This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824135.

2nd SPRING Progress Meeting – WP8

February 18 & 19, 2021

Markus Roth, Leibniz-Institut für Sonnenphysik

Leibniz-Institut für Sonnenphysik (KIS)

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Agenda of the meeting

Day 1 : Thursday, February 18th, 2021

All times in Central European Time

Start at	Speaker	Title
15:00	Markus Roth (KIS)	Welcome
15:30	Dirk Soltau (KIS)	A Small Aperture Synoptic Solar Telescope - Baseline Design
16:00	Hemanth Pruthvi (KIS)	HELLRIDE : A test bench for the back-end of SPRING.
16:30	Paolo Romano (INAF)	Recent advances of INAF small telescopes for synoptic observations
17:00	Break	
17:15	Giorgio Viavattene (INAF)	Ongoing work on post-focus instrumentation with IBIS 2.0
17:45	Francesca Zuccarello, (University of Catania)	A contribution to automatic flare detection: from science cases to an operational method
18:15	Robertus Erdelyi (University of Sheffield)	SAMNet (Solar Activity Monitoring Network) - Forecasting Flares and CMEs from the Ground
18:45	Alexei Pevtsov(NSO)	The Next-generation Ground based solar Observing Network (ngGONG)
19:15	All	Discussion
20:00		End of Day 1

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Agenda of the meeting

Day 2 : Friday, February 19th, 2021

All times in Central European Time

Start at	Speaker	Title
15:00	Markus Roth (KIS)	Welcome
15:15	Emil Kraaikamp (ROB)	A Prototype Lucky-Imaging pipeline at USET ROB
15:45	Robert Jarolim (Uni Graz)	Solar image enhancement and quality assessment with deep learning
16:15	Werner Pötzi (Uni Graz)	The data processing pipeline at Kanzelhöhe Observatory
16:45	Break	
17:00	Sabrina Bechet (ROB)	Progress on the correction of non-radial intensity variation for full-disk images
17:30	Theodosios Chatzistergos (MPS)	Calibrating and merging full-disk observations from various archives
18:00	Luca Giovannelli (University Tor Vergata)	The Tor Vergata Synoptic Solar Telescope (TSST): A robotic, compact facility for solar full disk imaging
18:30	All	Discussion
19:00		End of meeting

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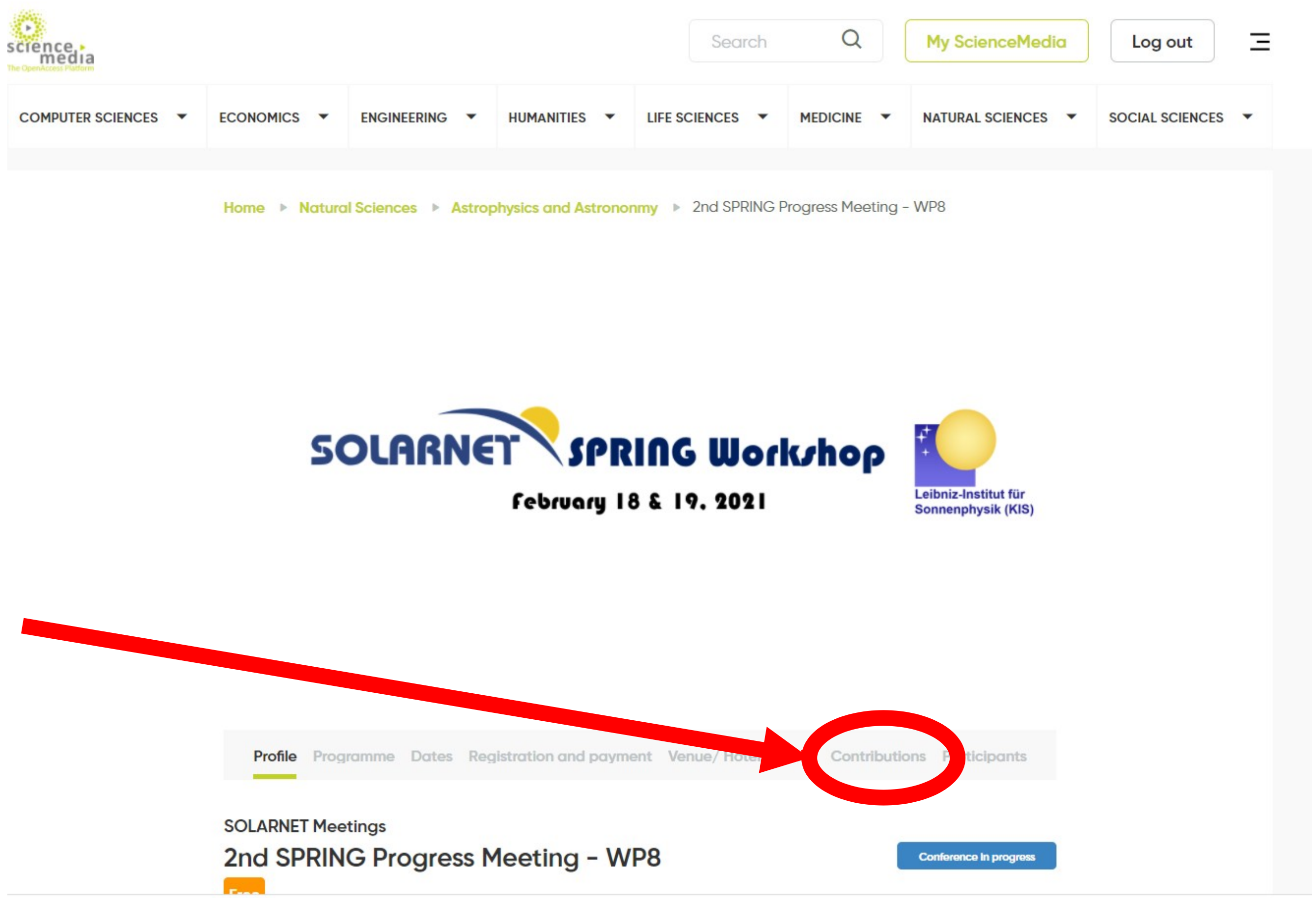
Collection of Slides

