



KARL-FRANZENS-UNIVERSITÄT GRAZ  
UNIVERSITY OF GRAZ



## Austrian contributions to ESA's SSA Space Weather Programme: Real-time detection of solar eruptions and space weather effects onboard aircraft

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Committee on the Peaceful Uses of Outer Space, Scientific and Technical Subcommittee,  
Fifty-first session, 2014 February 13



## Relevance of H $\alpha$ imaging of the Sun for space weather



Imaging of the different layers of the solar atmosphere:

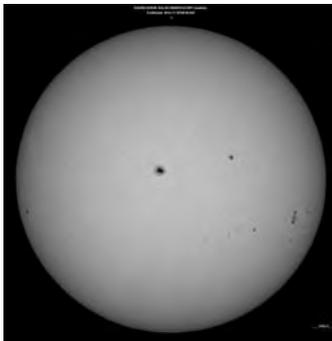
Photosphere  
ground-based

-

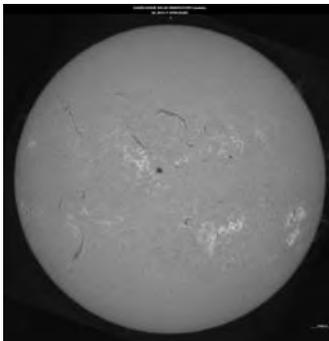
Chromosphere  
ground-based

-

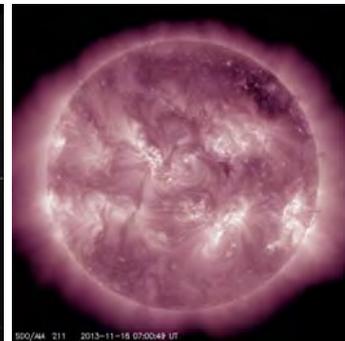
Corona  
space-based



White-light



H $\alpha$



EUV 211 Å

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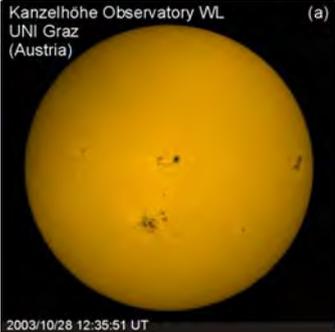


## Relevance of H $\alpha$ imaging of the Sun for space weather

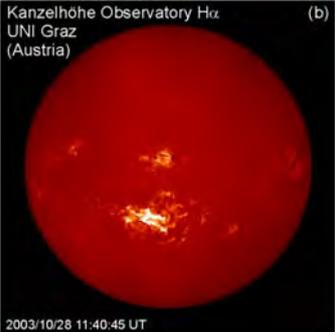


Imaging of the different layers of the solar atmosphere:

Photosphere	-	Chromosphere	-	Corona
ground-based		ground-based		space-based



(a)



(b)



(c)

Sun 10 years ago (28-Oct-2003): extreme high solar activity

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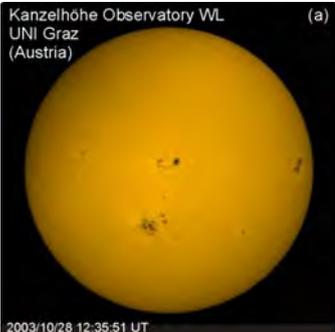


## Relevance of H $\alpha$ imaging of the Sun for space weather

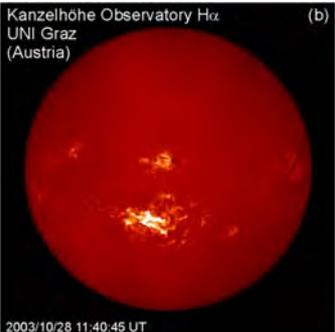


Imaging of the different layers of the solar atmosphere:

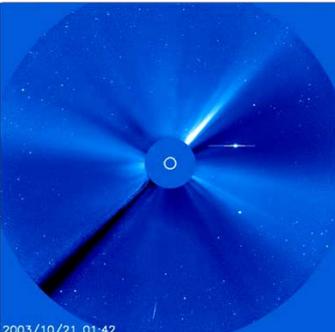
Photosphere	-	Chromosphere	-	Corona
ground-based		ground-based		space-based



(a)



(b)



(c)

Sun 10 years ago (28-Oct-2003)

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## Relevance of H $\alpha$ imaging of the Sun for space weather



