THE KASSEL LABORATORY ASTROPHYSICS THZ SPECTROMETERS

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P1899, ISMS Meeting, Urbana Champaign 2016
10 min, Thursday, 2016-06-23
01:30 PM - 01:40 PM,
Medical Sciences Building 274

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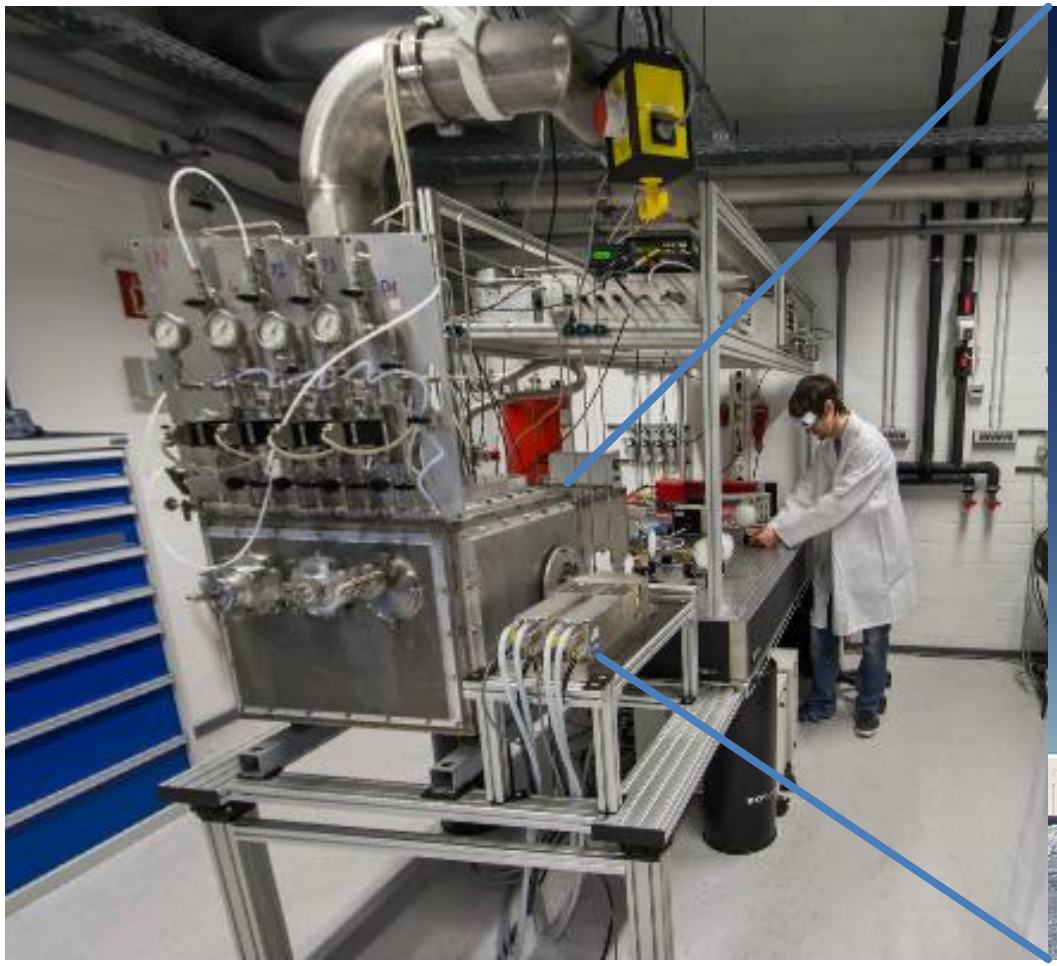
Abstract:
We present a brief overview of the recently established laboratory astrophysics group in Kassel/Germany with a focus on our THz technology. After an outline of our laboratory equipment and recent projects the talk will focus on our new fast spectral scan technique for molecular jet experiments. Here, a new test setup for broadband fast sweep spectrometry in the MW to submm wavelength region has been realized and can be applied to identify transient molecules in a supersonic jet. An arbitrary waveform generator (AWG) is used to generate chirped pulses with a linear frequency sweep in the MHz regime. Pulse durations are of a few microseconds. These pulses are up-converted in frequency, e.g. into the 50 GHz microwave frequency range utilizing a synthesizer, or using a synthesizer plus standard amplifier multiplier chain (AMC) to reach the 100-300 GHz region. As test, NH3 has been measured between 18-26 GHz in a supersonic jet of 500 µs duration. Acetonitrile (CH3CN) was tested in the (90-110) GHz range. The spectrometer is capable of providing fast, broadband and low-noise measurements. Experiments with non-stabel molecular production conditions can greatly benefit from these advantages. The setup enables the study of Vander-Waals-clusters, as well as carbon chain molecules and small metal-containing refractory molecules when combined with appropriate molecule sources.

