Thermal stability of carbon fibers in the P̄ANDA hypernuclear experiment

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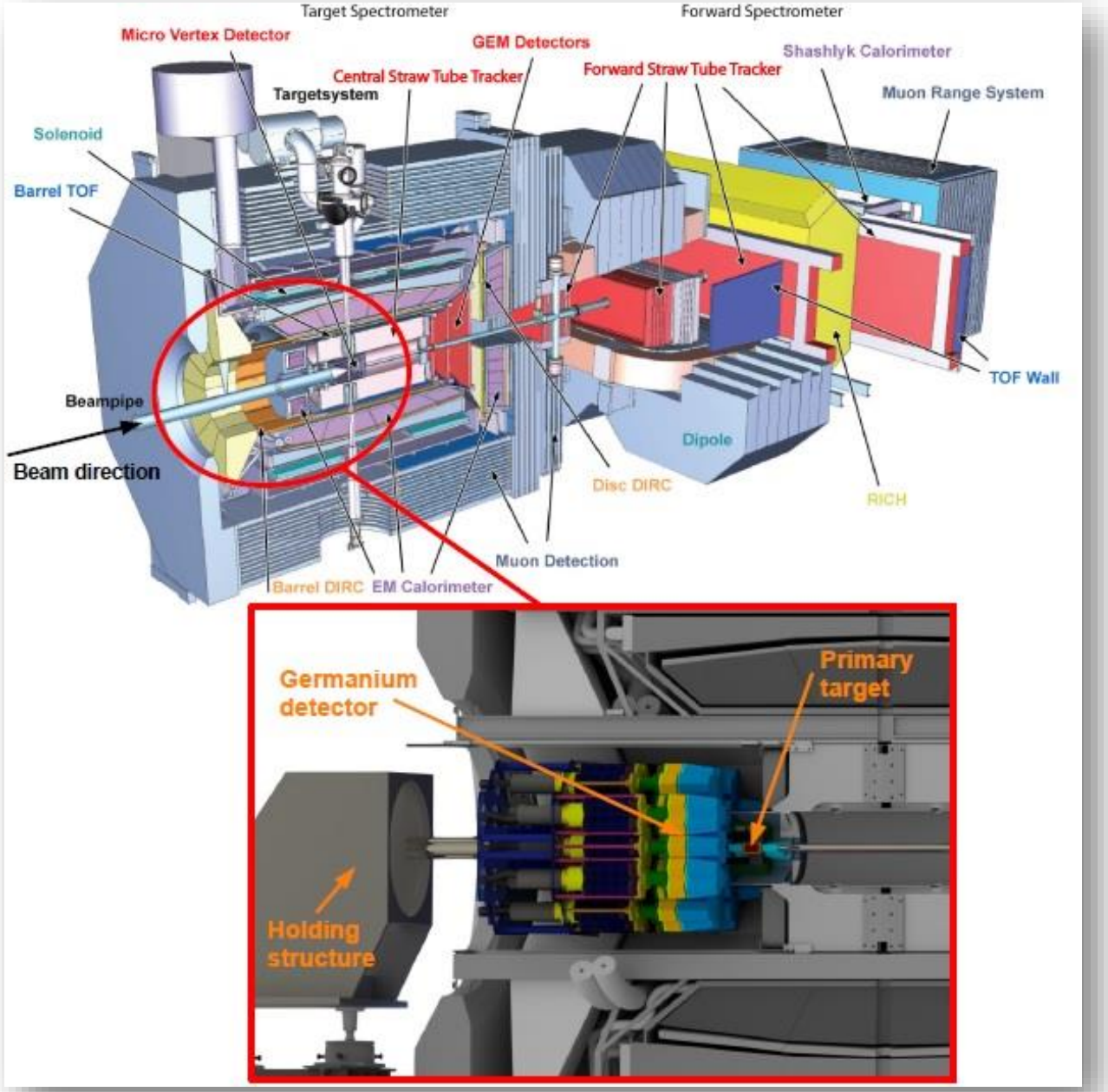
p̄anda

