33 Watt Average-Power Optical Parametric Oscillator *

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Outline - we have performed experimental parameter studies to optimize output power and improve beam quality

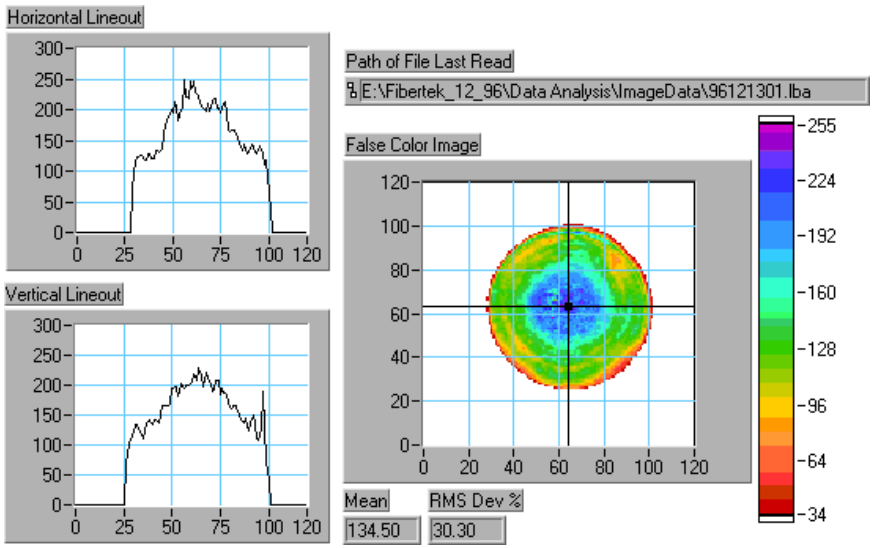
- **Two pump lasers**
  - **Spatial profile & temporal pulse width**

- **OPO Cavity Optimization**
  - **Ring vs. standing wave cavity**
  - **Total gain length**
  - **Output coupler reflectivity**
  - **Total cavity length**

- **Summary of best results to date**

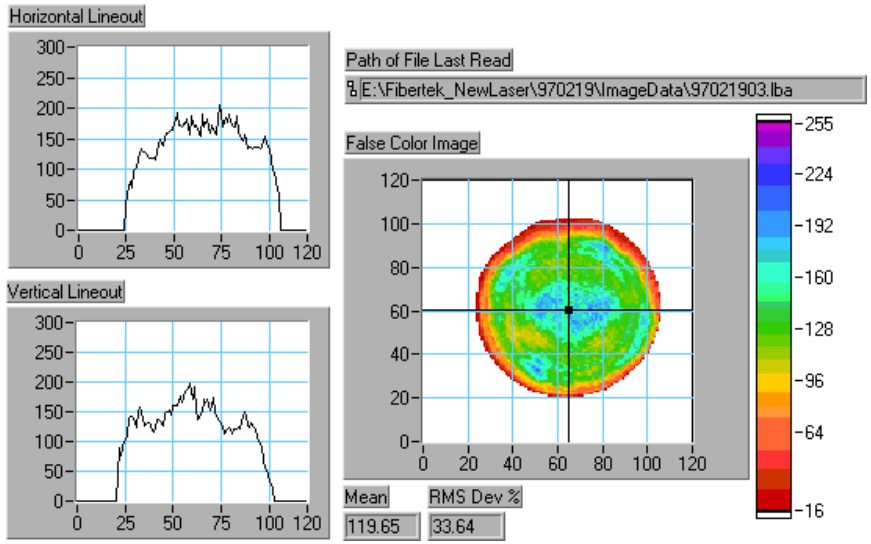
Two pump lasers were used during the course of these experiments

Laser 1



- 80 W available at OPO
- $M^2 = 5$
- FWHM = 22.5 ns
- Yield: $\eta = 36\%$ / $M^2 = 30$

Laser 2



- 107 W available at OPO
- $M^2 = 5$
- FWHM = 17.5 ns
- Yield: $\eta = 32\%$ / $M^2 = 41$

