# The Graz SMART-TT: Smart Transmit Telescope

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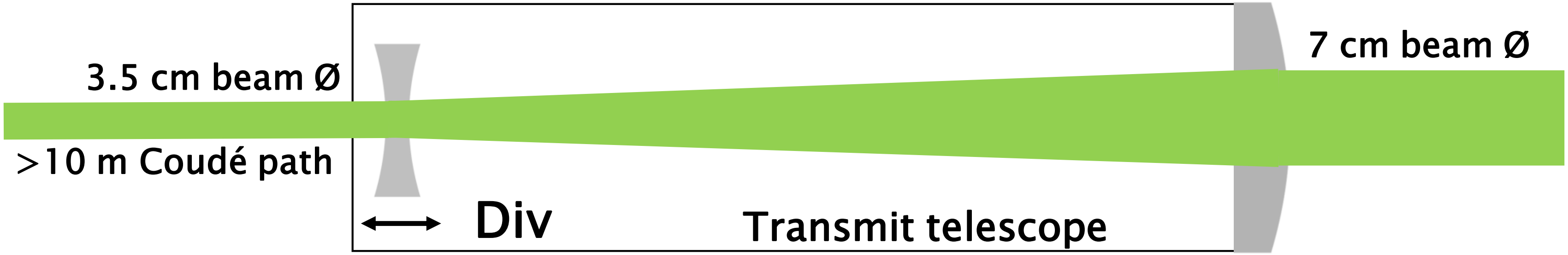
# Basic transmit telescope (Coudé Path System)

- Our >10 m long Coude path has a diameter of 5 cm; needs 3“ diameter mirrors
- Our transmit telescope has a final diameter of 10 cm
- However, we can allow only for a 7 cm beam diameter maximum:
  - Long (10 m) Coudé path, low stability etc; the rotating beam needs space ….
  - Our min. beam divergence is ≈ 5“ (25 µrad) FWHM (meas. with LAGEOS SLR)
  - With usual atmospheric seeings in Graz of several arcsecs, this is okay…




Basic transmit telescope: From 5 cm input to 10 cm output (maximum);
Graz values: ≈ 3.5 cm input beam Ø; ≈ 7 cm output beam Ø

