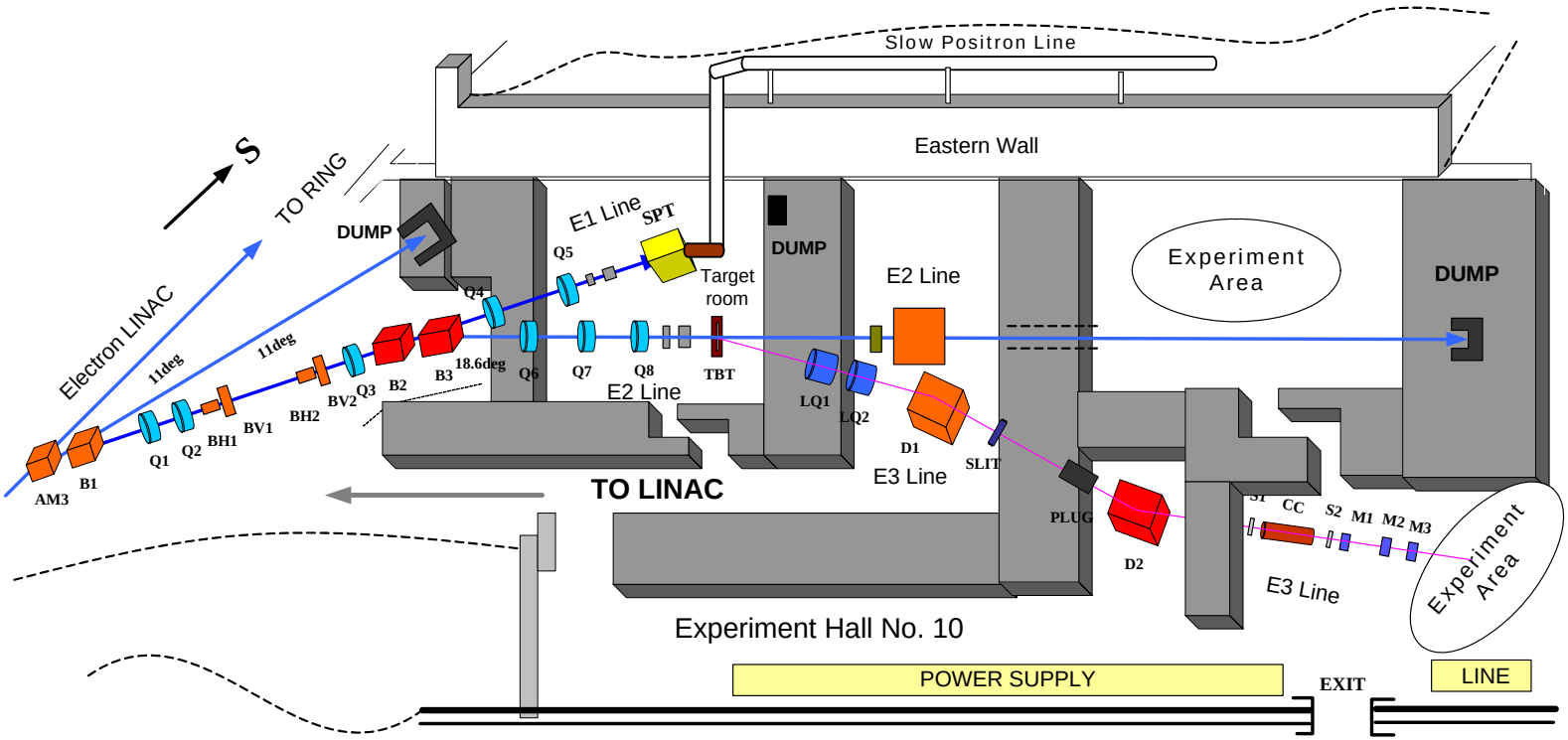
Outline

- **Introduction**
- **Current Status of Test Beam**
  - **Beam features**
  - **Detectors**
  - **Hardware**
  - **Software**
  - **Current Problems and upgrade**
- **Beam tests**
- **Summary**