http://www.science-media.org/cid/spring2021



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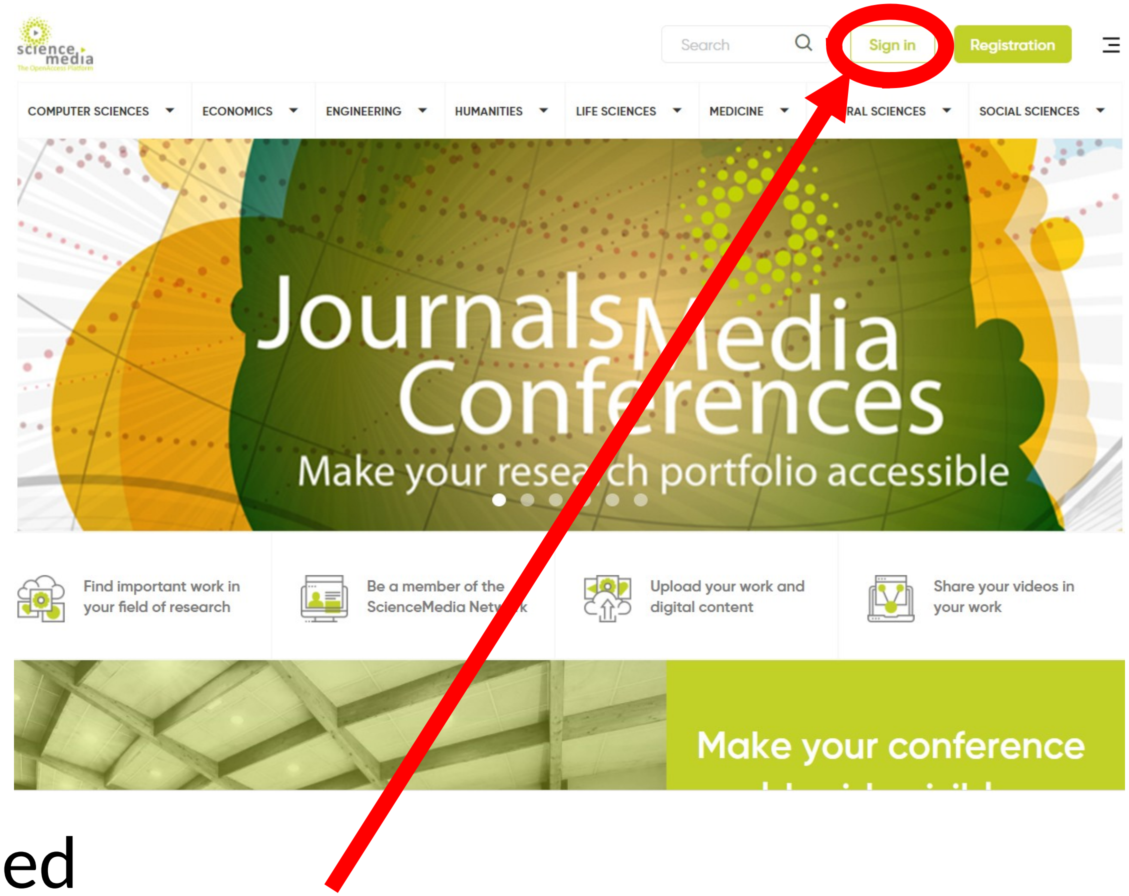

