Minutes of the FD-Prototype meeting, Karlsruhe, 14/15 July 1999,
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布局/建筑成本：

Los Leones建筑的总体布局已被接受。建筑的最终布局尺寸对于望远镜的安装至关重要。建筑成本根据初步估算为550万美元。资金来自校园发展计划的储备基金。

其他三座FD大楼的资金尚未分配。

datum points:

建筑需要有一个中心点，位于基础的曲率中心，提供至海平面的高度和建筑的地理位置。两个标点距离为11.5米，有助于定义建筑相对于地理北的定向（建筑定向决定尚待决定）。建筑定向的精度要求为0.1度。

在每个机房中，还需要两个标点来定位望远镜，并定义门窗相对于建筑定向的方位。这些标点位于半径R1=7.5米和R2=11.5米的同心圆上，以30.0度的相对角度定义6个径向方向。

所有标点在水平方向上应位于±0.5毫米，并在施工阶段予以保护。每个机房将有一个入口窗户，长3.30米，宽3.00米，底边高度为1.40米。每扇入口窗户将配备一个防紫外线的遮光帘（遥控百叶窗，布料背面）和防滑窗帘。所有望远镜机房将用防紫外线的窗帘隔开。所有机房表面应涂以防紫外线的漆。

C. Escobar/UNICAMP/Brasilia已负责调查适合的涂层。

坐标/望远镜中心：

望远镜的中心是镜架在球面上的曲率中心。该点将作为望远镜在建筑中的临时固定点。望远镜的中心（和原型）已固定在坐标z=1.80米，R=8.50米，相对于最终地板水平面和基础曲率中心。中心点的坐标将根据各机房的标点计算。

leeway around the telescopes:

相邻望远镜之间以及望远镜支持结构和后室墙壁之间的最小距离已固定为1.30米。望远镜支持结构必须相应设计。

doors:

进入望远镜机房的通道仅限于后室的3个门（不可通过入口窗户进入），如图纸所示。门的尺寸为2.50米高，1.30米宽。额外高度为2.10米的门可单独关闭。这些尺寸将确保进入机房的设备可以移动到望远镜之间。门将配备防紫外线的遮光帘。
PROTOTYPE

mirror assembly

Turin (R. Cester) is going to manufacture the mirrors and the mirror support structure for the first prototype telescope.

The radius of curvature of the mirror segments from this production (\(R=3.47\mathrm{m}\)) is different from the baseline design due to the different radius of the existing mould.

The surface quality of the mirrors required in the reference design of 90% reflected light returning from a point source at the centre of curvature to be concentrated in a spot of 10\(\mathrm{mm}\) diameter cannot be achieved with the proposed manufacturing arrangement.

The Turin group can only achieve a spot size of 20\(\mathrm{mm}\) diameter with respect to this specification. (Mirrors of sufficient quality had been produced at CERN, but this production line is not available for the group). This quality loss is unavoidable if the first prototype mirror system is to be ready on time.

The mirror support structure of the Turin group has been redesigned to restrict some unnecessary degrees of freedom in the mirror alignment. The new support consists of two identical sub-systems each supporting one half of the mirror assembly. The design of a sub-system is similar to the previous design, but the meridian bars and the central stanchion have now rectangular cross sections. The meridian bars are fixed to the central stanchion via a machined base plate which ensures the accurate positioning of the meridians on a sphere. \(X,Y\) position adjustments of the mirror elements on the sphere is possible through two bolts in a box which serves as the base of a three legged support as in the previous design. The crude radial position is defined by spacer rings between the \(X,Y\) box and the meridian bar. The fine adjustment of the radial position is accomplished with a bolt at the end of each leg carrying the mirror element. The central stanchions are going to be tilt up to 16 degree to align the optical axis with respect to the centre of the diaphragm.

Manufacturing of the support structure for the first prototype is scheduled to be completed in October 1999. The structure will be preassembled in Turin with some or all mirrors fixed and then disassembled again before shipment to Argentina.

F. Daudo/Turin is in charge of the design and manufacturing control of the support structure.

unimpeachable reference brace

R. Gumbsheimer (Forschungszentrum Karlsruhe) presented a design for alignment of mirrors, camera and diaphragm. The central part is a reference brace with ball point at the nominal centre of the diaphragm serving as a support of alignment tools, e.g. the mirror elements can be aligned by means of spacer rods defining angle and distance of the centre of a mirror element.

Each telescope bay is going to be fitted with such a permanent reference brace which will be retracted from the field of view after all alignments have been completed and could be brought back into its reference position without realignment if necessary. The reference braces are going to be the origin of the coordinate systems for the positioning and alignment of the optics components of each telescope.

The reference brace enables us to install the mirror assembly or the camera independent of the presence of the diaphragm.