Introduction

- BEPC Test Beam
  - At the end of the line accelerator.
  - Upgrade had been executed and finished by May 2003.
  - It costs more than 4 million yuan.
  - Up to now, Test Beam includes E1 line, E2 line and E3 line.
    - ✓E1 line has been used by slow positron equipment.
    - ✓E2 line is applied to do radiation damage experiment.
    - ✓E3 line has been successfully used for some detectors beam test, especially for the test and calibration of sub-detector modules of BESIII.

Configuration of Test Beam



AM3 B1 B2 B3: Bending Magnets
BH1 BH2 BV1 BV2: Dipole Corrector
Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 LQ1 LQ2 : Quadrupole
SPT: SLOW POSITRON TARGET; TBT: TEST BEAM TARGET;
M1 M2 M3 :Multi-wire Proportional Chanber
S1 S2 :Scintillator, CC : Cherenkov

IHEP BEPC-LINAC
THE CONFIGURATION OF TEST BEAM

0 2m

Current Status of Test Beam

- **The features of Test Beam lines**
  - **E1 and E2 lines are primary beams.**
    - ✓E1 line is produced by bent electron beam 22 degrees from the end of the line accelerator.
    - ✓E2 line is produced by bent electron beam 18.6 degrees from E1 line.
    - ✓E1 and E2 lines can provide electron beam and their energy between 1.1 and 1.5Gev depending on the line accelerator.
    - ✓The frequency is 12.5 or 25Hz and will reach 50 Hz following the upgrade of BEPC Ⅱ.

Current Status of Test Beam

- **E3 line is the secondary particle beam to be produced after electron beam of E2 line hitting fixed target.**
  - ✓It can provides e, π and proton particle beam.
  - ✓The momentum can be adjusted between 200Mev/c and 1.2Gev/c by magnetic spectrometer for different experiments.
    - The momentum of electron range between 200Mev/c and 1.2Gev/c .
    - The momentum of π and proton particle range between 400Mev/c and 800Mev/c .
  - ✓The momentum resolution controlled by magnetic spectrometer is less than 1 percent within the 1*1 square centimeter around the beam center.
  - ✓The spatial resolution giving by 3 MWPCs on E3 line is less than 0.3 millimeter while the momentum more than 500Mev/c.

Current Status of Test Beam

- **Detectors are applied on E3 line**
  - Three kind of detectors are applied to select single particle events on E3 line.
  - The detectors include one threshold gas Cherenkov counter (Čc), two scintillator counters (SC1 and SC2) and three Multi-wire Proportional Chambers (MWPC1, 2, 3).
    - ✓Threshold gas Cherenkov Counter**:**
      - Used for electrons selection
      - Use CO_2 gas as radiator
      - Air pressure is controlled on 1.2atmospheric pressure.
      - Apply XP2020Q PMT for recording signals
      - The efficiency of electron selection reached 99%