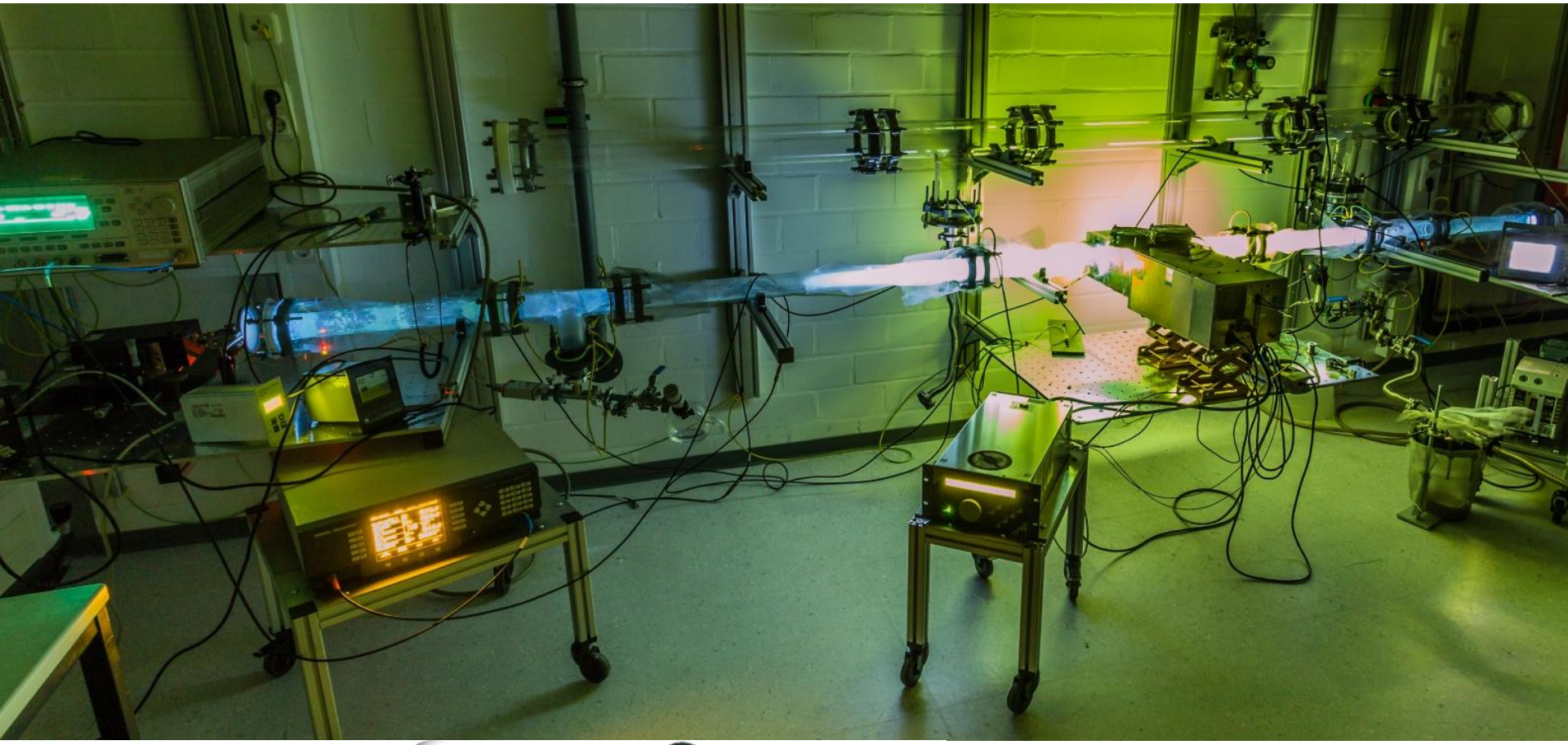
Kassel at the Heart of Germany

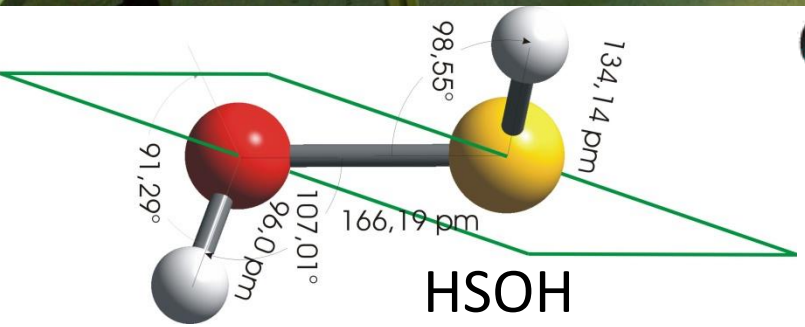
Astrophysics in Kassel since 2012:
Laboratory studies and astrophysical observations

