MAGIC II

- Motivation for a second telescope
  What can we gain?
- The telescope
  What can we improve?
  Technological upgrades
- Schedule
  When and how do we build it?

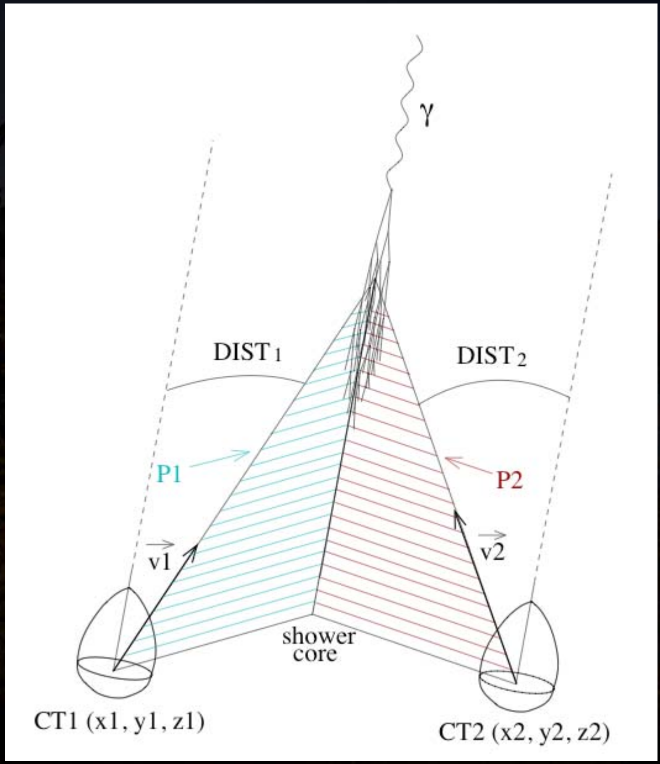
What do we gain with a second telescope?

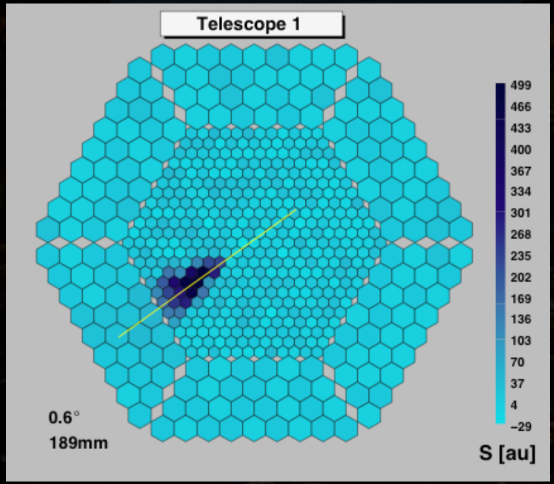
- Increase:
  - Sensitivity:
    - detect fainter sources
    - shorter observation times
    - better resolution of time variability of sources
  - Flexibility:
    - observe 2 objects simultaneously (e.g. flaring AGNs)
  - Angular and Energy Resolution
- Testbench for new technologies
  - higher Quantum Efficiency Camera

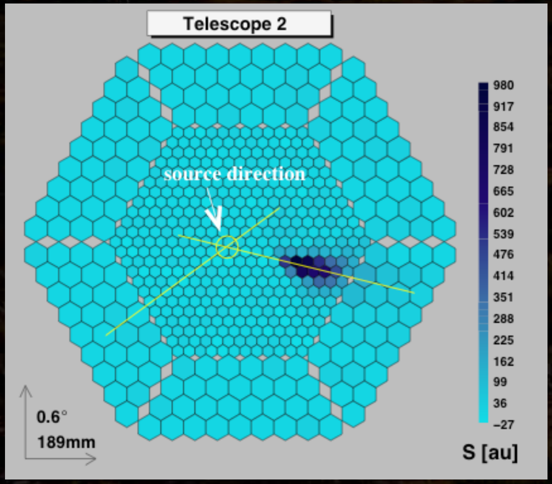
    => lower energy threshold

Monte Carlo Studies

- Stereo Analysis:
  - observe shower simultaneously with 2 telescopes
  - improve:
    - shower reconstruction (energy, arrival direction)
    - background rejection