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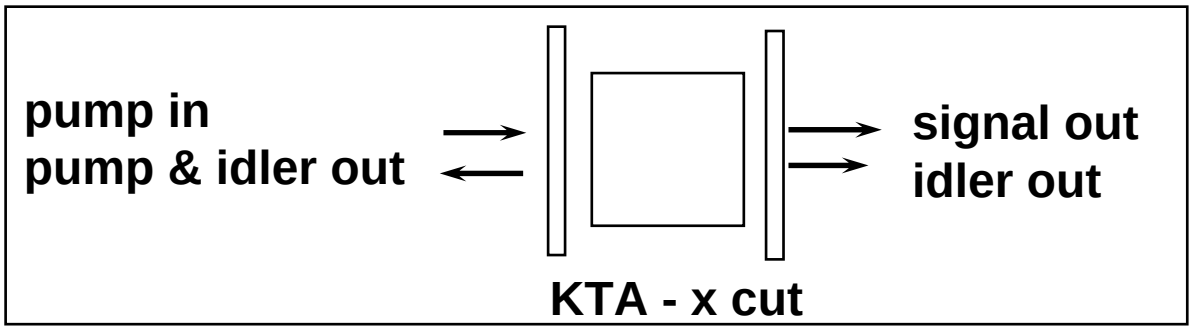
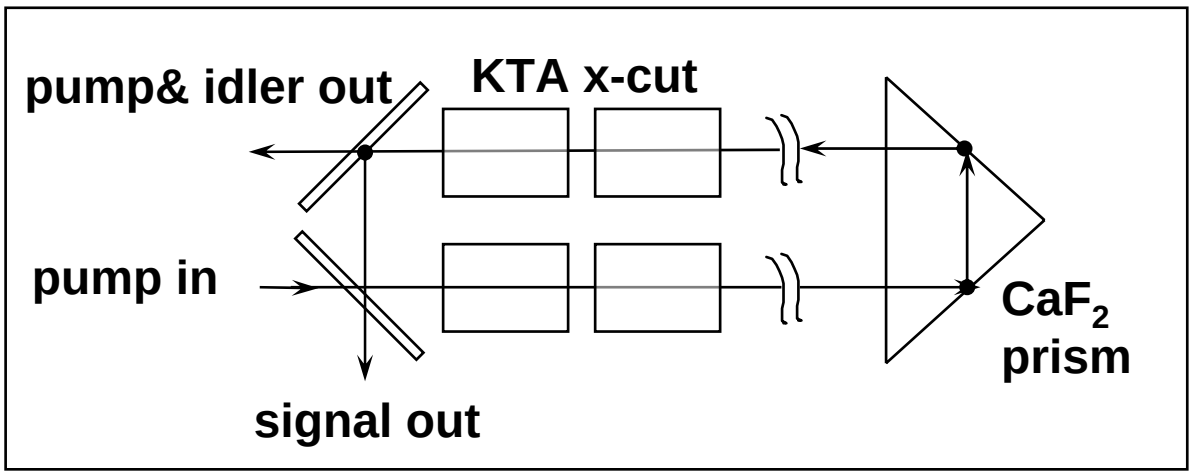
A ring OPO was chosen to minimize feedback and damage threshold requirements