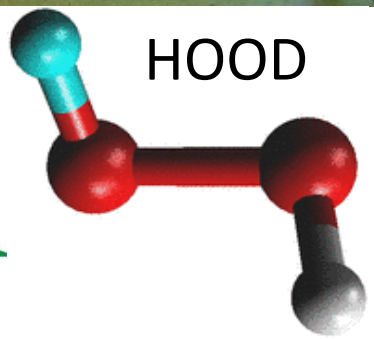


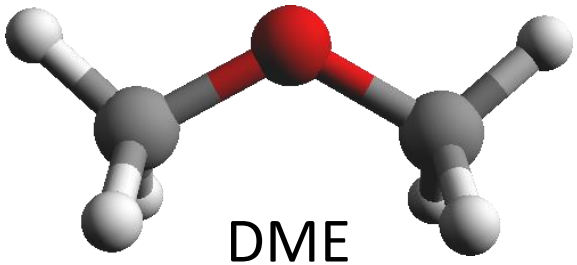
Laboratory in Kassel

Kassel THz Spectrometer





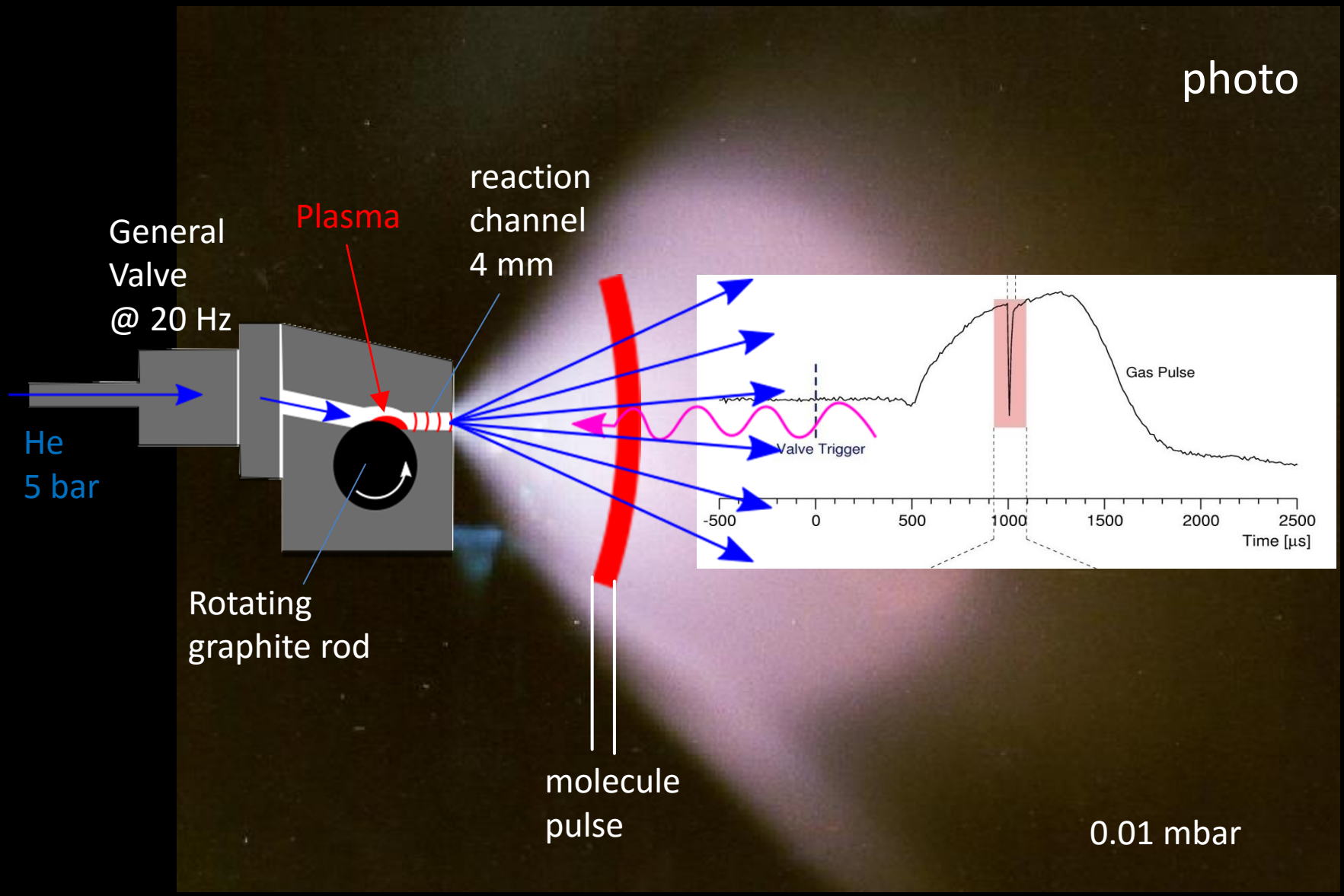


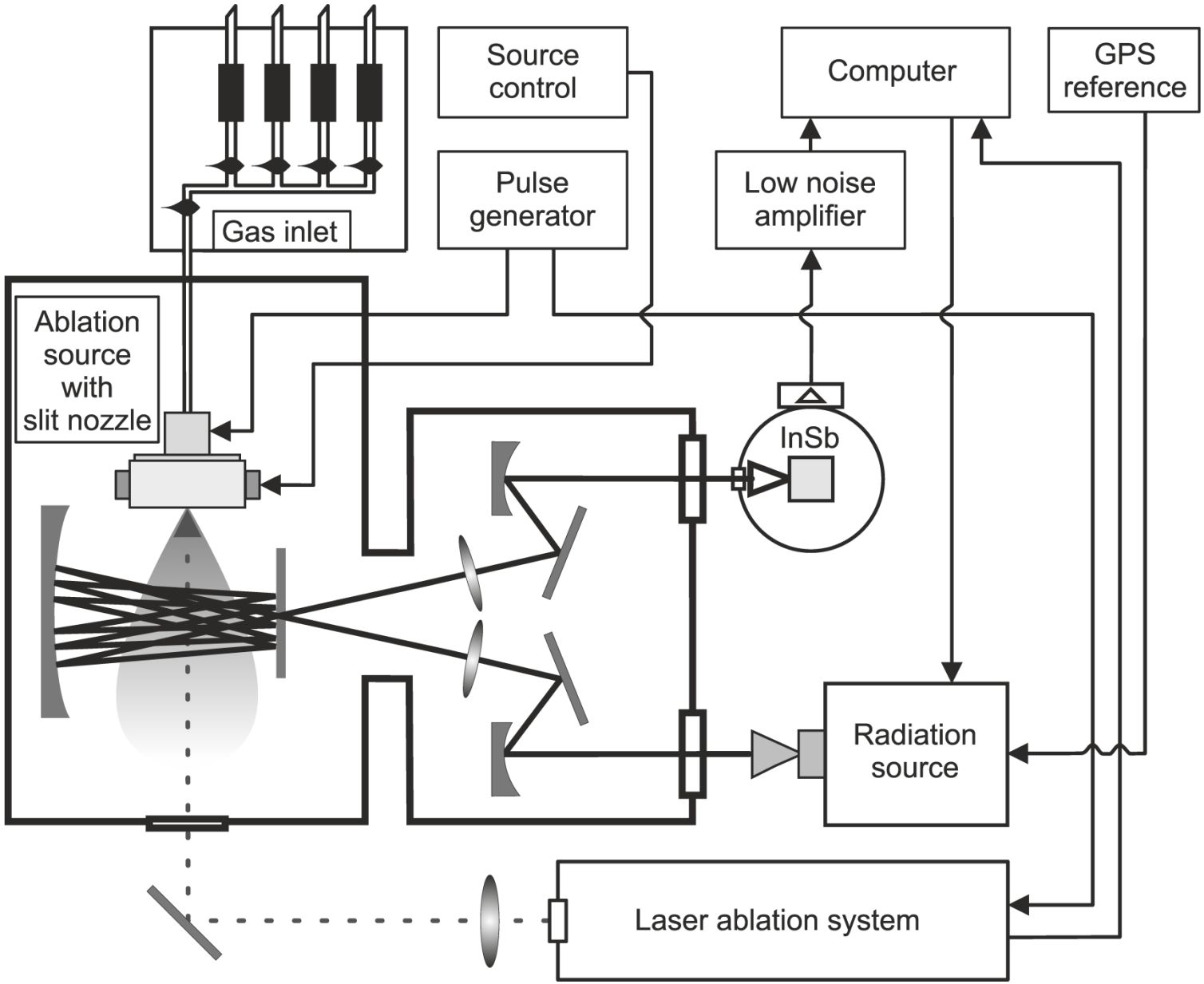