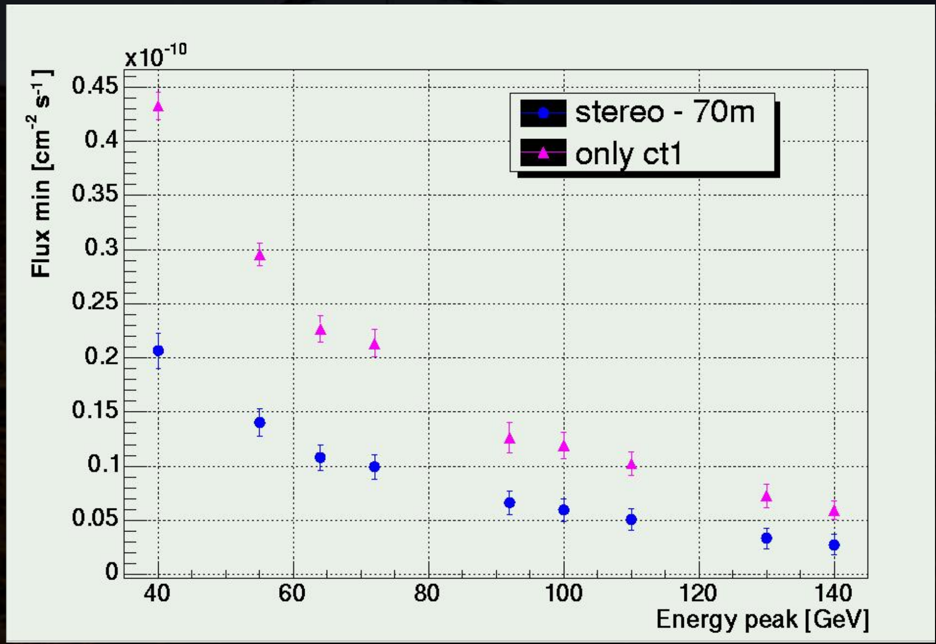




Monte Carlo Studies

Sensitivity (using Stereo Analysis):

- superior background rejection
- increase sensitivity by factor 2
- observation time to detect source reduced by factor 4 (instead of factor 2 for independent observation)

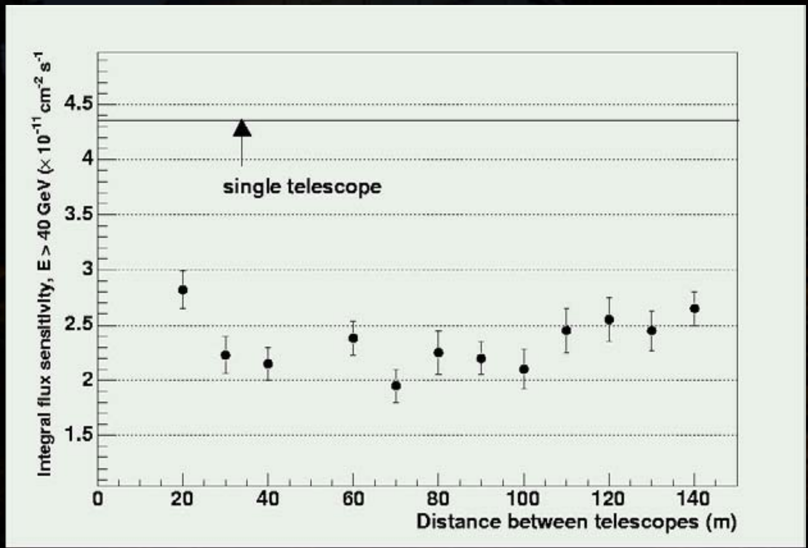


- little gain in **energy threshold** (see technological improvements)