Imaging of the Sun in the H $\alpha$  spectral line at 656.3 nm to observe the solar sources of space weather disturbances:

- 1) Flares
- 2) Filament eruptions, often associated with coronal mass ejections (CMEs)
- 3) Moreton (shock) waves, often associated with solar energetic particles (SEPs)

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## Relevance of H $\alpha$ imaging of the Sun for space weather

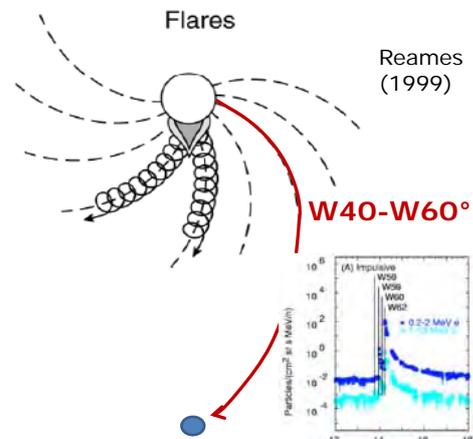
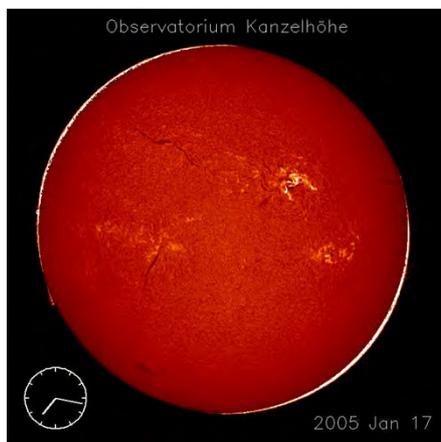


### 1) Flares:

Onset times & peak times

Importance class (area & brightness enhancement)

Location  $\rightarrow$  magnetic connectivity of flare-associated SEPs



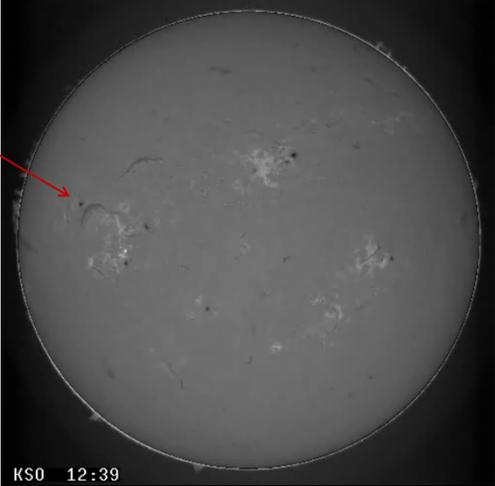
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## Relevance of H $\alpha$ imaging of the Sun for space weather



**2) Filament eruptions:**  
 Eruption onset times  
 Heliographic location



KSO 12:39

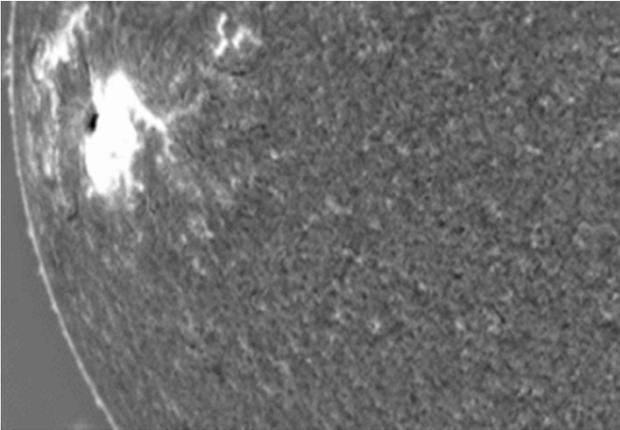
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## Relevance of H $\alpha$ imaging of the Sun for space weather



**3) Moreton waves:**  
 Onset times and location  
 Presence of coronal shock wave  $\rightarrow$  potentially associated SEPs



$v \sim 1000 \text{ km/s}$

ISOON/NSO  
 2006 Dec 6, 3B/X3.8 Flare  
 (Balasubramaniam et al. 2010)

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## KSO H $\alpha$ observations at ESA SSA SWE portal





