Imaging Solar Flares in Hard X Rays and Gamma Rays from Balloon-Borne Platforms

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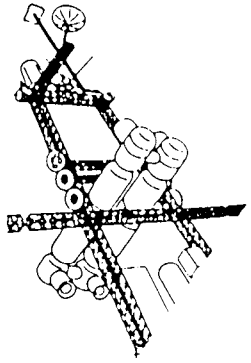
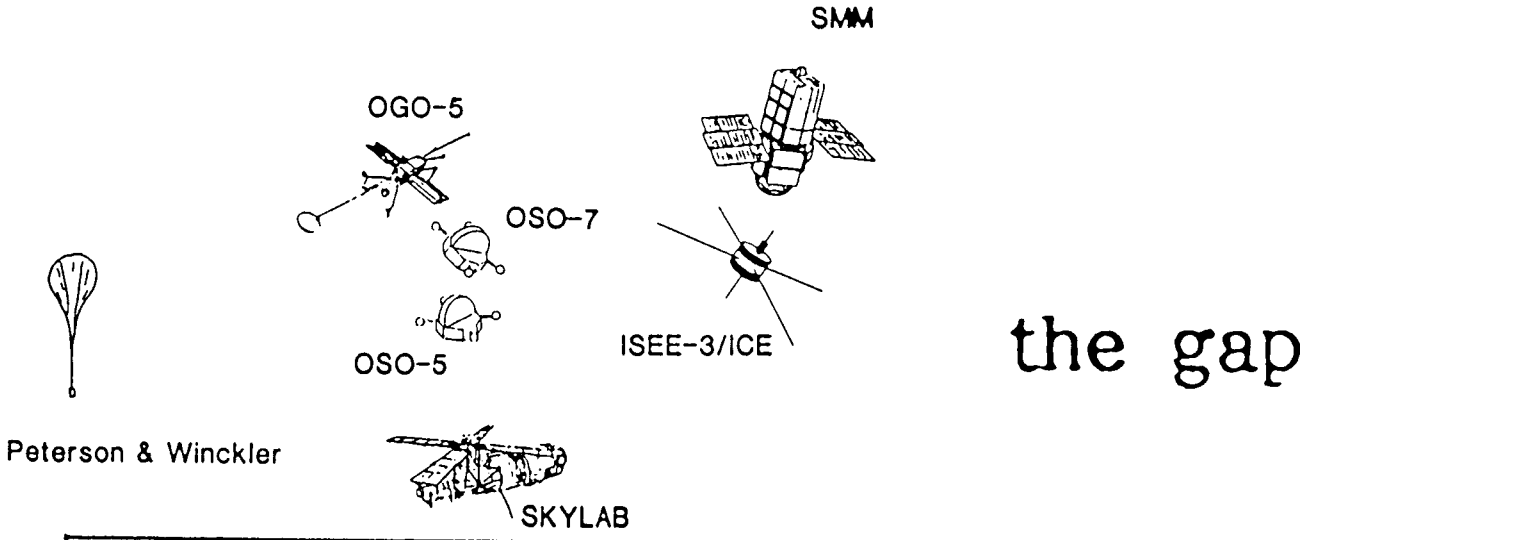
Hard X rays and gamma rays carry the most direct evidence available for the roles of accelerated particles in solar flares. An approach that employs a spatial Fourier-transform technique for imaging the sources of these emissions is described and plans for developing a balloon-borne Gamma Ray Imaging Device based on this instrumental approach is presented. This instrument, GRID on a Balloon, would enable observations with 1.6-arcsecond angular resolution, 10-millisecond time resolution, and whole-Sun field of view on long-duration balloon flights during MAX '91.

