

Lightning control using ultrashort lasers

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LOA - CNRS/ENSTA/Polytechnique*



Barcelona, October 2006

Ultrashort laser filaments



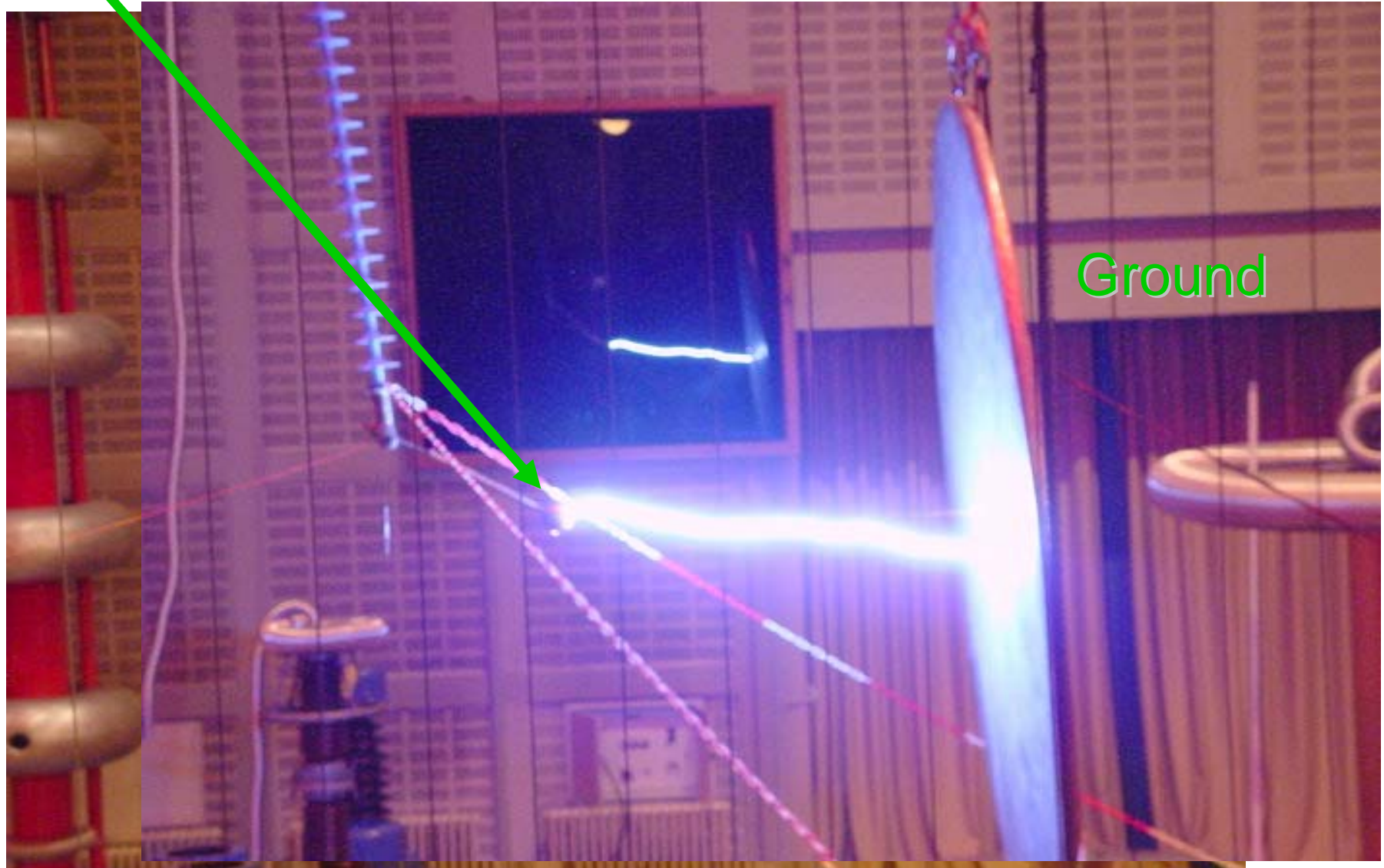
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- Non-linear optics in air: Self-guiding
- Long-range propagation
- Continuous plasma channel
 - $\phi = 100 \mu\text{m}$
 - Weakly ionized
 - Conducting: $1 \text{ M}\Omega/\text{m}$
 - Tens to hundreds of filaments in beam
- Propagate in adverse conditions
 - Turbulent air
 - Fog, rain
 - Reduced pressure