Kanzelhöhe Observatory



Institute of Physics



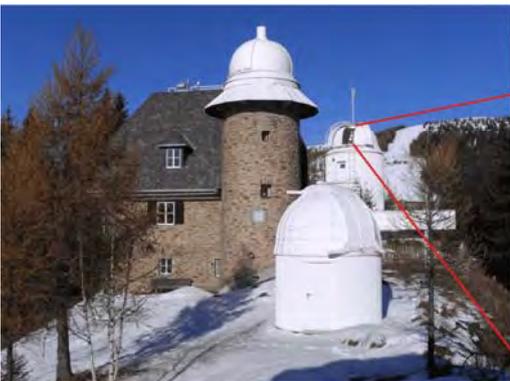
Kanzelhöhe Solar Observatory (KSO) of the University of Graz (in Carinthia on mount Gerlitzen): full-disk solar observations in H $\alpha$ , Ca II K, and continuum.

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## KSO H $\alpha$ observations at ESA SSA SWE portal






Kanzelhöhe Solar Observatory (KSO) of the University of Graz.

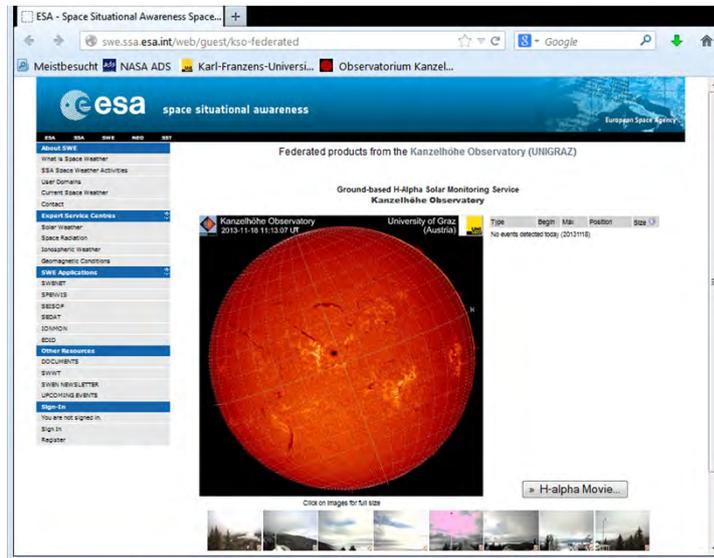
ESA SSA SWE programme:

- real-time provision of H $\alpha$  images on ESA SWE portal
- real-time detection and alerting of flares and erupting filaments

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## KSO H $\alpha$ observations at ESA SSA SWE portal

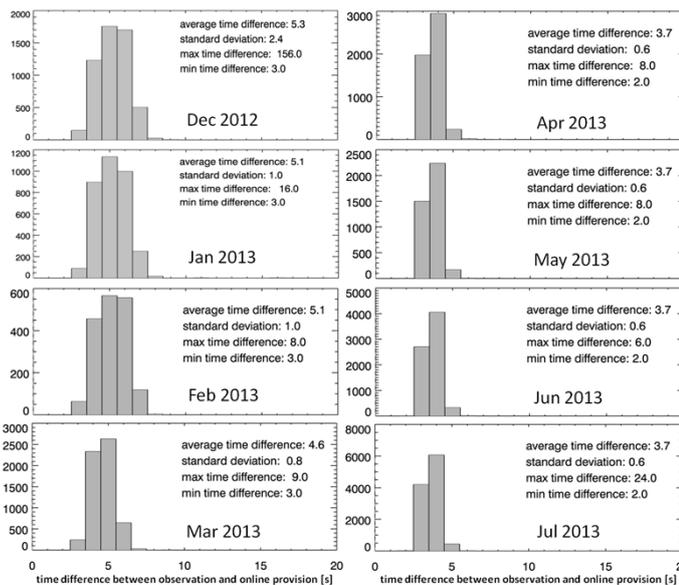


<http://swe.ssa.esa.int/web/guest/kso-federated>

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## KSO H $\alpha$ observations at ESA SSA SWE portal



Time delay between observation and online provision of the H $\alpha$  images is **<5 seconds**.