- Low threshold
- Moderate efficiency
- Low damage
- High feedback



- Moderate threshold
- Moderate efficiency
- High damage
- Low feedback

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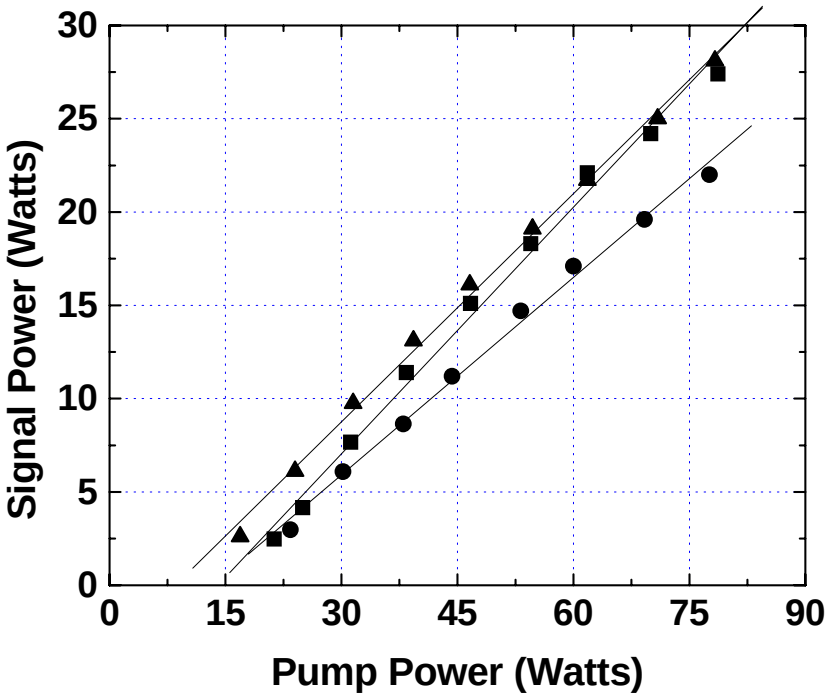
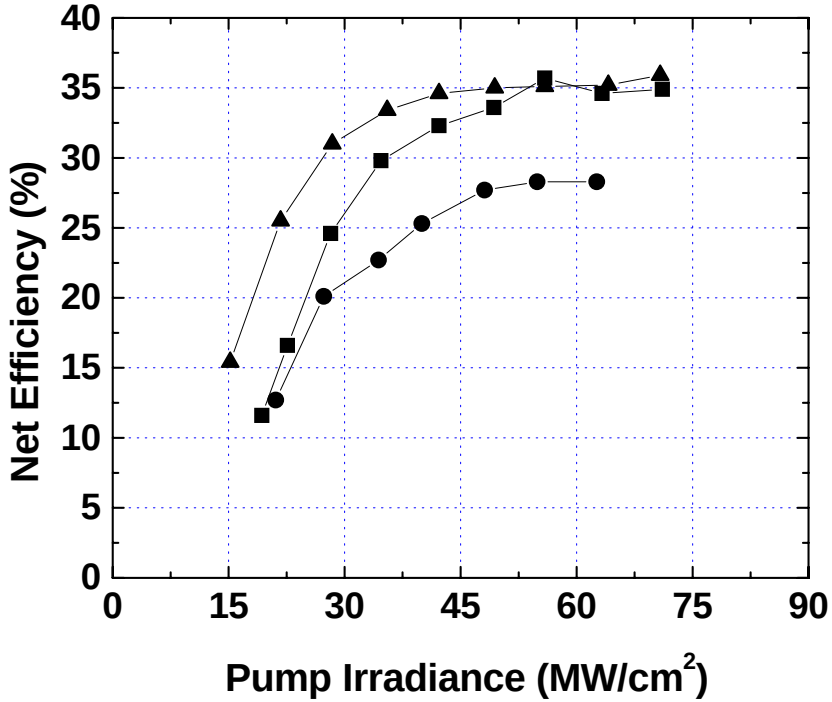
Optimal gain length was determined by high power efficiency measurements





l **KTA 20mm 2ea. / 70%R OC**
n **KTA 20mm 4ea. / 30%R OC**
s **KTA 20mm 2ea. + 25mm 2ea. / 30%R OC**