The hypernuclear experiment



- γ-spectroscopy of hyperatoms and –nuclei
- modular detector
- dedicated target system

  primary target:

  Production of Ξ^-

  secondary target :
  Conversion of Ξ^- in $\Lambda\Lambda$ inside nucleus

Production of hypernuclei

Ξ^- production:
$\bar{p}N \rightarrow \Xi^- \bar{\Xi}$

rescattering in primary target nucleus

deceleration in secondary target

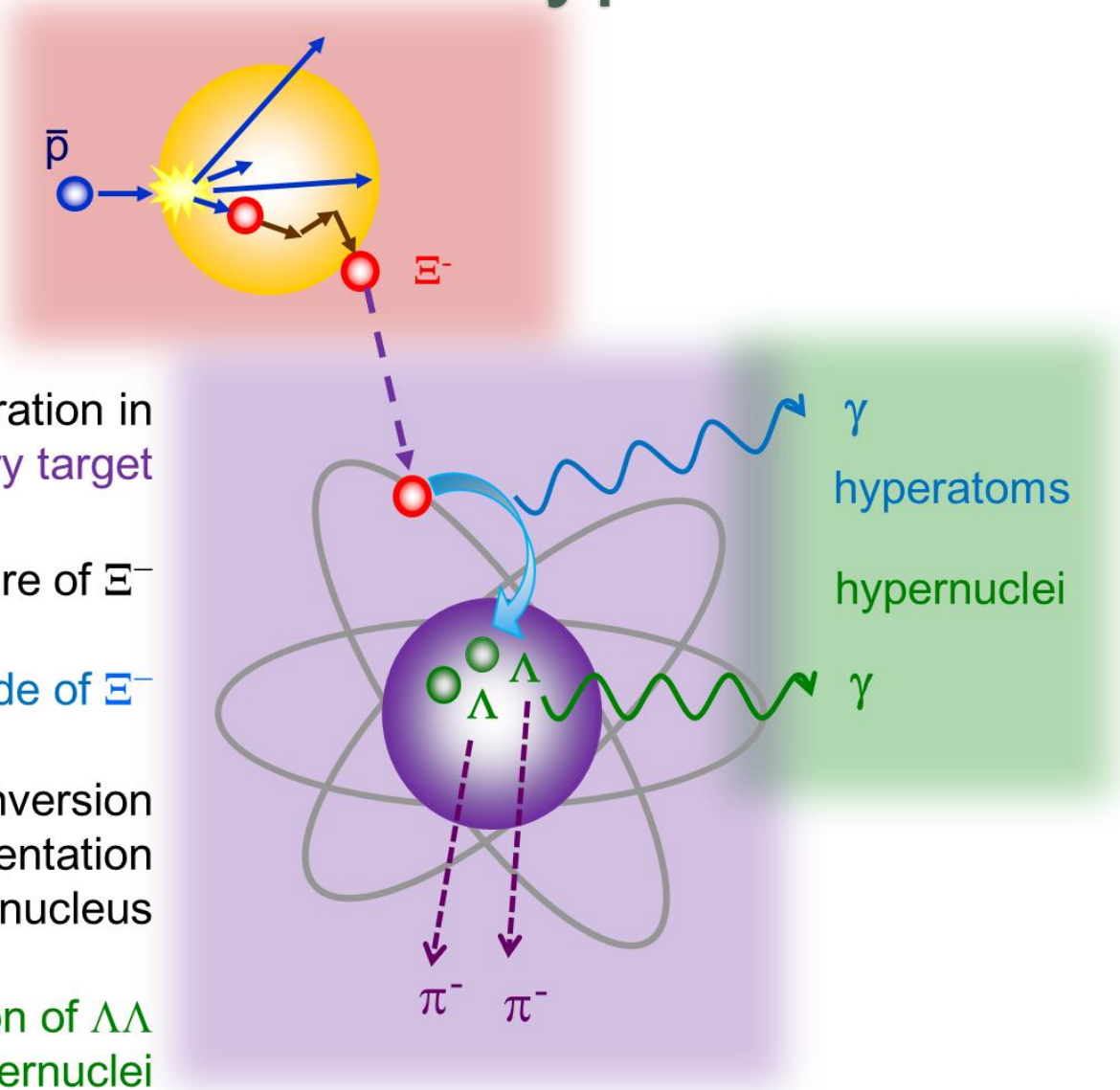
capture of Ξ^-

atomic cascade of Ξ^-

$\Xi^- p \rightarrow \Lambda\Lambda$ conversion
fragmentation
$\rightarrow$ excited $\Lambda\Lambda$-nucleus

