LASER ALTIMETER FOR PLANETARY EXPLORATION
Technology Demonstrator

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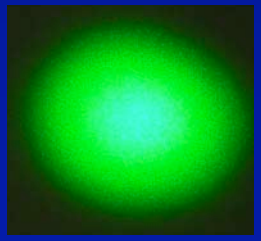
Goals:

- To develop a modular test equipment:
  Technology Demonstrator to test critical components and technologies of the photon counting
  Laser Altimeter for Planetary Exploration LAPE.

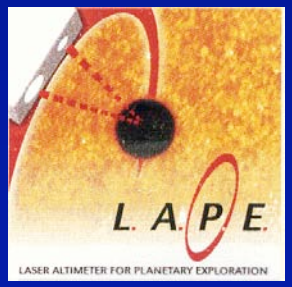
- CRITICAL COMPONENTS
- microlaser multi kHz
- detector SPAD / ADP
- optical filter

- CRITICAL PROCEDURES
- energy budget link & S/ N ratio
- data acquisition and processing
- signal mining techniques



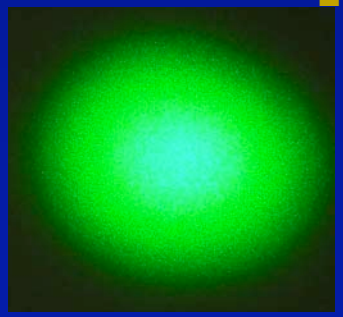
LAPE Parameters

Altitude	400 – 1000 (1400) km
Resolution	1 meter
Background	day and night operation on planetary orbit
Concept	photon counting multi kHz repetition rate
Mass / Power	5 kg / 10 W
Optics	separate T / R
receiver	reflector, 150 mm
transmitter	refractor 30 mm



LAPE Technology Demonstrator
Philosophy

- Based on experience acquired in space projects MARS and Mars Polar Lander
- Use of off-shelf components whenever possible
- Optical apertures scaled down
  to enable indoor and ground based tests
  of energy budget link
  (Difficult to test 1000 km / vacuum baseline)
- Receiver FOV and filter bandwidth scaled up
  to enable indoor and ground based tests
  of the S/N ratio and signal processing techniques

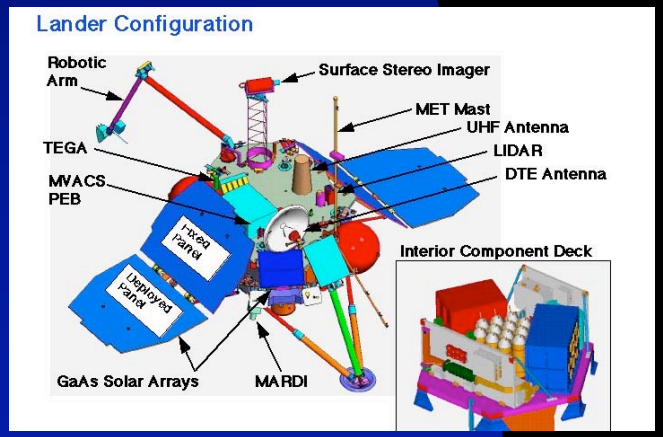


Photon Counting Laser Altimeter & Lidar

Project MARS 92, Russia

- Laser diode 100nJ / 2kHz
  Optics 30 x 50 mm
- Receiver Si SPAD 40 um
  Optics 20 mm diameter
- altimetry 0 - 5 km
- visibility 0 - 50 km
- clouds heights, density
- mass 400+400+100 900 g
- power average < 30 mW
  peak < 4 W (LD heat)