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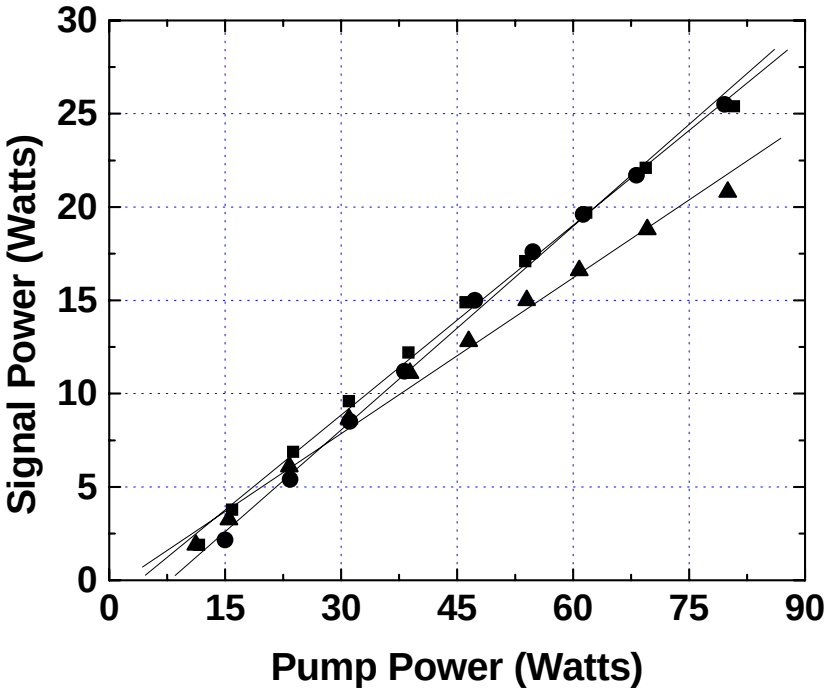
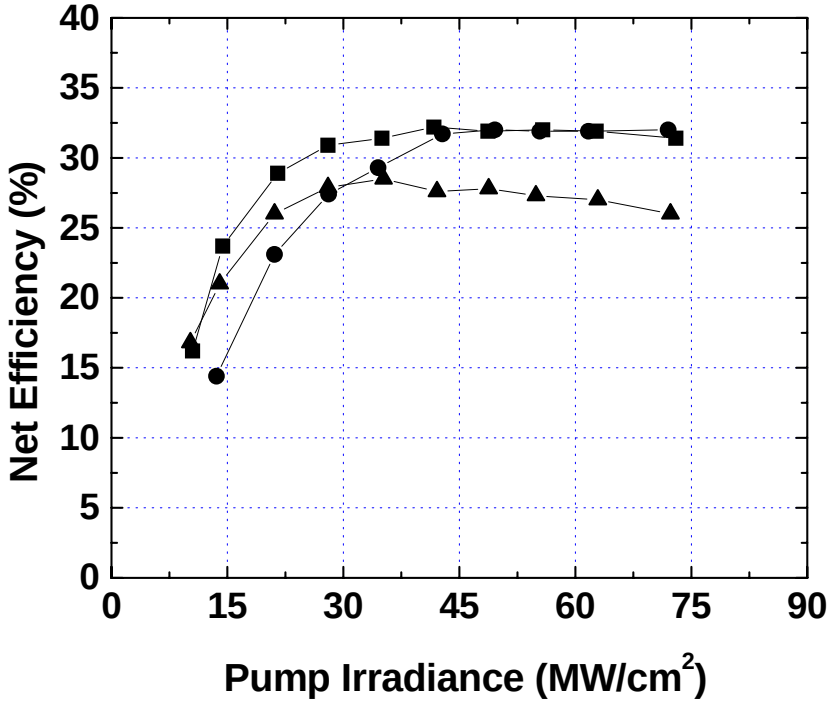
Lower output coupling reflectivity favored efficient operation at high pump power





l **KTA 20mm 2ea. + 25mm 2ea. / 30%R OC**
n **KTA 20mm 2ea. + 25mm 2ea. / 50%R OC**
s **KTA 20mm 2ea. + 25mm 2ea. / 70%R OC**

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The image of the OPO intracavity signal beam closely resembles the pump input

