

# CISS: Circular Slit Spectrograph

F. Landini<sup>1</sup>, F. Frassetto<sup>2</sup>, V. Caracci<sup>1</sup>, L. Cocola<sup>2</sup>, L. Abbo<sup>1</sup>, V. Andretta<sup>3</sup>, C. Casini<sup>1</sup>,  
A. Riva<sup>1</sup>, S. Fineschi<sup>1</sup>, M. Pancrazzi<sup>1</sup>, M. Romoli<sup>4</sup> and P. Zuppella<sup>2</sup>

1. INAF – Oss. di Torino

2. CNR – IFN Padova

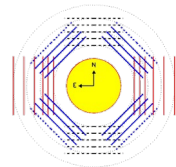
3. INAF – Oss. di Capodimonte

4. Univ. di Firenze

The spectroscopic investigation of the Solar Corona is based on classical spectrograph design, with linear slits. In order to obtain spectroscopic maps of the whole corona, the slit shall be moved at different heliocentric heights and positioned at different latitudes.

For example, the last spectrometer observing the extended corona in the EUV, UVCS (UltraViolet Coronagraph Spectrometer), operative from 1995 to 2009 aboard the SOHO (Solar and Heliospheric Observatory), took about 1 day to scan the entire corona.

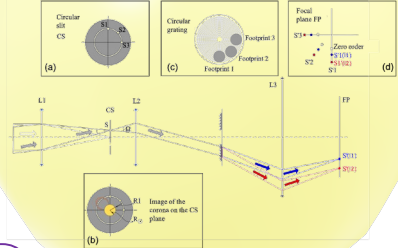
That made impossible to spectroscopically investigate the coronal dynamics that is typically evolving on a time scale of hours.



Example of coronal heights and polar angles observed with the UVCS synoptic program

In order to improve the classical spectrograph performance we had a very primitive idea. INAF fundamental research grants were providentially welcome: with such contribution we formed a small young team and we are pursuing the idea validation for a couple of years (extention pending). Within the grant, an enthusiastic wealth of solutions, designs and thoughts have been generated in a very short time frame.

The Circular Slit Spectrograph project, CISS, is funded by the Italian National Institute for Astrophysics (INAF) with the goal of demonstrating the feasibility of the circular slit approach by designing and building a Technology Readiness Level (TRL) 4 prototype.



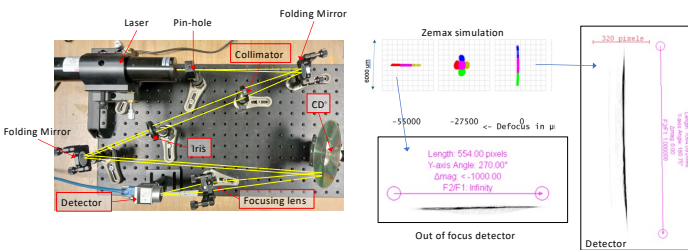
Innovative elements:  
• Circular Slit  
• Grating with circular concentric grooves.

## Concentric Circular Grooves Grating (CCGG)

The prototype design has been developed with Ansys Zemax OpticStudio (in the following, Zemax). Zemax provides a Diffractive Optical Element (DOE) library that could be suitable to simulate a CCGG. In order to evaluate the goodness of the Zemax library we pursued both a simulation and an experimental approach.

### Experimental:

A simple laboratory set-up was prepared with a CD as CCGG strawman



### Simulation

A custom library was developed in Zemax, with no optimization on the coordinate break management.

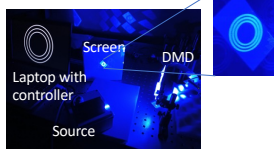
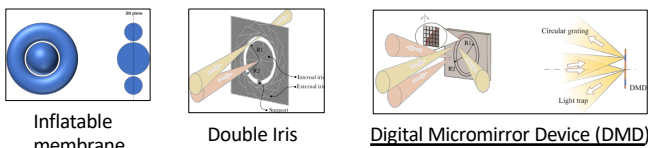
- 1) The custom library behaviour gives the same spot diagram on CISS focal plane as the Zemax DOE.
- 2) By coupling the Zemax DOE with diffraction order -1 and the custom library with diffraction order +1 we should get a neutral optical element. In other words, a collimated beam is still collimated after going through the two coupled elements. A Zemax simulation confirms this expectation.

In conclusion, we proved that the Zemax DOE radial grating as a suitable object to simulate the CCGG.

## Circular Slit with variable radius (VRS)

The baseline solution for CISS in order to explore different heliocentric heights and prove the principle of the circular slit spectrograph is a series of slits with fixed radius switched by means of a filter wheel. By changing the slit radius, different heliocentric heights can be selected.

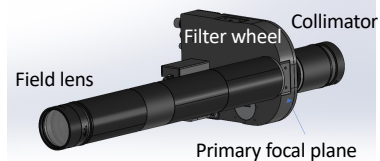
Nevertheless, it is a precise task of the project to investigate solutions that allow to dynamically (and not by finite steps) change the slit radius. To this aim, several possibilities are being evaluated.



**DMD** Probably the most viable solution. The micro-mirror coating shall be investigated for applications in the UV. Tests are ongoing on the protective window removal.

## Status

A preliminary optical design has been developed with Zemax. The optical path from the entrance aperture to the grating (including the slits filter wheel) is frozen. A mechanical design is ready as well.



A ray tracing simulation optimization is ongoing to freeze the last part of the optical design and to fix the grating specifications.