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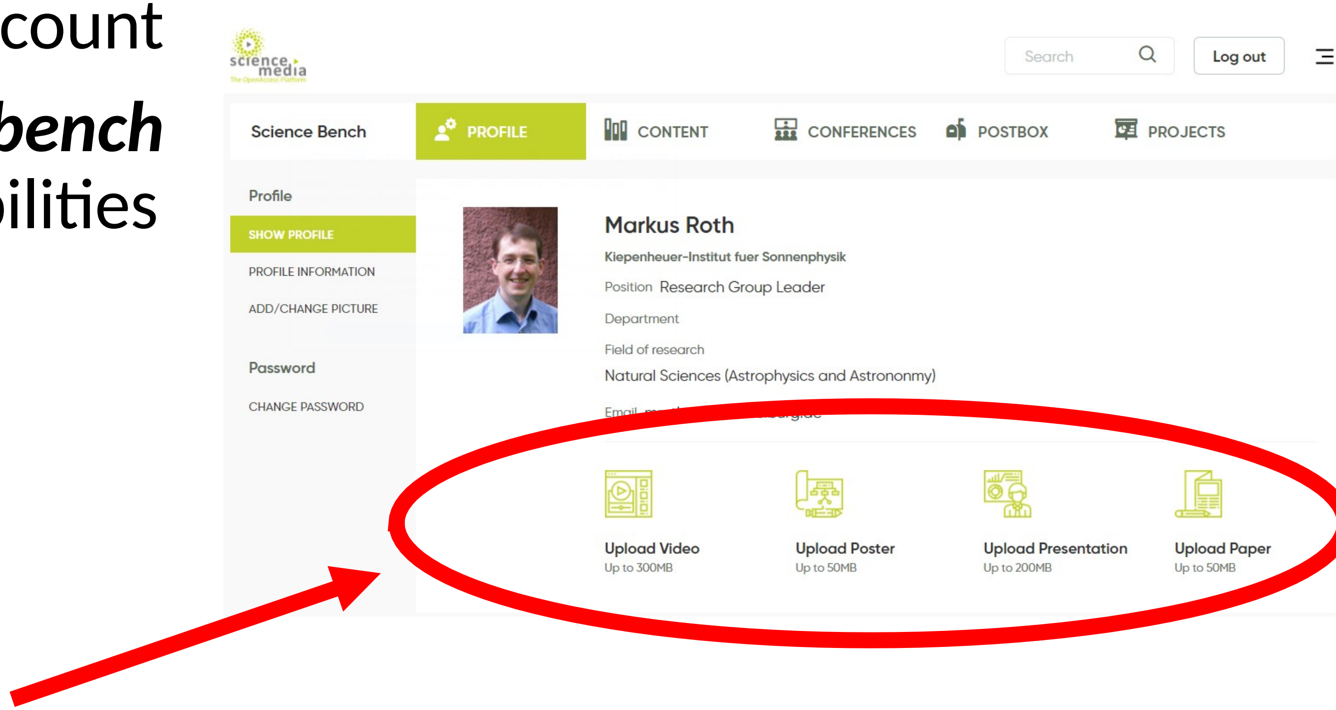