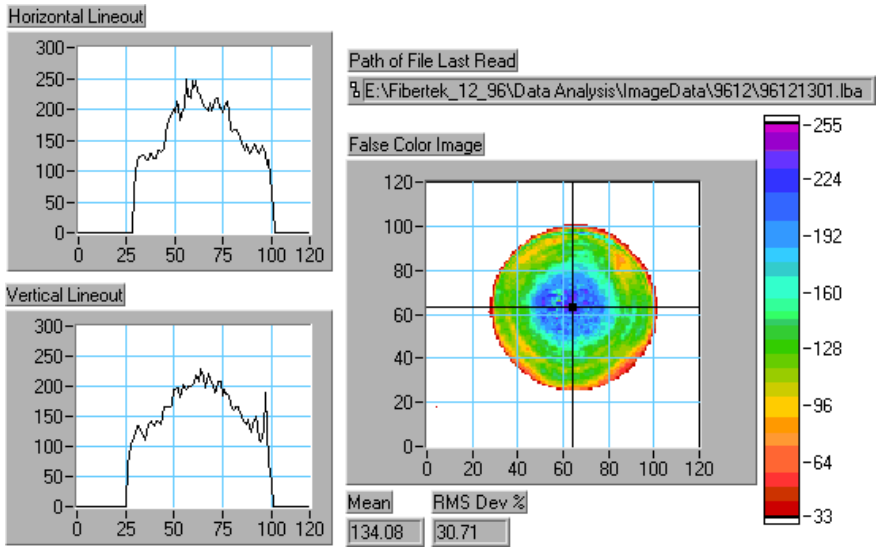

Image of pump input at plane of first OPO crystal

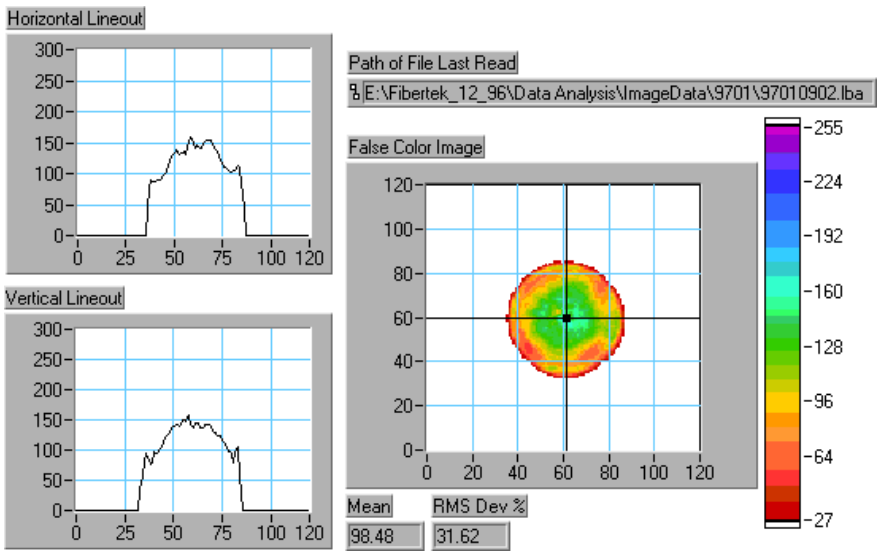

Image of signal at a plane inside resonator cavity

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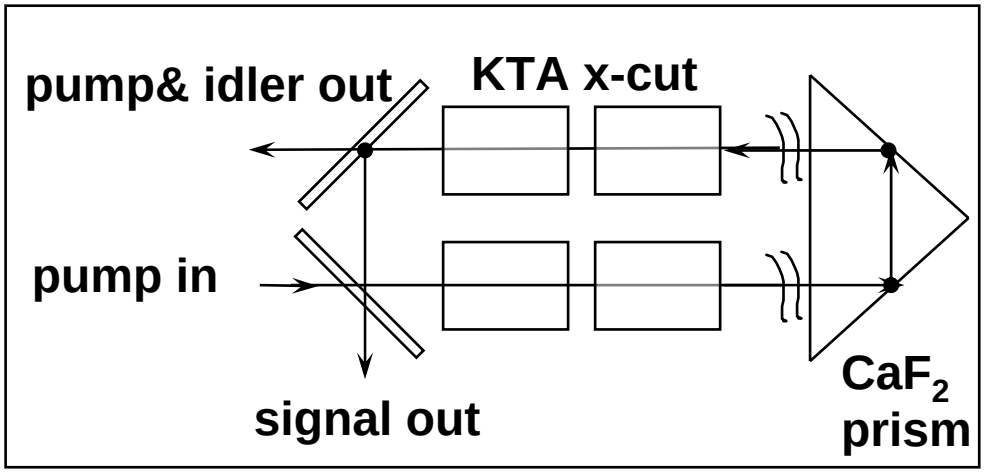
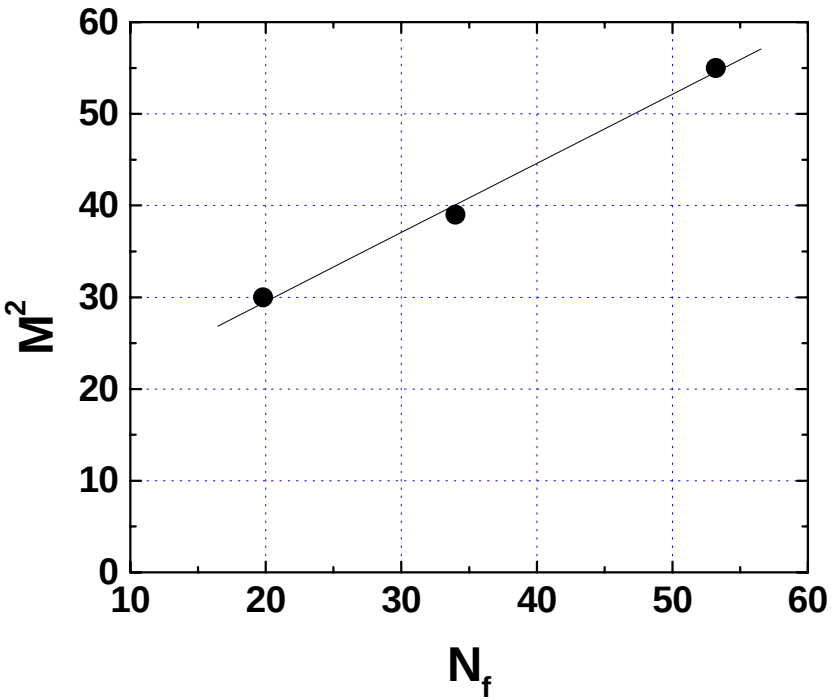
Beam quality was improved by decreasing the fresnel number of the cavity without reducing net efficiency