Current Status of Test Beam

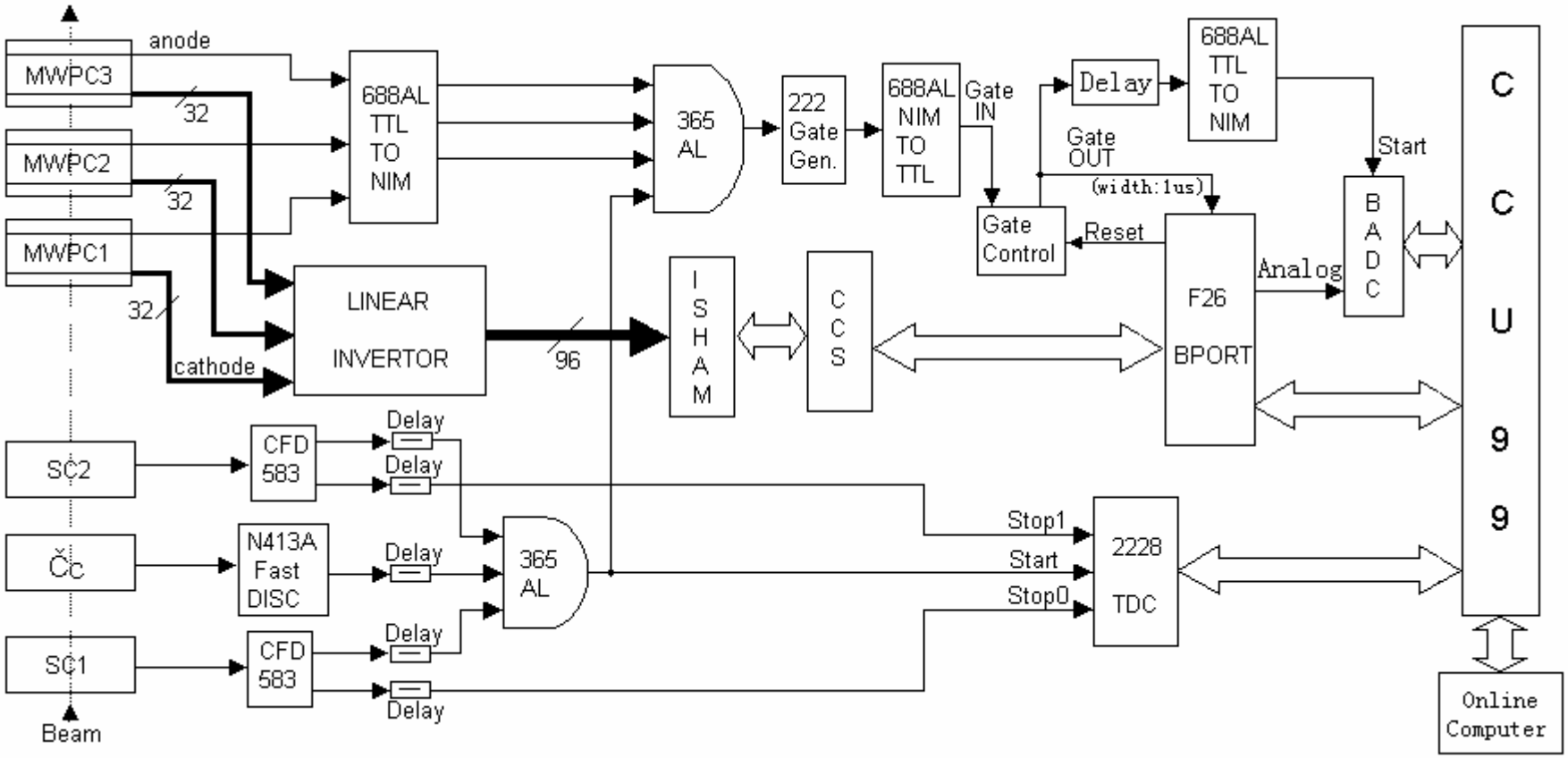
- **Detectors are applied on E3 line**
  - ✓ **Scintillator Counter**
    - Used to measure the time of flight (TOF) of particles to identify π and proton particle.
    - The volume is 50*50*3 cube millimeters or 35*35*3 cube millimeters.
    - Also Apply XP2020Q PMT for recording signals.
  - ✓ **MWPC (Multi-wire Proportional Chamber)**
    - Used to select single particle events, calculate the bi-dimensional hit coordinate, rebuild the track for single particle event.
    - Collaborated research and development with USTC.
    - Use 20% CO_2 and 80% Ar mixed gas as draft.
    - Worked with gas with flow mode and gas runoff is about 50 ml/min.
    - Each MWPC has one anode signal and 32 induced signals on cathode.
    - Anode signal translated by one coaxial-cable.
    - Cathode signals translated by twisted-pair cable with 32 pairs.

