



# EFFECTS OF GAMMA IRRADIATION ON PHASE-SHIFTED GRATING BASED FIBER LASER

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## Presentation outline

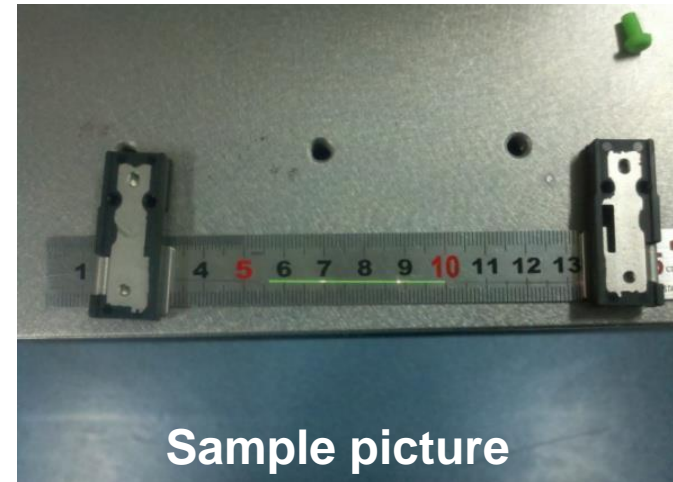
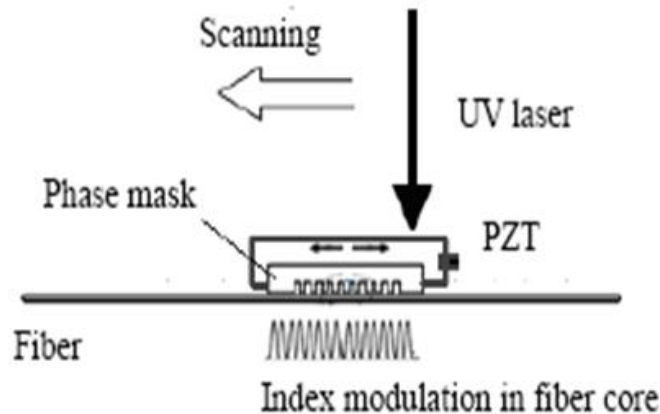
- ✓ Introduction
- ✓ Phase-shifted gating fabrication
- ✓ Distributed feedback fiber laser
- ✓  $\gamma$  Irradiation experiment
- ✓  $\gamma$  Irradiation results
- ✓ Outlook



# Introduction

- ◆ Optical fiber sensing widely applied currently.
- ◆ Facing different irradiation conditions, such as X-ray, gamma ray, neutron radiation, and electron beam when applied in a nuclear environment.
- ◆ Radiation induced attenuation (RIA) is common for various fibers.
- ◆ For fiber gratings, radiation induced peak shift of FBG is an another common effect.

## Phase-shifted gating fabrication



- ◆ The phased-shifted grating was fabricated with dithering phase mask technique on a section of Er-doped optical fiber.
- ◆ The phase-shifted grating lengths of these samples were about 30 mm to 40 mm.

## Gating fabrication



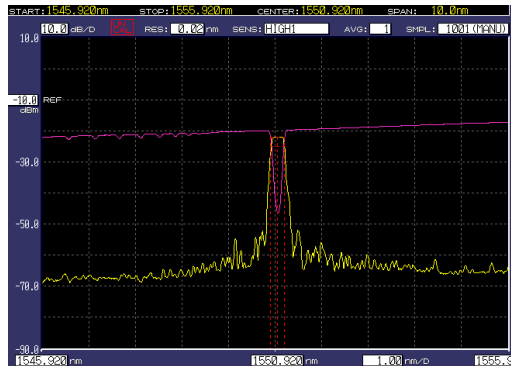
FBG fabrication system based on 248nm Excimer laser



