Fiber laser system: Educational kit

This fiber laser education kit is intended to be used for building different configuration fiber lasers in fiber optics laboratory programs for students in technical institutes, colleges or universities. This kit will give an opportunity to its users to get experienced with different optical component like pump laser, active fiber, fiber Bragg grating (FBG) mirror, all-fiber laser cavity etc. Components are made or pigtailed using single mode fiber (SMF) with 3mm cable for the easy handling, long term use and robustness. Generally speaking, optical fiber is so delicate that professionally trained personal only can safely handle it. This kit designed and packaged for uses without prior experience in optical fiber handling.

This kit can be used for doing experiments to learn about

1. Fiber laser system
2. Laser threshold
3. Optical pumping
4. Pump saturation
5. Conversion efficiency of fiber laser
6. Working principle of linear cavity fiber laser
7. Working principle of ring cavity fiber laser
8. Backward and forward pumping

And much more …

List of items in the kit

Item	Description	Quantity
Pump Laser at 980 nm	Complete turn-key solution. Maximum power 150mW	1
Fused fiber WDM	For multiplexing 980 nm pump and 1550 nm signal	1
Erbium-doped fiber	5 meter long Erbium (Er^{3+}) doped single mode fiber	1
HR-FBG	High-reflecting FBG written in SMF-28 fiber	1
PR-FBG	Partially reflecting FBG written in SMF-28 fiber	1
Optical circulator	-	1
Power splitter	-	1
FC/APC mating sleeves	To connect between FC/APC connectors	5

Features

- Complete solution
- Reconfigurable
- Easy to handle packaging
- User instruction

Description

All the components pigtailed with 3mm PVC tubing and terminated with FC/APC connectors. User can easily connect the components using FC/APC mating sleeves included in the kit. A fiber laser assembly is shown in figure 1. This is simply a fiber laser with linear structure. This linear structure can be modified as a ring structure, as shown in figure 2. Here we used an circulator and a power splitter, in addition to the components used in linear structure. Power splitter drop ~30% of the power to the output and remaining ~70% is circulated in the loop.

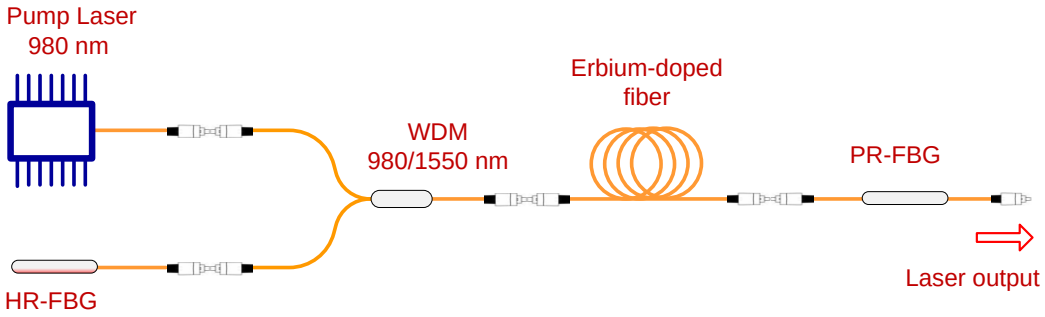


Figure 1: Fiber Laser - linear structure

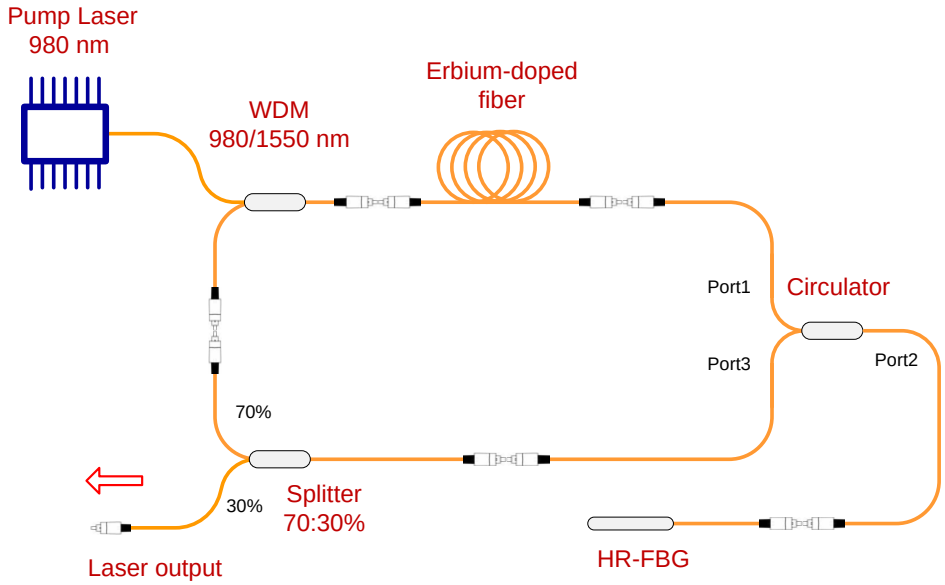
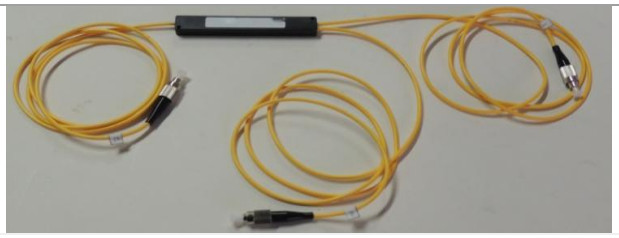
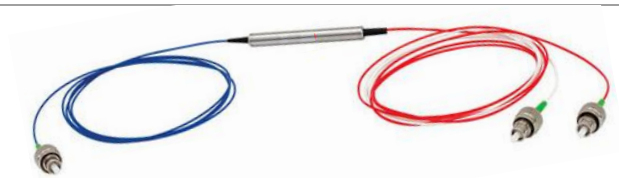