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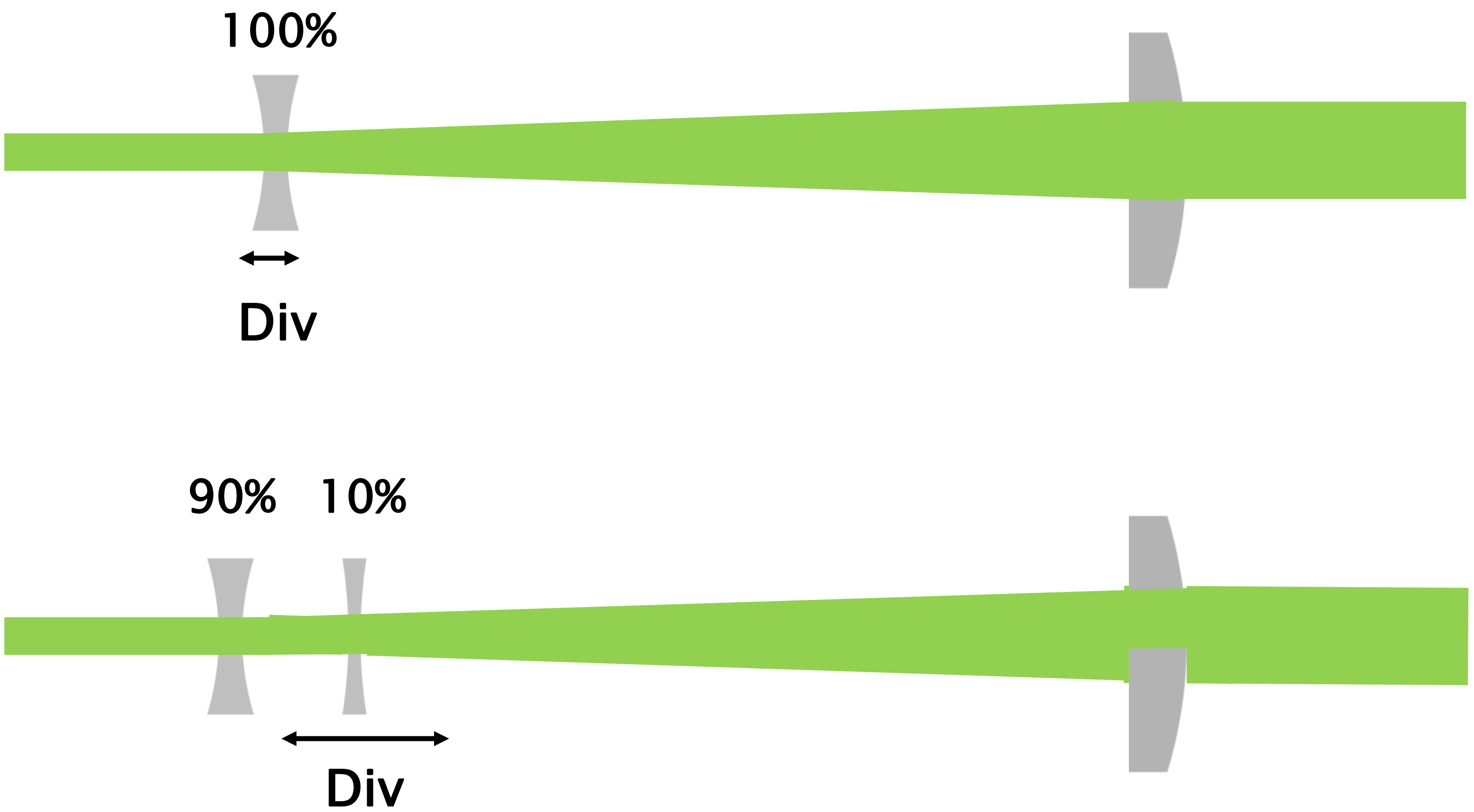
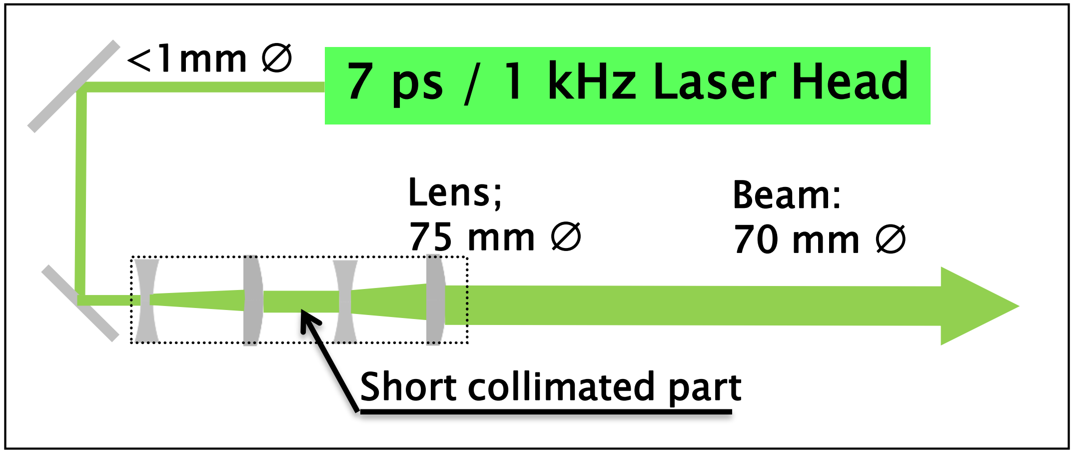