Current Status of Test Beam

- **Hardware configuration of the on-line data acquisition system**
  - Inclusive of discriminator unit, delay unit, level adapter unit, 4-fold logic unit, TDC unit and BADC unit, and so on.
  - SC1 ,SC2 and TDC unit to measure the time of flight (TOF) to identify π and proton particle.
  - The Čc is used to select electron when its signal coincide with SC1 and SC2, or anti-coincide with SC1 and SC2 to exclude electron.
  - The BADC unit is the first time used in test beam. It converts the induced signals on cathode of MWPCs into digital numbers. Its start signal is generated from 6-fold coincidence of detectors trigger signals.

Current Status of Test Beam

- **Hardware configuration of the on-line data acquisition system**

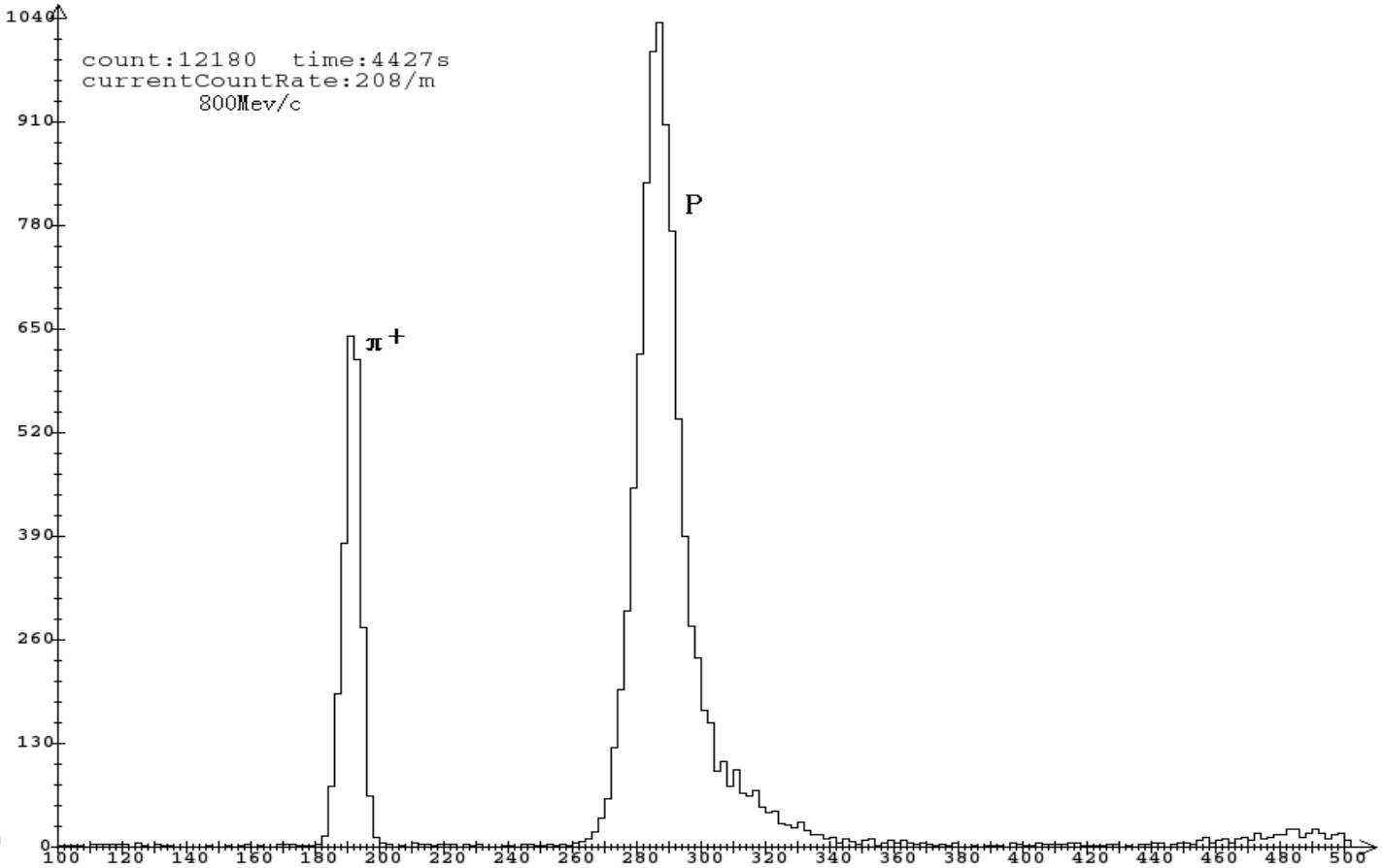


Current Status of Test Beam

- **Software**
  - **Data acquisition software**
    - ✓Also includes the calibration software.
    - ✓Programmed with object oriented language .
    - ✓The GUI based on Qt library.
    - ✓Runs on the platform of Linux Redhat .
    - ✓Read data from CAMAC system according to different types of CAMAC unit.
    - ✓Shows the data as histograms to users when acquiring data.
    - ✓Finally saves the data as a text file for offline data analysis.

Current Status of Test Beam

- **Data acquisition software**
  - ✓One histogram is given by the software—TOF spectrum of π^+ and proton particles with 800Mev/c momentum .



