E U R O P E A N S O U T H E R N O B S E R V A T O R Y

Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral
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LA SILLA OBSERVATORY

FEROS ADC CONCEPTUAL DESIGN

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CHANGE RECORD

Revision	Date	Section/Paragraph	Remarks
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1. INTRODUCTION

Since the move of the Fibre-fed Extended Range Optical Spectrograph (FEROS) from the 1.52m to the 2.2m telescope the need of adding an Atmospheric Dispersion Corrector (ADC) stir up.
The astronomers believe that the overall performance of FEROS will be substantially improved with the ADC in the whole wavelength range from 350 to 920nm. This is at Zenith Distances ZD greater than 20 degrees.

1.1. PURPOSE AND SCOPE

This document is intended to act as a concise and centralized reference of the work done in developing the concept of the ADC. Starting from the user requirements it shows the foreseen mechanical, optical and electronic solutions and finally to which extent the requirements could be meet by the presented solutions.

1.2. REFERENCE DOCUMENTS

[RE1] http://www.ls.eso.org/lasilla/sciops/feros/Projects/ADC/index.html
[RE2]

1.3. APPLICABLE DOCUMENTS

[AP1] FEROS-II User Requirements LSO-URS-ESO-22400-0002 Issue 1.0 J. Pritchard June 23, 2003.
[AP2] FEROS on 2p2 Telescope New ADC Mode Technical Report LSO-TRE-ESO-75441-005 Issue 1.0 A. Gilliotte February 18, 2003
[AP3] FEROS on 2p2 Telescope New ADC Design Technical Report LSO-TRE-ESO-75441-005 Issue 2.0 A. Gilliotte May 7, 2003
[AP4] FEROS on 2p2 Telescope Final ADC Design Technical Report LSO-TRE-ESO-75441-005 Issue 3.0 A. Gilliotte September 4, 2003
[AP5] Implementation of ADC for FEROS User Requirements LSO-URS-ESO-90400-0002 version 0.91 Ivo Saviane

1.4. ACRONYMS & ABBREVIATIONS

ADC	Atmospheric Dispersion Corrector
VME	Versa Module Europe
FEROS	Fibre-fed Extended Range Optical Spectrograph
TBD	To Be Defined
VLT	Very Large Telescope
WFI	Wide Field Imager
NTT	New Technology Telescope
SCSM	Sliding Calibration Selection Mirror
ZD	Zenith Distance

2. USER REQUIREMENTS

The user requirements are listed below as on [AP1]. Following each point a short text explains up to which extent each requirement could be fulfilled.

1. Maximum image decentering of 0.2 arcsec in the forseen configuration (1.96 arcsec fiber aperture diameter), for a wavelength range 350-920nm, over ZD range 0-60 degrees CRITICAL.

Interpreting “image de-centering” as the wavelength dispersion effect produced by the atmosphere only, we see in the simulation of the ADC unit that even with the 2 counter rotating prism solution it is not possible to compensate better than 0.5 arcsec for the 0 to 60 deg. ZD range. The limitation is mainly due to the chromatic aberrations introduced by the prisms themselves. Normally the prism position is a trade-off between the prism size and the focal plane distance at which the prisms are located, being the greater distance the better. Due to space constrains, in the FEROS ADC design, the distance is defined and corresponds to 45 mm from the focal plane. As a reference the HARPS ADC has the prisms located at 170mm.

2. Maximum light loss in the ADC of 10% across full spectral range (350-920 nm) CRITICAL

Each prism will introduce a maximum light loss of ~3%, 1% in each coated side and 1% glass transmission loss (6% for the 2 prisms ADC unit).

3. Tolerance in the parallactic angle positioning is: 1deg desirable, 5 deg acceptable CRITICAL.

Almost any cheap of the shelve encoder/motor/tacho combination could meet the 1 deg specification.

4. No Vignetting of the WFI beam when parked CRITICAL

This constrain together with the reduced space available is precisely what made the mechanical design difficult and is the reason why several mechanical and optical solutions were considered. Additionally to this requirement the light scattering by the ADC unit should be considered and avoided.

5. Tracking of the ADC must be continuous. Maximum tracking speed required is 2.5deg/min. Presetting speed required is 90deg/min CRITICAL

The encoder/motor combination together with the standard MACCON controller could easily meet these requirements, provided that the proper reduction ratio for the prism drive motor is selected.