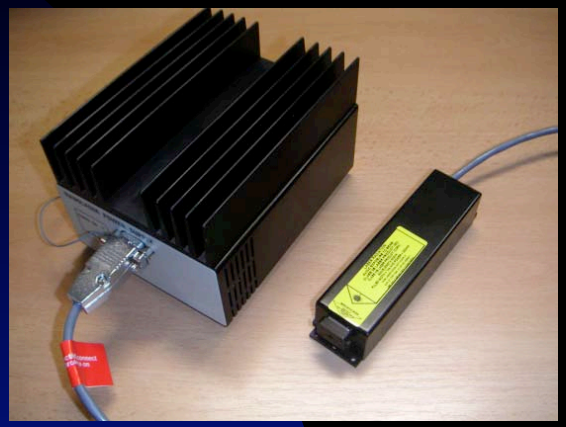
NASA Mars Polar Lander 98



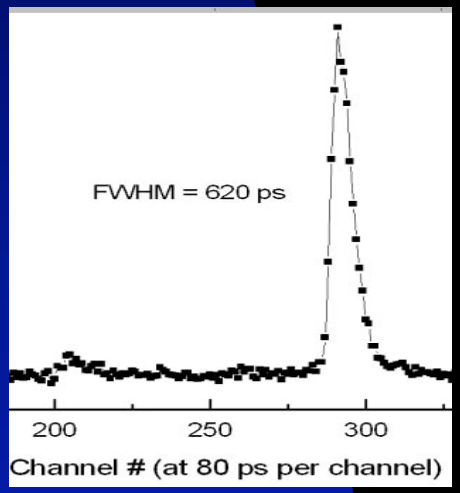
S.P.Pershin et all, IKI Russia

I.Prochazka,K.Hamal, CTU Prague, June 2004

LAPE Technology Demonstrator LASER TRANSMITTER



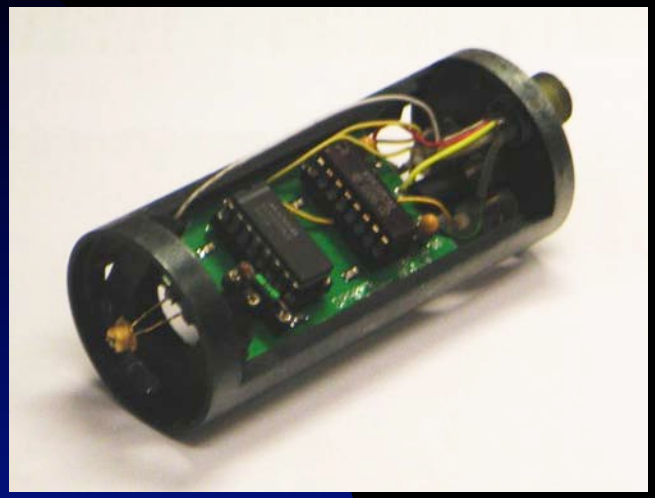
- diode pumped microlaser
- frequency doubled NdYAG
- 10 mW @ 532nm , 10 kHz
  = > 1 uJ / shot



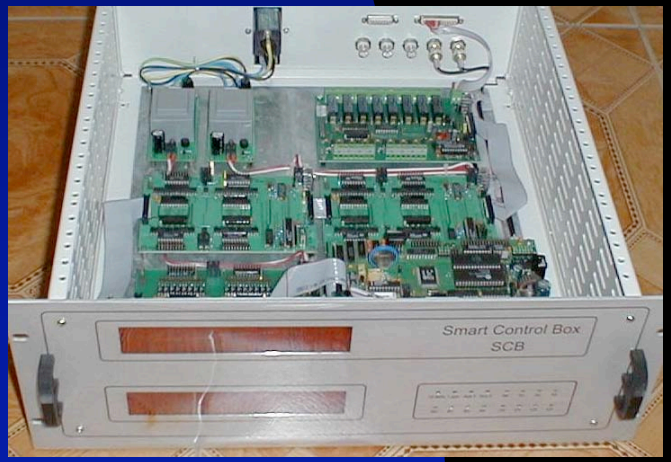
FWHM = 620 psec

TEM_{00} mode
divergence 4 mrad

LAPE Technology Demonstrator
Detector, Timing and Control



- DETECTOR PACKAGE
- # 1 SPAD on Silicon K14
- 25 um diameter, uncooled
  space qualified
- cw / gated, active quenching
- # 2 APD @ 1064 nm, cooled
  made by Silicon Sensosrs



- TIMING & CONTROL
- program. gate arrays 100MHz
- interval & epoch timing
- range gating
- µP controller