NASA SOLAR FLARE MISSIONS



Space Station



Proposal for a GAMMA-RAY IMAGING DEVICE (GRID) ON A BALLOON

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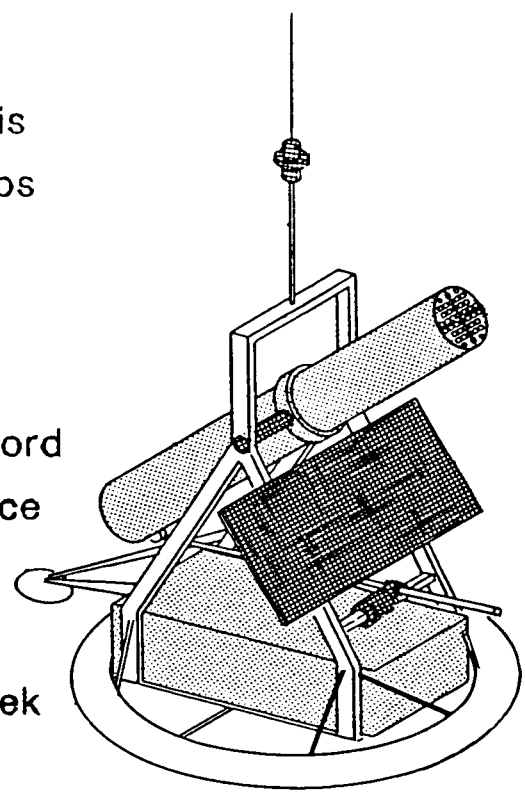