γ-deexcitation of $\Lambda\Lambda$ hypernuclei

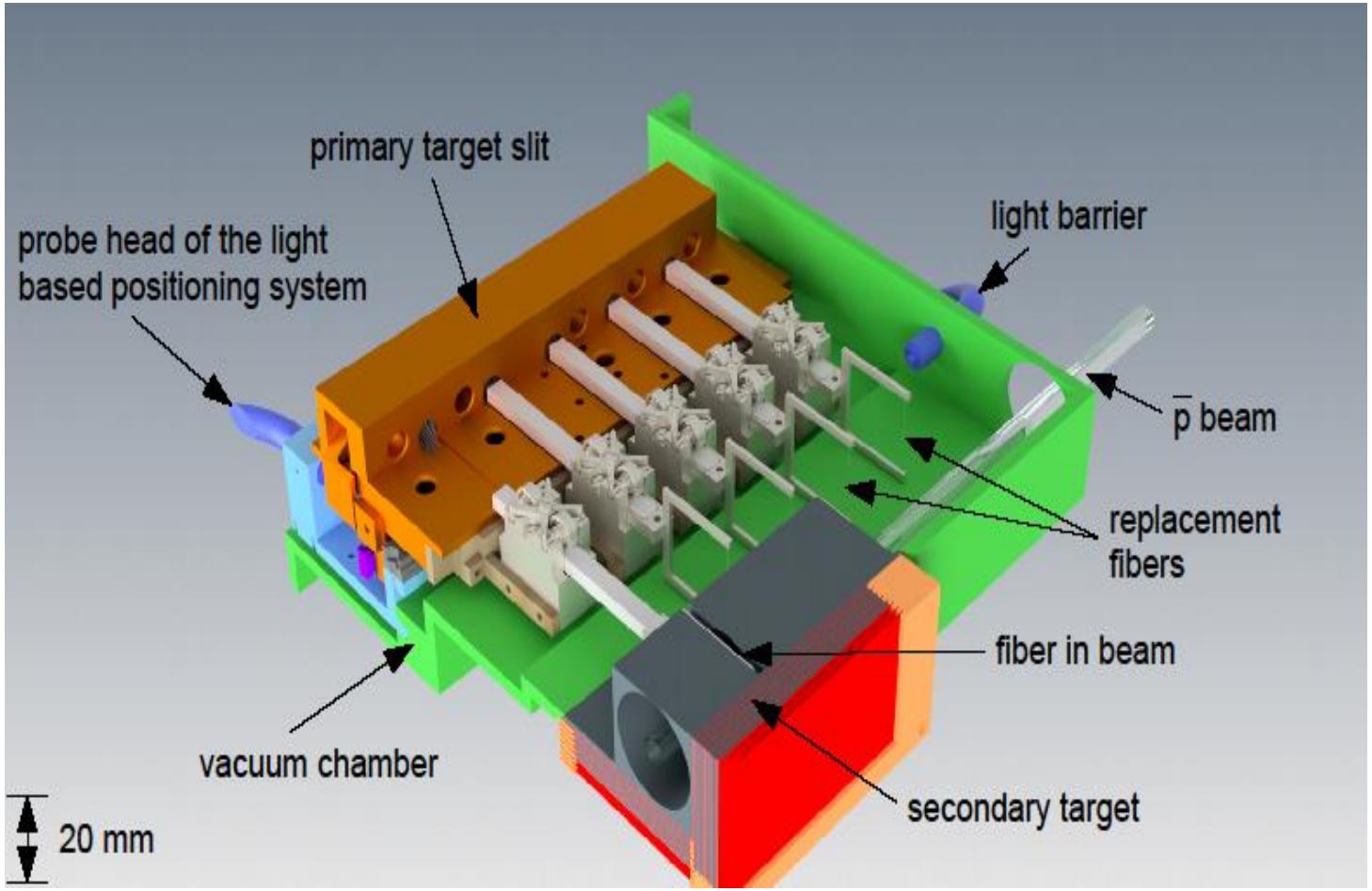
weak pionic decay



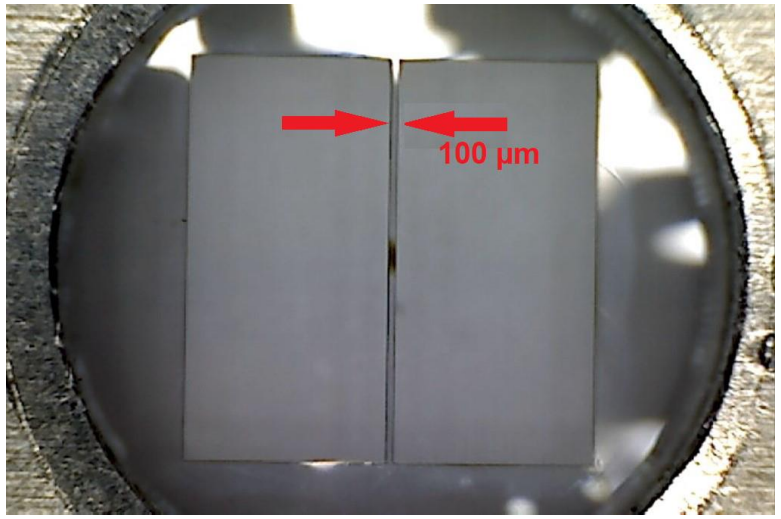
The primary target

Requirements

- Compromise:Ξ^- production and stopping probability, luminosity loss factor
  → carbon
- Luminosity experiment
  → thickness in range of µm
- Precise positioning
- 5 single targets