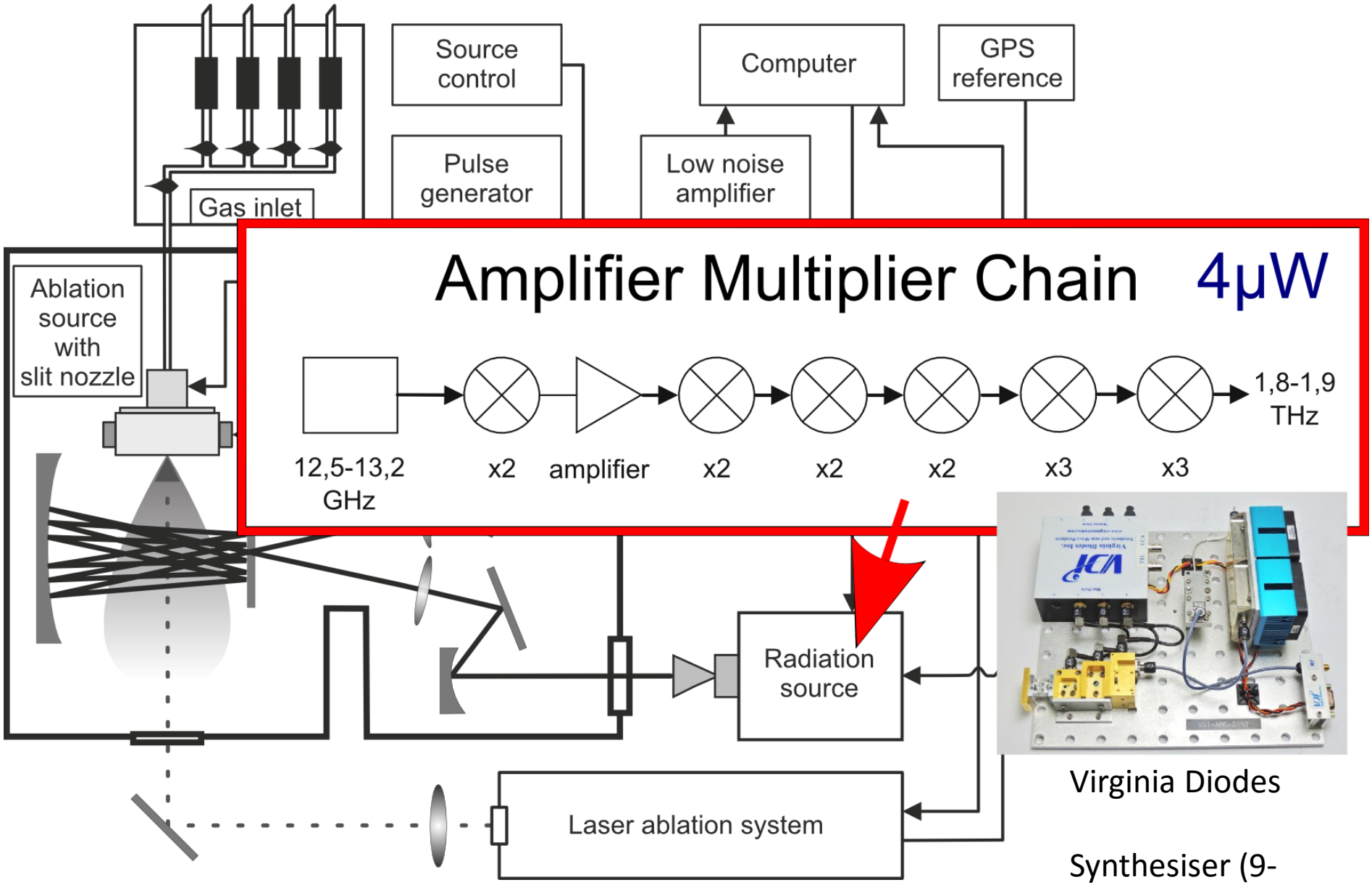
Kassel THz Jet Spectrometer

laser ablation / dc discharge supersonic jet

Laser ablation production of pure carbon molecules in a supersonic jet

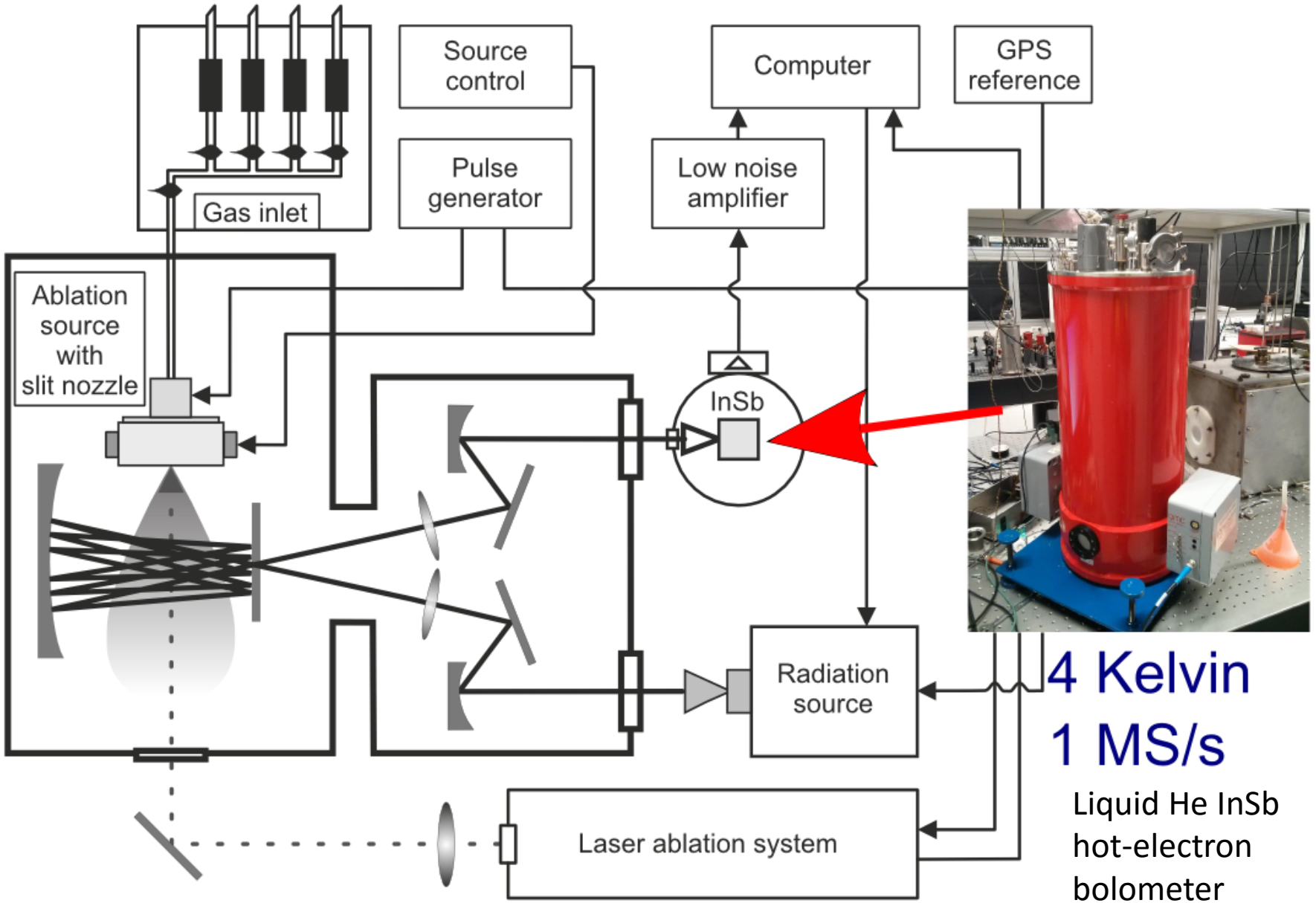