$$N_f \equiv \frac{r^2}{\lambda L_{RT}}$$

where: r = pump radius (4 mm)
λ = signal wavelength (1534.7 nm)
L_{RT} = round trip cavity length



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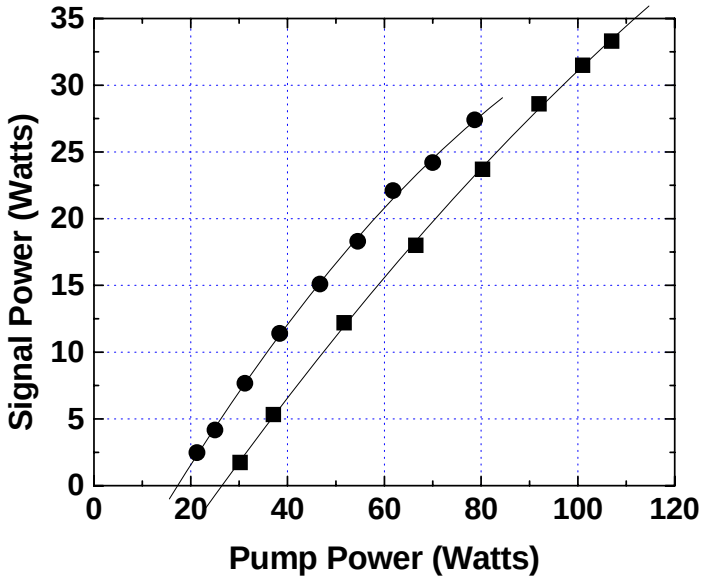
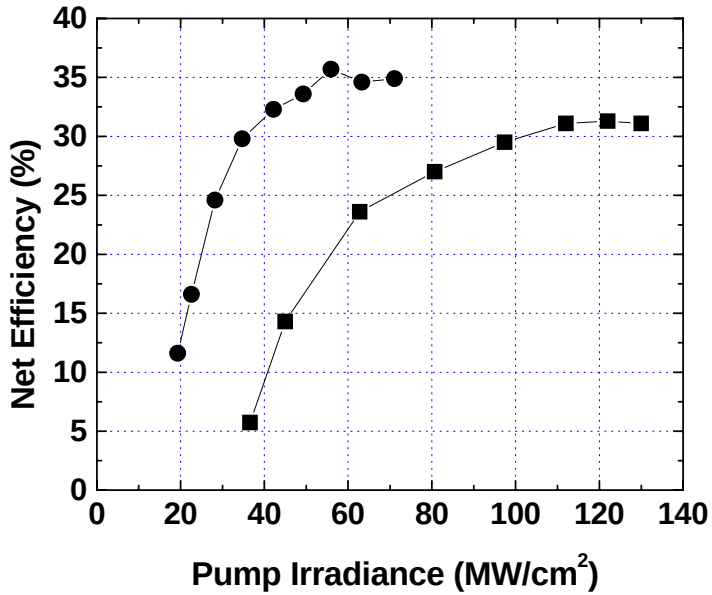
In summary, high power results, to date, show moderate efficiency, but beam quality needs improvement





Pump Laser 1
Signal power = 28 Watts
Net efficiency = 36%
Signal beam quality (M^2) = 30
20ns pulse width
8 mm diameter (near field)

Pump Laser 2
Signal power = 33 Watts
Net efficiency = 32%
Signal beam quality (M^2) = 41
16ns pulse width
8 mm diameter (near field)

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