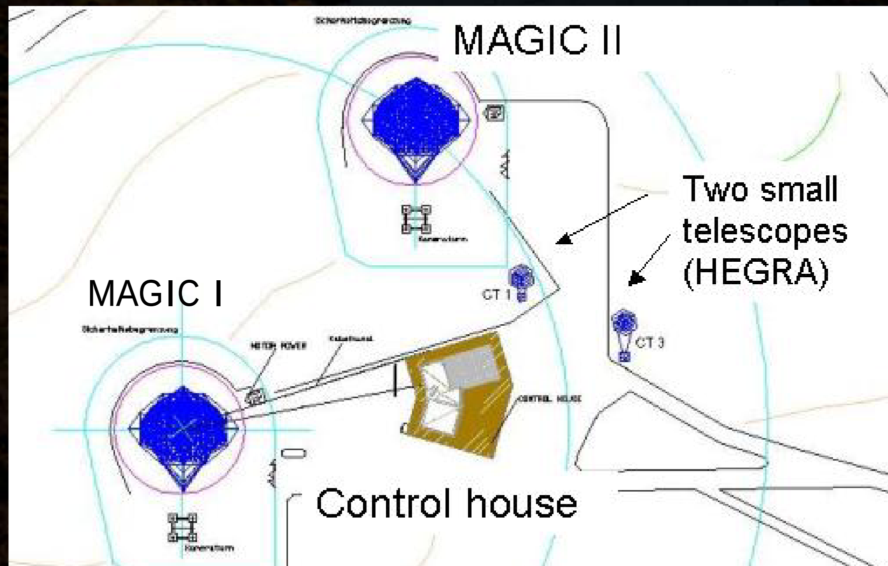
Monte Carlo Studies

optimum distance of telescopes

- wide optimum plateau in sensitivity between 40 and 100 m
- useful since effective distance depends on zenith angle



planned distance: 85 m



MAGIC II: "improved Clone"

technological improvements:

(=> lower energy threshold)

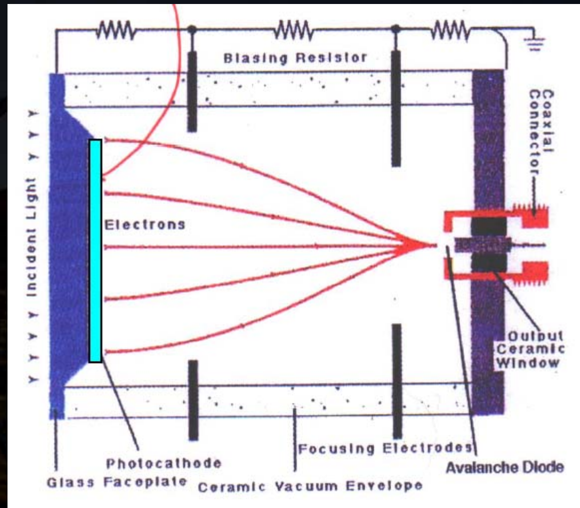
- high(er) Quantum Efficiency Camera
  - high QE PMTs
    (several companies working on QEs improvements up to 35 %)
  - HPDs (QE up to 50%)
  - long term: SiliconPMs
    (QE up to 60 - 90% possible)

- Fast 2Gsamples/sec Digitization
  - multiplexer FADC (already for MAGIC I)
  - switch capacitors (development by PSI & Pisa)

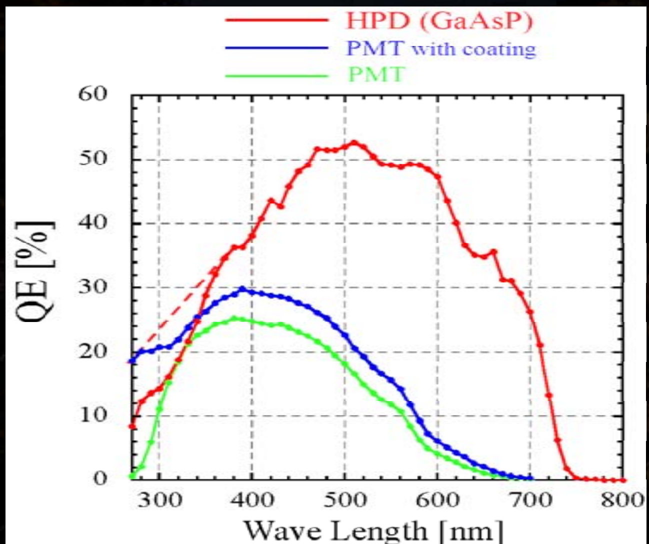
Hybrid Photo Detectors

maturing technology after long, fruitful collaboration with industry

- Principle:
  - high QE GaAsP Photocathode
  - vacuum tube operated at 6-8 kV
  - Avalanche Diode (~300 V)