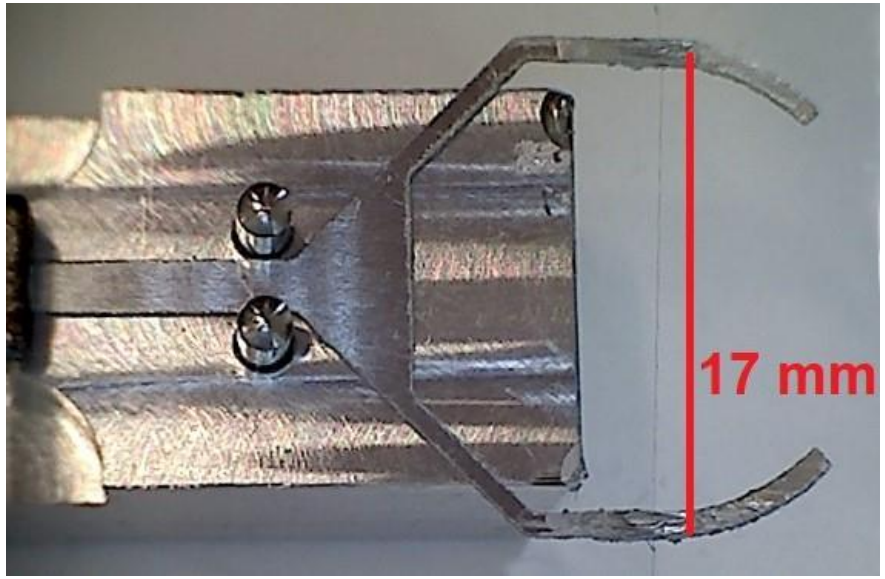


Carbon as target material



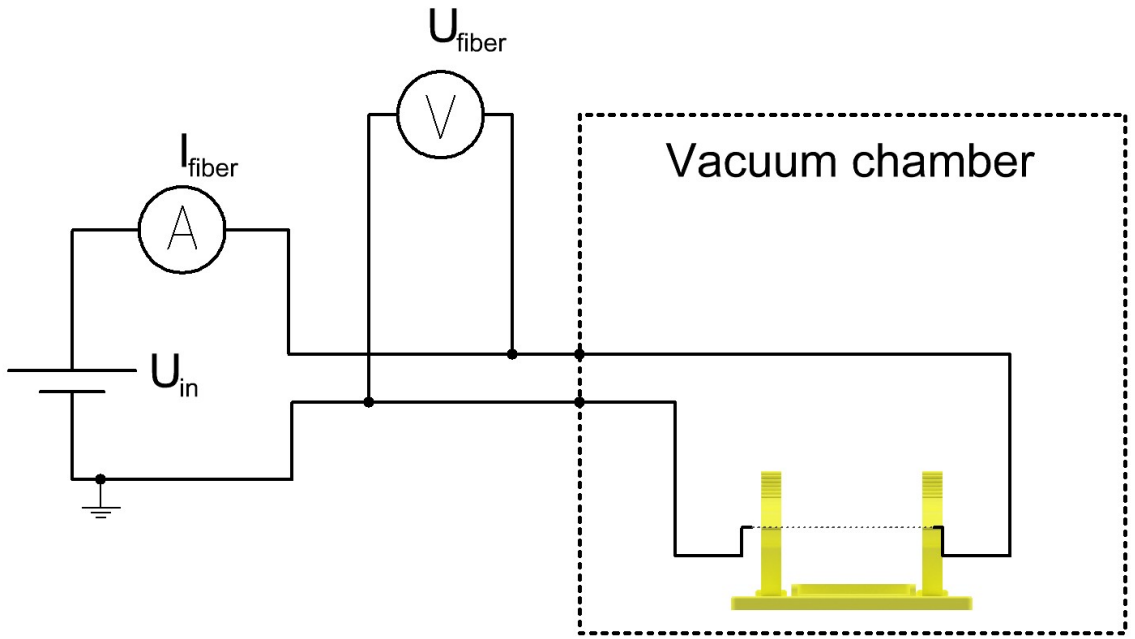
- CVD-Diamant (100*3 µm^2): Raman-spectroscopy