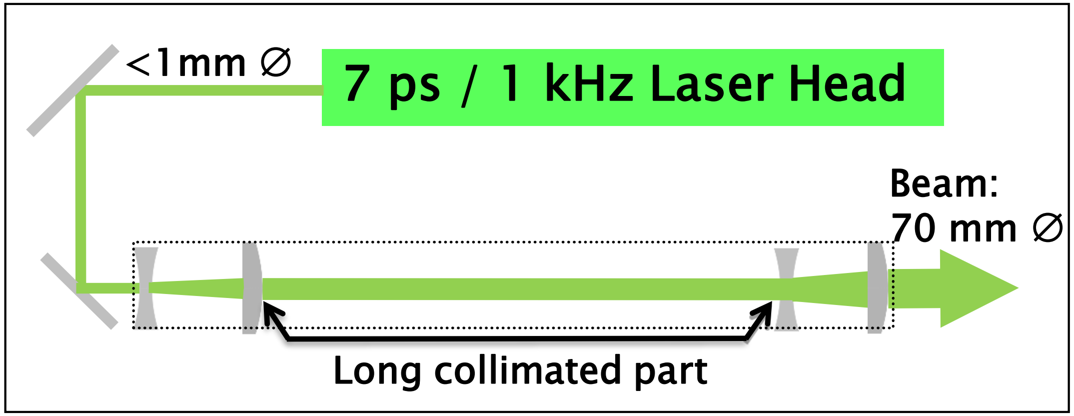
# Basic Transmit Telescope, as used in Graz (Coudé Path System)