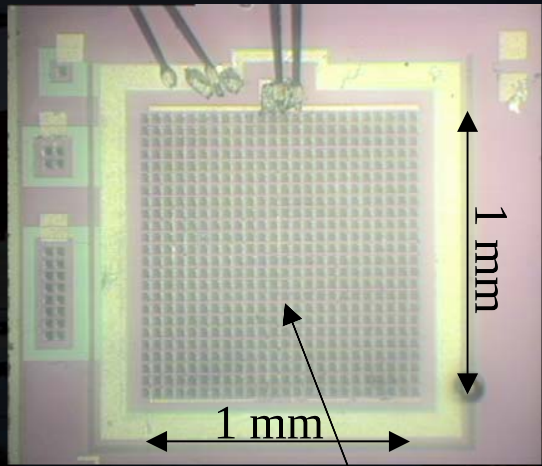
- Goals in agreement with Hamamatsu:
  - high QE (50% achieved)
  - 18 mm diameter detectors (existing)
  - lifetime > 10.000 h (recently achieved)

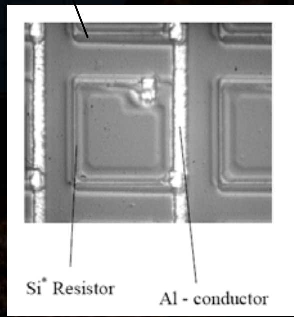


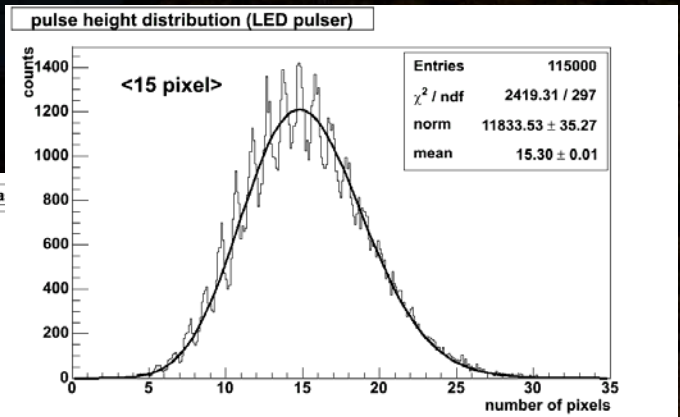
- application to equip MAGIC II with HPDs
- positive response by MPG

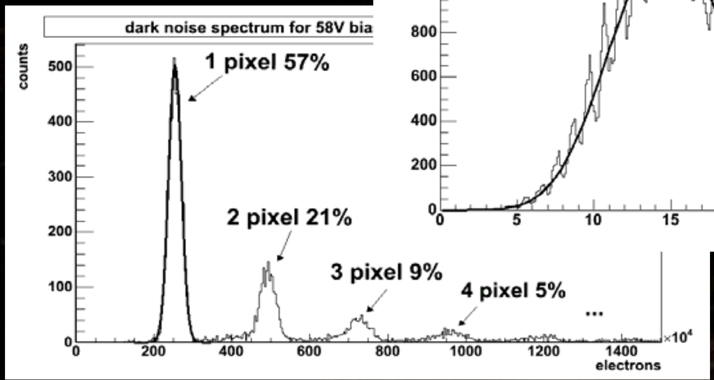
Silicon Photomultipliers

- matrix of avalanche diode pixels operated in limited Geiger mode
- Characteristics:
  - very good multiple photo electron resolution
  - potentially very high QE (60 - 90%)
  - Ultra-fast signal response
- Challenges:
  - high dark noise rate
  - cross talk between pixels





