

ASPEX

Your Prêt-à-Porter All Sky Monitor

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On behalf of:

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Driving Idea

Main Mission Requirement: promptly localize as many bright GRBs as possible
=> The largest Sky Coverage is required

A True Full Sky Coverage ($\geq 2\pi$, see below) with limited resources:
=> very few resources allocated per steradian

This is possibly incompatible with optimal performance at any direction.

Our proposal: different tasks for different instruments.

Imaging in 7-30 keV on 2π with a SuperAGILE-like instrument:
=> several tens bright bursts localized per year

Non-imaging **Spectroscopy** in $\sim 1-300$ keV on a narrower field (~ 1 sr total?) with
a SDD+CsI –like instrument (see Marisaldi/Labanti presentation)
=> few (10-30/year) GRBs studied in details

Concept for an ASM: Bandwidth

Current measured noise figure for SA ASICs (ENC): $294e^- + 19.6e^-/pF$
Hamamatsu Si μ -strip, SA-like, 650 μm thick, 1 tile: 13 pF
Today's reasonably expected improvement from ASIC optimization and new CMOS technology: $\sim 30\%$

Predicted noise figure: $\sim 385 e^-$
 $\Rightarrow 1.4 \text{ keV rms}$
 $\Rightarrow 3.3 \text{ keV FWHM}$
 $\Rightarrow \sim 7 \text{ keV Lower Energy Threshold}$

Upper Energy Threshold (from Si transparency): $\sim 30\text{-}40 \text{ keV}$

Today's Useful bandwidth: 7-30 keV

Concept for an ASM: Sensitivity

Today's Basic Module (example):

Energy range:	7-30 keV
Geometric Area:	2 x 100 cm ² (1+1 tile)
Si thickness:	650 μm (quotation in house)
FOV:	66° x 66° (FWZR)
Mask open fraction:	50%
Coding:	2 x 1D

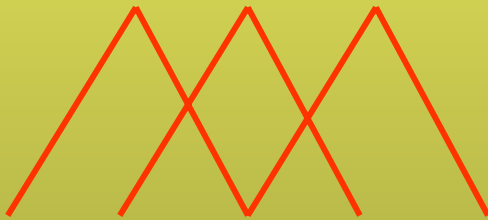
expects: ~5 mCrab on-axis in 50 ks (5σ, 2 x 1D imaging)
~1 Crab on-axis in 1s (5σ, 2 x 1D imaging)

Concept for an ASM: Sky Coverage

One Module:

FOV: $66^\circ \times 66^\circ$ (FWZR)

$33^\circ \times 33^\circ$ (FWHM) $\Rightarrow \sim 1000$ sq.deg.



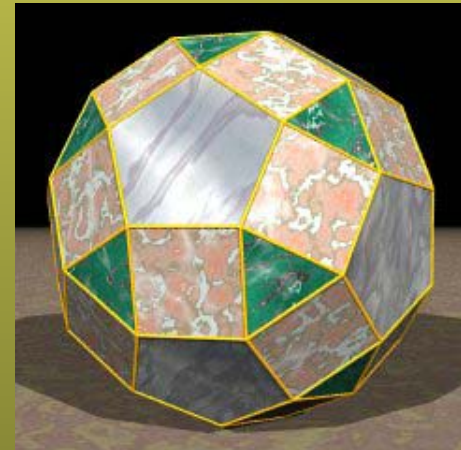
\Rightarrow Any direction exposed to full on-axis area

Full Sky: ~ 50.000 sq.deg.

ASM coaligned with NFI + Smart Pointing:

\Rightarrow full sky achieved with 2π coverage

\Rightarrow Possible layout: 25 modules, to be arranged on the surface of a polyedrum around the NFI Telescope



Example Concept for an ASM: Budgets

Energy Range:	7-30 keV
Energy Resolution:	~3.5 keV
FOV:	2π
Coding:	2 x 1D
Opening Fraction:	50%
Angular Resolution:	6 arcmin
Pixel Size:	3 arcmin
Source Location Accuracy	~1-2 arcmin ($>10\sigma$ detection)
Total Geometric Area:	5000 cm ²
Geometric Area to any direction:	200 cm ²
5σ Sensitivity at any direction:	~ 5 mCrab in 50 ks ~ 1 Crab in 1s (<i>Swift has 0.4 Crab</i>)
Volume (one module):	15 x 25 x 15 cm ³
Total Weight (25 modules):	< 50 kg (including mech. & electr.)
Total Power (25 modules):	< 50 W
Total Telemetry (event by event):	~ 600 kbit/s

Improvements and Optimizations

Things to think about:

- Different lay-out solutions
- Double-sided Si μ -strip detectors (real 2D localization, useful for all sky monitoring, but power doubles)
- Mask size larger than detector size (optimize FOV vs geometric area, but on-axis sensitivity decreases)
- Decrease Mask opening fraction (reduces wide field bkg and telemetry)
- Increase geometric area per steradian (costs x 2, benefits x $\sqrt{2}$)
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R&D and technology optimization:

- Decrease Lower energy threshold (work on ASIC)
- Increase detector thickness (rise energy upper bound and probably decrease load capacitance, increase bias HV)
- On-chip FET
- **Position sensitive SDD (see next slide) instead of Si μ -strip detectors**
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Mid-term Developments

For the “today’s solution” imaging separated from wide-band spectroscopy

If R&D work is allowed, the two instruments may evolve into a single instrument using the recently developed Controlled Drift Detectors (Castoldi, Gatti, Guazzoni, Struder, et al.) to increase the monitor sensitivity and simultaneously:

- 2D imaging of low energy X-rays (1-40 keV,)
- Reading-out the scintillator (30-300 keV) for spectroscopy

No technological obstacles to produce large areas, but requires significant investments and time.