Splitting the diverging lens, relaxes the position accuracy requirements
( © Contraves USA – they produced our mount / telescope >40 years ago ☺)

# Transmit telescope design, without Coudé path: Laser mounted on an ASA receive telescope



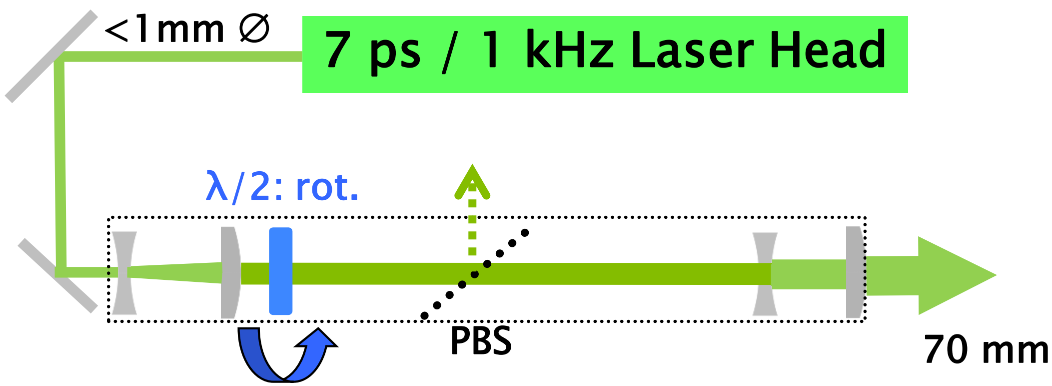

- The Transmit telescope design allows easy adaption to available space

  The long collimated part allows to add additional optical systems

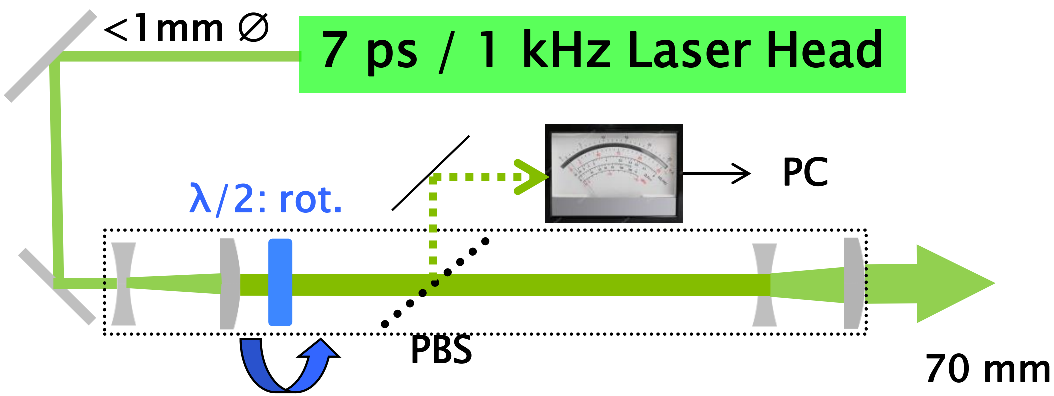
  75 mm ø **lenses are COTS**

  **70 mm ø beam allows a minimum divergence of 25 µrad (5“): Sufficient for low power SLR to GEOs**

# The long collimated part allows various options



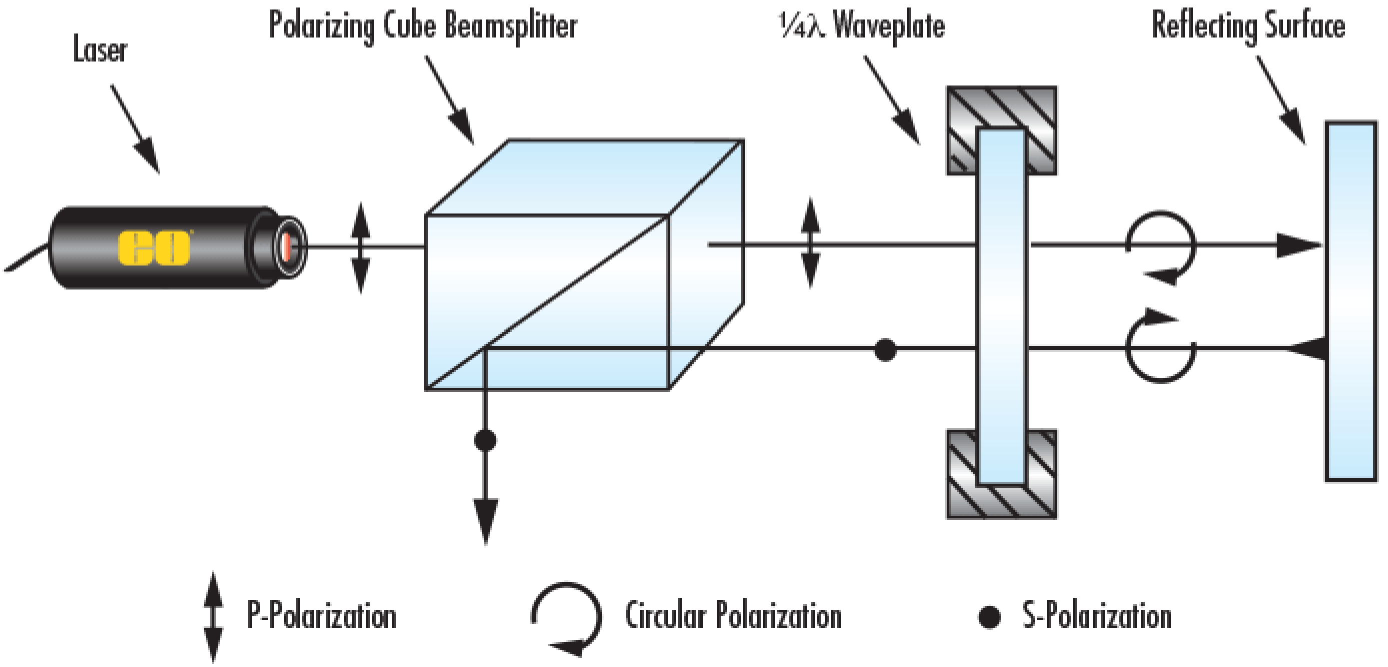

- A rotatable $\lambda/2$ waveplate plus a polarizing beam splitter (PBS) allows continuous attenuation of the laser beam energy: From 100% to $\approx$ 0% (e.g. to maintain single photon receiving)