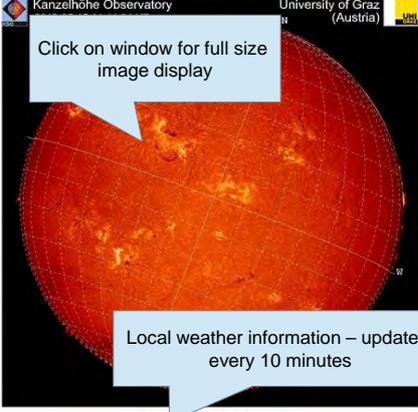
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## KSO H $\alpha$ observations at ESA SSA SWE portal



**Ground-based H-Alpha Solar Monitoring Service**  
Kanzelhöhe Observatory



Click on image for full size

Type	Begin	Max	Position	Size
Flare	1034	1039	N14E21	SF
Flare	0908	0908	N11E55	SF
Flare	0624	0625	N10E60	SF
Flare	0521	0522	S25E32	SF

Flare and filament eruption information  
Updates every minute, ongoing events  
are in red color

H-alpha movie popup window

» H-alpha Movie...



page refresh each 60 seconds

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## Automatic real-time detection of flares and filaments at KSO



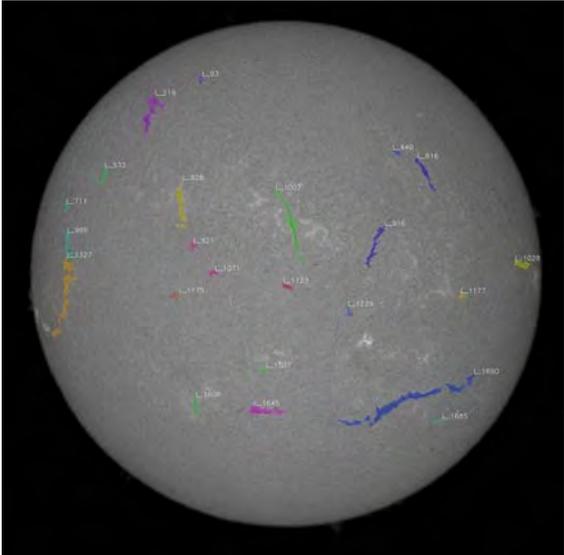
**Automatic detection of filaments:**

Based on intensity and shape.

If a filament ID disappears → an eruption is detected.

Real-time output:

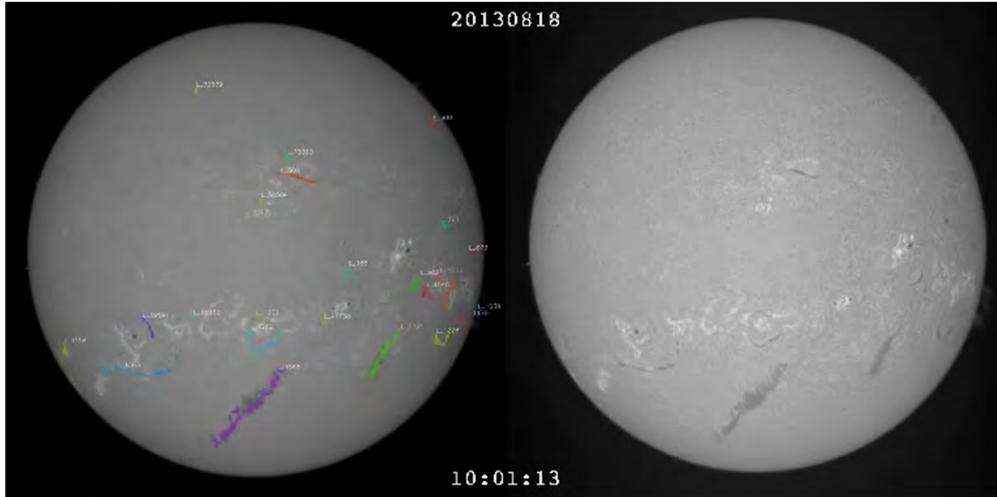
- Filament eruption alert
- Heliographic location
- Time of disappearance



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## Automatic real-time detection of flares and filaments at KSO