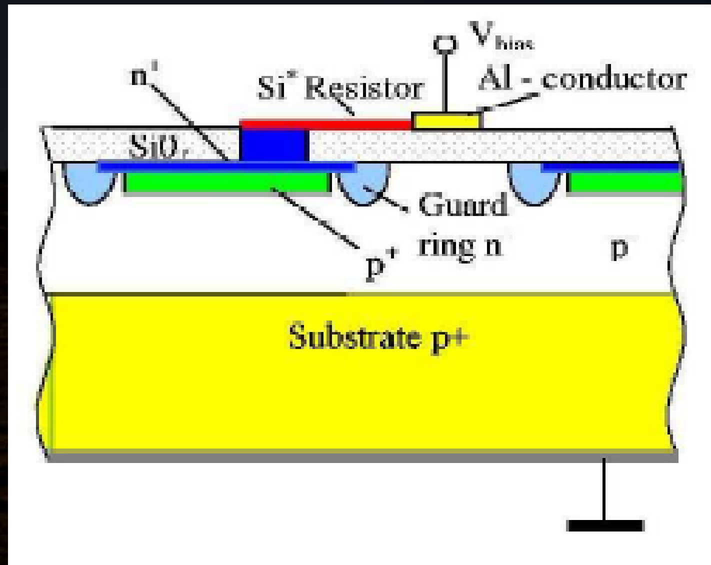


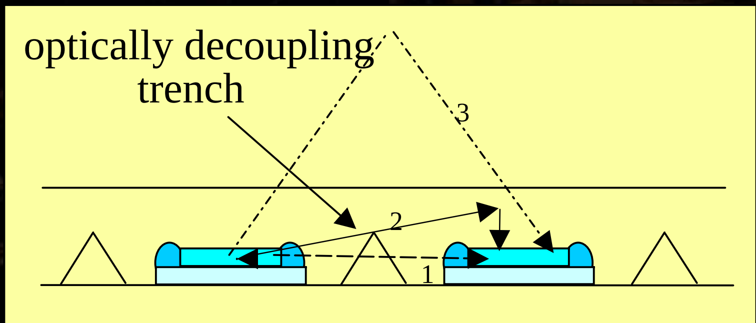


SiPM: collaboration with MEPhI & Pulsar

Goals:

- 10 x 10 mm^2 (orig. 1 x 1 mm^2)
  (5x5 mm^2 expected next year)
- keep pulse width small (<2 nsec)
- increase QE up to 60 %
  (40% expected next year)
- dark noise 1/10 of the LONS
  (cooling down to -40 C)
- limit cross talk < 1%





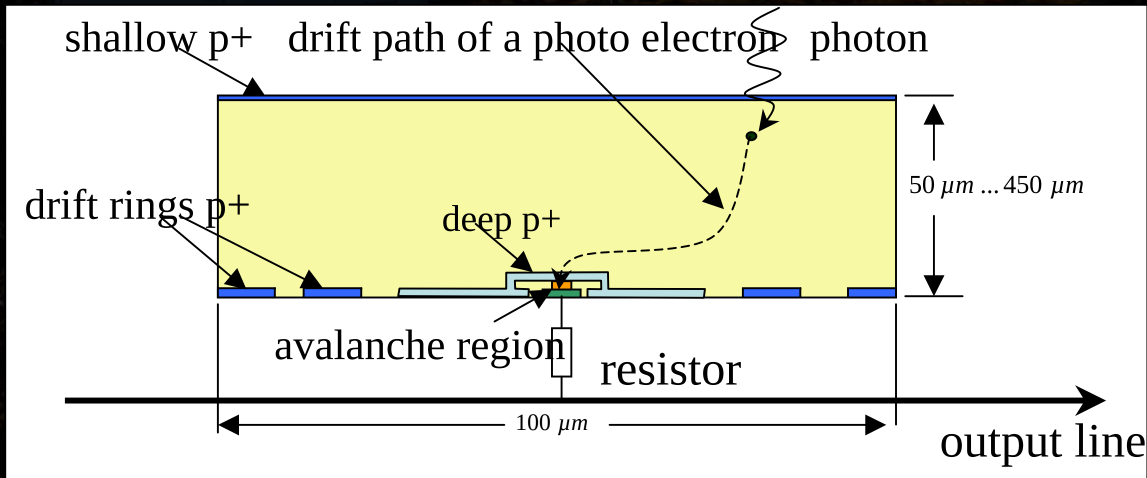
- cross talk caused by IR photons exciting neighboring pixel