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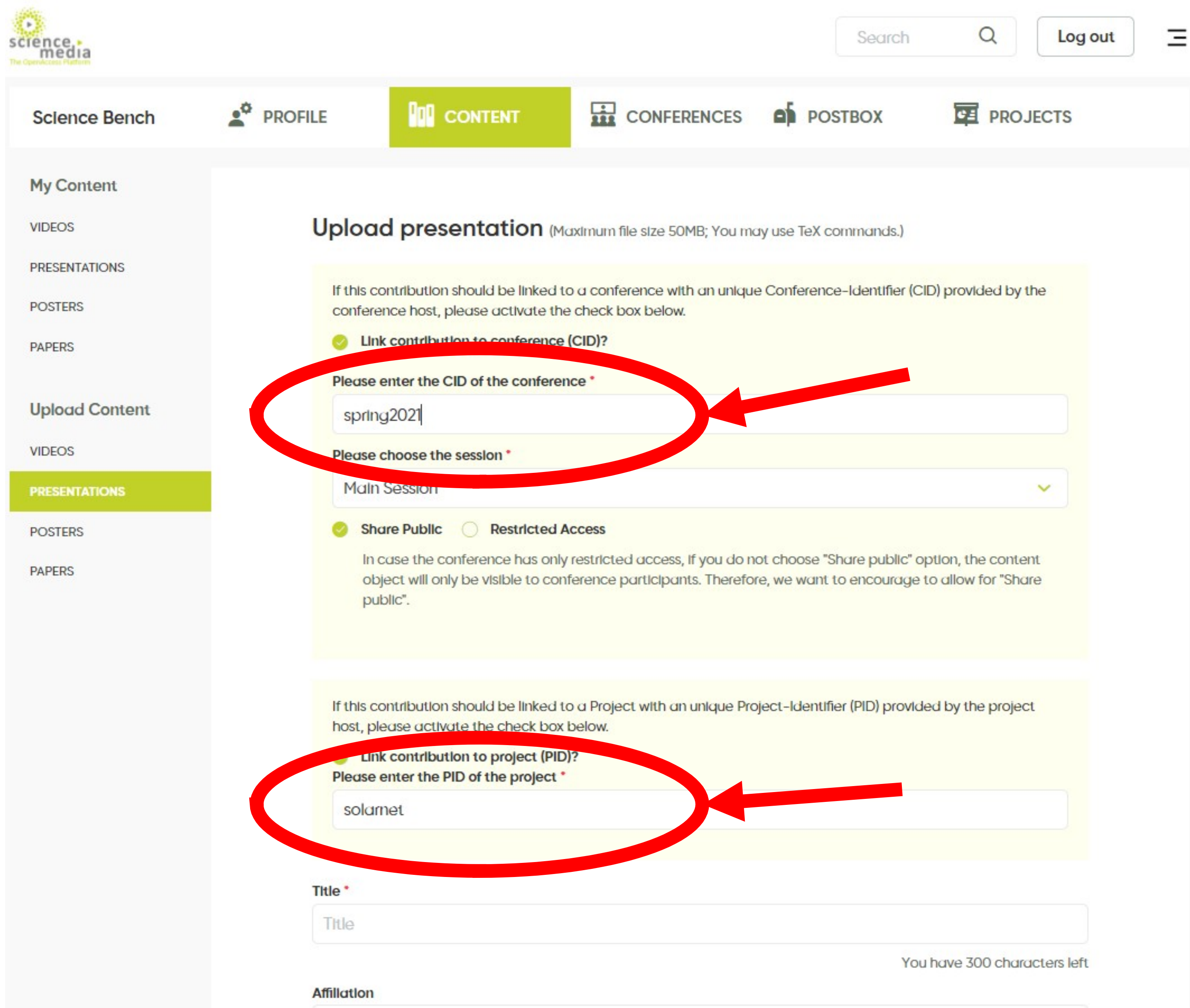
- Fill out the form
- ***Conference identifyer (CID):*** ***spring2021***
- ***Project Identifier (PID):*** ***solarnet***
- In the end all material will be on the workshop website



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Motivation for SPRING

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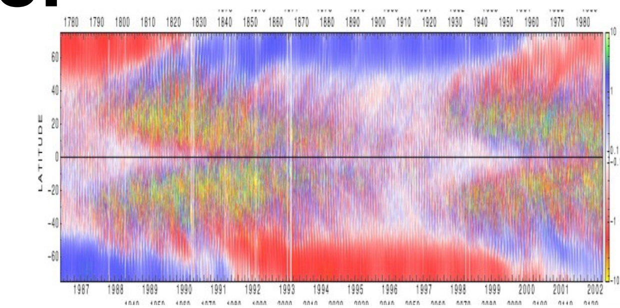
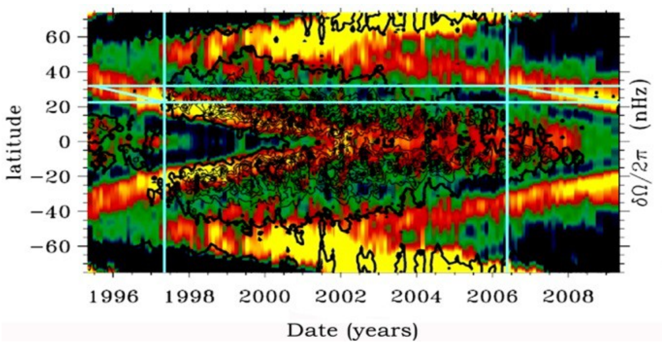
he Need for Synoptic Observations of the Sun