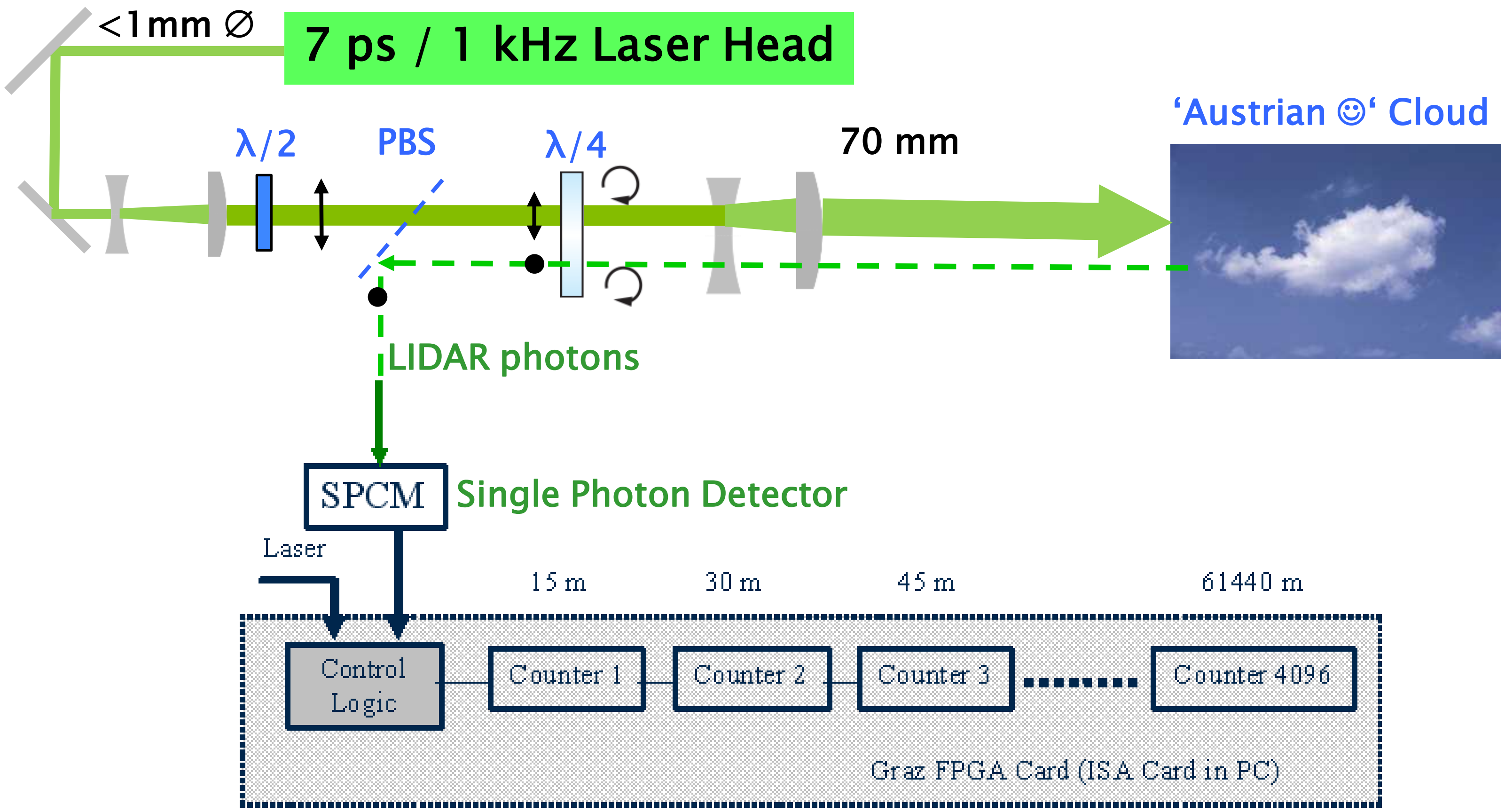

- It can be used also for simple laser beam energy measuring:

  => To check laser operation
  => To monitor output energy during ranging etc.