Source control
Computer
GPS reference
Pulse generator
Low noise amplifier
Gas inlet
Ablation source with slit nozzle
InSb
Radiation source
Laser ablation system



Virginia Diodes

Synthesiser (9-14 GHz) x 144



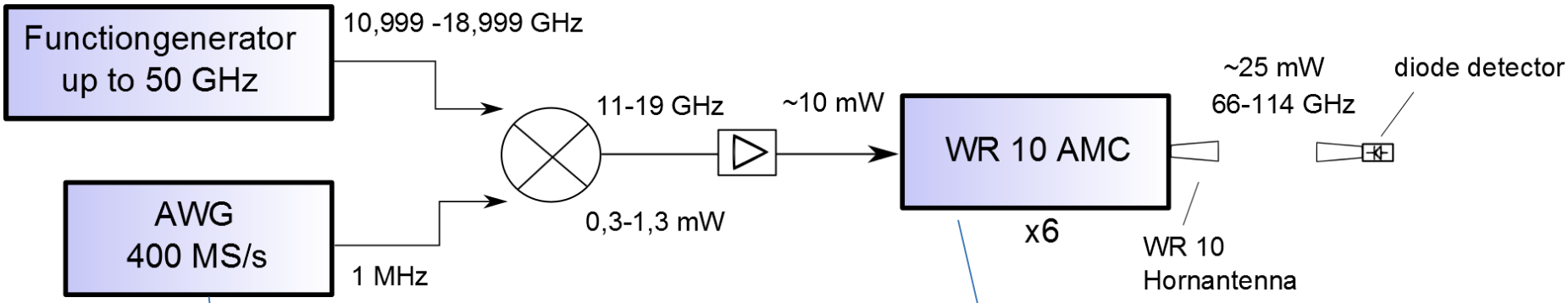
4 Kelvin

1 MS/s

Liquid He InSb hot-electron bolometer (QMC instruments)

Problem:

- Scan modus (freq step-by-step), 10-15 µs time per pulse
- Molecule production can vary from pulse to pulse
  ⇒ Intensities of lines can vary (extreme: missing lines)
- For automated scans equal conditions per spectra wanted
  ⇒ Fast sweep modus



16 bit resolution,
145 MHz bandwidth

Test measurements on acetonitrile (CH_3CN)