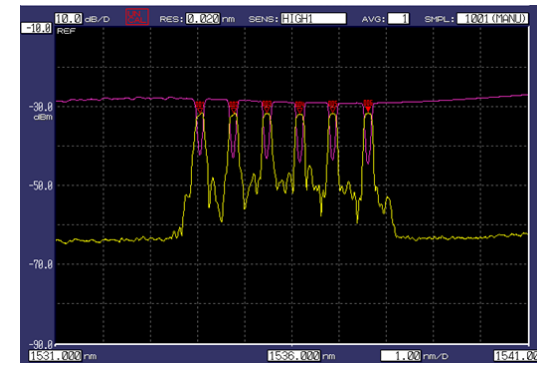
DFB-FL fabrication system based on 244nm Argon laser



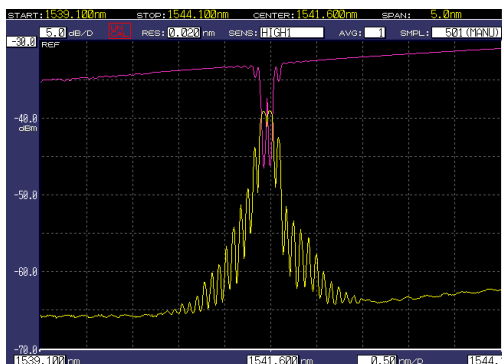
# Gating fabrication



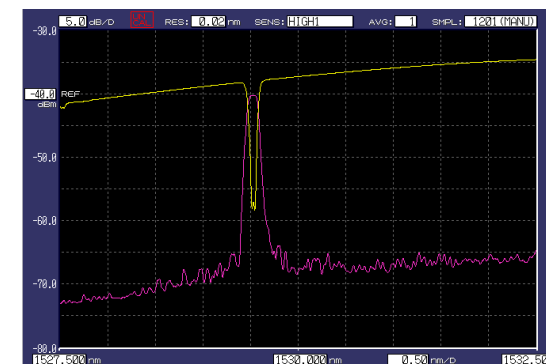
FBG



FBG series

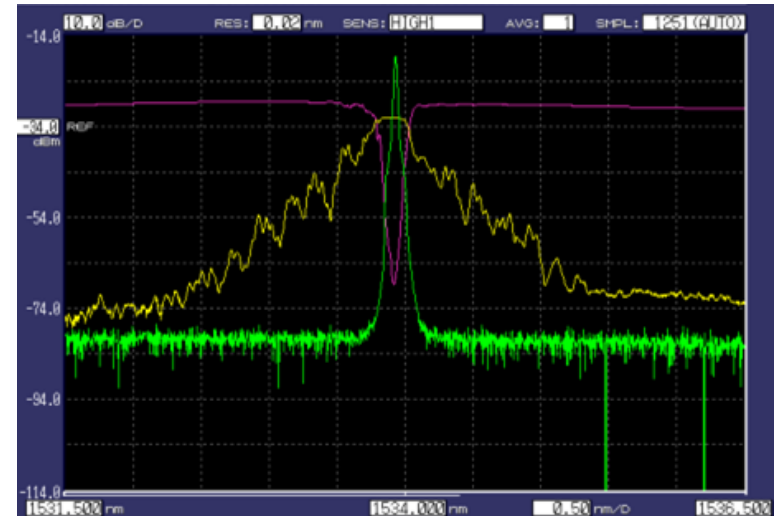
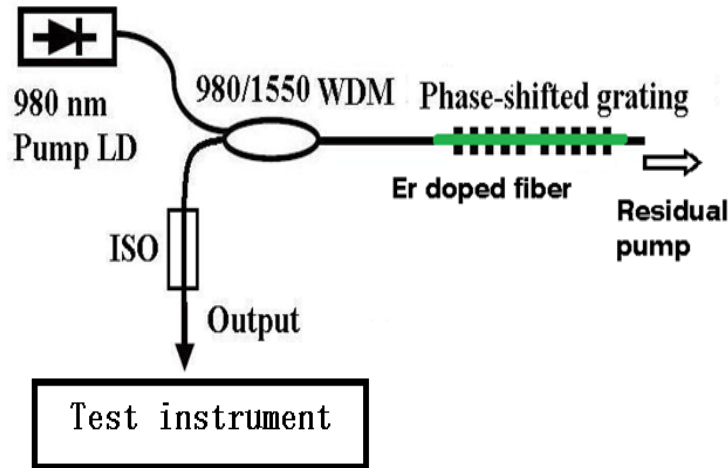


