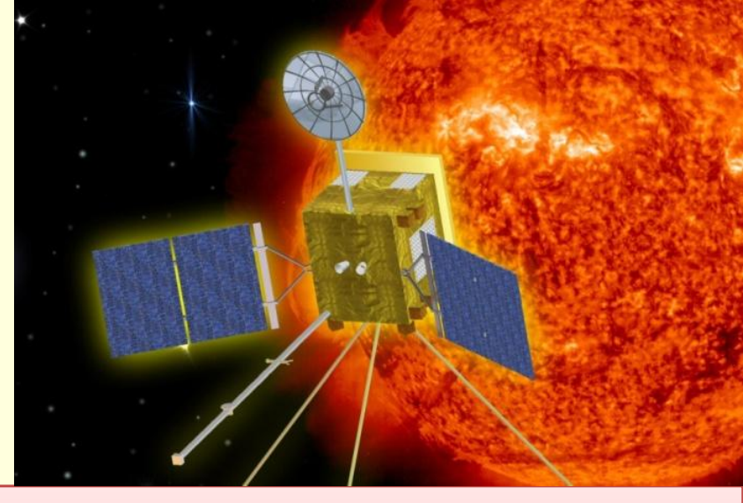
Intended for STIX aboard Solar Orbiter



Possible modification of STIX allowing for imaging and monitoring the soft X-ray emission

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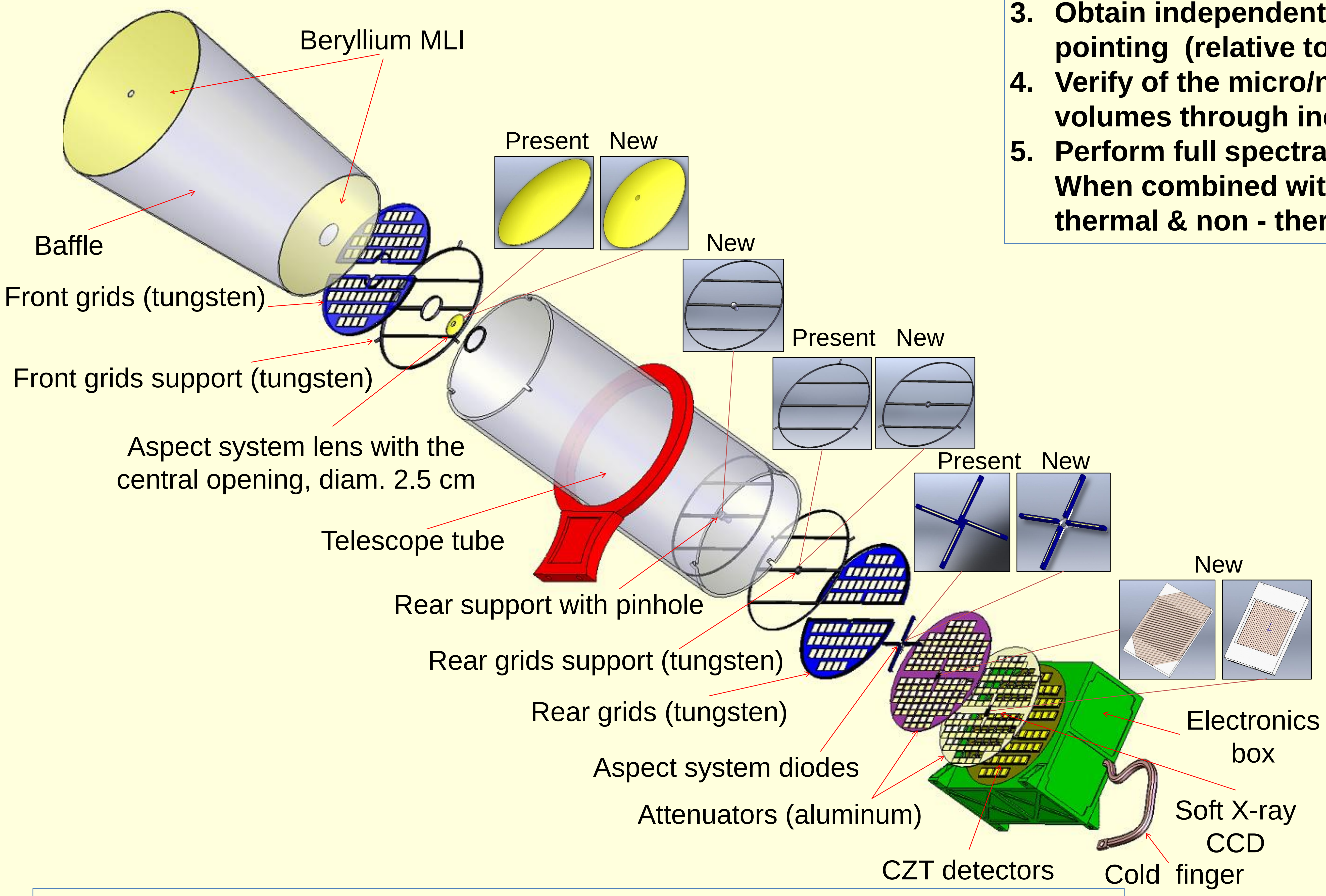
ABSTRACT