  →conversion in grafit

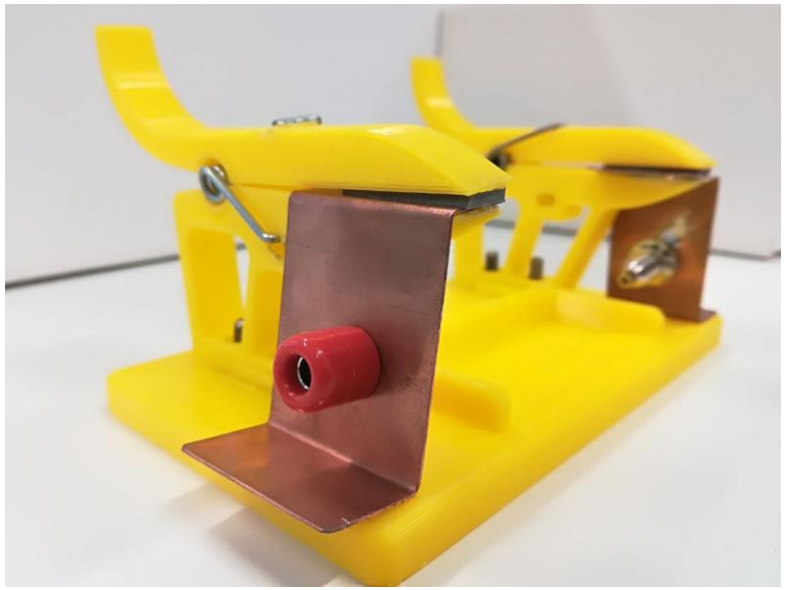
- Carbon fiber (d=7 µm) has similar structure as grafit
- SGL Group: Sigrafil (PAN)