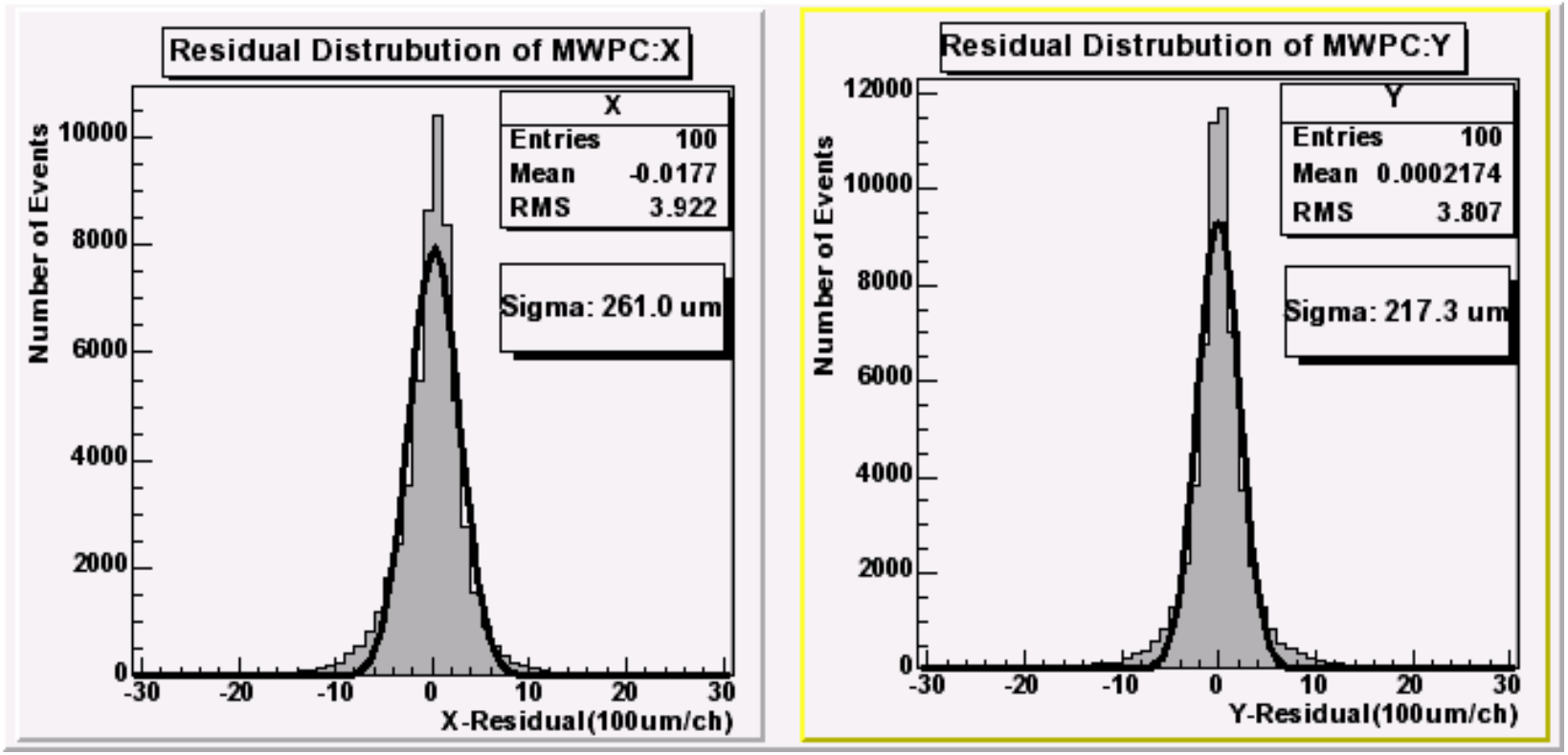
Current Status of Test Beam

- **Software**
  - **Offline data analysis software**
    - ✓ **Inclusive of:**
      - Correction of induction efficiency of MWPC's cathodes,
      - Identification of single particle event,
      - Calculation of bi-dimensional hit coordinate and the angle of incidence,
      - Rebuilding the track of single particle ,
      - and so on.
    - ✓ **Some analysis results:**
      - The spatial resolution giving by 3 MWPCs is less than 0.3 millimeters while the momentum more than 500Mev/c.
      - The ratio of single particle events to events on record is about 30~50% with event rate of 3-4 Hz, so the average frequency of single particle event is about 1.5 Hz at present

Current Status of Test Beam

- **Offline data analysis software**
  - ✓One result of offline data analysis

--Spatial Resolution measured at 500Mev/c of electron beam



Current Status of Test Beam

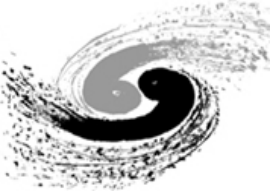
- **Current problem and upgrade**
  - Electronic noise: The noise from earth and EMI (Electro Magnetic Interference) has interfaced with our electronic system. We have adopted some methods such as upgrade of earth and addition of isolated transformer to reduce and restrain noise. How to reduce and restrain as much noise as possible is a problem faced us.