SiPM: development in Halbleiter Labor for MAGIC & EUSO (patent pending)

- idea: back-illumination:
  - 100 % active area & no photon absorbing top layer

=> very high Quantum Efficiency possible (up to 90 %)

- challenges:
  - pulse width (< 2nsec)
  - dark noise (large drift volume => large noise)
  - cross talk (keep order of magn. smaller than physics noise)

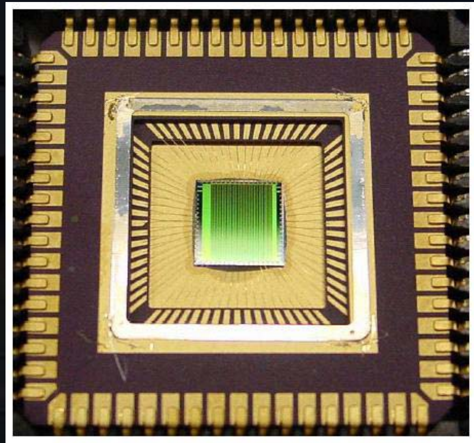


MPI activities:

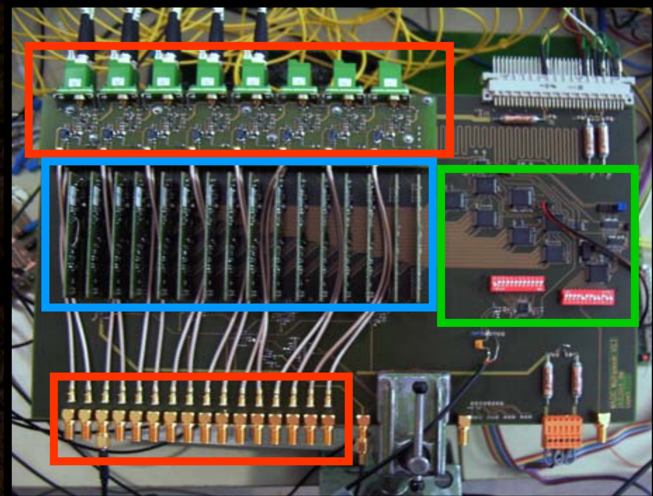
- 1 phpostdoc
- 2 PhD
- 1 diploma student

Strong support by MPG !

2Gsample/s Digitization



- default solution:
  - "Domino" switch capacitor array (PSI & Pisa development)
  - fast (~ 2GHz) analog sampling in array of capacitors
  - slow (40 MHz) readout and external digitization
  - available end of 2006?