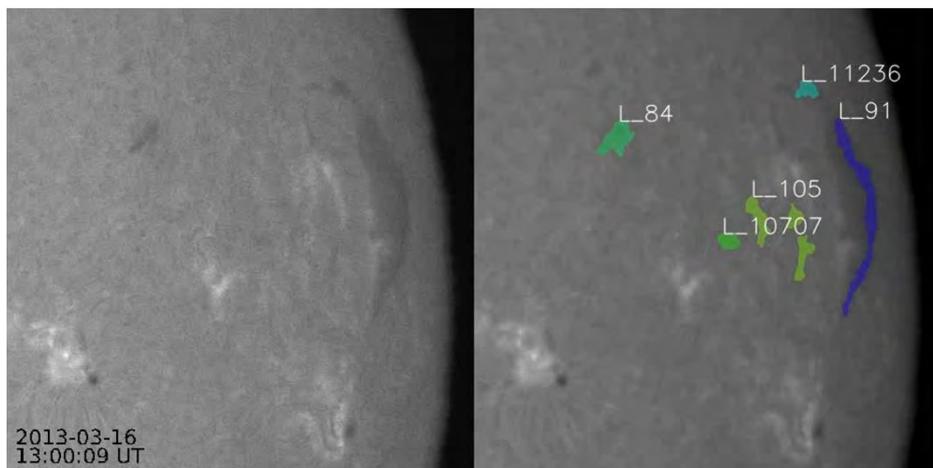


Sample result on **filament recognition** on KSO H $\alpha$  image sequence: Right: raw image. Left: the detected filaments are outlined in color. Each filament has an ID assigned, which is annotated in the image.

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## Automatic real-time detection of flares and filaments at KSO



Sample result on **detection of filament eruption** on KSO H-alpha image sequence close to the solar limb. Filament ID **L\_91** disappears, i.e. the filament has erupted.

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## Automatic real-time detection of flares and filaments at KSO



### Automatic detection of flares:

Based on increase of intensity in localized regions.

Real-time output:

- Start & peak time
- Heliographic location
- Importance class (size, brightness)

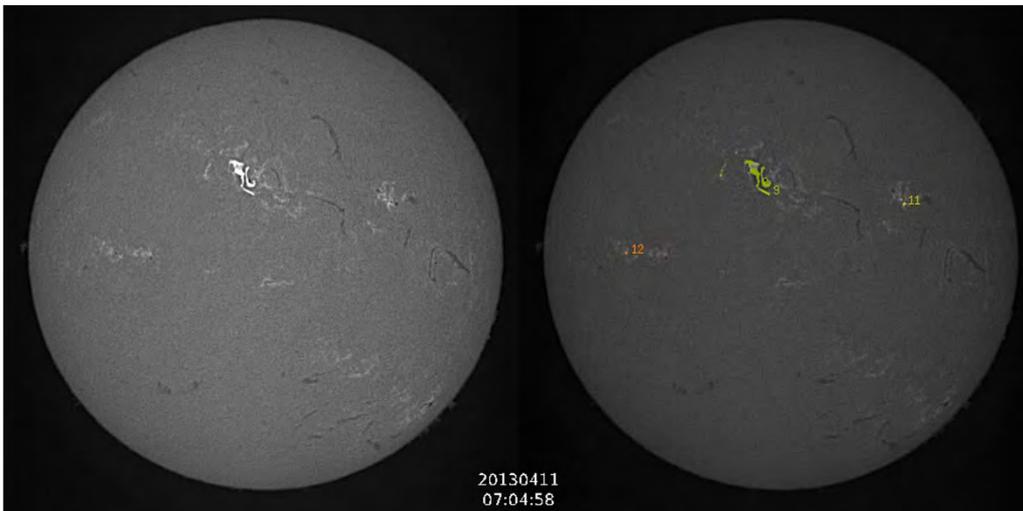
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## Automatic real-time detection of flares and filaments at KSO



Real-time output of flare-recognition program



Original H $\alpha$  images.

H $\alpha$  images with flare IDs identified.

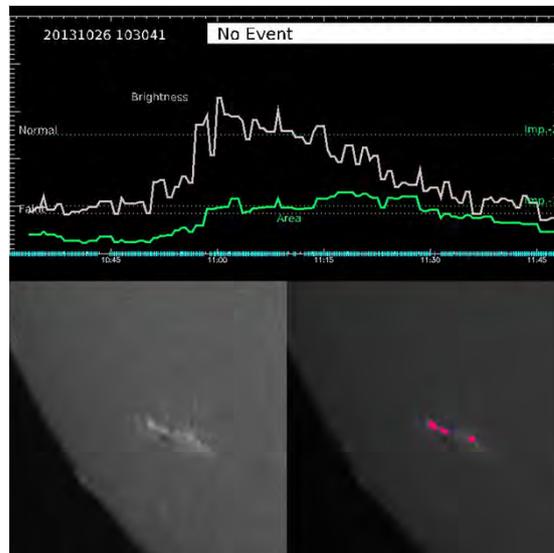
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## Automatic real-time detection of flares and filaments at KSO



Real-time output of flare-recognition program



Flare area and brightness as function of time.