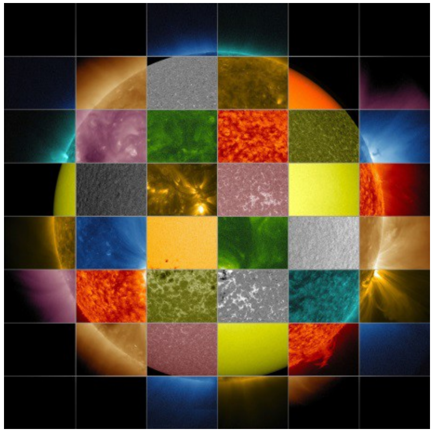
- **Long term monitoring of the solar magnetic fields**
  - to understand solar dynamo
  - evolution with solar cycle (polar and active region fields)
  - Active region evolution for space weather studies
  - surface flows via feature tracking



- **Long term monitoring of velocity fields**
  - subsurface flows via helioseismology
  - solar cycle variations and relationship to solar dynamo
  - Flows beneath emerging flux regions and active regions for space weather studies



- **Context imaging for next generation high-res telescopes such as DKIST and EST**
  - Large scale effects (flares, filament eruptions) of small scale events such as flux emergence
  - Technically the fulldisk image could support the pointing system



Current synoptic facilities cannot serve all these new demands!

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Past Activity in Solarnet FP7: **Conceptual Design of Solar Physics Research Integrated Network Group (SPRING)**

Objective: Development of instrumentation for large field-of-view observations of the Sun with a network of solar telescopes in support of observations with existing high-resolution solar telescopes (either isolated or in a coordinated way).

Technical Requirements / Future synoptic telescopes should provide

- Full-disk Doppler velocity images
- Full-disk vector magnetic field images
- Full-disk intensity images
- Measurements of quantities relevant for space weather

- Provide the above data products in a variety of wavelengths
- Provide the above data products at a high cadence (≤ 60 seconds)
- Provide the above data products at a spatial resolution of 1” (0.5” pixels)
- Provide the above data products at least 90% of the time
- Provide the above data products for at least 25 years
- Complement space missions

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Objectives

The objective of WP8 is to translate the technical concept for SPRING (Solar Physics Research Integrated Network Group), a new ground-based network of telescopes developed under SOLARNET during the EU FP7 funding period 2013 – 2017, into a preliminary design.

Tasks:

- WP8.1 Design of the mounting and telescopes
  Partners: AMOS, KIS, AURA, UCAR, ASU, INAF, USFD, UNITOV
- WP8.2 Design and proto-typing of the post focus instruments
  Partners: KIS, UNITOV, INAF, USFD, AURA, UCAR, BDP E&M
- WP8.3 Definition of the data processing pipelines
  Partners: CSIC-IAA, KIS, NSO, INAF, UNITOV, UNICT, USFD, UCAR, ORB,UNIGRAZ, ASU, SKOLTECH

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WP8.1 & WP8.2
Design of telescopes and instrument platform

- One (50cm) telescope is required for precise magnetic field measurements of the full-disk, optimized for wavelengths between 0.38 to 1.56 microns
  → linked to a multi-plexed spectrograph

- In addition full-disk imaging telescopes in parallel to provide data in white light and in several wavelength ranges in the blue (3933 – 5434 Angstroms), red (5890 – 6768 Angstroms) and infrared (8542 – 15648 Angstroms)
  → linked to filtegraph instrument

  Current work concentrates on developing the smaller full-disk telescopes in connection with the Etalons

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8.1 Design of telescopes and instrument platforms

Partners: AMOS, KIS, AURA, UCAR, ASU, INAF, USFD, UNITOV

One telescope is required for precise magnetic field measurements of the full-disk

- A 50cm telescope is needed to allow a signal-to-noise in Stokes Q, U, and V of 1000 for photospheric lines, and 10000 for chromospheric lines
- Optimized for wavelengths between 0.38 to 1.56 microns

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8.1 Design of telescopes and instrument platforms

In addition full-disk imaging telescopes in parallel to provide data

- in white light and in several wavelength ranges in the blue (3933 – 5434 Angstroms), red (5890 – 6768 Angstroms) and infrared (8542 – 15648 Angstroms)
- with a cadence of 10 s

Further requirements are

- Compactness
- polarization free symmetric optical design
- active tip-tilt corrector built into the system.