Simulation of thermal output in $\bar{P}$ANDA through electric current

- Fiber heated through electric current
- Tests in air and vacuum (few mbar)
- Measurement of temperature only indirectly possible

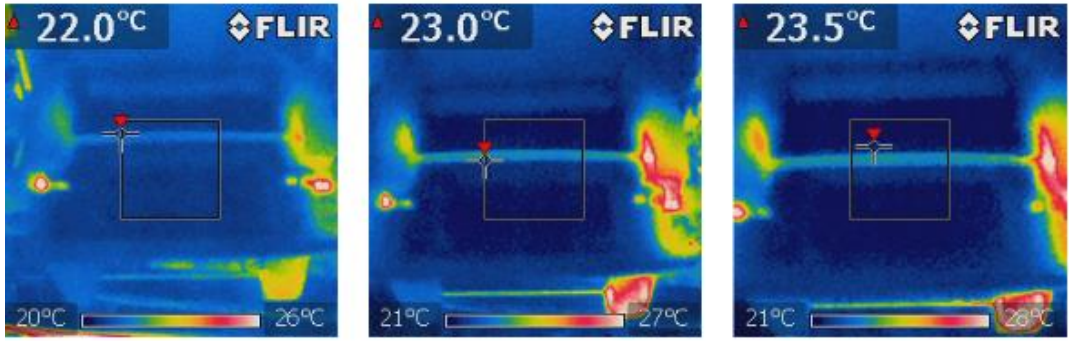




Temperature observations

In air:

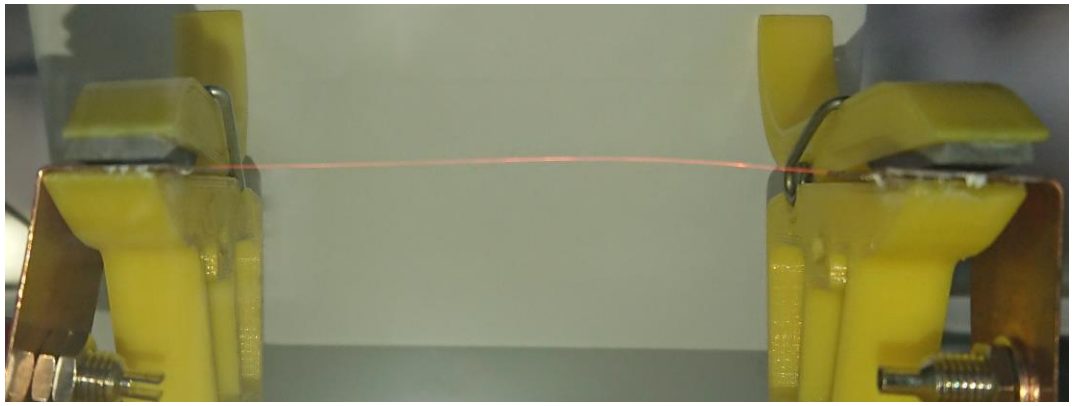
- Infrared camera: convection
- Temperature proportional to voltage



