Dynamic Shack-Hartmann System
“RAPID”

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UNAM
PAPIIT IN104910
Telescopes OAN

OAN-SPM

- 2.1m telescope
- 1.5m telescope
- 0.84m telescope

OAN-Tonanzintla

- 1m telescope
Astronomical site SPM

Observing statistics
1982-2002 (Tapia+ 2007)

- “Photometric” nights: 64.1%
- “Spectroscopic” nights: 80.2%
- “Bad weather” nights: 21.2%

- Sky Transparency
  Extinction coefficients:
  - Visible: $k_y = 0.14$
  - Red: $K_R = 0.05$

SPM confirmed have largest fraction of clear nights of any site in the Northern Hemisphere
Sky Brightness in SPM

Brightness magnitudes

- $m_U = 21.7$
- $m_B = 22.4$
- $m_V = 21.5$
- $m_R = 20.7$
- $m_I = 19.2$
Astronomical site SPM

San Pedro Martir

- Good sky transparency
- Big number of clear nights
- Excellent image quality
- Photometric stability
- SPM is one of the darkest sites in the Northern Hemisphere
- SPM is good for IR observing
- So, we are looking for big telescopes

1.5m telescope
Telescopio Optico-Infrarrojo Mexicano (TIM)

- alt-azimuth mount
- Segmented mirror
- 6.5m > BTA
- (1996-2004)
SPM-Twin

- Copy of Magellan
- 2 x 6.5m telescopes f/4.5 :
  - WF-Spectroscopic Telescope
  - WF AO telescope
- (2005-2008)
Synoptic All-Sky Infrared Survey (SASIR)

- Magellan-inspired
- 6.5m mirror
- At least we have the mirror.
- (2008-...)

![Image of Synoptic All-Sky Infrared Survey (SASIR) instrument]
Rapid - Dynamic Shack-Hartmann

- All modern telescopes demand installation of adaptive system.
- So, we have to study of spatial and temporal characteristics of the wavefront distortions.
- We have chosen a Shack-Hartmann wavefront sensor:
  - It is simply
  - Compact data
**Rapid - Dynamic Shack-Hartmann**

1. **Collimator:**
   - Focal distance 200mm

2. **Lenslet-Array. Shack–Hartmann diaphragm:**
   - Consists of 48 lenses with a focal distance of 150 mm
   - Hexagonal arrangement to minimize the wavefront measurement errors
**Rapid - Dynamic Shack-Hartmann**

- **Image Intensifier Tube**
- Generation 2 (ЭП-10)
- Photocathode diameter, mm - 24.5
- Resolution, lp/mm - 33.8
- Photocathode sensitivity, μA/lm - 280
- Light gain, 30,000
- Dark background brightness, max, cd/m² - 2.5x10⁻³
- Signal-to-noise ratio - 4
- Consumption, max, mA - 35
- Mean time before failure, hours - 2,000
Rapid - Dynamic Shack-Hartmann

- **Light intensifier**
  - Generation 2 (ЭП-10) 3
  - Photocathode operating diameter, mm: 24.5 18
  - Resolution, lp/mm: 33.8 58
  - Photocathode sensitivity, μA/lm: 280 1500
  - Light gain: 30,000 42,000
  - Dark background brightness, max, cd/m2: 2.5x10^-3 0.4
  - Signal-to-noise ratio: 4 21
  - Consumption, max, mA: 35 20
  - Mean time before failure, hours: 2,000 10,000
Rapid - Dynamic Shack-Hartmann

- High-speed CCD
  - Based on SONY ICX055AL 1/3-inch CCD Image Sensor for CCIR B/W Camera
  - 25,50,100,200 fr./sec.
  - 200 is possible only for 256*288
- Electronic shutter
- Special processor
  - Calculate coordinates of the center of mass for each spot.
Rapid - Dynamic Shack-Hartmann

- Rapid Software:
  - Creation, saving or loading of RAPID protocols
  - Viewing and addition copies of the camera image, with tuning and textual comments saving
  - Execution of operation of data accumulation in "Master" (Wizard) mode.
steps

First step:

- choose of parameters of the camera
- assignment of the dark current.
- choose a video mode for reading data
- amount of frames, used for a dark level calculation.
- Shutter on/off
- amplification
steps

Second step:

- Parameters for Hartmann picture place calculation:
  - frequencies
  - 200/100/50 (for 256*288)
  - 100/50/25 (for 512*288)
  Hertz are available,
  amount of averaged frames:
  from 2 up to 1024
- Amplification of the camera
- Amplification of the II
- "Preview" for previewing the image.
Third step:
Choice of threshold meanings for Hartmann picture calculation. Appropriate buttons

Fourth step:
Save data on the memory

Fifth step:
Save on the hard disk
Rapid Software

In the same protocol also it is possible:

- write text of the comment
- save up to 50 mages directly from ccd.
The phase reconstruction is very fast and simple.
Hartmann method