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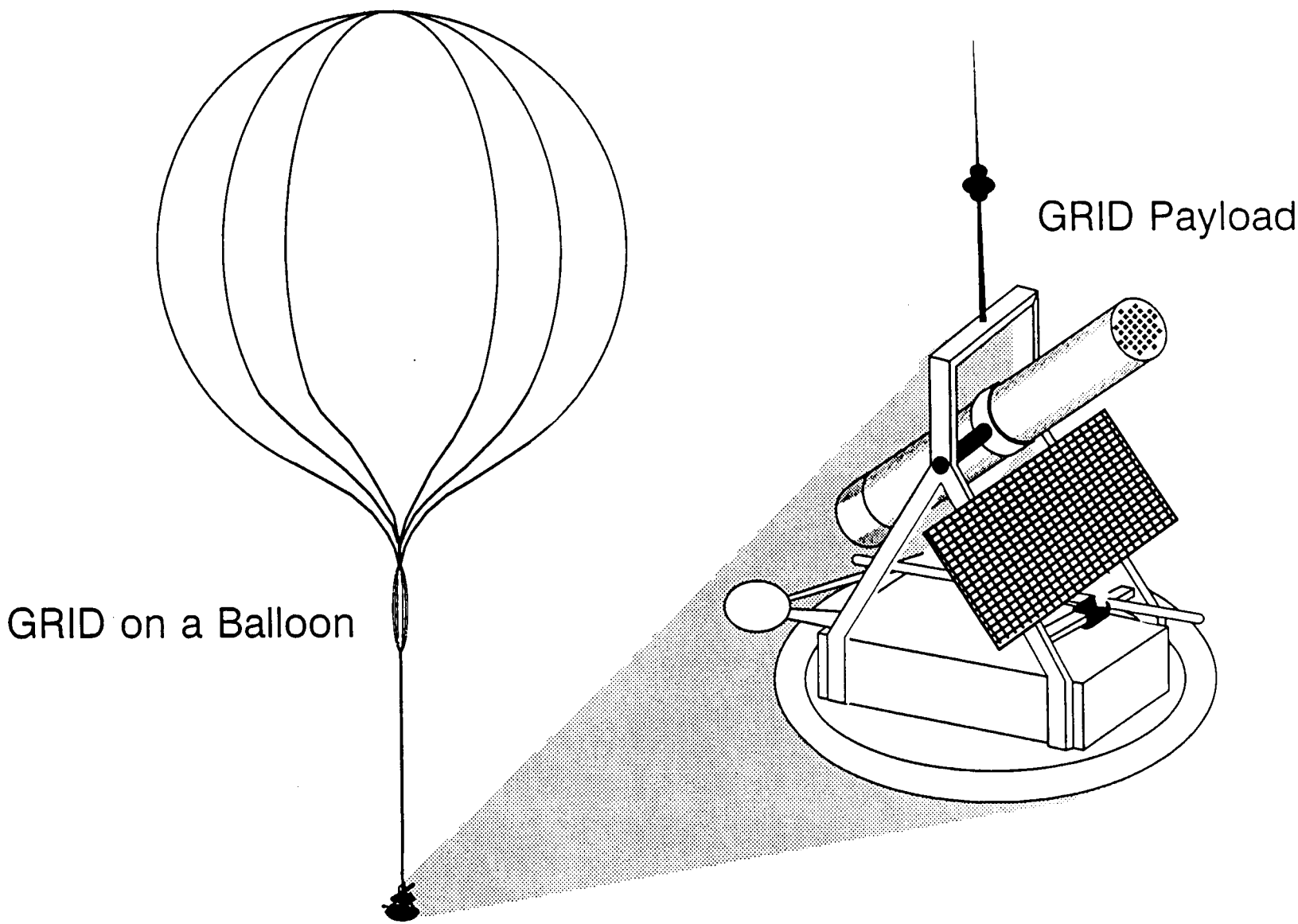