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8.2 Post-focus instrumentation

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Partners: KIS, UNITOV, INAF, USKD, AURA, UCAR, BDP E&M

Select the first-light instruments for

- magnetic field and velocity measurements

Magnetograph:

- synoptic full disk measurements of the Sun at all polarization states sufficiently well enough to derive the full magnetic field vector in areas of weak (i.e., quiet Sun) and strong (i.e., sunspots) magnetic field
- with moderate spatial and temporal resolution (1 arc second pixel size and one hour cadence), changing to flare mode (cadence 10 min) in case of an event

Proposed concept is a multi-plex slit spectrograph linked to the 50 cm telescope.

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8.2 Post-focus instrumentation

Doppler Imager:

- Enabling improved and continued measurements for studying
  - the surface
  - internal dynamics and interior structure

The proposed concept is to link Fabry-Perot interferometers to the three smaller full-disk telescopes for the three wavelength ranges.

Plan: Usage of VTT & HELLRIDE to build up a prototype for full-disk observations

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8.3 Data Recording and Processing

Partners:
CSIC-IAA, KIS, NSO, INAF, UNITOV, UNICT, USFD, UCAR, ORB,UNIGRAZ, ASU, SKOLTECH

8.3.1 Lucky Imaging
(ORB, UNIGRAZ, INAF, NSO)

Aim:

- Develop Lucky imaging techniques to improve the effective resolution that can be obtained by SPRING observations
- Required resolution: 1 arcsec

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8.3 Data Recording and Processing

- **8.3.2 Data Calibration, Merging, and Inversion**
  (KIS, CSIC-IAA, NSO, USFD, QUB, ASU, UNIGRAZ, INAF, UNITOV, UNICT)
- Given the defined spatial, spectral and temporal resolution of the post-focus instruments, the data rate of the SPRING network is high.

Challenge:

- provide science-ready data in near real-time.

Development work:

- running software solutions with code acceleration and parallelization for
  - the real-time calibration of the raw data
  - continuous merging of the time-series when switching observing sites
  - Stokes inversion of the polarimetric data of the multiplexed slit spectrograph and the Doppler Imagers.

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8.3 Data Recording and Processing

- **8.3.3 Data Homogenization & Automatic Flare Detection** (UNIGRAZ, SKOLTECH, ORB, NSO, INAF, UNITOV, UNICT, ASU)

Development work:

- Algorithms to homogenize the full-disk solar images from different SPRING network stations, in order to
  - provide continuous high-quality context observations
  - real-time triggers of dynamic observing targets (like flares) for the high-resolution observations

Make use of two high-performance clusters at SKOLTECH (Russia) to which we will get guaranteed access for use in the SOLARNET project.