6. Overhead: 2 minutes absolute maximum CRITICAL

The worst case is when the "Sliding Calibration Selector Mirror" is in the optical path. The SCSM in-out time, is still pending to be measured. Assuming 1 minute for this operation we see no problem in fulfilling the requirement.

7. Software controlled with three modes: OUT, preset to mean parallactic angle of exposure and continuous tracking of parallactic angle CRITICAL

No problem so far.

8. Compatible with the "object-calibration" mode DESIRABLE

Not compatible due to the mechanical interference of the ADC prisms with the "Sliding Calibration Selector Mirror" which due to the reduced space reside in the same position-plane when operational.

3. ADC MECHANICS OPTICS AND ELECTRONICS

3.1. Overview

The optical, mechanical and electromechanical design of the FEROS ADC is severely constraint by the space available inside the FEROS adapter. It should be kept in mind that both the Wide Field Imager (WFI) and FEROS reside always installed at the telescope and the selection of one instrument or the other is done just by a software commanded in-out mirror arm. The space available for housing the ADC is approximately one cubic decimetre.

3.2. Optics

Three optical solutions are considered:

- No ADC.
- A single rotating doublet prism.
- Two counter rotating doublet prisms.

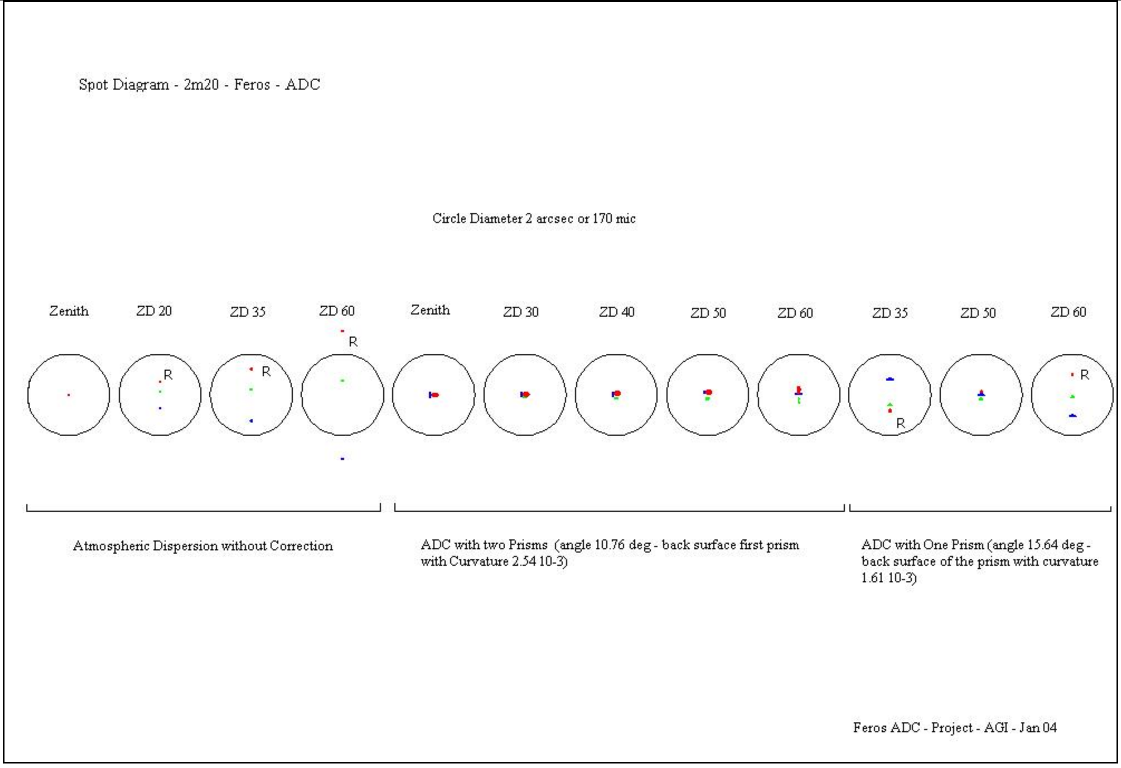

Figure 1: Spot Diagrams

Figure 1 above illustrates the atmospheric dispersion for the three optical solutions at various ZD. For further details on the optical design refer to [AP2], [AP3] and [AP4].

3.3. Mechanics

After exploring several mechanical solutions for the single and double prism ADC we choose the most compact and practical of the designs. Practical in terms of manufacturing and compatibility with the available of the shelve motors and encoders both for the prism and swing arm drives.