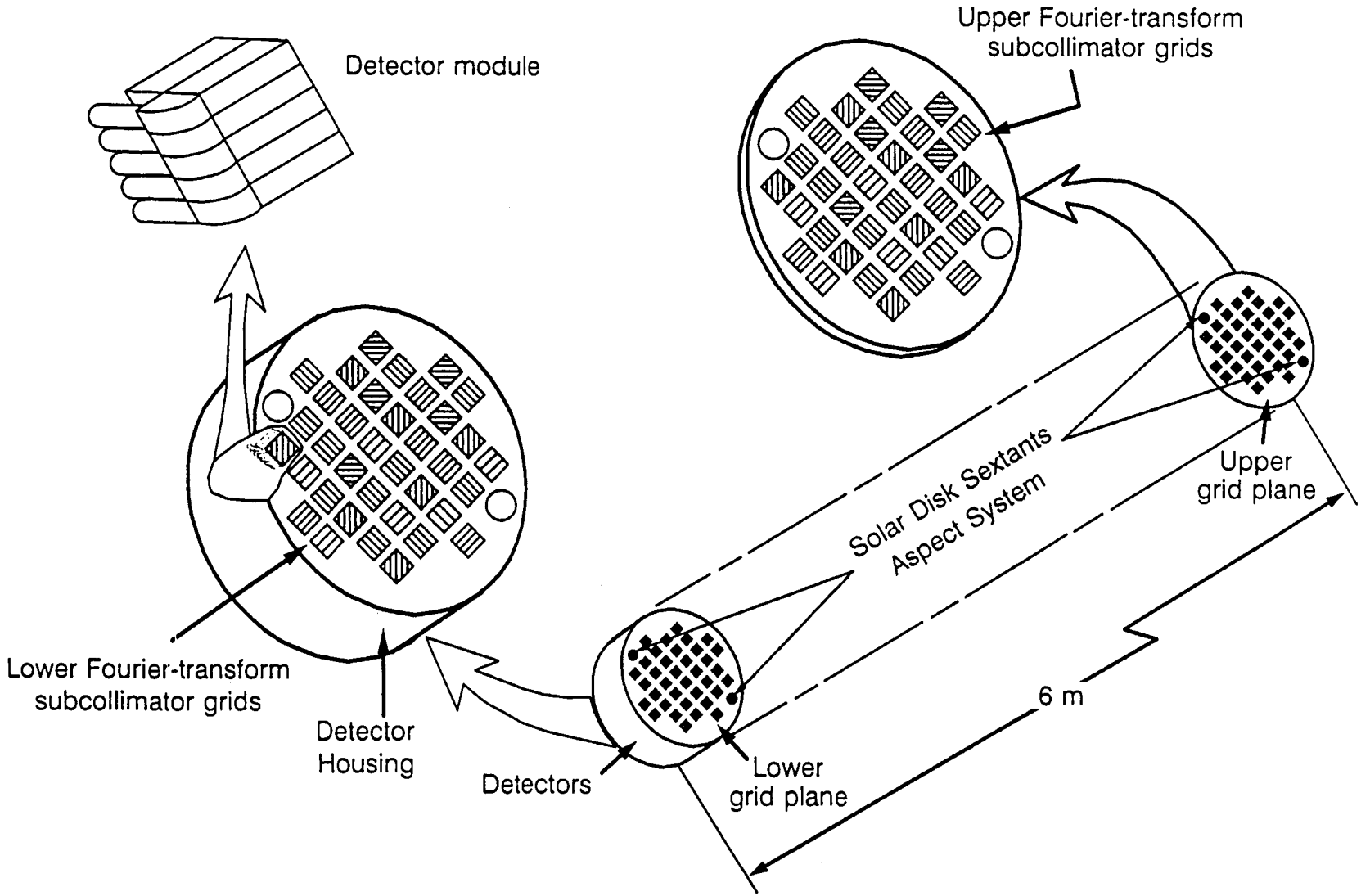
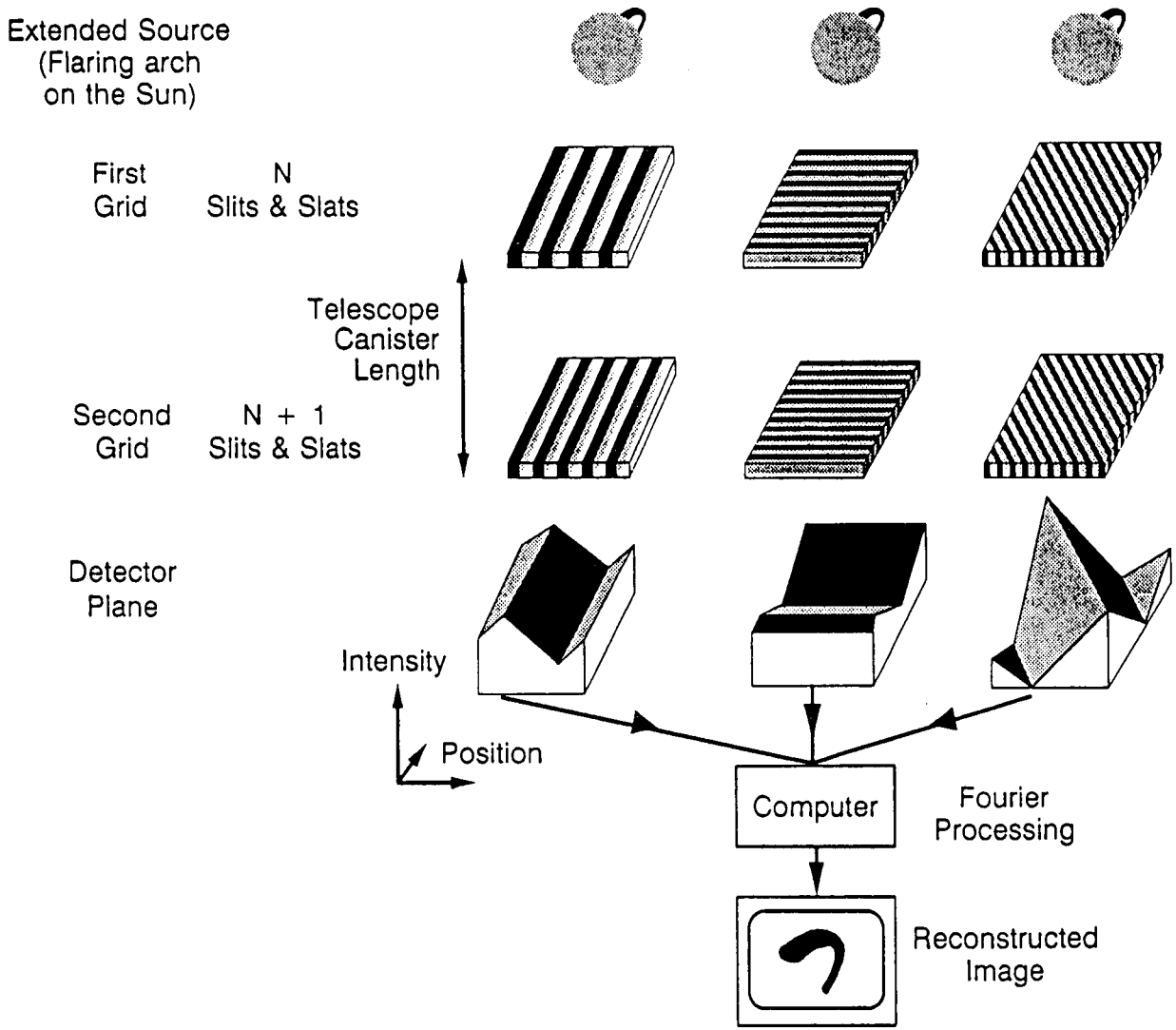
GRID on a Balloon