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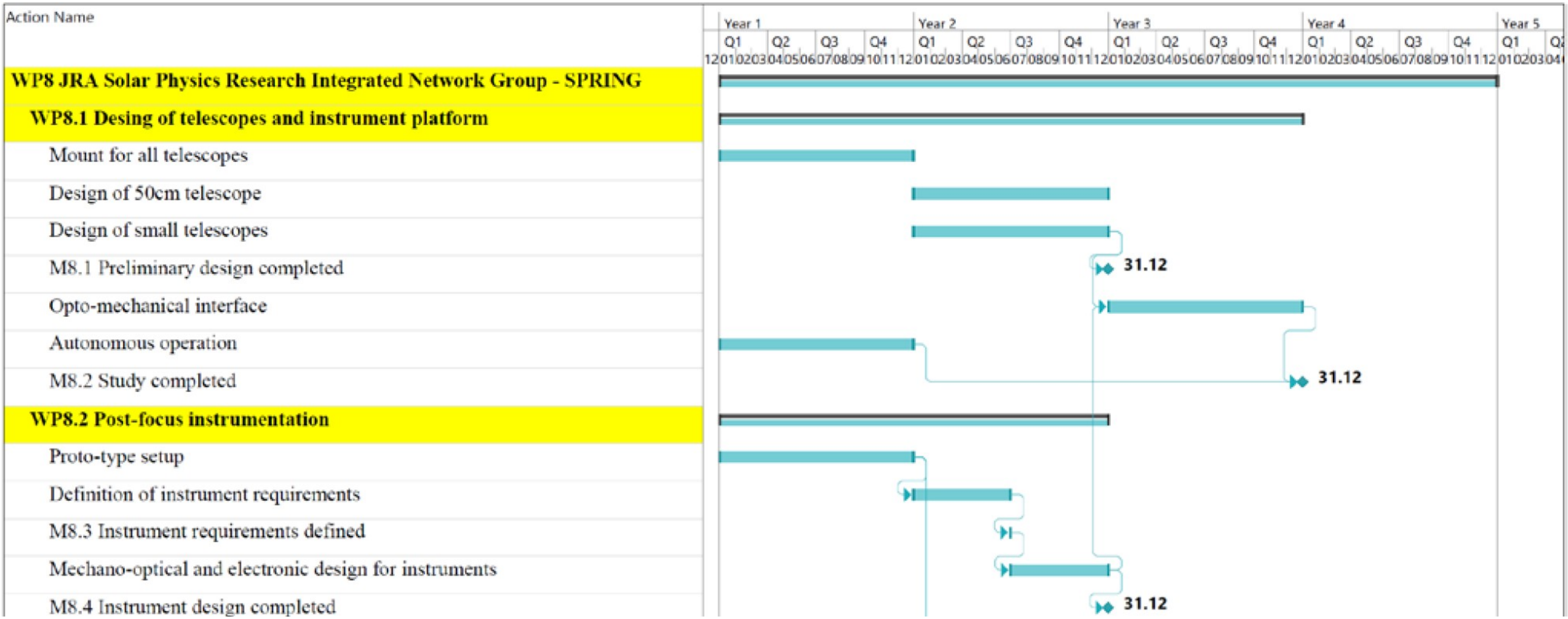
Timeline



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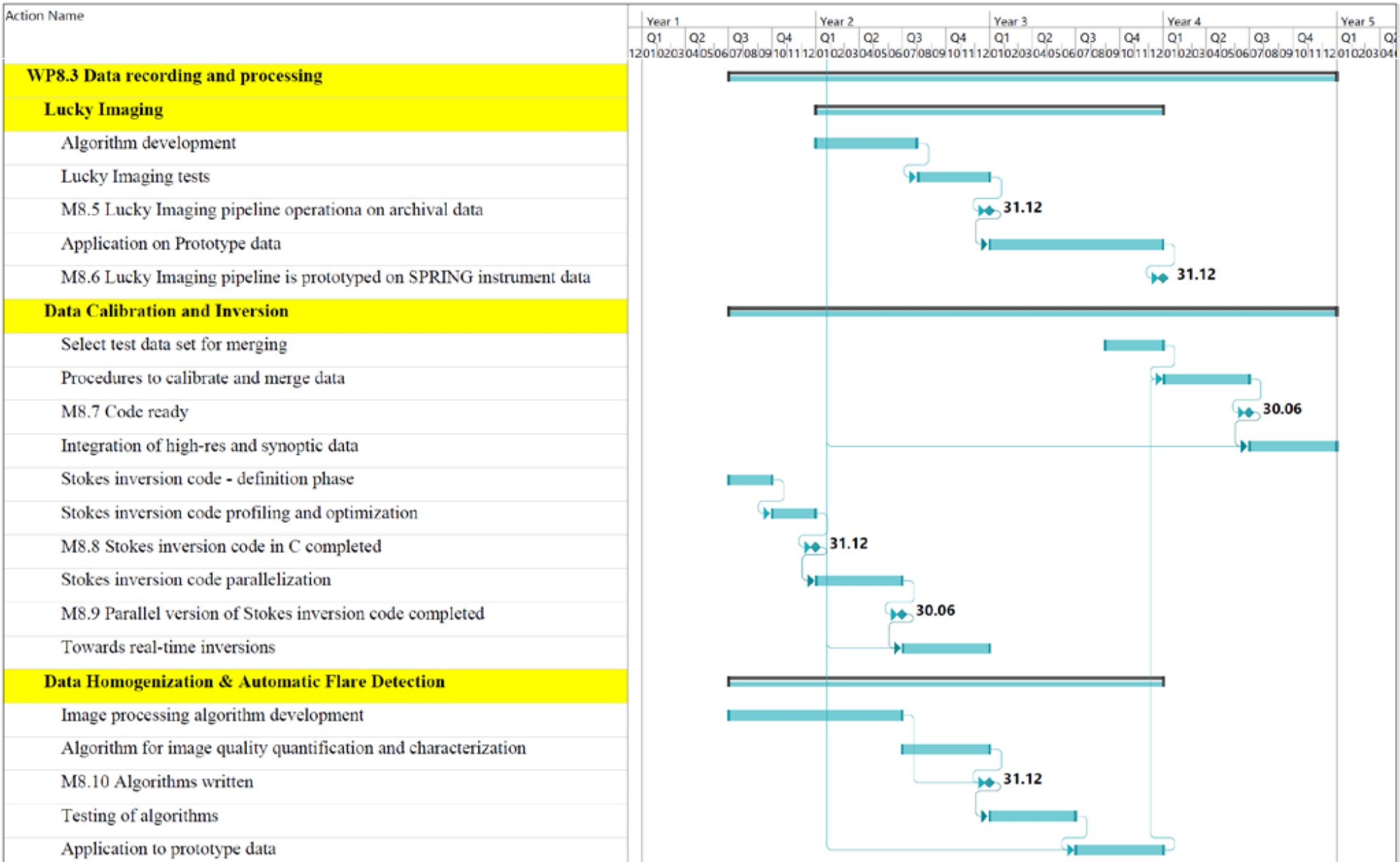
Timeline