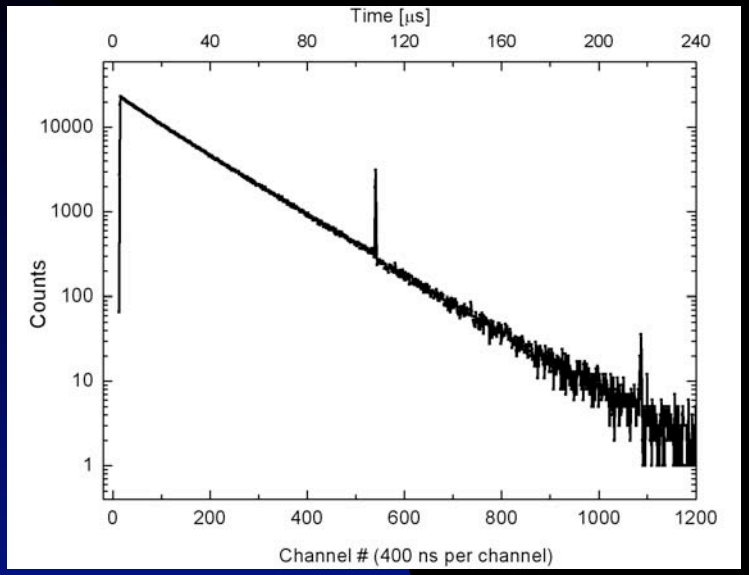
LAPE Technology Demonstrator

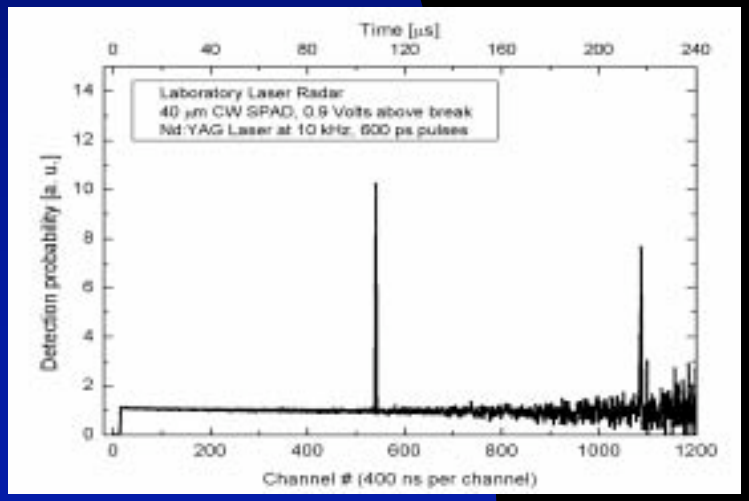
Energy Budget Link and S / N Scaling

- PHASE A indoor / static
- energy budget reduced $2.3 * 10^{10}$
- = > range reduced $1.5 * 10^{5}$
  1 -10 m indoor corresponds to 150-1500 km in orbit
- backgound increased $1 * 10^{1}$
  Earth dayligh corresponds to Mercury dayligh

- PHASE B outdoor / air-born / dynamic
- energy budget reduced $2.3 * 10^{6}$
- = > range reduced $1.5 * 10^{3}$
  100-1000 m ground corresponds to 150-1500 km in space
- backgound increased $1 * 10^{1}$
  Earth dayligh corresponds to Mercury dayligh

LAPE Technology Demonstrator
Energy Budget Link and S / N Test Results





- INDOOR RANGING, Phase A
- 1.5 m distance < = > 225 km
- 10 kHz @ 532 nm laser
- high noon background
- raw data histogram, log scale
- echo data rate 100 / s
- window 240 us ~ 36 km

- the same data set converted to detection probabilities

- demonstrates the feasibility of 30 km wide range gates in daylight on a low altitudes