# Smart Transmit Telescope: Use it as a LIDAR! The basic principle:



# LIDAR integrated into the Transmit Telescope

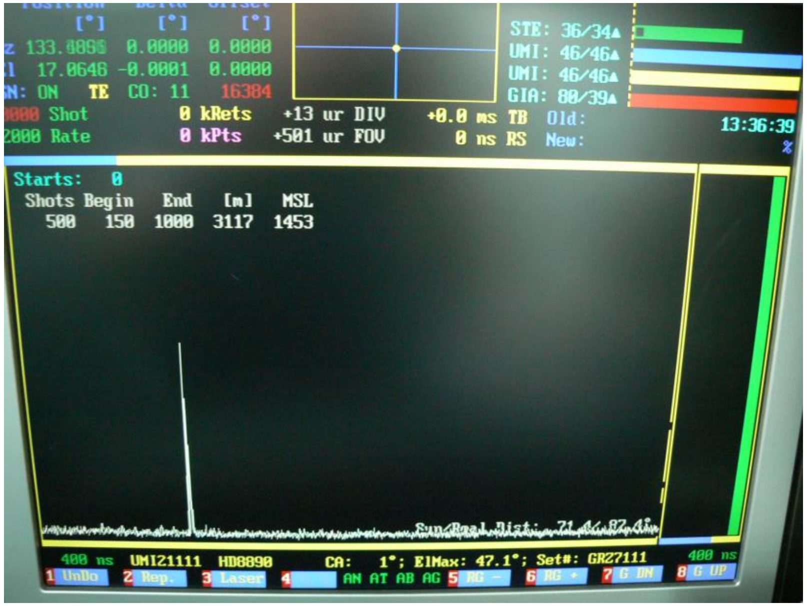



Each counter counts the # of photons coming from a certain 15 m interval (100 ns)

Max distance with 4096 counters (in FPGA) thus is > 61 km

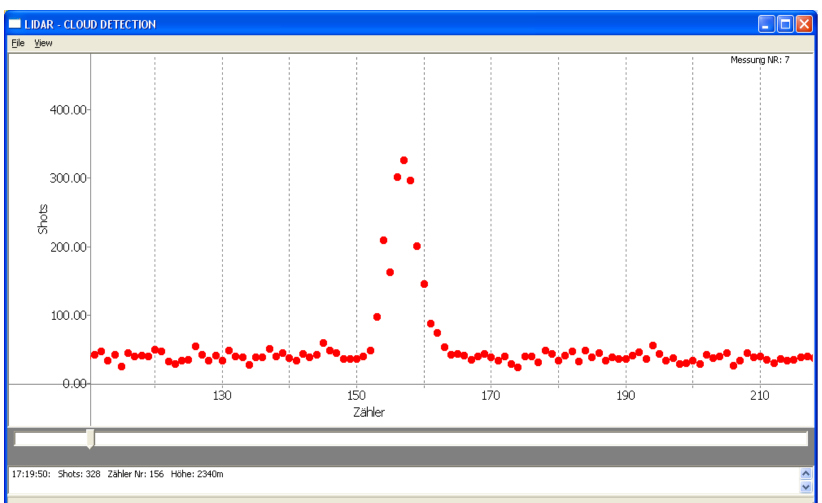
With 1 kHz rep rate, we get good averages within << 1 s