Figure 2: Fiber Laser - loop structure

Components

Pump Laser	
Fused fiber WDM	
Optical circulator	
Power splitter	
FC/APC mating sleeves	

Fiber laser: Fundamentals

Fiber laser is a special type of laser, where active gain medium is an optical fiber doped with rare-earth elements like erbium, ytterbium, thulium etc. Each dopant is characterized by its emission wavelength. The one we discuss here is the erbium (Er^{3+}) doped fiber for laser emission around 1550 nm wavelength range of the infrared (IR) spectrum. (This wavelength range is referred as C-band in optical communications). Fiber laser is pumped optically with semiconductor laser or another fiber laser.

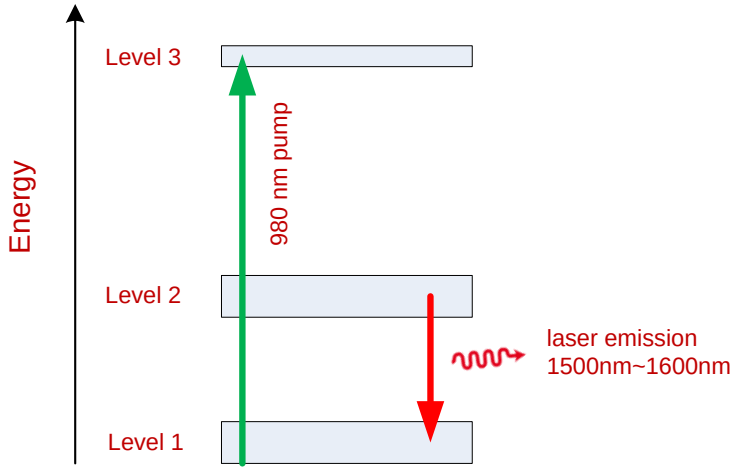
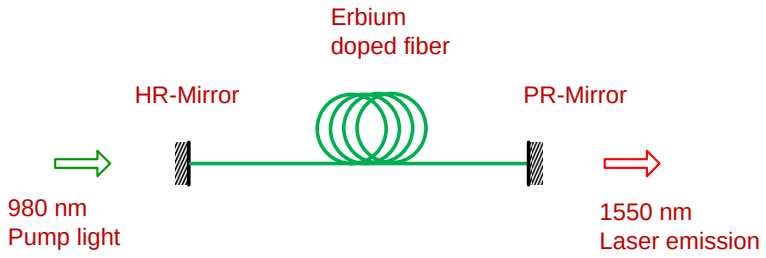


Figure 3: Energy levels of Erbium doped fiber laser

Energy level diagram of erbium doped fiber laser is shown in figure 3. Here laser is pumped by 980nm pump laser (usually semiconductor diode laser) and laser emits in 1500~1600 nm wavelength range. To achieve the laser emission this active gain medium is placed in suitable optical cavity formed by two mirrors. Schematic of a simple erbium-doped fiber laser system is shown in figure 4. Here mirror reflects 1550nm wavelength light, so laser emits at that wavelength. To make the system an *all-fiber* structure, the mirrors can be replaced by fiber Bragg gratings (FBG, a reflective element inscribed within the fiber).



HR-Mirror: High Reflection (>99%) at 1550 nm, High transmission at 980 nm
PR-Mirror: Partial Reflection (partial transmission) at1550 nm, also works as output coupler (OC)

Figure 4: Schematic of erbium-doped fiber laser system