

PK4 Dust Manipulation Laser

status Sept. 2004

- feasibility to be proven in PK4 predevelopment phase
- money from DLR granted 2002
- originally, optical laser power of 150 mW requested
- Laser power requirement recalculated in May 2004
- optical power of several Watts required
- high efficiency laser preferred
 - ⇒ infrared diode laser
- diode laser module of 20 W max. power selected
- ordered in July 2004, including visible pilot laser
- to be delivered end of September 2004,
(but no pilot beam!)

Laser Power Requirement Estimation

radiation pressure on a melamine-formaldehyde
microsphere in a dusty plasma
Lin et al, Physics of Plasmas, January 2003

$$F_{\text{laser}} = \alpha \cdot I_{\text{laser}} \quad \alpha = q \cdot \frac{n \cdot \pi \cdot r_p^2}{c}$$

q reflects optical properties, $q \approx 1$ found for MF spheres
and $\lambda \approx 500 \text{ nm}$

$$\Rightarrow \boxed{\alpha \approx 10^{-20} \text{ m} \cdot \text{sec}} \text{ for } 1 \mu\text{m MF spheres}$$

gas drag forces (Epstein formula)

$$F_{\text{gas}} = \gamma \cdot v_p \quad \gamma = \delta \cdot \frac{4\pi}{3} N \cdot m \cdot \bar{c} \cdot r_p^2$$

$$\boxed{\gamma \approx 3 \cdot 10^{-12} \frac{\text{Ns}}{\text{m}}} \text{ for } 100 \text{ Pa of Ne and } 1 \mu\text{m spheres}$$

$$F_{\text{laser}} = F_{\text{gas}} \Rightarrow I_{\text{laser}} = \left(\frac{\gamma}{\alpha} \right) \cdot v_p$$

\ independent of
particle size

for $v_p = 1 \text{ cm/sec}$ at 100 Pa Ne :

$$I_{\text{laser}} = \frac{3 \cdot 10^{-12}}{10^{-20}} \cdot 10^{-2} = 3 \cdot 10^6 \text{ W/m}^2$$

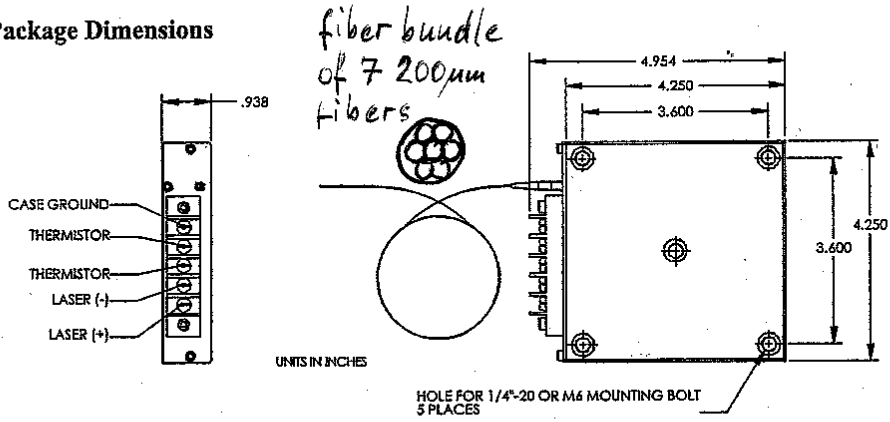
$$\boxed{I_{\text{laser}} \approx 3 \text{ W/mm}^2}$$