  - Beam background: The great pulse electron beam hit fixed target, a lot of sources may originate noise and background. In order to reduce the beam background we built a wall between detectors and experiment modules.
  - Frequency of single particle event: The average frequency of single particle event is about 1.5 Hz at present. How to improve beam quality and increase the frequency of single particle event is our main task in next work.

Beam tests

- **Some beam tests for BESⅢ sub-detectors**
  - From January 8,2005 to March 3,2005:TOF(Time of flight) counter module beam test.
  - From March 4, 2005 to April 20,2005: EMC(Electromagnetic Calorimeter) sub-detector experiment.
  - From April 21, 2005 to May 24,2005:MDC(Main Drift Chamber) 1:1 module beam test.
  - From June 1,2005 to June 18, 2005: sub-detectors united test.
- **Others**
  - Beam test for radiation effects on optical fiber.
  - Beam test of luminosity monitor (USTC).

Summary

- In 2004~2005's run, Test Beam provided about 6 months to test and calibrate 3 sub-detector modules of BESIII.
- The average frequency of single particle event is about 1.5 Hz.
- The results of experiments have achieved the original design requirements basically.
- In order to assure Test Beam will operate smoothly and adapt for more applications, we plan to upgrade test beam system.
- Meanwhile, we must thank all people who collaborated with us as well as who attend to Test Beam.



Thanks