SolarLab as Pathfinder towards SPRING

1 Introduction

SolarLab is a container-based observatory for full disk observations of the Sun. It will be installed and operated on site of the Thüringer Landessternwarte Tautenburg (TLS). SolarLab will be used as a laboratory for instrument development as well as for scientific observations and public outreach. The science and technical requirements for SolarLab are derived from SPRING – a future synoptic solar observing network. Therefore, SolarLab will serve as a pathfinder towards a SPRING prototype. The most important development work is setting up a large tunable Fabry-Pérot interferometer as a two-dimensional spectrometer and develop suitable calibration methods for full disk 2D spectropolarimetry.

2 Science requirements

The successful GONG (Global Oscillation Network Group) instruments observe in one spectral line and therefore their ability to investigate height-dependent phenomena on the Sun is limited. In addition, the instrument begins to age. An extensive study in the frame of the EU project SOLARNET resulted in a science requirement document which outlined the future demands for a successor of GONG. The most ambitious demand is the requirement to observe many spectral lines in a short cadence to follow phenomena propagating through the solar atmosphere. A scanning Fabry-Pérot interferometer can do the job.

Spectral line (Å)	Element	Formation height (km)	SNR required
3933	Ca II K		1400
3968	Ca II H		1000
5173	Mg I b1	595±5	450
5250	Fe I		250
5434	Fe I	556±25	350
5576	Fe I	310±15	350
5890	Na I D2	927±35	450
5896	Na I D2		550
6173	Fe I	276±26	320
6301	Fe I	337±23	350
6302	Fe I		320
6563	H I a	1200-1700	600
6768	Ni I		300
7090	Fe I	284±32	420
8542	Ca II		800
10830	He I		1400
15648	Fe I		500

Table 1: List of solar spectral lines which may be used for solar synoptic observations. In red, chromospheric lines.

3 From FDISP to SolarLab design

Within the SPRING project (SOLARNET frame) a container based design has been developed which is contained in a 20 foot container and uses the etalons in front of a vertical mounted Ritchey-Chrétien telescope (collimated mount). The design is driven by the maximum size of the etalons.

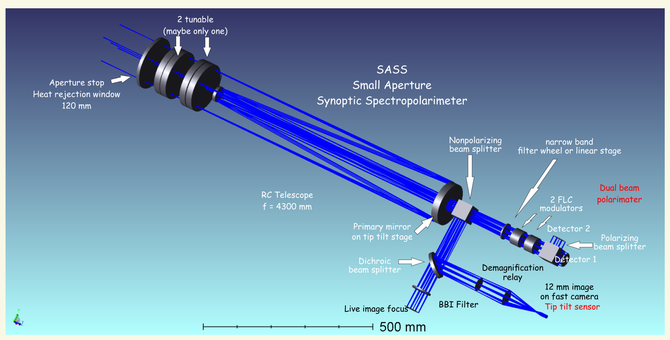

Figure 1: Full Disk Spectro-Polarimeter (FDISP). Design study for a possible GONG successor

The FDISP design study raised a couple of questions. E.g.

1. How does a commercial 150 mm aperture etalon perform in the entrance pupil?
2. Collimated mount vs. a telecentric one for full disk observations?
3. What signal to noise ratio can be achieved?
4. How is full disk data calibration done?

In order to address these and more questions we build SolarLab.

4 SolarLab - A testbench for synoptic solar physics

SolarLab is a customized 40 feet container to be set up in Tautenburg. A two-mirror polar heliostat reflects the sunlight vertically into the container. Here a folding flat directs the light on a large optical table. The plane optics allow for an unvignetted field of view of nearly 1° and for an aperture size of the imaging part of approx. 130 mm.

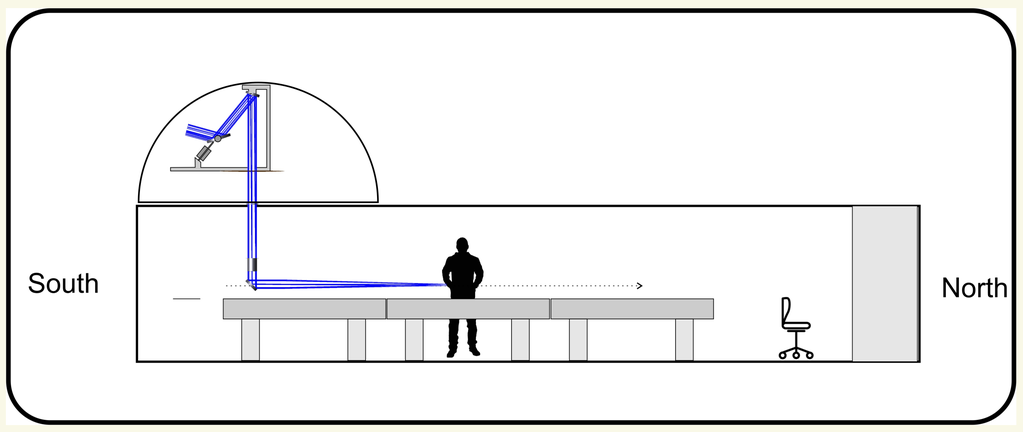

Figure 2: SolarLab in a 40 feet container. The optical tables are resting on own foundations that are decoupled from the container and light-feed.