Both designs comprise a swing arm in which the ADC prisms are mounted and the necessary rotation of them is done via toothed belts.

Both the single and double prism mechanical solutions have the following common characteristics:

1. A base-block which serves as mechanical mainframe for the ADC and fix it stably to the FEROS tower. This is a rather complex piece to machine due to the various angles. See Drawing Appendix Figure 2. Additionally the block shall incorporate manual adjustment along the optical path for bringing the ADC into focus.

2. A two-position swing-arm holding the ADC optics in the light path. The arm must be stiff and it cannot have any mechanical play when placed in the optical path position. The mechanical drive for the arm positioning is intended to be a scaled down copy of the FEROS M3 drive design.
3. Toothed belt drives for the prism rotation. See Drawing Appendix Figure 3.

The mechanical solutions are:

1. Single drive for a single doublet prism. This is the simplest solution in every aspect, optical, mechanical and electronically. The prism drive is built around a DC motor, tacho and an incremental encoder with zero pulse signal and line drivers. Very easy interfacing to the MACCON incremental electronics. See Drawing Appendix Figure 4.
2. Double drive for two counter rotating doublet prisms. Due to the lack of space it is not possible to use the standard incremental encoders for the prism drives. Pulse transmitters coupled to the motor/tacho axis and separate init switches are instead used. The init switches and the pulse transmitters require special signal conditioning in the form of a small custom PCB board mounted over the unit. See Drawing Appendix Figure 5.

3.4. Electronics

The control electronics must be the standard MACCON INC and VME-4SA VLT standard hardware residing on the FEROS LCU. The hardware shall be supported by custom electronic interlocking hardware for the ADC swing arm and the Sliding Calibration Selection Mirror (SCSM) which reside in the same position when operative.