# LIDAR Real Time Display / ‚Cloud Bit‘



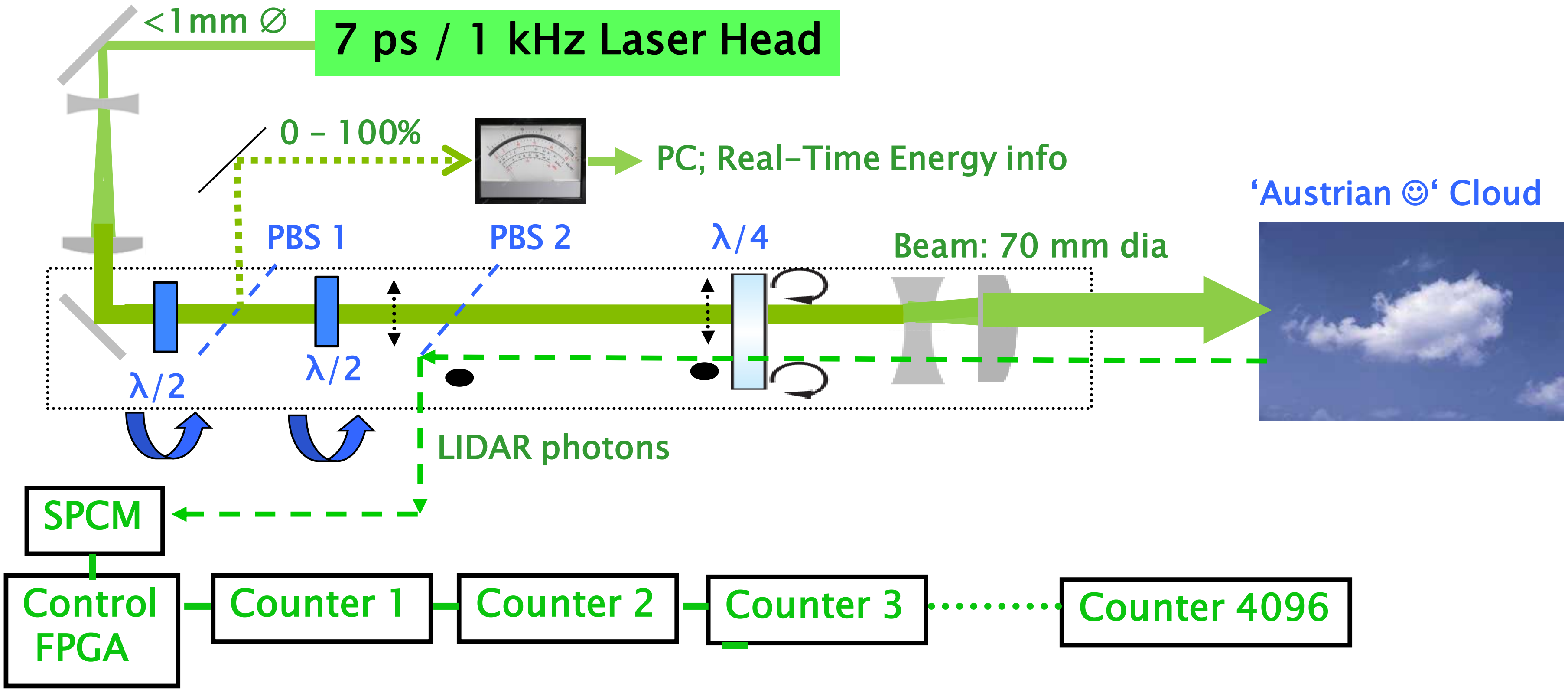

- Real-Time display of a cloud in a distance of 3117 m, in 1453 m MSL
- For Graz SLR: Nice enhancement for the human observers ☺

> *For any automatic SLR system this allows a reliable check for clouds*
>
> *Without this: Any automatics will start a (useless) search procedure ☹*




- LIDAR data points, showing a thin cloud in counter # 156 (≈2350 m)
- Cloud Altitude: 2340 m (calculated from distance and elevation angle)

# Combining LIDAR + Attenuation + Energy measurements into the Transmit Telescope




Perfect info [„**cloud / no cloud bit**"] for autonomous SLR systems

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# Thank you !

http://www.youtube.com/watch?v=5o6OtPJKRJ8
Video of Graz SLR station ranging to ILRS satellites