Good candidates for lightning contro

Free discharge

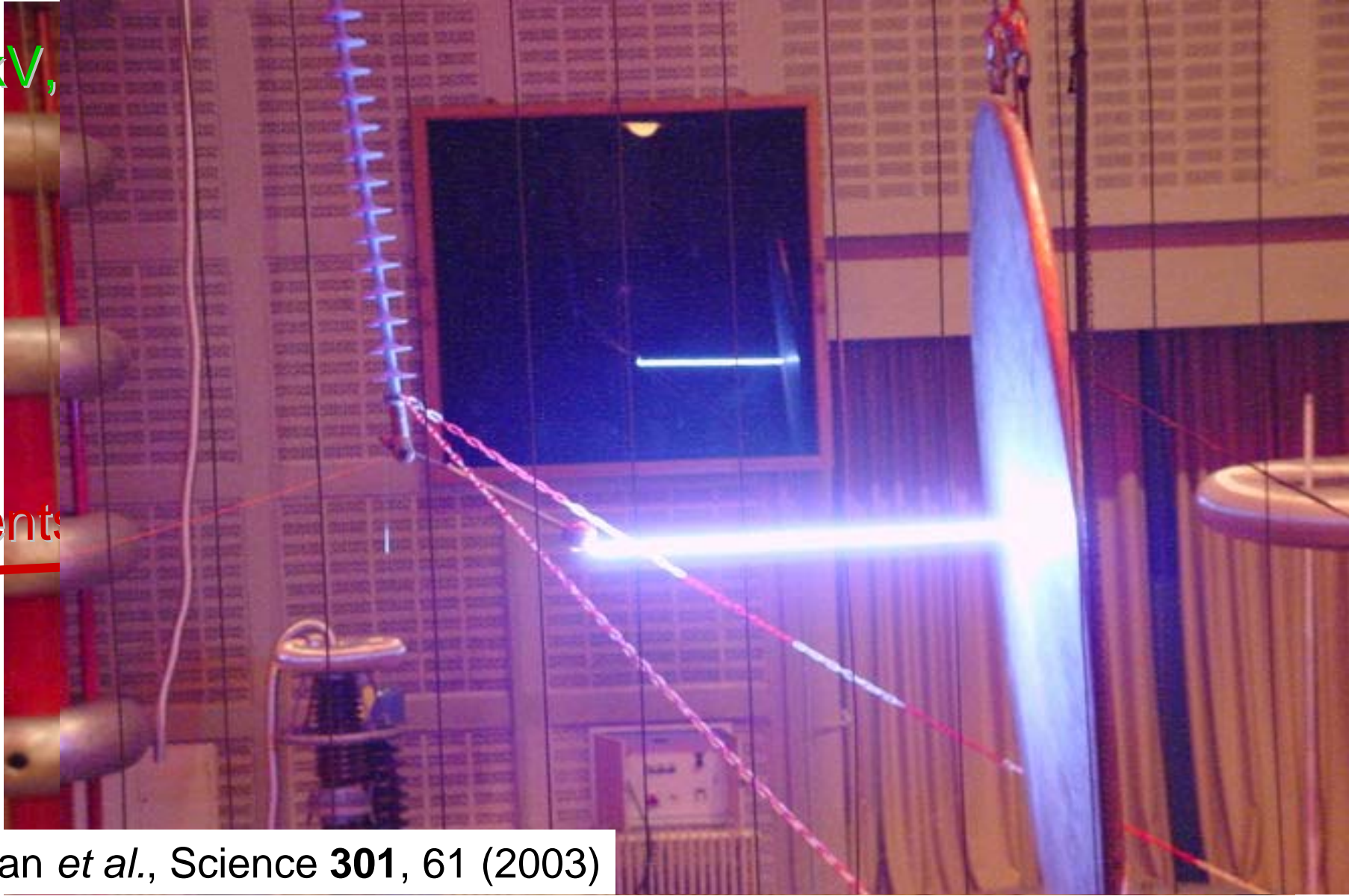
-1 MV, 1,2 μ s



Laser-guided discharge

-700 kV,

Filaments



Laboratory experiments

- Helvetera facility: 30 mJ, 30 fs, 100 Hz
- Spectral control: EOM: Dazzler
- Spatial control: deformable mirror
- Plasma optimization: lifetime, density, length, conductivity
- X-Ray emitted from the plasma: Directional ?