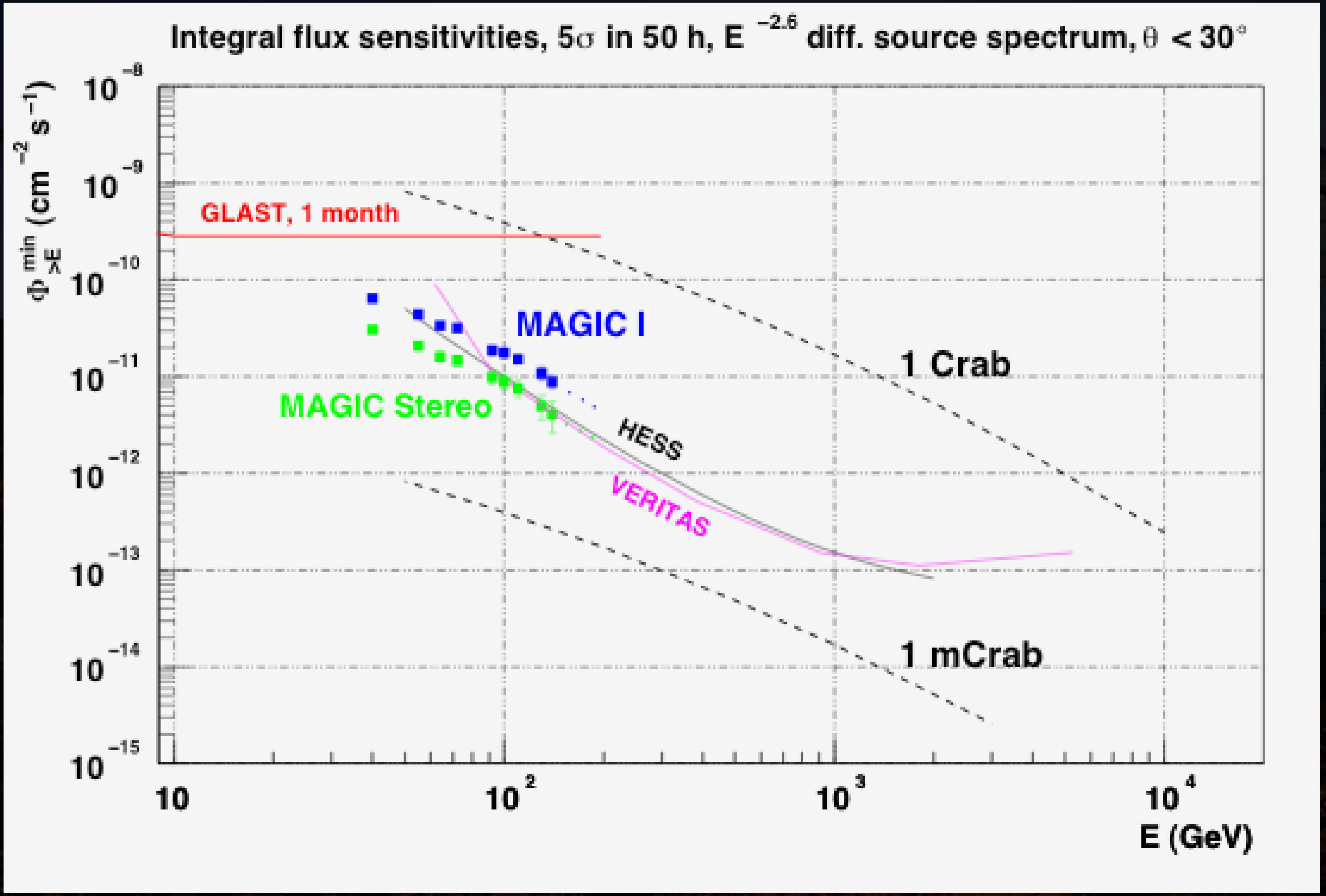
- backup solution:
  - 2GSamples/sec multiplexed FADC with optical delays (MPI development to be installed in MAGIC I)

Schedule

- Operational latest in 2007 (before GLAST launch)
- Telescope structure installed in La Palma by fall 2005
  - large part of mechanical constuction completed by MPI
  - Tendering of concrete foundation early 2005
- MPI finances largely secured. Collaborators contibutions starting 2005
- Task distribution:

– telescope structure (include drive system)	MPI, German Univ.
– mirrors	Italy
(prototype tests)	Italy, MPI
– Active Mirror Control	ETH
– light sensors (PMTs, HPDs)	MPI, German Univ.
– camera (design & construction, possibly second high QE camera)	MPI
– Lasers (VCSELs) for analog optical transmission	Spain
– optical fibers	MPI
– optical receiver boards	Spain
– FADCs	Italy & MPI
– Trigger & DAQ	Italy
– Central Control	Spain
– Software	All

backup slides



Integral flux sensitivities, 5σ in 50 h, E −2.6 diff. source spectrum, θ < 30°
Φ min >E (cm −2 s −1)
GLAST, 1 month
MAGIC I
MAGIC Stereo
1 Crab
HESS
VERITAS
1 mCrab
E (GeV)