For details c.f. drawings attached.
**camera/camera support**

The prototype camera will contain only 100 phototubes when it is shipped to Argentina. The missing 340 phototubes and the necessary components (Mercedes stars, back planes etc.) are going to be ordered beginning 2000 (funding provided) and the camera is going to be upgraded during the prototype phase of 2000.

The camera body for the first prototype has been manufactured and is currently in Catania for preassembly. It will be moved to Rome by the end of August for installation of the phototubes and mercedes.

The camera support for the prototype is a rigid stand on two steel legs. Mechanical adjustments will provide for displacing the camera body in 3 perpendicular directions and two degrees of rotational freedom.

The camera body will have three reference points for alignment along the optics axis of the telescope. The accuracy of the radial placement of the camera will be ±2mm, the lateral position of the camera can be adjusted to ±1mm.

The design has up to now no provisions for fixing the electronics crate behind the camera. Camera body and electronics crate have to be decoupled mechanically to prevent vibrations being transmitted from the electronics crate to the camera.

The electronics crate will most likely be suspended on thin steel rods from the ceiling of a bay (with stabilization to the floor) or from a frame located outside of the telescope's field of view.

R&D to use this method for the camera support as well will be going on during 1999 and could be tested during the prototype phase in 2000.

This concept would cause less obscuration in the field of view. In either case will the cables run alongside the support structure.

**absorption filters**

The camera reference design makes no provisions for absorption filter to be integrated into the camera assembly. Absorption filter from Schott are usually made from hardened glass which shatters easily when cut. If this glass can be shaped into a spherical surface with a radius of curvature close to the radius of the focal plane of the camera a possible position for the filter would be in front of the camera, otherwise the only option available for the prototype design is to fit the filter in the diaphragm (reference design for filter position). The size of the filter area is than 3.8m^2 (1st cost estimate M-UG2 7500 Eu) (without correction annulus 2.3m^2) instead of 1m^2 (1900 Eu) in front of the camera.

Responsibility for the filter lies with the Turin group (R. Cester).

A preliminary test for transmission in the wavelength range 350nm-420nm and absorption outside of this wavelength band has been carried out for three different filter glasses. All three filter types appear to meet the reference design specification with respect to the required transmission and absorption (R. Cester), but the results are not conclusive. Test have to be extended to different thickness and density of samples.

A first cost estimate drawn from the cost of the samples would leave only the type M-UG2 as an affordable option.

- UG1 sheet size disc d=0.052m, 0.0021m^2, 31 Eu
- UG11 sheet size disc d=0.052m, 0.0021m^2, 85 Eu
- M-UG2 sheet size 0.85m x 0.425m, 690 Eu

Further investigation on cost and quality is necessary. In addition tests have to be carried out with respect to the filters self supporting strength to decide whether the filter can serve as a environment protection window in the aperture. The filter in the aperture will have an impact on the imaging quality of the telescope if there are significant deviation from flatness. Limits for the required mechanical precision of the filter have not yet been defined.
CORRECTION OPTICS

A correcting lens covering the total area of the aperture in order to correct the spherical aberration of the Schmidt telescope has been rejected as a viable option for the FD telescopes.

The option to increase the performance of the Schmidt telescope with an annulus shaped ring around the aperture of 0.85m radius is going to be investigated by the sub task group consisting of the following institutes:

UNICAMP/Brasilia/C. Escobar
Praha-Olomouc/Czech Republic/P. Schovanek

These institutes are going to investigate the optimal design parameter, define the necessary optics quality, work out possible manufacturing processes and will determine the accuracy of alignment together with the sub task group responsible for the aperture system.

The aperture sub task group consists of the following institutes:

Turin/Italy/R. Cester
Campinas/Brasilia/C. Escobar
Krakow/Poland/H. Wilczynski
Karlsruhe/Germany/H. Klages

The annulus correction lens is supposed to enhance the signal of the telescope, not to reduce the spot size due to spherical aberration. It requires an enlarged mirror area to avoid vignetting at the mirror edges.

First simulations show an improvement in signal of about 100% could be achieved without deterioration of the image spot size in a combination of mirror size 3.85m x 3.85m and an annulus dimension of 0.85m inner radius and 1.1m outer radius.

This mirror size could only be accommodated in an enlarged building, otherwise access around the telescopes would be severely restricted.

We have fixed the size of the mirror at 3.6m x 3.6m, the maximal size not demanding enlargement of the building. The corners of the mirror area are then not free of vignetting with the simulated annulus dimensions.

The optimized shape and dimensions for a corrector annulus with the boundary condition of a 3.6m^2 mirror area, 0.5 degree spherical aberration and a outer radius of less than 1.1m is currently under investigation (Campinas, Olomouc).