4. DRAWING APPENDIX

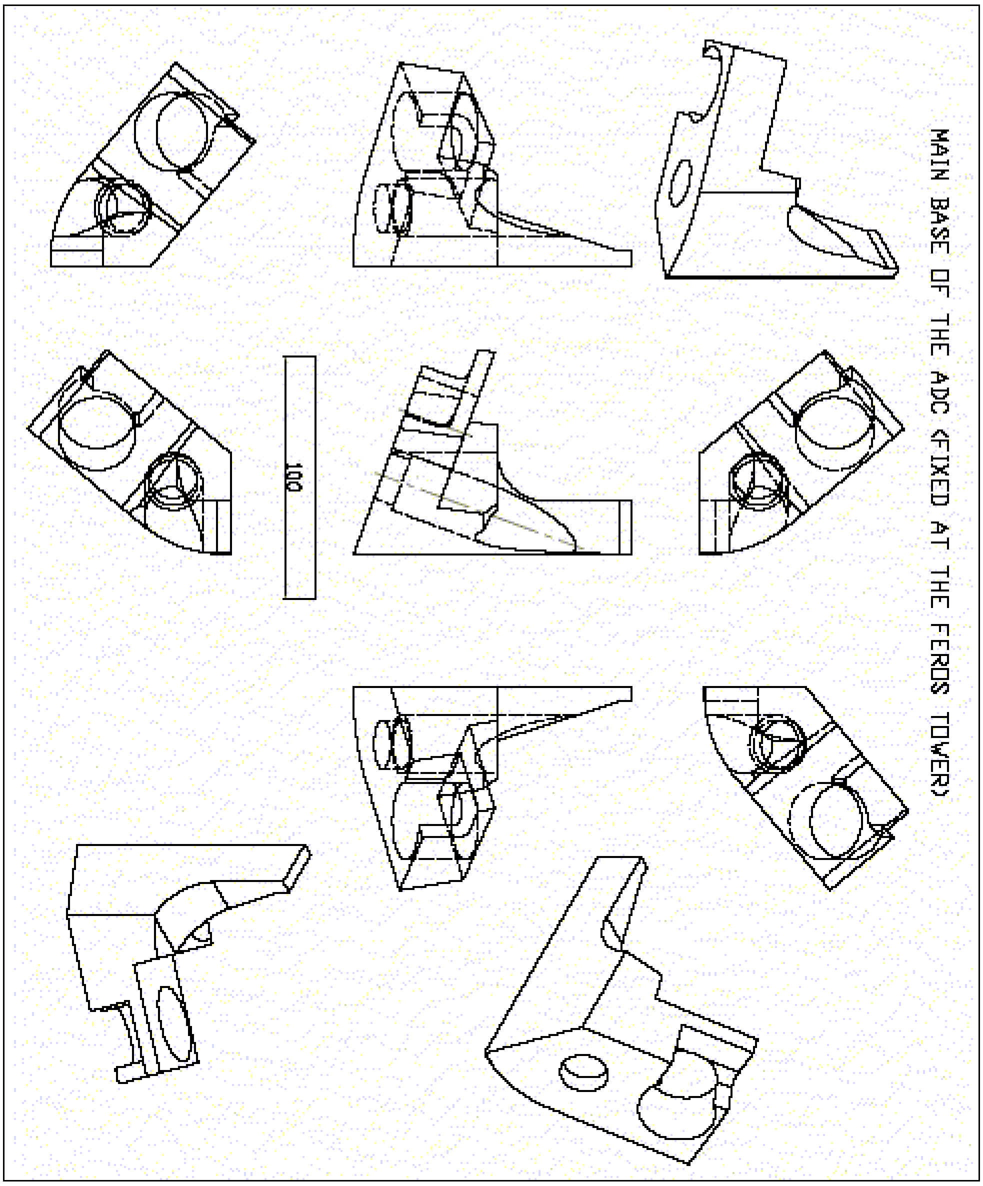

Figure 2 : ADC Base Block Views

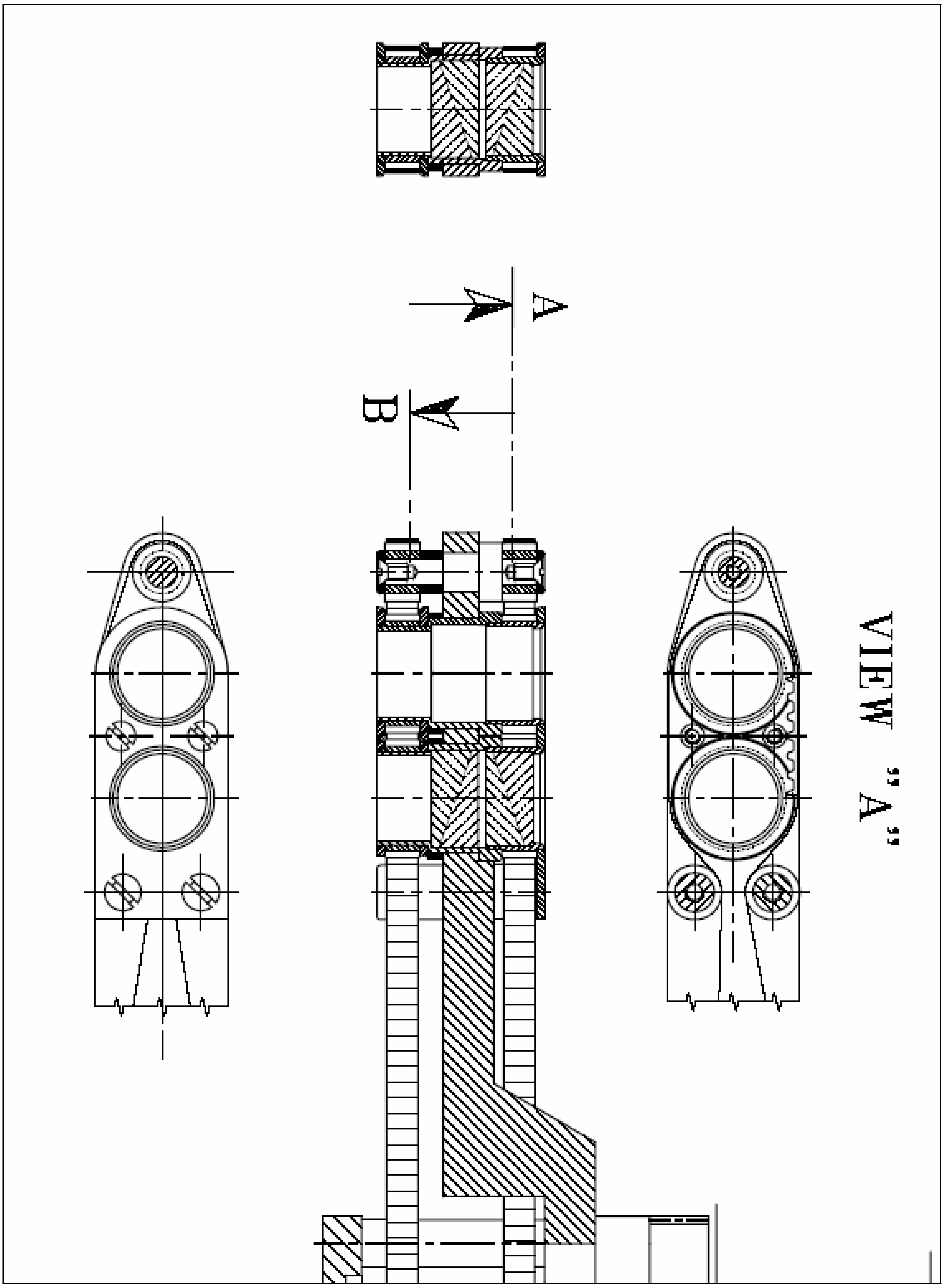