The first experiment that we plan is an etalon based spectro-polarimeter in a collimated mount. The optical scheme is shown in Fig 4. In a first step, we shall use only one etalon and omit the image stabilization.

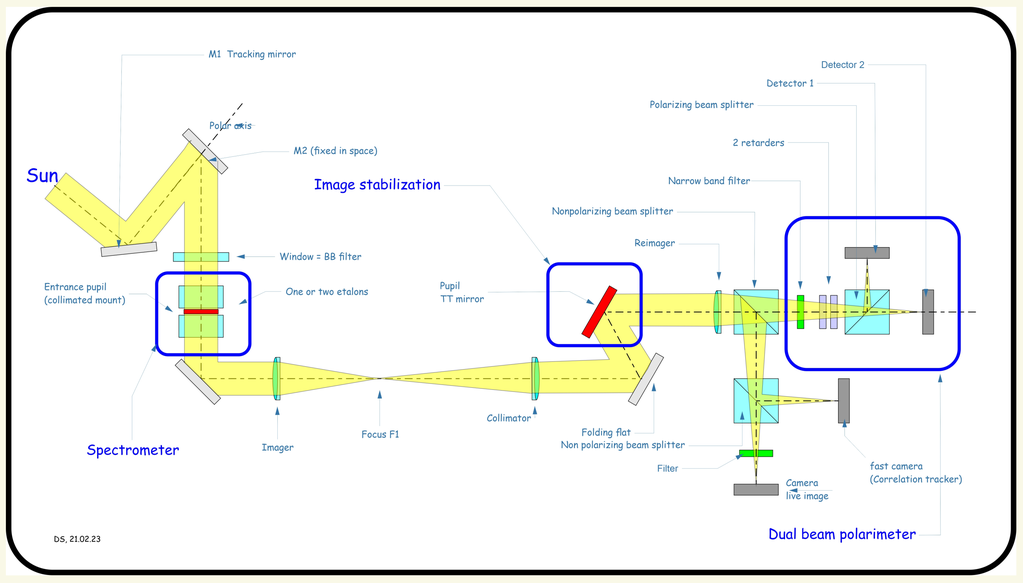

Figure 3: First experiment for SolarLab: Full disk spectro-polarimeter with etalon(s) in collimated mount

5 Current status

The project is on track. Etalon and container are ordered. Many minor components are purchased. Work on infrastructure and civil engineering is ongoing. According to our planning we expect "first light" by the end of 2023, and commissioning in 2024. SolarLab will probably be operational in 2025.

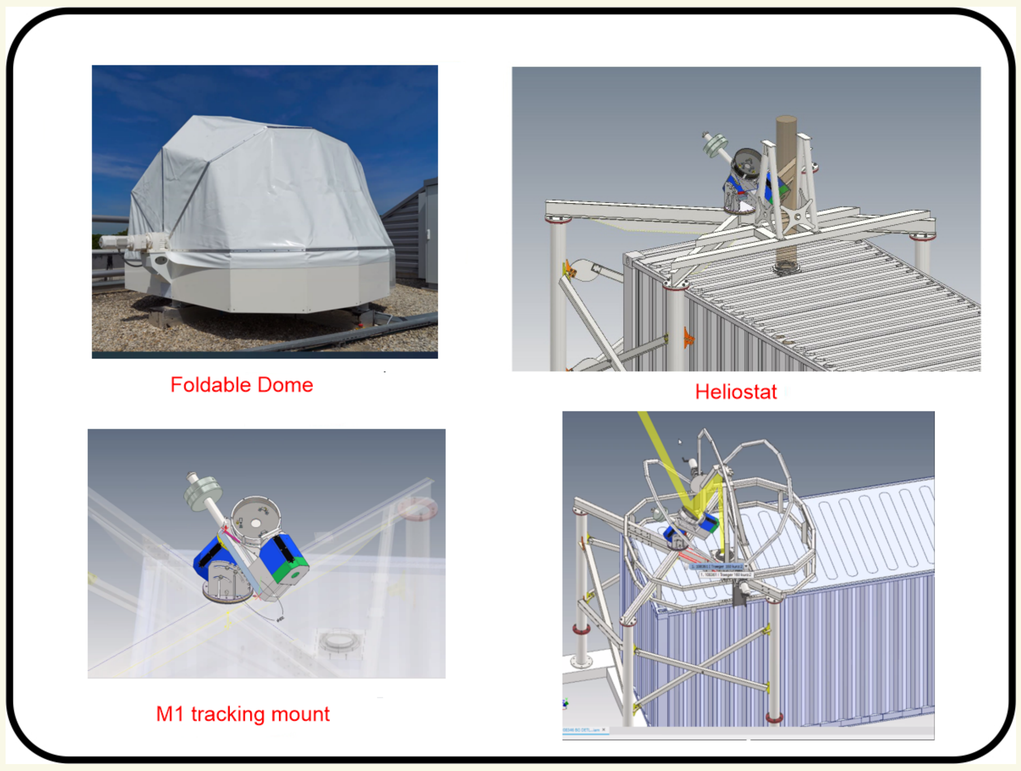

Figure 4: Some impressions from the container and heliostat design work (courtesy Astelco)

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