GRID Payload
GRID on a Balloon

EXPLODED VIEW OF GRID TELESCOPE



FOURIER TRANSFORM CAMERA



Gamma Ray Imaging Device (GRID) on a Balloon

Objective:

- Advance solar flare science during the next solar maximum using state-of-the-art balloon-borne instruments

Rationale:

- Hard X-ray and gamma-ray imaging, together with fine-resolution gamma-ray spectroscopy are identifiied as the next steps in high-energy solar physics by both **MAX '91** study committees
- No access to space is available on orbital missions during the next solar maximum
- Balloons offer unique opportunities for repetitive 15-day missions

Gamma Ray Imaging Device (GRID) on a Balloon

Goals:

- Provide a definitive test of solar flare models
- Image the site of high-energy solar flare emissions with spatial resolution corresponding to the fundamental scale length of electron interactions
- Using associated microwave observations, investigate magnetic field structures characterizing the high-energy source site
- Achieve arcsecond spatial resolution and sub-second temporal resolution of hard X-ray and gamma-ray sources in solar flares from 15 to 511 keV
- Develop hard X-ray and gamma-ray imaging technology as a precursor to the **Pinhole/Occulter Facility** on **Space Station**

Gamma Ray Imaging Device (GRID) on a Balloon

Approach:

- Develop **GRID** as a balloon payload in a cooperative effort between government laboratories, university scientists, and foreign collaborators
- Use in-house expertise from each participating institution to minimize costs
- Use heritage of the NASA-sponsored **Pinhole/Occulter Facility** and **MAX '91** studies plus efforts for the **SHAPE** proposal to define hardware
- Fly **GRID** on multiple, long-duration (15-day) balloon missions throughout the next peak in solar activity (1990 - 1994)