Figure 3 : ADC Toothed Belts Prism Drive

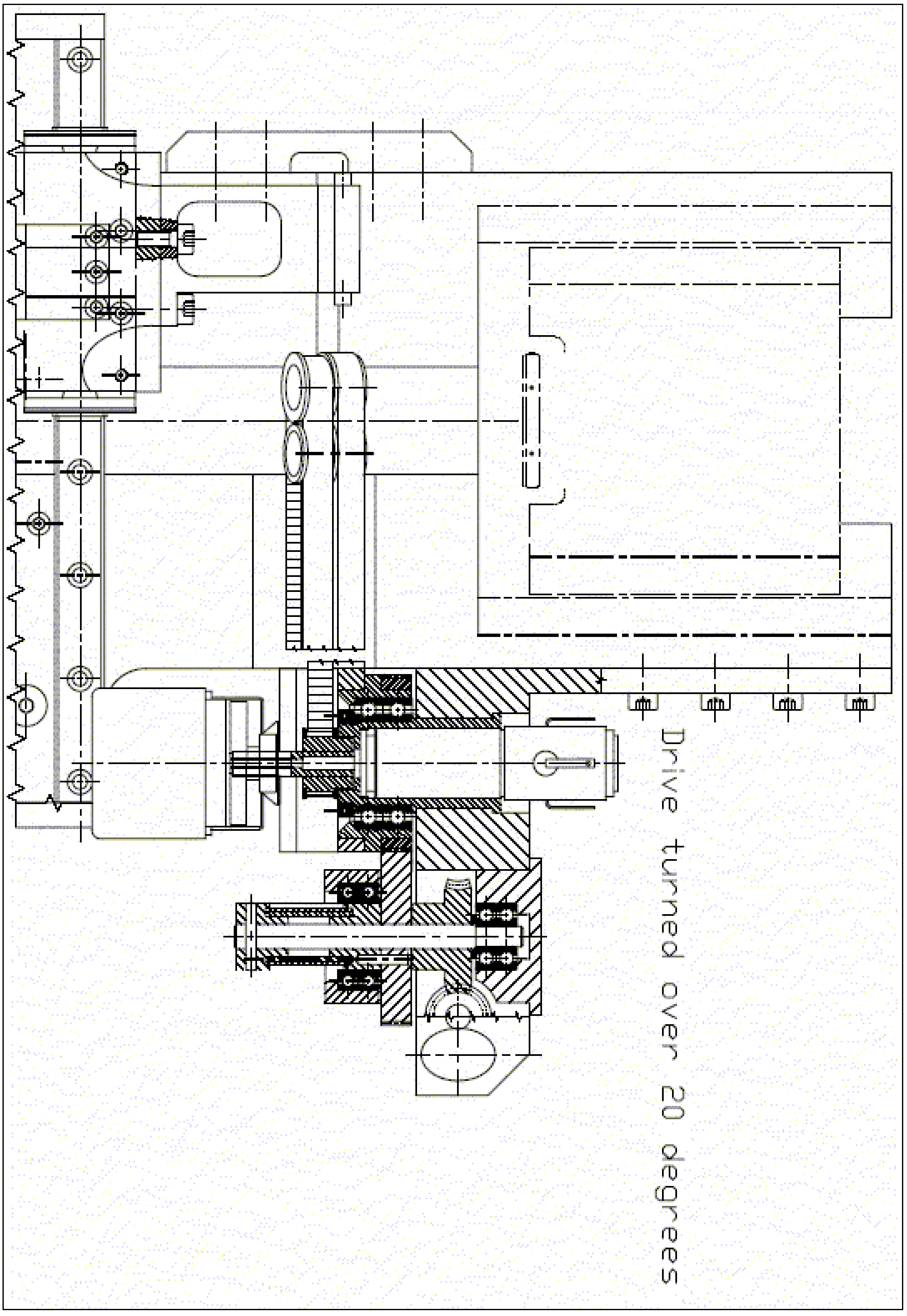

