Present status of design study
Downstream geometry

Updated with the recent data (Phone conf. 73, March 17)

5-cm clearance between detectors
## Particular points

<table>
<thead>
<tr>
<th>Detector</th>
<th>Longitudinal position $z$ (cm)</th>
<th>Radial distance (cm)</th>
<th>Beam RMS (cm)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOF 2</td>
<td>45</td>
<td>26</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>CKOV 2</td>
<td>83</td>
<td>38</td>
<td>14</td>
<td>At the upstream face of aerogel</td>
</tr>
<tr>
<td>CALO</td>
<td>114</td>
<td>36</td>
<td>33</td>
<td></td>
</tr>
</tbody>
</table>

Beam RMS from Y. Torun (Phone conf. 73, March 17)

- No absorber
- No shielding
- No RF
Muon distributions

From Y. Torun (Phone conf. 73, March 17, 2004)
Muon momentum distribution

From A. Tonazzo (Phone conf. 73, March 17, 2004)
From Yagmur’s results (Summary of phone meeting held on March 1, 2004)

± 3σ containment requires the following transverse sizes

- 30 cm for TOF 2
- 42 cm for CKOV 2 (at the entrance window)
- 65 cm for MUCAL

They were based on

- estimates of the longitudinal positions
- no magnetic shielding
- no RF
- field configuration from MICE note #49

The present designs of TOF 2 and CKOV 2 already meet these dimensions.
• PM tubes have to operate in magnetic fields less than 2.5 kGauss (preferably axial)

• CKOV 2 must be longitudinally as small as possible
Colored dots: stray field at the photocathode positions
Shielding against stray field

Optimum solution (i.e. smallest size)

15-cm thick iron circular disk 150-cm diameter
Assumed to be located 20 cm downstream the last coil.
50-cm diameter hole centered on the beam axis

Details given during video conference Jan 28, 2004

At z=45 cm (TOF PM's)

Computed for a 20-cm diameter hole

Max. allowable field for TOF2
TOF conditions with shieldings

At the photocathodes, $B_{\text{TOF2}} \cong 1 \text{kGauss}$
CKOV2 conditions with shieldings

At the photocathodes, $B_{\text{CKOV2}} \approx 0.6 \text{ kGauss}$
At the photocathodes, $B_{\text{CALO}} \cong 1$ kGauss
Field lines inside CKOV2

Conditions:
- shield 150-cm diameter
- thickness = 15 cm
- no MICE shielding

Cherenkov design: see above

No mumetal

Residual field at the photocathode $\approx 30$ Gauss

Residual field can still be reduced with a standard 2-layer protection (5-mm iron + 1-mm Armco)
Iron structure

- 15-mm thick iron plates
- Gas tight welding
- Nickel plated

Stainless steel « legs » to cope with the magnetic forces from the shielding
Reflecting 4-face pyramid

- At 45°
- 4 plane faces
- aluminized polycarbonate sheets (3-mm thick)
- supported by a Nomex honeycomb structure attached to the particle exit window
Light collection devices

Winston cones (aluminized plexiglas)

8 photomultipliers

EMI 9356 KA (8 inch)

Winston cones: 30° acceptance angle
Reflective layers

A. Braem (private comm. 2002)

Al + MgF₂ + Hf₂O₃ evaporated layers

A. Braem (private comm. 2002)
Local shielding

Double layer shielding against stray field

5-mm soft iron

1-mm Armco (mumetal)
Details

- Mumetal
- Iron structure
- Optical glass window
- Aerogel
- Wedge pieces covered with aluminized Mylar
- 7-mm thick honeycomb with one Al skin
- Winston cones
- O-rings

Gas tightness and fixation of glass windows
Aerogel

PM's can be removed without breaking gas tightness of the vessel

Removable honeycomb window (for gas tightness during assembly and transportation)
Front view (for particles)

Nomex honeycomb supporting structure for the mirrors

Optical glass windows (aluminized everywhere except in front of photocathodes)
Present design based on

- an 10-cm thick aerogel radiator of max. size 55 cm x 55 cm
- 20-cm (8") diameter low noise photomultipliers EMI 9356 KA (available at no cost !)
- a rather simple mechanical design

It seems to me to be the most economical size !

Increasing/decreasing the transverse size would imply:

- Buying larger/smaller diameter sizes PM’s of equivalent quality !
- No significant decrease of the construction costs (still Winston cones and the roughly same size of the optics)

**Cheapest solution:** try to keep the overall dimensions
but reduce the size of the radiator to 45 cm x 45 cm if useful !
Next steps

Need of sample electron and muon tracks (~ 10 keVts each)

(x,y) coordinates and directions at $z_{\text{entrance}}$ (upstream aerogel face)

Only then and if the present basic mechanical design is globally acceptable,

- generation of Cherenkov photons,
- evaluation of the optical performances
- estimation of the detection efficiency
## Budget update

<table>
<thead>
<tr>
<th>Item</th>
<th>Supplier</th>
<th>Delivery (after order)</th>
<th>Costs (no VAT) kEuro</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerogel</td>
<td>Matsushita</td>
<td></td>
<td>57</td>
<td>4</td>
</tr>
<tr>
<td>Glass plates</td>
<td>Schott</td>
<td>9-11 weeks</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Cutting + Packaging</td>
<td>TBD*</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Aluminization</td>
<td>A. Braem</td>
<td>TBD*</td>
<td>2.5</td>
<td>3</td>
</tr>
<tr>
<td>Winston cones</td>
<td>TBD*</td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Containment vessels (raw steel plates + flanges)</td>
<td></td>
<td></td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Machining + Welding</td>
<td>TBD*</td>
<td>12 wks</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Ni plating</td>
<td>TBD*</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Assembly + Tests</td>
<td>TBD*</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>8 PM's EMI9356-KA</td>
<td>Trieste</td>
<td></td>
<td>Free</td>
<td></td>
</tr>
<tr>
<td>+ve HV supply</td>
<td>CAEN</td>
<td></td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Mumetal shielding</td>
<td>Imphy</td>
<td></td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Mechanical supports</td>
<td>TBD*</td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Slow controls (sensors...)</td>
<td>TBD*</td>
<td></td>
<td>?</td>
<td>1</td>
</tr>
<tr>
<td>Transports/Shipping</td>
<td>TBD*</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>TBD*</td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>&gt;111</td>
<td></td>
</tr>
<tr>
<td>Contingency 10%</td>
<td></td>
<td></td>
<td>9</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>&gt;120</td>
<td></td>
</tr>
</tbody>
</table>

-50 k€

-50 k€
Different optical configurations

Light spot at the detector position

$\varepsilon = 81 \%$

Non-meridian rays hit the Winston cone at angles larger than the acceptance angle

Try to keep the optical path length as compact as possible

many back/forth reflections

losses when taking actual reflectivities into account
Most compact.

Note. Mirror radius not optimized!

Conclusion.
- Extended off-axis source object
- short distances w.r.t. mirror radius
- larger light spot (aberrations) compared to config. #1
- (probably) no change with elliptical mirror (except cost).

ε = 70 %