Phase shifted FBG



Apodized PS-FBG

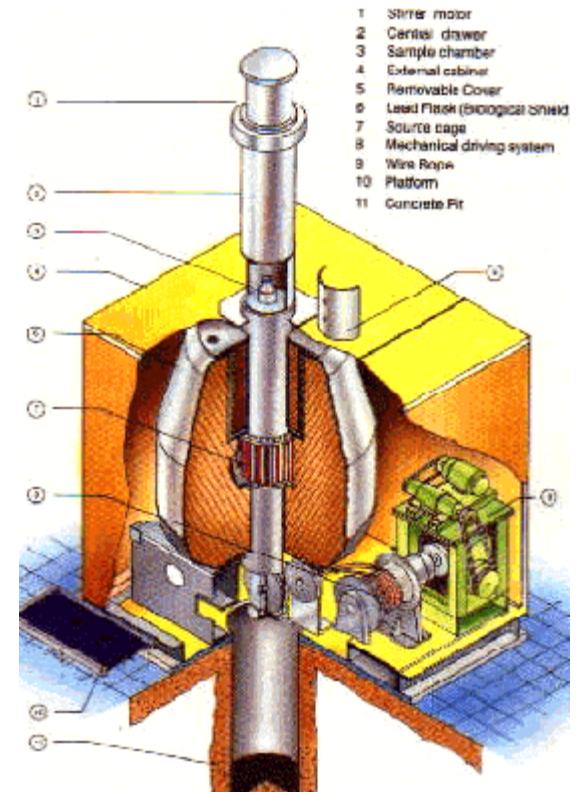
# Distributed feedback fiber laser



- ◆ The phase shift opens a very narrow transmission in the Bragg reflection band which ensures its single longitudinal mode operation.
- ◆ The phase-shifted grating emits laser with a narrow line width at the Bragg wavelength when pumped through a wavelength division multiplexer (WDM) with a 980 nm LD.

## $\gamma$ Irradiation experiment

- ◆ Eight samples were irradiated under different gamma radiation doses in batches.
- ◆ Irradiation instrument:  $^{60}\text{Co}$  the research irradiator type GC-5000 with an chamber volume of 5000 cm<sup>3</sup>.
- ◆ Irradiation condition: about 10 cm above the base; different gamma doses of 2, 12, 36, and 60 kGy at a dose rate of 4.4 kGy/h; 36 ° C.





## $\gamma$ Irradiation results

$\gamma$ dose (kGy)	Sample Code	Length (mm)	Output power before irradiation ( $\mu$ W)	Output power after irradiation ( $\mu$ W)	Difference ( $\mu$ W)	RIA (dB)	RIA/Length (dB/m)
2	DFB-01	40	73	60.6	-12.4	0.81	20.25
	DFB-09	44	18	9.8	-8.2	2.64	60
12	DFB-10	40	187	62	-125	4.79	119.8
	DFB-02	40	Broken		-	-	-
36	DFB-11	40	160	43.8	-116.2	5.63	140.8
	DFB-03	45	240	97	-143	3.93	87.3
60	DFB-12	40	149	37.5	-111.5	6.0	150
	DFB-04	35	135	37.3	-97.7	5.59	159.7

- ◆ Evident radiation induced power loss was observed and found to be nearly proportional to the irradiation dose.
- ◆ This suggests that the semi-quantitative radiation dosimetry by DFB-FL is possible.



## Outlook

- ◆ The RIA here include the contributions from pigtail fibers and Er-doped fibers under radiation.
- ◆ Since the negligible changes in grating strength mentioned before, the increase of cavity loss could be decided which led to the laser efficiency decrease excluding the RIA from fibers.
- ◆ The quantitative measurement of the used fiber characteristics need be carried out in the future investigation .



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## Thank you for your attention