Figure 4 : Single Prism Drive Overall View

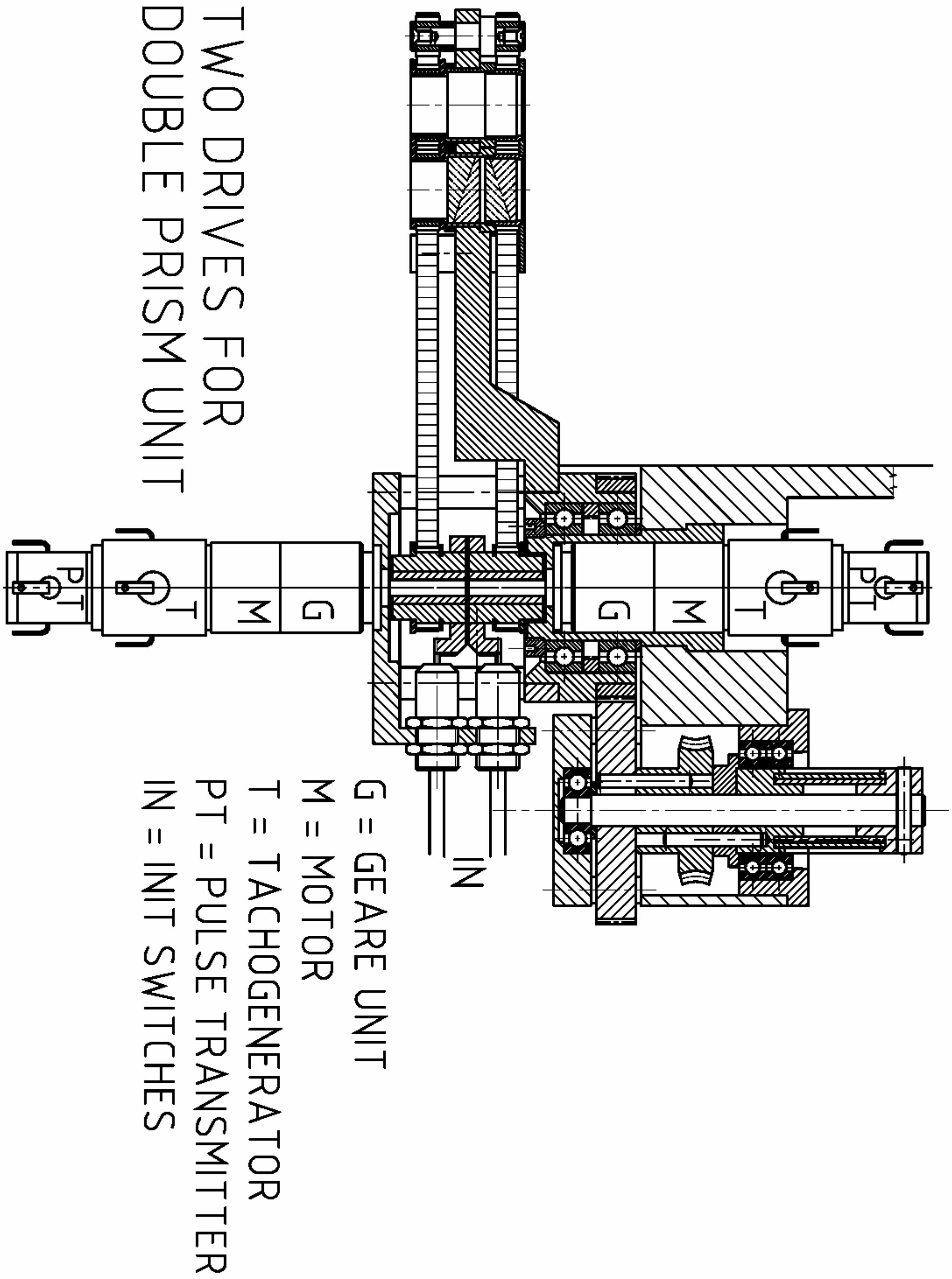

Figure 5 : Double prism drive overall view