I.Prochazka,K.Hamal, CTU Prague, June 2004

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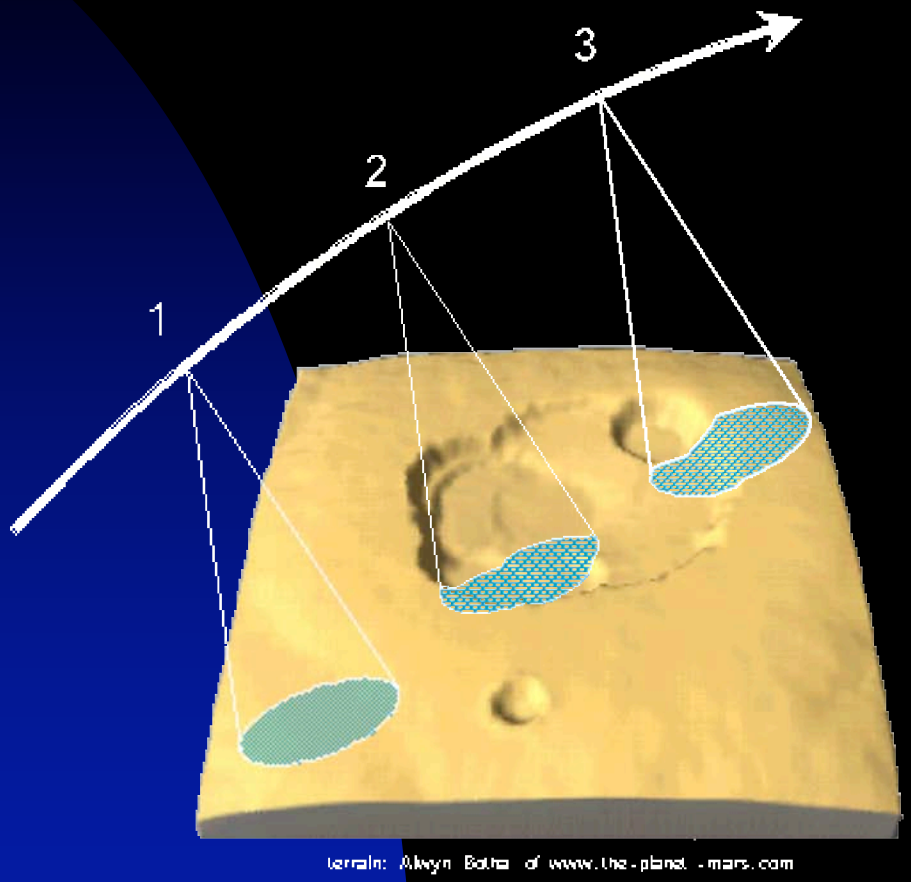
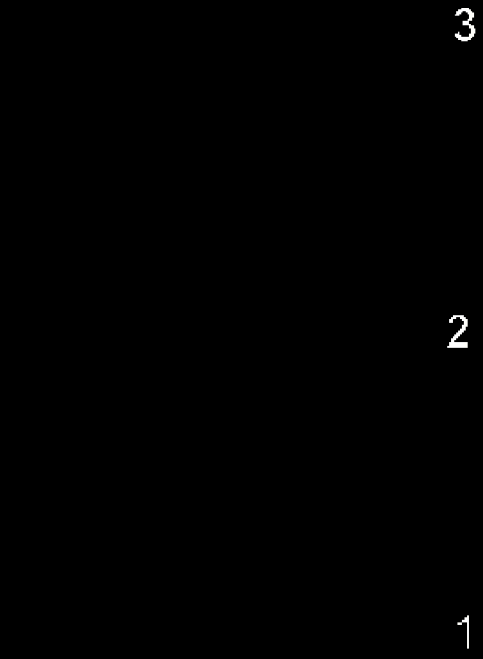
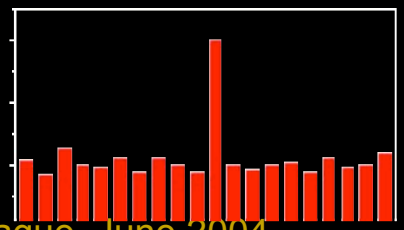
Planet Topography Contribution to S/N Ration Degradation







J. Blazej, "LAPE simulator" ,
SPIE Remote Sensing, Sept. 2004

LAPE Technology Demonstrator
Conclusion

- The Technology Demonstrator of the photon counting Laser Altimeter for Planetary Exploration LAPE is under development

- PHASE A indoor / static tests
- the Demonstrator version A - operational 10kHz / 1uJ @ 532 nm / SPAD
- - energy budget link
- - S/N ratio for daylight
- the planet topography contribution simulator under construction

- PHASE B outdoor / air-born / moving objects tests
- 2 kHz/ 10 uJ @ 1064 / APD
- project funding dependent