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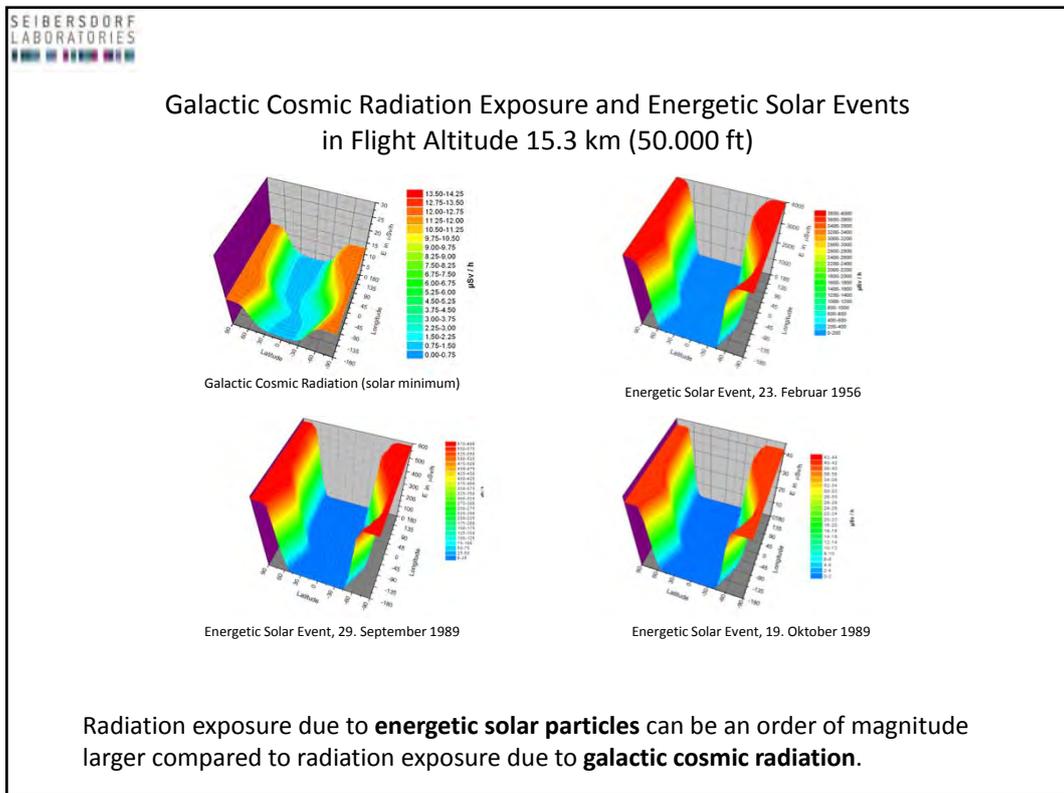
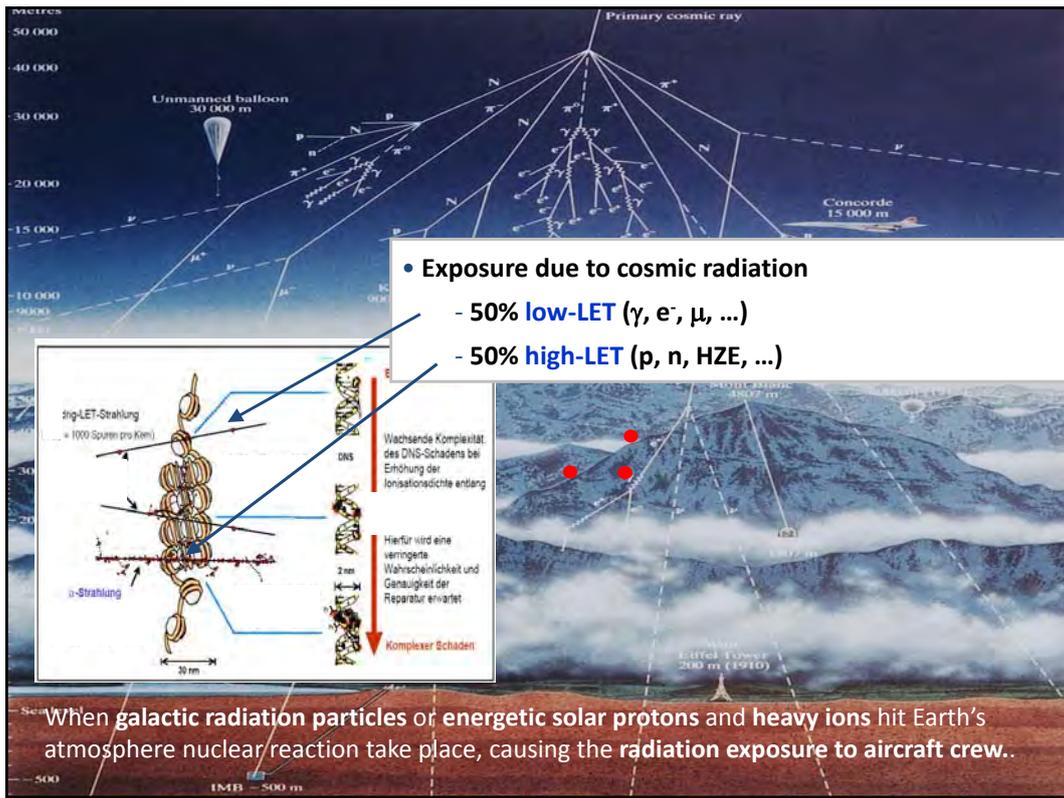
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LABORATORIES  
PROFICIENTLY ASKED SOLUTIONS