We suggest a modification of the present STIX hardware design which will allow to see the coronal and flare thermal plasma. The thermal flare locations can be determined with spatial resolution better than ~ 1arcmin and flare spectra measured with high cadence in the range 1 - 10 keV with ~200 eV resolution. Proposed imaging is through the use of a pin-hole "lens" and 2D soft X-ray imager (CCD or CMOS). The pin-hole is to be located on the instrument axis and the imager in the centre of the detector plate. Such a modification will allow for monitoring the (micro)flaring activity of the corona as well as provide medium-resolution imaging of the observed portion of the solar atmosphere in thermal X-rays.



Rationale for suggested modifications

1. **Provide imaging of the solar atmosphere within the FOV similar to STIX (2.5^0) in the energy band 1 - 10 keV.**
2. **Measure solar soft X-ray spectra in the range 1 - 10 keV with resolution ~ 20 - 150 eV. Line groups are seen atop the continuum at this resolution.**

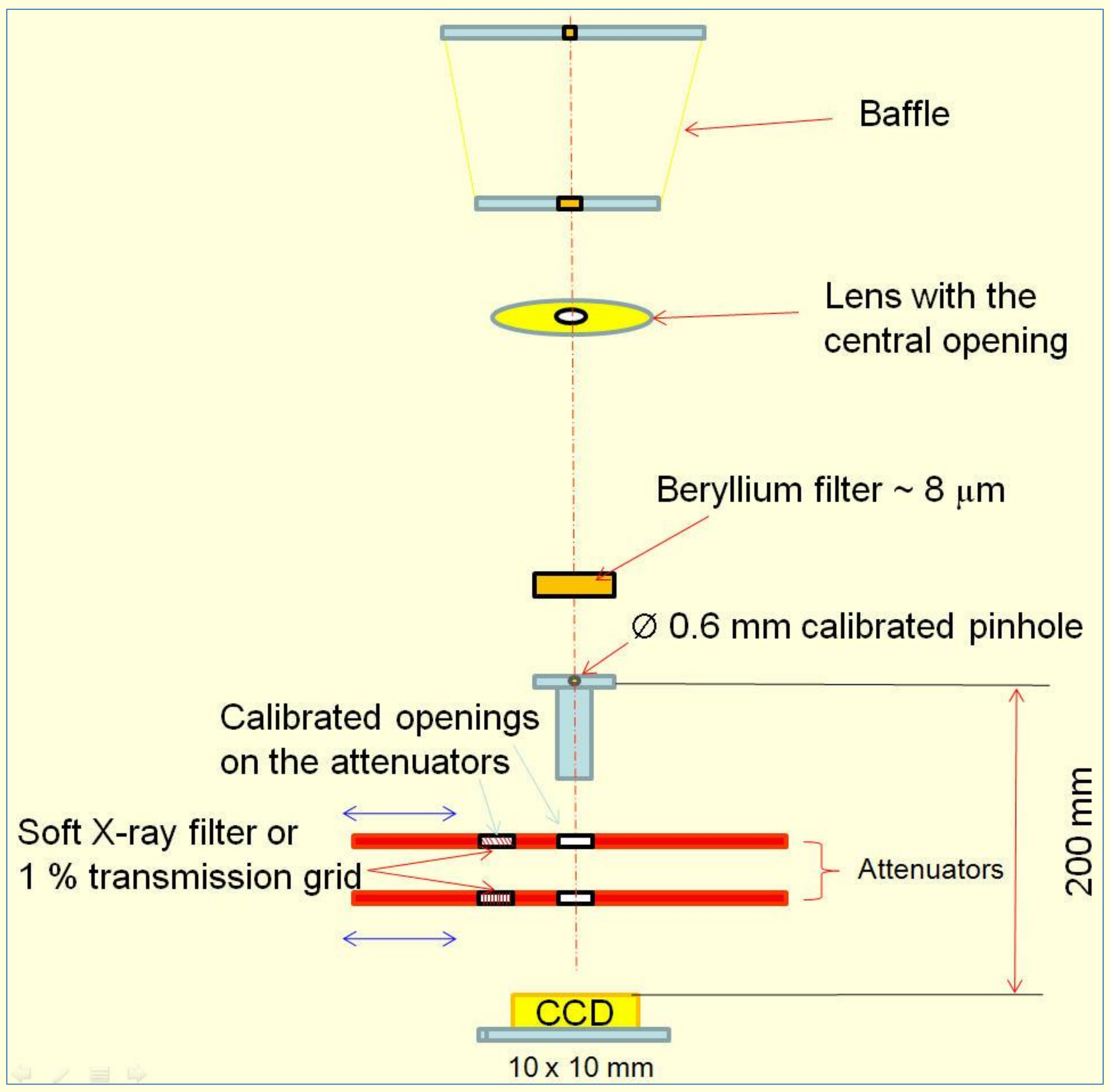
With the new data, it would be possible to:

1. **Determine the plasma temperature distribution in the soft X-ray corona with spectral resolution ~ better than 1 arcmin.**
2. **Determine the plasma composition over interesting areas.**
3. **Obtain independent information on the STIX instrument pointing (relative to the soft X-ray limb).**
4. **Verify of the micro/nanoflare heating of the active region volumes through increased signal- to- noise.**
5. **Perform full spectral diagnostics in the range 1 - 100 keV. When combined with primary STIX objectives, i.e. combined thermal & non - thermal approach.**

We suggest following modifications to the existing STIX construction:

1. Lens modified, Φ ~ 1mm central hole present.
2. Added intermediate support for the SXR imager pin-hole.
3. Added system of calibrated grids mounted on the attenuators.
4. Modified location of aspect system diodes in order to clear, the soft X-ray optical path (along the optical axes of the instrument).
5. Modified rear grids support in order to clear the central aperture.
6. Add 512 x 512 or 1024 x 1024 CCD or CMOS imager at the centre of detector unit. (Takagi et al., arXiv: 07100.0785v1, 2007)
7. Add the appropriate electronics and software.

Estimated cost ~ 1.5 mln. Euros (total)
Increase of weight ~ 100 - 150 g
Increase of power ~ 0.3 - 0.5 W
Increase of telemetry ~ 10 %



Nanoflare/microflare detection: the assumptions

- The rate of heating to support the observed corona: 4.5×10^5 erg cm^{-2}s^{-1} (Krucker and Benz, Astrophys. J., 501, L213, 1998)
- Energy release in a single nanoflare: 10^{24} ergs in ~ 20 s, rectangular shape for simplicity→rate 5 10^{22} erg/s
- If evenly distributed → area on the surface to support single nanoflare: 10^{17} cm^2 ~→ 3300 km x 3300 km
  i.e. 4.6 x 4.6 arcsec from 1 a.u., but 20 x 20 arcsec from 0.22 a.u.
- Pin-hole of diameter 0.6 mm (0.4 mm^2 area) at the distance of 60 cm has the right resolution
- The size of 2D imager is ~ 10 x 10 mm, 1024 x 1024 pixels (512 x 512).
  In order to have ~ 3 degrees FOV, the pin-hole should be located at the distance ~ 20 cm, so the pin-hole 0.6 mm has 1arcmin diameter ~ 10 nanoflares from 0.22 a.u.
- Nanoflare volume (V): 10^{17} cm^5 x 10^8 cm = 10^{25} cm^3 *f (f-filling factor <<1?)
- Plasma T in nanoflare ~ 10 MK. Assuming 10% of energy in thermal component (E_{th}) 10^{23} ergs →

$$EM = \left(\frac{E_{th}}{3kT}\right)^2 \frac{1}{V \cdot f}$$

- Nanoflare detection possible only if T ~ 1 MK and f ~ 10^{-6}
- Detection of microflares much more easy as seen from the table

Table with EMISSION MEASUREs [10^{40} cm^{-3}] of 10 nanoflares expected within FOV

T[MK] → f- filling factor ↓	1	2	5	10
1	6	1.4	0.2	0.05
0.01	60	14	2	0.5
10^{-4}	600	140	20	5
10^{-6}	$6 \cdot 10^3$	$1.4 \cdot 10^3$	200	50

Green: detection possible for nano-flares
Yellow: detection possible for microflare

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