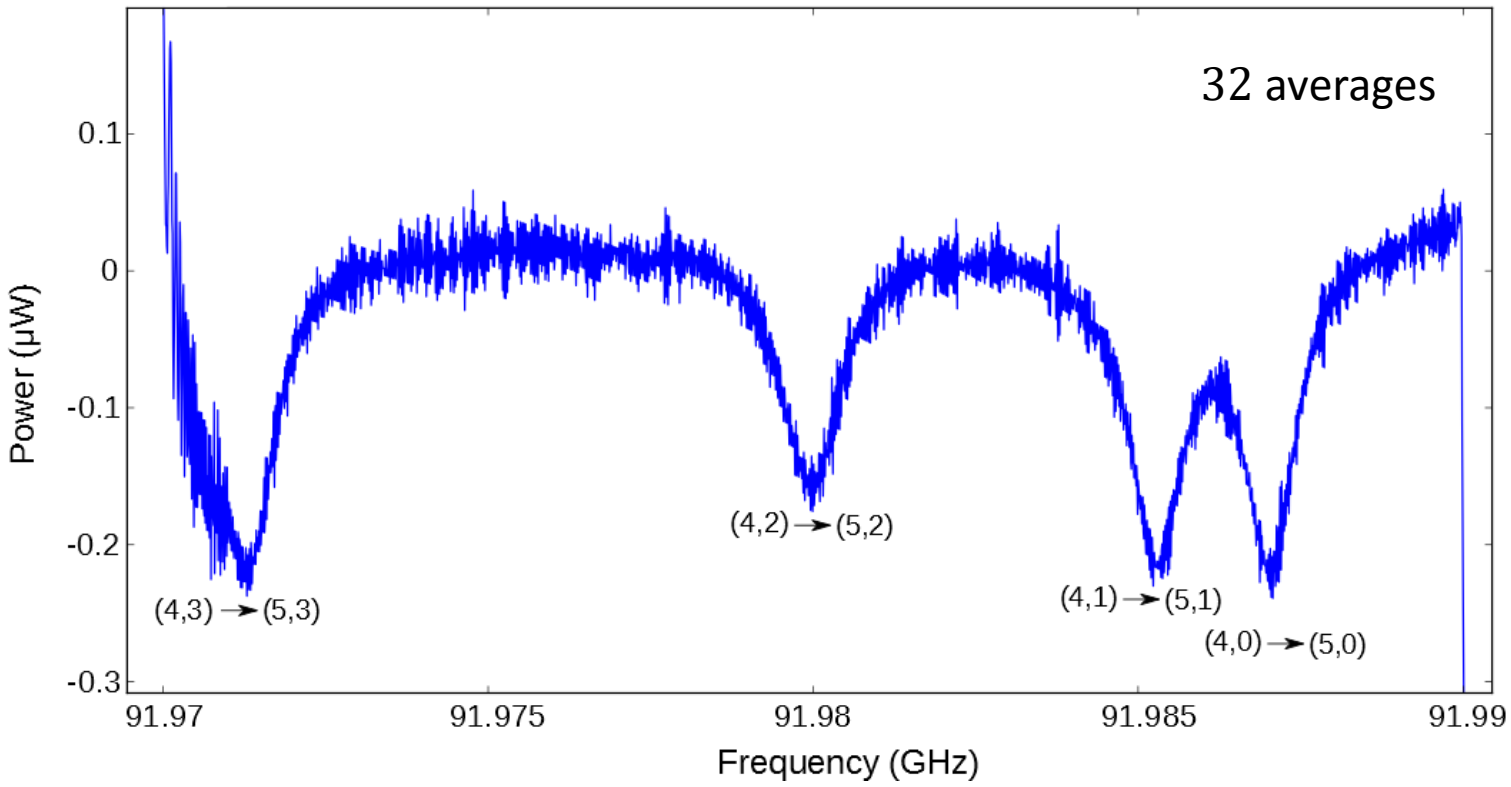
AWG Sweep : $50 - 53,333$ MHz, 1 ms

Synth. carrier frequency: 15,278 GHz

AMC: Frequency multiplier factor 6

$91,97 - 91,99$ GHz

(20 MHz scan)



Summary

- Now: Labastrophysics group in Kassel

- Aim: Cover THz regime as much as possible
  (100 GHz – 3 THz)

- Currently: 70 GHz – 1.1 THz (& 1.9 THz)
  - glas tube absorption cells (also with rf discharge)
  - Supersonic jet (laser ablation / dc discharge)

- Work on fast sweep/chirped pulse technique

Thank you for your attention!

Acknowledgment

THOMAS F. GIESEN, A. BREIER, JOHANNA CHANTZOS, DORIS HERBERTH, PIA KUTZER, CHRISTOPH MUSTER

DFG GI 319/3-1, DFG GI 319/3-2, DFG SFB 956, Uni Kassel

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