## AVIDOS Aviation Dosimetry

Seibersdorf Laboratories:  
P. Beck, M. Latocha



Aircraft crew workers are radiation protected workers in Europe.  
European countries take legal measures to ensure that aircraft crew worker do not exceed limits of radiation exposure.



**SEIBERSDORF LABORATORIES**

## AVIDOS at ESA:

[swe.ssa.esa.int/web/guest/avidos-federated](http://swe.ssa.esa.int/web/guest/avidos-federated)

This service is federated via ESA by Seibersdorf Laboratories

September 2012 at 10:29:50

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**Welcome to AVIDOS**

AVIDOS is an informational and educational software for the assessment of cosmic radiation exposure at flight attendants.

Public Aircrew Waypoints Science

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**AVIDOS - "aviation dosimetry":** software for online calculation of radiation exposure on-board aircraft.

**SEIBERSDORF LABORATORIES**

## AVIDOS World Wide Web User:

[swe.ssa.esa.int/web/guest/avidos-federated](http://swe.ssa.esa.int/web/guest/avidos-federated)

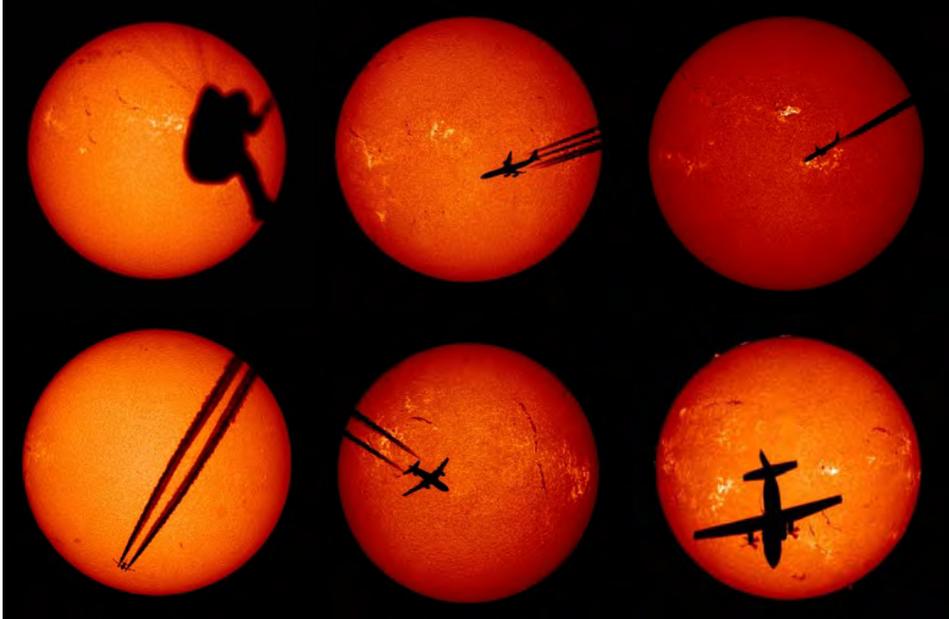
Karte Satellit Gelände

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Thank you for your attention!



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