Gamma Ray Imaging Device (GRID) on a Balloon

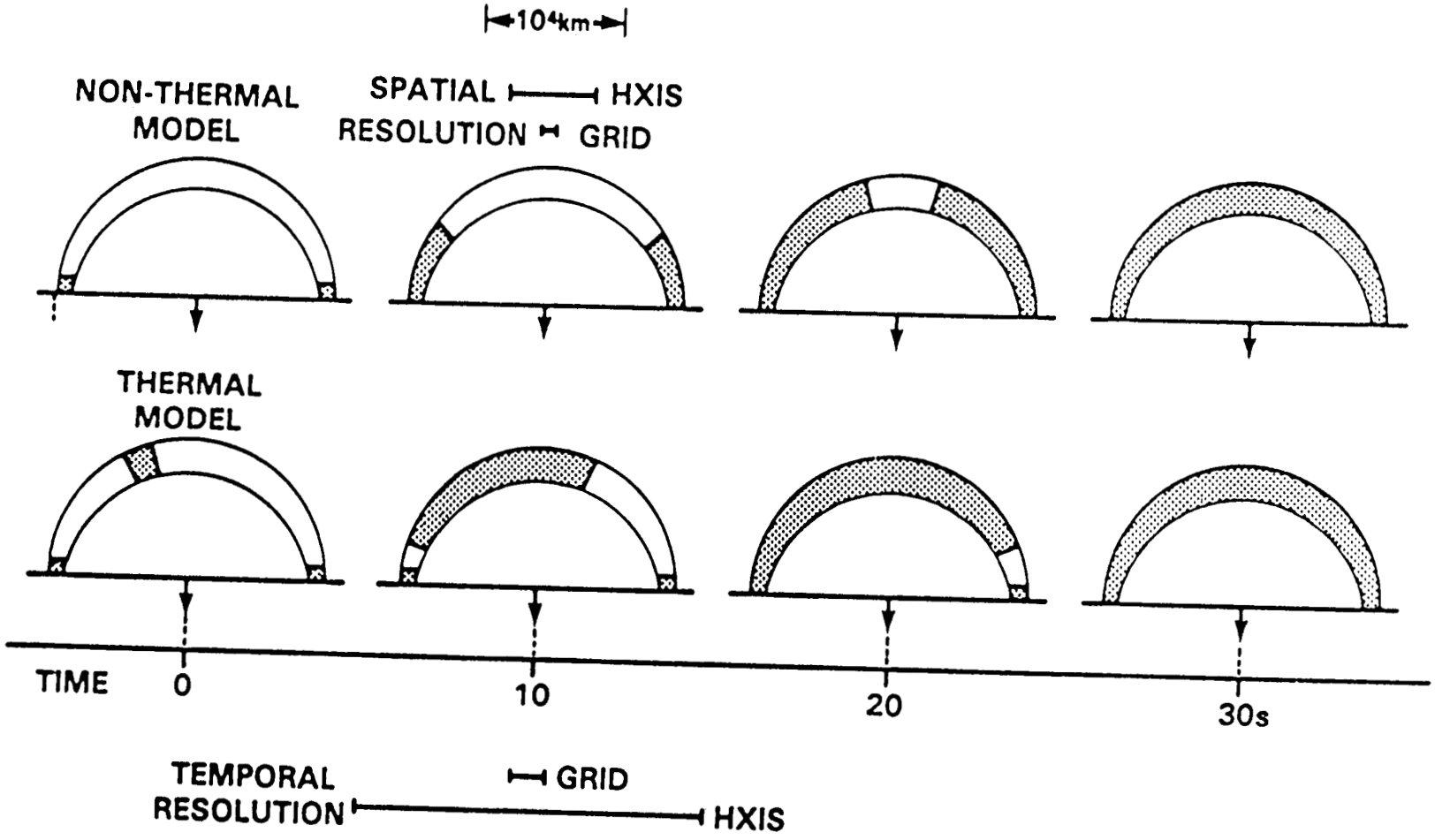
Design Objectives:

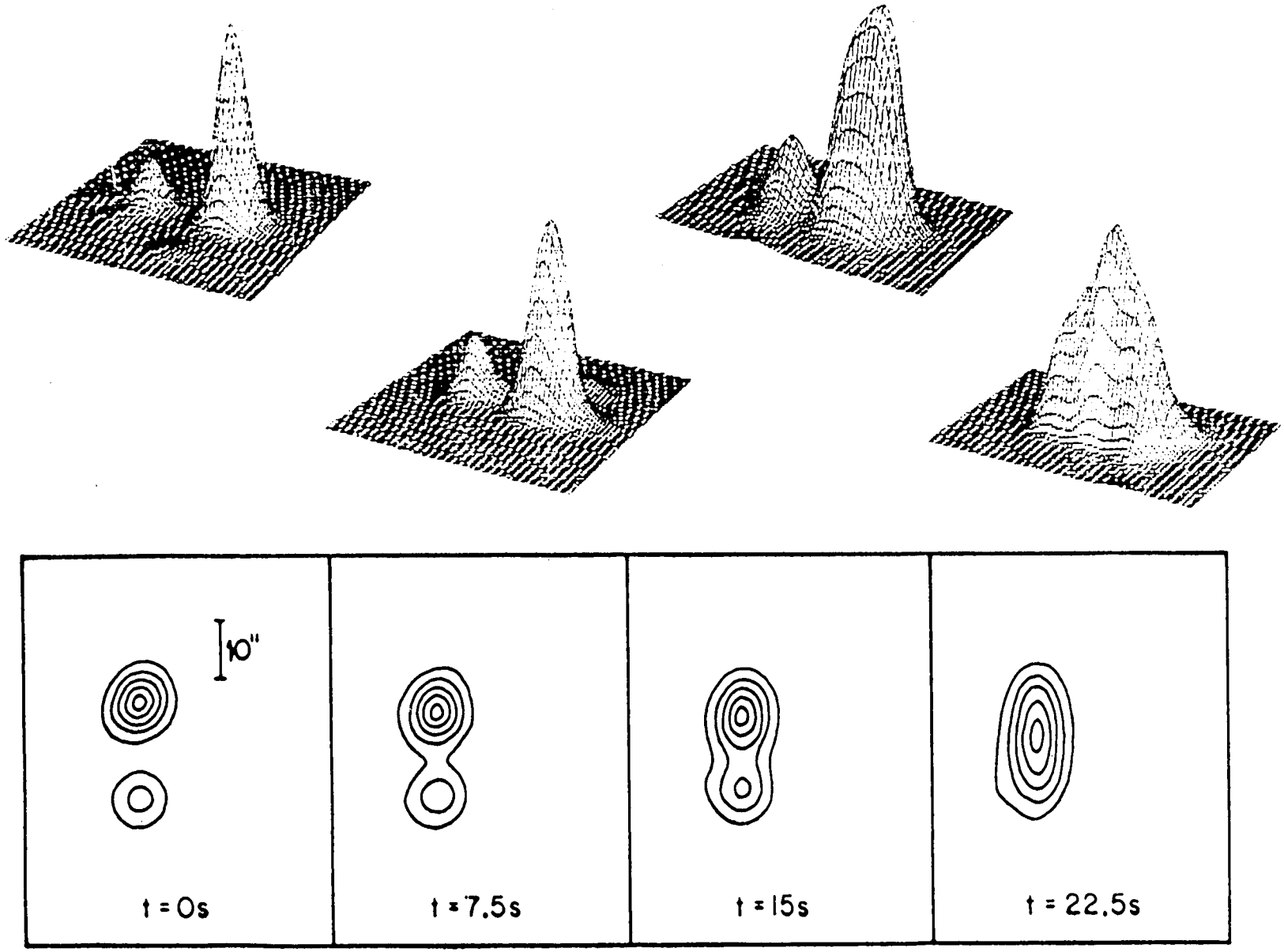
obtain hard X-ray and gamma-ray images of solar flares

angular resolution	$\sim$1.6 arcsecond
temporal resolution	10 milliseconds
energy range	15 to 511 keV
field of view	full Sun
number of Fourier components measured	32
effective detector area	20 cm^2 per component

Instrumental Techniques:

- o spatial Fourier transforms for hard X-ray and gamma-ray flare images
- o aspect determination using the Solar Disk Sextant


10⁴km
NON-THERMAL MODEL
SPATIAL RESOLUTION
HXIS
GRID
THERMAL MODEL
TIME
0
10
20
30s
TEMPORAL RESOLUTION
GRID
HXIS


10"
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