COMET実験のための
Straw Gas Chamberの開発

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COMET Experiment

• Search for Muon to Electron Conversion at a sensitivity better than $10^{-16}$

The Detector
• Muon Stopping Target
• C-shape Electron Transport
• Electron Detection

The Muon Source
• Pion Production Target
• Pion Capture Solenoid
• C-shape Muon Transport

ELECTRON TRACKER and calorimeter

muon transport (curved solenoids)

muon stopping target

Pion-Decay Muon-tracker
A section of muons from decay of pions under a solenoidal magnetic field.
Why need Straw?

- Electron Tracker is placed in vacuum (Detector solenoid).
- should withstand for vacuum operation (pressure difference, etc...)
- Sufficient energy resolution
- COMET requires better energy resolution than 1MeV
JP Straw chamber purposes

1. **Build (nearly) Full-Scale Prototype**
   - approx. 1m length
   - wounded Mylar straw
   - thickness of straw is 25µm

2. **Test in Vacuum**
   - Establish the stable operation
   - Checks, not only gas leak but also deformation

3. **Integrate Relevant Items**
   - Front-end Electronics
   - HV, Gas Controlling, Slow Control System, etc.
The diameter of Mylar Straw is 5mm.
- Double plane (4 tubes + 3 tubes)
- 1 single tube chamber, 2 double plane chamber
- 1 double plane chamber will be studied by glued each other
- With Large Gas-manifold to contain HV traces, readout front-ends
Straw Chamber
Study Items

- Gas leak Study
  - First, studied by pressurized 2 atm in air
  - Second, studied by measuring pressure build-up in vacuum
- Deformation Study
  - Small deformation was measured by capacitive sensors as a function of position along wire

Contrinex AG
capacitive sensor
Gas Leak Study (Preliminary)

- 2 atm Operation
  - ~0.6199 cc/min.
- Vacuum Operation
  - ~0.2267 cc/min.

not consistent...
Deformation Study (Preliminary)

- 2 atm Operation
  - ~60µm (at 1/4 straw)
  - ~140µm (at 1/2 straw)
- Vacuum Operation (Vacuum rate: 6.32 Pa)
  - ~37µm (at 1/4 straw)
  - ~67µm (at 1/2 straw)
- From My calculation, deformation is ~8µm

Any result is not consistent...
Chamber Signal

Raw signal is very good S/N
Raw signal level is ~8mV
QDC&TDC data is being acquiring with B-ray Source(Sr90).
QDC shows reasonable landau distribution.
TDC shows drift time distribution.
in order to investigate the intrinsic position resolution, X-T relation will be extracted from data.

DAQ

Raw Signal

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QDC (very preliminary) TDC (very preliminary)
Test in Vacuum (progressing)

- Need to operate straw chamber in Vacuum chamber.
- Gas Leak needs to be measured again with N2 gas for Pirani-gauge calibration.
- Deformation needs to be Corrected, because sensors were leaning.
- Deformation needs to be measured at another Vacuum rate.

Need to another study

- In order to reduce deformation and gas leakage, gluing study between straws will be done, etc...

Analysis about straw chamber for COMET operation.
COMET is aiming a sensitivity better than $10^{-16}$

Built full scale prototype of COMET straw gas chamber
- approx. 1m length,
- straw is 25µm thickness, 5mm in diameter

Test in Vacuum (progressing)
- Measured deformation.
  - ~140µm at 2 atm operation, ~67µm at Vacuum operation
- Gas Leak is measured.
  - 0.6199cc/min. at 2 atm operation, 0.2267cc/min. at Vacuum operation
- Pressure study is not consistent with vacuum operation...

The Straw Chamber can be operated in the air.

This R&D is just started, More studies will be done!
THE END of SLIDES
Back up Slides
Capacitive Sensor 時間變化

![Graph showing data points ranging from 2.724% to 2.738% against a percentage scale from 0% to 400%]

- Series 1
Straw Chamber Design Work

Cross Section View

Schematic View

Manifold Design (progressing)

Side View

Top View

Status: Almost Finished

- Double plane (4 tubes + 3 tubes)
- 1 single tube chamber, 2 double plane chamber
- 1 double plane chamber will be studied by glued each other
- With Large Gas-manifold to contain HV traces, readout front-ends
To Do Lists

- Straw Chamber
- Chamber Construction
- Vacuum Chamber
- Gas Control System
- Front-end Electronics
- Trigger
- Data Acquisition System
- Study Tools
  - Capacitive Sensor study
  - 2atm Operation study
Capacitive Sensor Calibration

- Calibration
  - In Air
    - Calibrate with M6 Cap
    - +1 cm × 1 cm Alum tape
  - In Chamber & Vacuum
    - Calibrated
- Result
  - Repeat Accuracy is not so good
  - Use only slope
Capacitive Sensor Calibration

Calibration
- In Air
  - Calibrate with 1cm×1cm Alumi tape

Result
- Repeat Accuracy is not so good
- Use only slope
Vacuum Chamber

- **Status: Ready**
- 2m length in order to contain full-size prototype (1m tube with ~20m manifold on both ends)
- the degree of Vacuum is 6.7pa (with nothing included in chamber)
- Build up test is done.
Status: Under Consideration

Basically, we may use scintillation counter for RI sources and cosmic rays... just usual way....

Pencil Trigger counter is readied.

Tested in Vacuum chamber.
Detectors is placed in vacuum.
Data Acquisition System

- Status: Will be finished soon
- VME; TDC + ADC (minimum set)
- Modified CAEN sample codes with CAEN’s APIs.
Roesti project (Tatsuya Part)
(Read-Out Electronics for Straw Tube Instrument)

For offline analysis...
- Waveform sampling enables to deal with pile up and to get better time resolution.

For operation in vacuum...
- Low power consumption
- Reduce number of feedthrough by using an RJ45 connector.