5

CPM-20

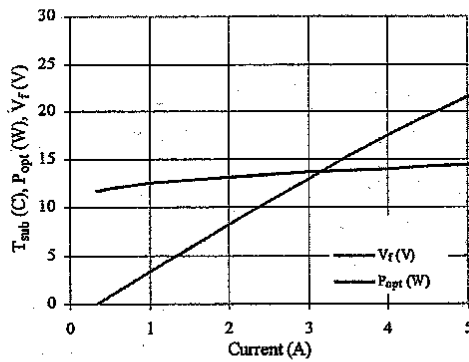
915 nm

Package Dimensions



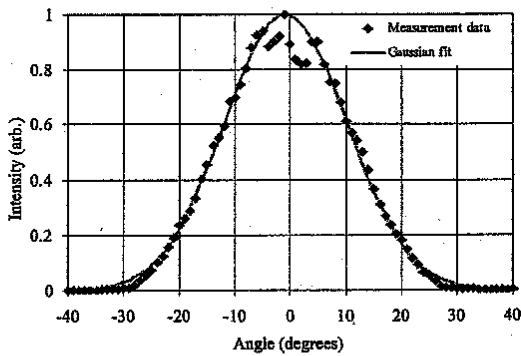
Typical Electro-Optical Performance

LIV Characteristics



efficiency ≈ 30%

Far Field Output



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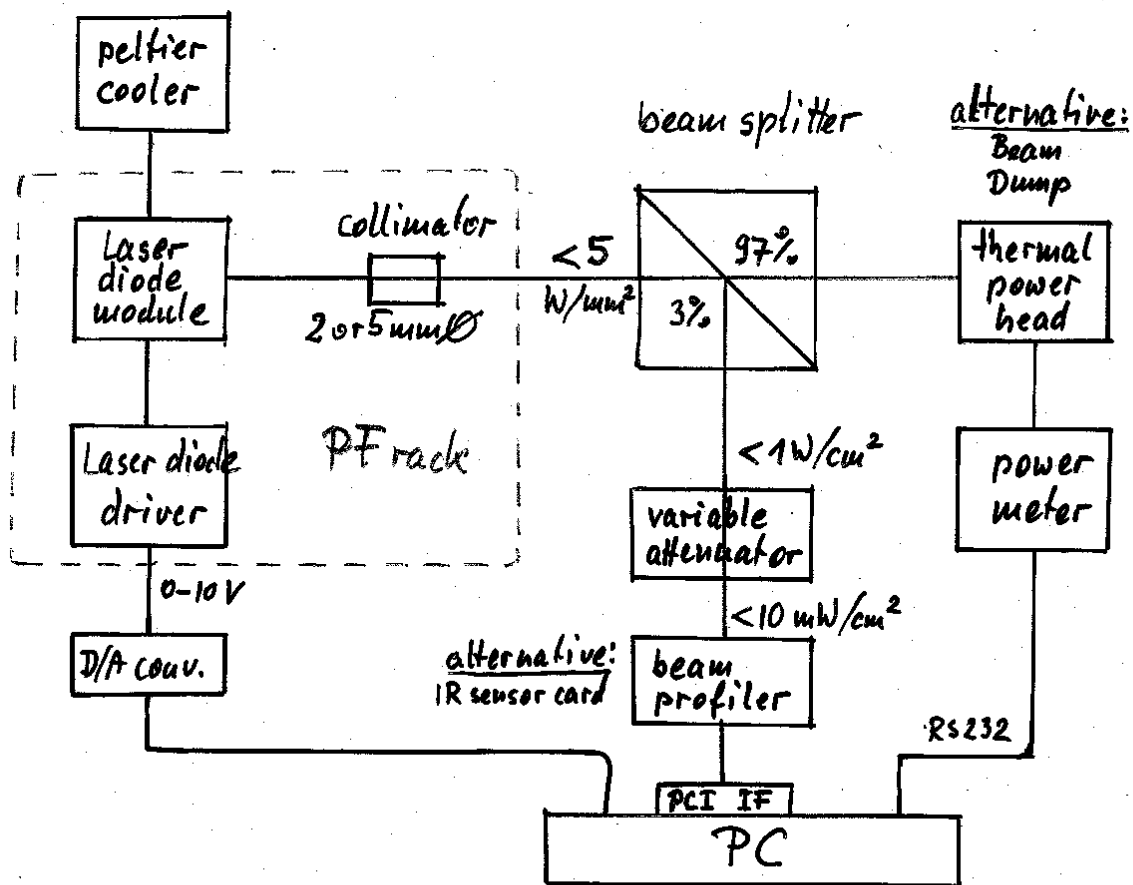
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Calibration Setup for Manipulation Laser

purpose: power calibration
beam stability determination
laser module temperature dependence
beam profile measurements
collimation and divergence optimization



support equipment:
wide angle NIR viewer

44% IR