The annulus lens cannot be manufactured as a single piece due to its size. But segmentation into 20 to 30 elements is an alternative.

Any optical system in the aperture has to be of high quality and precise alignment. Manufacturing of the annulus may turn out to be too expensive to become a viable option. The necessary R&D will not allow to have the annulus available at the time of the scheduled prototype assembly, but it could be attached at a later date during 2000.

We have agreed to provide the option to accommodate the correction annulus, i.e. the design of the aperture will include a support structure for the ring elements, the size of the entrance windows (all bays) will be enlarged and the filter (if it is installed at the diaphragm) of the prototype will be enlarged as well.

Only the decision on the size of the entrance windows of the Los Leones building is irreversible if the annulus correction lens does not become part of the reference design for the telescopes. All other changes of the reference design specifications could be reset to the previous values.
second prototype

Karlsruhe is going to manufacture mirrors and a support structure for a second prototype which will meet all reference design specifications, especially those not achieved with the first prototype. 55% of the mirror assembly will be occupied by the Karlsruhe Al-mirrors, the other 45% will be occupied by glass mirrors manufactured in the Czech Republic. The mirror elements will be fixed with the central mount designed at Karlsruhe and the Karlsruhe support frame will be used in this prototype. It will be modified to provide meridians for the larger number of Czech mirrors with hexagon shape. This prototype will eventually replace the mirror assembly of the first prototype if a second camera and aperture is not going to be available during 2000.

TEST LABORATORY AT FORSCHUNGSZENTRUM KARLSRUHE

The Karlsruhe mirror group (H. Klages) has started to install a laboratory at the Forschungszentrum to test design specifications of mirror elements and all optic components of the telescope. The laboratory contains a set-up to test the quality of individual mirror elements with respect to design specifications. A suitable number (decision pending) of mirrors from the three manufacturing groups are to be tested for absolute value of specification. Relative quality checks with respect to these norm samples can then be performed at the manufacturing sites. Test procedures and suitable equipment will be developed/acquired in close cooperation between Karlsruhe/Germany/H. Klages and the Praha-Olomouc/Czech Republic/P. Schovanek.

The mirror support in the test laboratory is based on the Karlsruhe central mount design. A fully functional prototype of this mirror support is already installed. Suitable adaptors for other mounts will be designed in close cooperation of the groups.

The laboratory is large enough to install and test other components of a telescope, i.e. annulus correction lens, reflective flat calibration screen, a full size dome, a camera, uv-absorbent paint, and 4/5 of the telescope’s mirror assembly. An x,y scanner for different light sources and receivers is already installed.

Most of the components of the second prototype will be preassembled in the test laboratory before they are shipped to Argentina.

mobile workshops

The Forschungszentrum Karlsruhe is going to provide mobile (container trailers) workshops for the FD-building sites. One mechanical workshop and one for electronics and optics equipment. All institutes are invited to come forward with suggestions for suitable equipment.

cooperation and exchange of information

Karlsruhe is going to install a www page to keep updated information on the prototype development. All participants have promised to forward relevant information without delay. (either on request, or automatically if they think it could be of interest for other groups).
**shipment to Argentina**

Shipment to Argentina of prototype equipment is going to be organized by the individual institutes if the procedures depend on the country of origin. Central delivery is going to be investigated for equipment which is preassembled for testing. Some institutes at the Forschungszentrum have special relations with Argentina which could be exploited for a central shipment (to be investigated, J. kleinfeller).

**WBS**

J. Kleinfeller is going to send out a form for detailed description of time schedule, funding and resources (manpower) as well as a status report of the current prototype development, job description for installation work at Los Leones, and risk assessment data sheets.

**items on the agenda not covered:**

The requirement on conduit (cable and fibres) was not discussed during the meeting.
Modification of reference design parameter:
The attached list of reference design parameters has been agreed by the participants of the meeting. Some of the parameters (references: Specification for the Fluorescence Detector Reference Design/ P. Sommers/ http://www.physics.utah.edu/~sommers/hybrid/specs/summary.html) were either up to now not explicitly defined, or have been replaced by more reasonable values:

critical parameters to be fixed for design of telescope

<table>
<thead>
<tr>
<th>item</th>
<th>nominal</th>
<th>actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) mirror R of curv.:</td>
<td>3400±20mm</td>
<td>unchanged</td>
</tr>
<tr>
<td>2) camera R of f-surf.:</td>
<td>1743±2mm</td>
<td>1743±2mm</td>
</tr>
<tr>
<td>3) camera inner R of curv.:</td>
<td>Ri=1641mm</td>
<td>unchanged</td>
</tr>
<tr>
<td>outer R of curv.:</td>
<td>Ro=1701mm</td>
<td>unchanged</td>
</tr>
<tr>
<td>4) diam. of aperture:</td>
<td>1700±3mm</td>
<td>unchanged</td>
</tr>
<tr>
<td>5) annulus corrector inner R:</td>
<td>Ri≥850mm</td>
<td>Ri≥850mm</td>
</tr>
<tr>
<td>annulus corrector outer R:</td>
<td>Ro≤1000mm</td>
<td>Ro≤1100mm</td>
</tr>
<tr>
<td>6) mirror size (sphere)</td>
<td>3500mm x 3500mm</td>
<td></td>
</tr>
<tr>
<td>7) mirror size free of v</td>
<td>3440mm x 3440mm</td>
<td>depends on size of annulus</td>
</tr>
<tr>
<td>8) mirror size w annulus</td>
<td>3750mm x 3750mm</td>
<td>3600mm x 3600mm</td>
</tr>
<tr>
<td>9) camera body</td>
<td>930mm hori. x 860mm vert.</td>
<td>unchanged</td>
</tr>
<tr>
<td>camera inclination</td>
<td>16 degree</td>
<td>fixed</td>
</tr>
<tr>
<td>10) filter area at aperture</td>
<td>no annulus 2.3m²</td>
<td>with annulus 3.80m²</td>
</tr>
<tr>
<td>11) filter area at camera</td>
<td>&lt;1m²</td>
<td></td>
</tr>
<tr>
<td>12) height of mirror b-edge</td>
<td>200m</td>
<td>263.8mm</td>
</tr>
<tr>
<td>13) height of mirror centre</td>
<td>1790mm</td>
<td>1800mm</td>
</tr>
<tr>
<td>14) height of aperture centre</td>
<td>2730mm</td>
<td>2740mm</td>
</tr>
<tr>
<td>3400mm*sin(16deg)=940mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15) adj. R of curv.:</td>
<td>±10mm</td>
<td>unchanged</td>
</tr>
<tr>
<td>16) adj. z direction</td>
<td>±5mm</td>
<td>unchanged</td>
</tr>
<tr>
<td>17) adj. theta/phi</td>
<td>±2.5deg</td>
<td>unchanged</td>
</tr>
<tr>
<td>18) adj. gaps</td>
<td>≤2mm</td>
<td>unchanged</td>
</tr>
<tr>
<td>19) spot size at centre of curvature</td>
<td>90% in r=5mm</td>
<td>unchanged</td>
</tr>
<tr>
<td>20) reflectivity (surface)</td>
<td>90%</td>
<td>86% including coating</td>
</tr>
<tr>
<td>at 300nm-400nm</td>
<td>at 350nm-420nm</td>
<td></td>
</tr>
<tr>
<td>21) degradation</td>
<td>1%/year</td>
<td>unchanged</td>
</tr>
<tr>
<td>22) filter transmission TS at &gt;350nm</td>
<td>75%</td>
<td>unchanged</td>
</tr>
<tr>
<td>23) filter figure of merit R=TS/sqrtTB</td>
<td>1.65</td>
<td>unchanged</td>
</tr>
<tr>
<td>24) precision of building orientation</td>
<td>0.10deg</td>
<td></td>
</tr>
<tr>
<td>25) precision of bay datum points</td>
<td>alignment 0.01deg</td>
<td></td>
</tr>
<tr>
<td>relative to central coordinates</td>
<td>position ±1mm</td>
<td></td>
</tr>
<tr>
<td>26) radial position of bay datum points</td>
<td>R1= 7500mm</td>
<td>R2=11500mm</td>
</tr>
<tr>
<td>28) space between telescopes</td>
<td>≥1300mm</td>
<td></td>
</tr>
<tr>
<td>29) space behind telescopes</td>
<td>≥1300mm</td>
<td></td>
</tr>
<tr>
<td>30) size of doors</td>
<td>h=2500mm, w ≤ 1300mm</td>
<td></td>
</tr>
</tbody>
</table>

The parameter in the list below are not to be interpreted as modified reference parameters for the prototype, they were only agreed to provide some leeway to gather experience (18) and to keep the deployment of the first prototype on schedule (19).

<table>
<thead>
<tr>
<th>item</th>
<th>nominal</th>
<th>actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>18) adj. gaps</td>
<td>≤0.002m</td>
<td>≤0.005m</td>
</tr>
<tr>
<td>19) spot size at centre of curvature</td>
<td>90% in r=0.005m</td>
<td>90% in r=0.01m</td>
</tr>
</tbody>
</table>
alignment unit

spreader rod

spherical button

data plate

alignment rod

support structures

5m

datum plates
alignment unit

datum plates

support structures

alignment rod

spherical button

support

level

5m