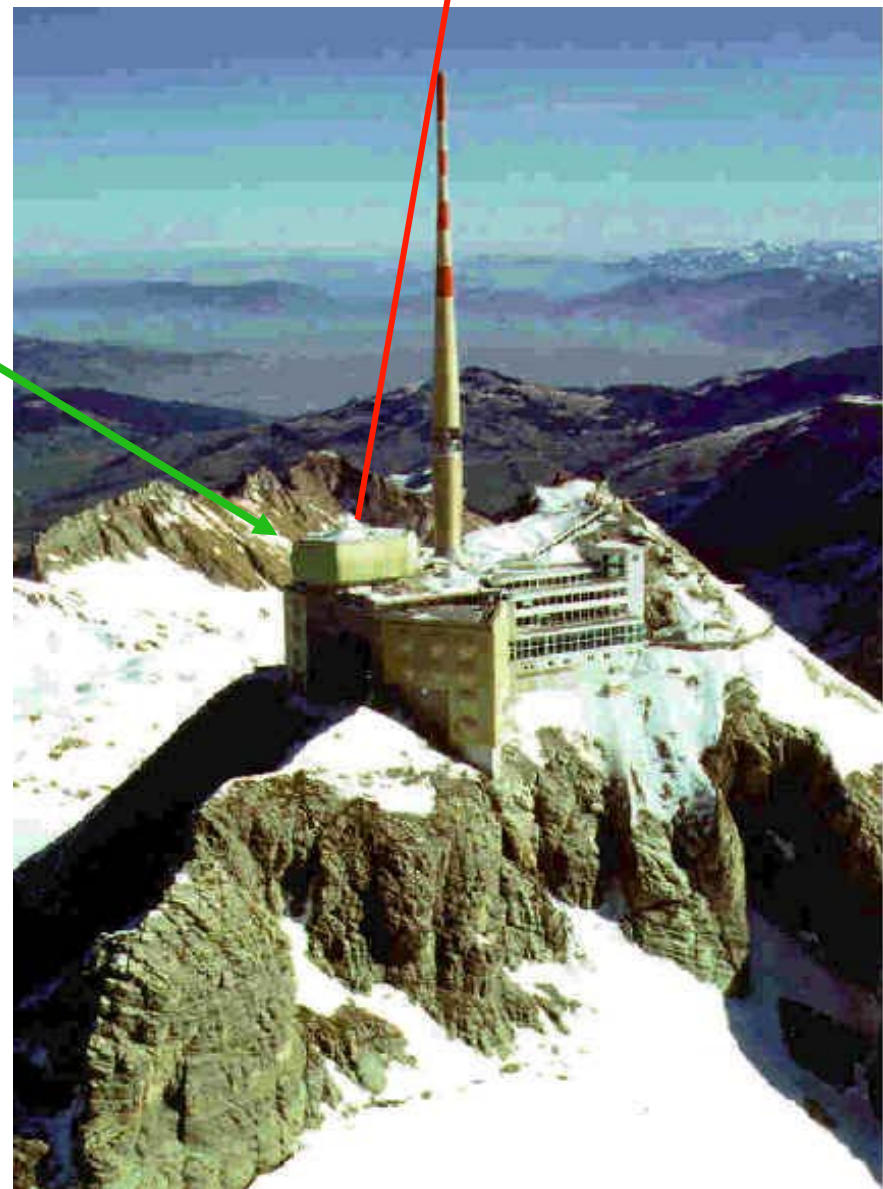
"Mid-scale" experiments

- Teramobile facility
 - 350 mJ, 70 fs, 5TW
 - Unique: mobile
 - French-German-Swiss collaboration
- HV facilities: TU Berlin, CEAT Toulouse, EC Lyon
- Scaling of lab results



Real-scale campaign

- Teramobile laser
- Säntis station
 - Swisscom
 - 1200 lightnings/yr/5 km area:
7 x Monte San Salvatore
 - EPFL permanent lightning
observatory
- Observables
 - LMA localization
 - Visual observation (CCD)
 - Tower instrumentation: I, U...



Summary

- Main goal: trigger and guide lightning
- Microdischarges in clouds, triggered by filaments
- X-Ray emission
- This demand: 243,000 CHF = 160 k€ for 3 years
- + International co-funding: FNS (CH), CNRS (FR), DFG (DE)