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SOLARNET Midterm Review

Reviewer Report:

„The SPRING project (WP8) has made impressive advance towards the definition of a standardized instrumental configuration for ground-based synoptic solar observations. The basic characteristics of such an instrument set have now been settled on.

The set, consisting of a 50-cm telescope and three smaller auxiliary telescopes is expected to be able to provide full-disk filtergrams, dopplergrams and magnetograms in a wide variety of spectral lines with a high cadence.

As such, it is expected to replace the existing GONG helioseismology network, with added capabilities corresponding to the single-site SOLIS observing station in the US. The development has been taking place in coordination with the observational solar physicist community in the EU and elsewhere."

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SOLARNET Midterm Review

“The conceptual design work on SPRING (WP8) has a strong potential to impact on European policy making in the field of solar instrumentation.“

“For WP8 - SPRING network - I recommend a maximum usage of existing infrastructure, even if the scientific objectives are slightly affected.”

Leibniz-Institut für Sonnenphysik (KIS)

Deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D8.1	Report on optical and mechanical design of telescope and mounting	35 - AMOS	Report	Public	24
D8.2	Preliminary design for front-end telescope and mounting including schematics	35 - AMOS	Report	Public	42
D8.3	Design for post-focus instrumentation (Dopplergraph and magnetograph)	1 - KIS	Report	Public	42
D8.4	Technical feasibility report on rationale and results of the quasi real-time Lucky-Imaging data-reduction pipeline at ROB	17 - ORB	Report	Public	24
D8.5	Report on Demonstration Platform and results of Lucky-Imaging using multi-instrument data	17 - ORB	Report	Public	42
D8.6	Software for Stokes inversion	9 - CSIC	Demonstrator	Public	24
D8.7	Report on preliminary design of GPU implementation of inversion code	9 - CSIC	Report	Public	30
D8.8	Software for data calibration, data merging	1 - KIS	Other	Public	48
D8.9	Report on rationale and results of the data homogenization and multi-instrument flare detection developed and tested on archival data	21 - UNI GRAZ	Report	Public	30
D8.10	Report on data homogenization of SPRING prototype data and feedback to calibration sub-WP	21 - UNI GRAZ	Report	Public	42

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Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS20	Preliminary telescope design completed	35 - AMOS	24	Presentation of design concepts (cf. WP 8.1)
MS21	Design study of telescopes and instrumental platform completed	35 - AMOS	36	Design study completed; thermomechanical design for validation. (cf. WP 8.1)
MS22	Post-focus instrument requirements defined	1 - KIS	18	Optical setup tested on working proto-type instruments. (cf. WP 8.2)
MS23	Instrument design completed	1 - KIS	24	All post-focus systems validated and parameters for opto-mechanical interface defined. (cf. WP 8.2)

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Meeting objectives

- Reviewing our work versus the objectives and promises
  - Progress made
  - Status of deliverables and milestones
- Networking
  - Exchange of information and knowledge
  - Coordination of our activities
- Discussing next steps
  - What needs to be done according to the DoW
  - Time & Resource planning

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