Continued Development of High Resolution Camera

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Early System

Cavity is rotated and moved longitudinally. The cavity moves to swallow the camera cylinder.
Inside the Cylinder

The camera can be moved by a Linear Actuator to adjust the working distance.

Mirror can be tilted by a Pulse Motor.
Camera Specification

- 1.5M-pixel CMOS Color Camera
  1400px X1000 px: 5.0μm/px
  Toshiba teli CSF5M7C3L18NR

- Distortionless Lens(0.15x ~ 0.35x, f75mm)
  V.S. Technology Corp. VS-LD75

- 40mm Extension Tube (later)

Maximum resolution: ~0.70x, ~7μm/px (~15μm/px)
Limited by the Working Distance~120mm

VS-LD75
CSF5M7C3L18NR

http://www.ff-net.ne.jp/ffhome/vsldseries.html
http://www.toshiba-teli.co.jp/ise/cmoscolor/csf5m7c3l18nr.htm
Statistics of spots (>100μm) in Z84

Diameter Population

The last photo

The Number of Spots

Diameter [μm]

100 130 160 190 220 250 280 310 340 370 400 430

0 2 4 6 8 10 12

REMARK: All the spots were found at the input coupler side of the EBW seam.
Interior Surface of Zanon #84

- 28 spots like cat’s-eye were found at the equators of the cells. (only the spots with diameters larger than 100μm are counted.)
- Any other kind of spots were not found.
- Likely convex (no confirmation).
Interior Surface of Zanon #84

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Interior Surface of Zanon #84

EBW seam

spot

1mm
Interior Surface of Zanon #84

EBW seam

spot

1mm
New Inspection System

New camera cylinder & illuminator

damper

rotation

longitudinal movement
Longitudinal movement (longer stroke)

Pulse motor
Ball screw

Pulse motor
Camera
Lens

High angular reproducibility
- Vertical Test was performed at FNAL/JLAB.
- Quenched at $E_{acc} \sim 15\text{MV/m}$ without field emission (no X-ray).
- Passband mode measurements show that #3 and #7 cell are suspicious.
- In CERNOX measurements, two hot spots were found at the equator region of #3 cell.
AES001 has hard quench at 15MV/m, where its location was identified by Cernox at FNAL.
Correlation with Thermometry

Two thermometers show the temperature rise.

24mm?

The width of the thermometers are about 5mm.

Dmitri A. Sergatskov: Thermometry on AES01 cavity at Fermilab @webex20071204

Two hot spots@FNAL/JLAB

Three spots found@Kyoto
The location

7~8mm from the center
AES001 #7 cell 325°

EBW affected area

Largest grains

Larger grains

Transition?

Fine grains

to Equator and #6 cell

200µm/div
Stripe Illumination(SI)

- Fourteen Electro-Luminescence(EL) strip sheets are 10mm in axial direction and cover 100mm in azimuthal direction.
- These fourteen strips can be turned ON/OFF one by one.
- Assuming that cavity’s interior surface is a complete mirror, we can measure wall gradients of the cavity’s interior surface with these ELs.
Inside the Cylinder

The camera can be moved by a Linear Actuator to adjust the working distance.

Mirror can be tilted by a Pulse Motor.
Inside the Cylinder

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Wall Gradient Measurement

\[ \theta = \frac{1}{2} \arctan \left( \frac{z}{R - r} \right) \]

inner radius of the cavity \( R = 100 \text{mm} \)

Outer radius of the cylinder \( r = 25 \text{mm} \)

mirror: 45deg

hole

light source (EL)

position of EL turned ON: \( z \)

to camera

2008.4.21 SCRF meeting @FNAL
Wall Gradient Measurement

The center spot move left to right
Wall Gradient Measurement

-7 -6 -5 -4 -3 -2 -1 0 1 2 3 4
• This data shows that the spot is a convex (ball).
• Because of the continuity of the measured gradient, we can integrate the gradient to estimate the height of the spot.
Height of spot at #3 cell 181°

Black curve is a fitted gaussian.

Cavity Wall side

Air or Vacuum side

40 μm from gradient data assuming gaussian.

43 μm

200 μm/div
Wall Gradient of spot at #7 cell 325°

Left: Measured gradients and a fitted differential gaussian. Right: Schematic drawing of the integral of the fitted curve in the left. This data shows that the spot is a concave(pit).

200µm/div
Height of spot at #7 cell 325deg

Black curve is a fitted gaussian.

28μm from gradient data assuming gaussian.

200μm/div
Stiffener out side?

AC74:
spot1 95°

AC74: spot2 141°
Bubble sign exist on cell #1,2,3 equator.
Reduce it for #4,5,6..., Nothing in cell #9.
ERL single-cell cavity 内面観察 (1)
（エンドシングルセル）

渡邉 謙
STF Baseline group meeting
2008/3/28
観察した空洞: エンドシングル空洞

- センターシングル空洞
  - セル形状の検証
  - 表面処理工程の確認

- エンドシングル空洞
  - ビームパイプ構造の検証
    - 大口径ビームパイプ
    - 偏心フルート
    - インプットポート
    - ピックアップポート

4月？に観察予定
観察位置

④赤道からLBPアイリスに向かう面
①LBPのアイリス部
②赤道部: EBW後バフ研磨
③SBPのアイリス部
①LBPのアイリス部

ビーム軸方向

5mm

所々ポール状のものやピットがあった。
②赤道部：EBW後バフ研磨

ボール？（突起）らしきものが見えた

赤道部はバフ研磨しているため、溶接痕は消えていた。
③SBPのアイリス部

アイリスから外れた部分に大きな穴らしきものがあった。
溶接痕の上にも全体的にピットが観測された。
レンチを落とした傷をベビーグラインダーで一部分研磨したとのこと（#800？）
研磨した面では傷が残っていた。
目視でも確認できるレベルの傷であった。
このような傷はEP(30μm)で取れないことが分かる。
Prototype design for production series
Prototype design for production series

Cavity not included!
Prototype design for production series

Upper Module
Prototype design for production series

Cavity Table
Camera Cylinder Head
The Camera Head

Eye Direction

Mirror

EL sheet

Motor

Center light (LED)

EL sheet moves with mirror angle
Cylinder Support

Moves 2 ways:
up down
and
left right
Camera Cylinder and its Support
Camera Cylinder and its Support

No hole on cylinder
Illumination Control Panel Layout (tentative)

Stripe Illumination Control

10  9  8  7  6  5  4  3  2  1  0 -1 -2 -3 -4 -5 -6 -7 -8 -9 -10

All ON/OFF (toggle)

to left end
step right
Center
step left (run when hold)

to right end (right half ON)
Pulse Motor Controller

Suruga Seiki
Handy Terminal D200

Suruga Seiki
PM Driver/Controller D22x

GP-IB, RS232C, USB
1~6 Axis
Whole System

Stripe Illumination Control

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- All ON/OFF (toggle)
- to left end
- step right
- Center
- to right end (right half ON)
- step left (run when hold)
Summary

I. The resolution of 7.4\(\mu\)m is achieved.

II. AES1 spot locations agree with the results from passband mode and thermometry.

III. The wall height/depth can be estimated by integrating the measured gradient.

IV. Design of the production model is finished.

V. The first lot will be delivered to KEK soon.

VI. Searching trading company to handle exporting bureaucracy.