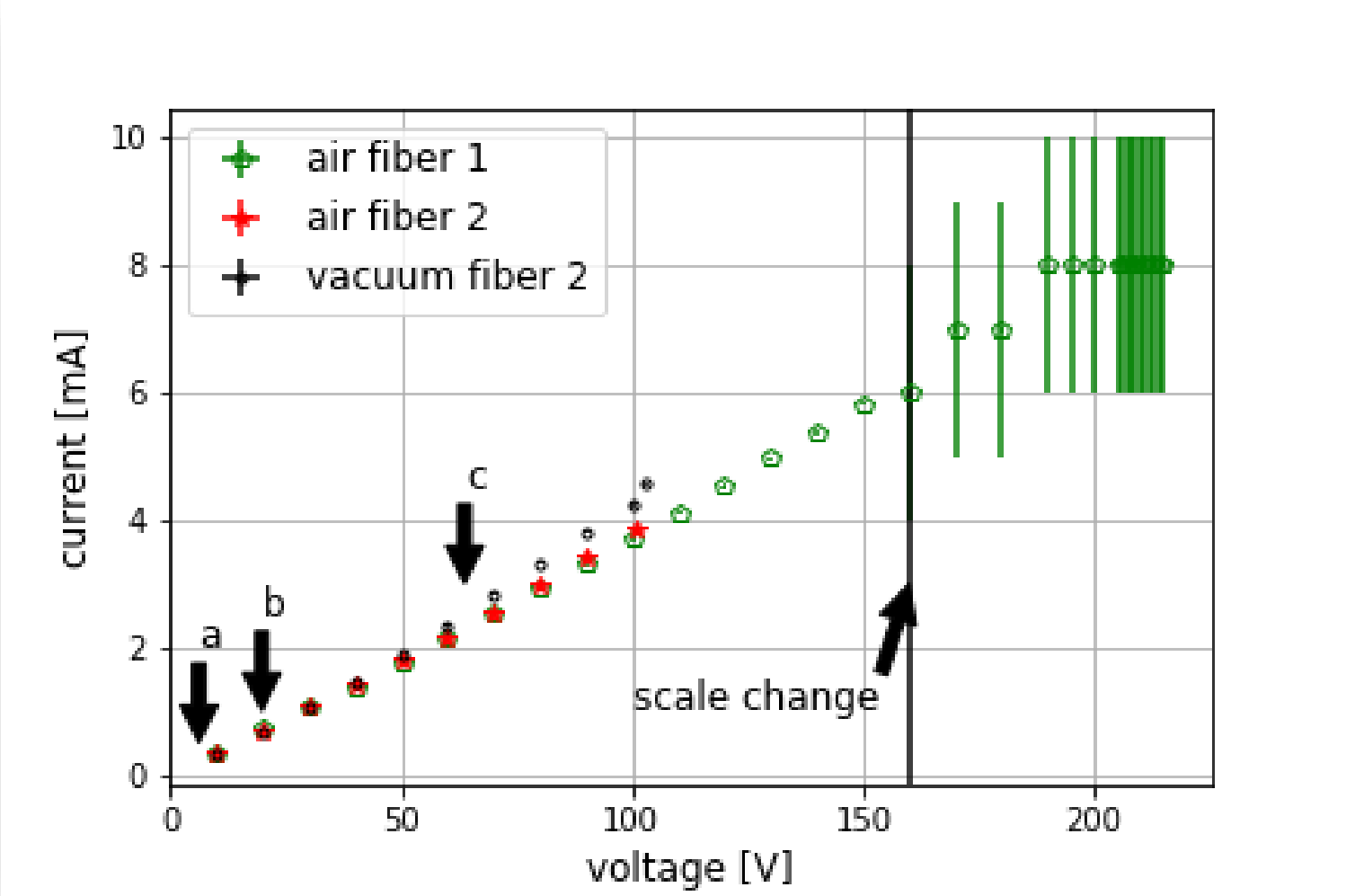
U_{faser} = 150 V U_{faser} = 200 V U_{faser} = 210 V

In vacuum:

- Cherry red glow of filament at U_{fiber}= 90 V
- Temperature ca. 800°C (black body radiation)
- Evaporation through oxidation



Measurements in air and vacuum



Comparison to expected thermal output at $\bar{P}$ANDA:

rate	P[1] [mW]	U [V]	
4×10^6	1.3	6.2	a
4×10^7	13.1	19.8	b
beam center	135.4	63.7	c

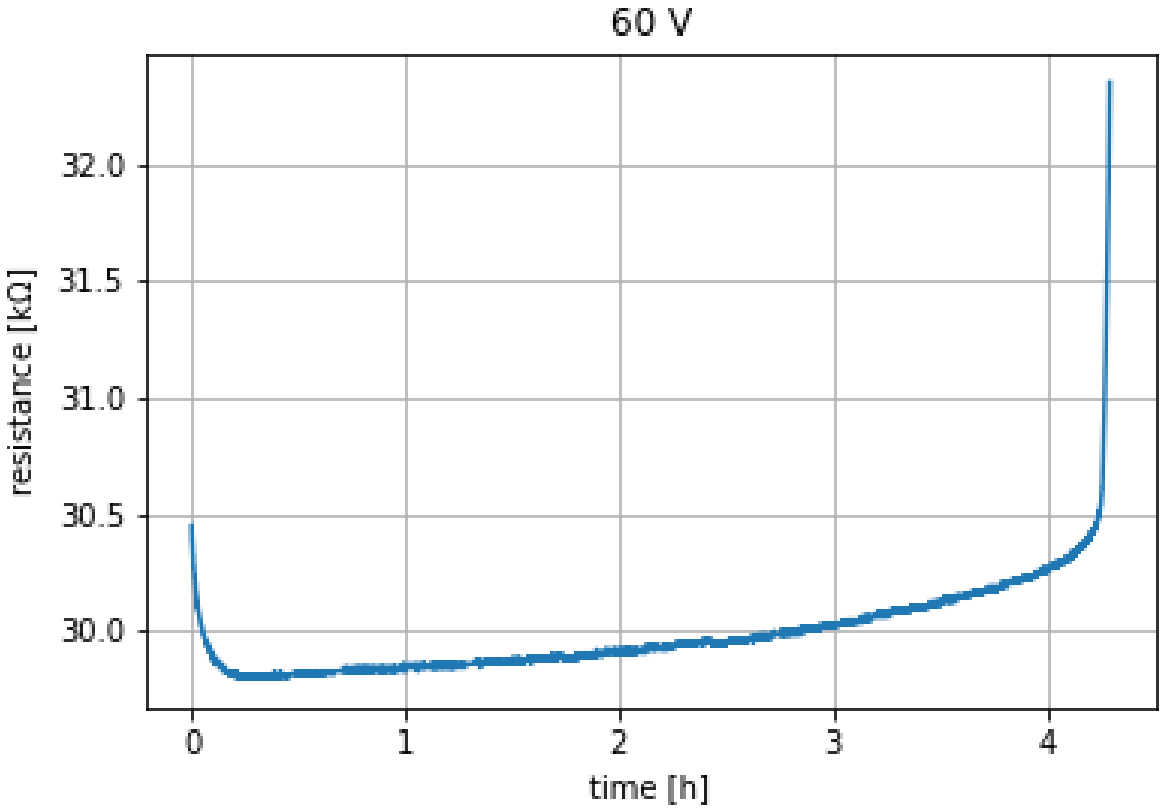
[1]conducted in a simulation, rescaled to fiber length

Long term measurements with constant voltage

- 6V: interaction rate at P̄ANDA
- 13V: fiber still intact after 17 days

- 60V: close to maximum overlap (not intended in P̄ANDA)
  - to 0.2 h: heating up ($\frac{dR}{dT}|_{T=20°C} < 0$)
  - 0.2 h to 4.3 h: evaporation
  - at 4.3 h: fiber broke

- 4 h at max overlap correspond to reaction of antiprotonen within 700 cycles



Summary

- primary target for $\bar{P}$ANDA with fiber (7 µm) constructable
- thermal stress through $\bar{P}$ANDA non-critical
- Filament is able to withstand stress at the maximum overlap long enough to allow adjustments in positioning

Thank you for your attention

Extra: Long term measurement at 13 V