The44th JSMRM in Saitama

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~ Part.1 ~
Examination of the effect of RF shielding, using an electromagnetic wave shield materials offered commercially in MRI

「第1法　MRIにおける市販電磁波遮蔽材を用いたRF遮蔽効果の検討」

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☑ The author has no conflict of interest to with respect to this presentation

Background

Not only considering various risks, but also managing strict safety control, we carry out the MRI examination.

We think that the heat generated by the metal in the human body is the most problematic in the various risks.

In recent years, various kinds of electromagnetic shielding products including carbon fiber are offered in the market.

Purpose

- ✓ We have focused on the shielding effect of electromagnetic waves of carbon fiber and silver fiber.
- ✓ We examined the effect of RF shielding of carbon fiber electromagnetic shielding material and silver fiber electromagnetic shielding material.

Materials

- MRI
  - ・GE Co. SignaHDxt 1.5T
  - ・SIEMENS Co. Magnetom Skyra 3.0T
- COIL
  - ・GE Co. HD Body Array Coil
  - ・SIEMENS Co. Body18 , Spine 32
- PHANTOM
  - ・GE Co. SNR Phantom Square
- ELECTROMAGNETIC WAVE SHIEDING MATERIAL (size:1m*1m/sheets)
  - ・Toray Industries,Inc. Torayca Cross(CO6343)
  - ・MEDICAL-AID,Inc. EMC sheet(ES100)

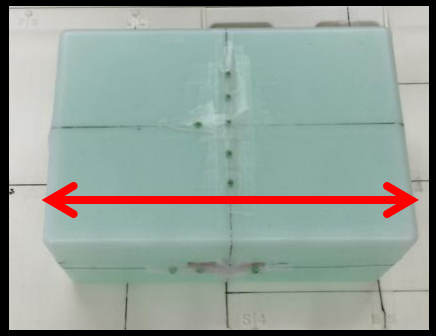
Method

1. We shielded by winding carbon fiber or silver fiber around a half of the phantom.
2. The center of the magnetic field was matched up with the central part of shielding in the phantom.
3. The number of electromagnetic wave shielding materials were changed from one to four.
4. By using a T1 weight fast SE method , it was taken sagittal images and coronal images in the center of the phantom were taken.
5. Those images were taken by 1.5T MRI and 3.0T MRI under the same conditions.
6. SNR and Sensitivity distribution were measured by using image analysis software..

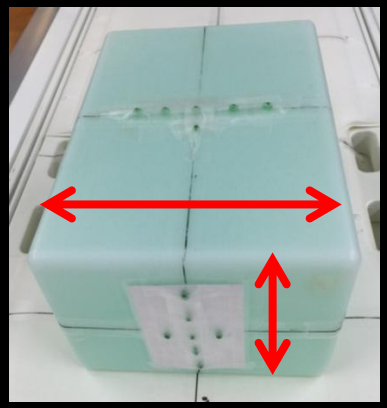
Imaging parameter of each T1W imaging technique

Sequence parameter	T1 Weighted Image			
MRI Unit	Siemens Skyra3.0T		GE signaHDx1.5T	
Pulse Sequense	2D-Quiet TSE		2D-FSE XL	
Sacning orientation	Sagittal	Coronal	Sagittal	Coronal
Field of view(FOV)(mm)	400		400	
Matrix	256*256		256*256	
Slice thickness(mm)	10		10	
Repetition time(TR)(ms)	600		600	
Echo time(TE)(ms)	20	24	20	24
PAT mode	GRAPPA		ASSET2.0	
Band width	300(Hz/Px)	201(Hz/Px)	80(MHz)	128(MHz)
TSE factor	3		3	
Flip angle(deg)	150		90	
Phase enc.dir	F>>H	R>>L	F>>H	R>>L
FOV phase(%)	100	100		
Averages	1	1	2	2
Coil elements	Body123,Spine123		HD/Body Full	
Filter	Prescannormalize medium Distotion corr		PURE	

Figure.1



Length : 33.3cm



Width
: 22.6cm

Height : 16.5cm

Figure.2

Figure.1

- Putting a mark on the surface in order to indicate the center of the square phantom.
- The oral care product “BREATH CARE" was used as a mark.

Figure.2

- The Square phantom and a phase array coil.
- Putting a mark on the center of the coil, the square phantom was placed in the center of the phase array coil.

Figure.4 : Carbon fiber Shield

Figure.5 : Silver fiber Shield

- Each fiber was wound around the square phantom.
- Wrapped the surface of the box with carbon fiber and silver fiber.
- Insert the phantom into this box.

Figure.4
Silver fiber Shield material in 3.0TMRI

Figure.5
Silver fiber Shield material in 3.0TMRI

- Shielding a half of the square phantom by using carbon fiber or silver fiber.
- The number of electromagnetic wave shielding materials were changed from one to four.
- The center of the magnetic field was matched up with the central part of shielding in the phantom.

Conditions of measurement

1. **Room temperature 20℃**
2. **The frequency of each imaging was three times.**
3. **Measurement interval for preparation of each set of shielding materials was at least 10 minutes**

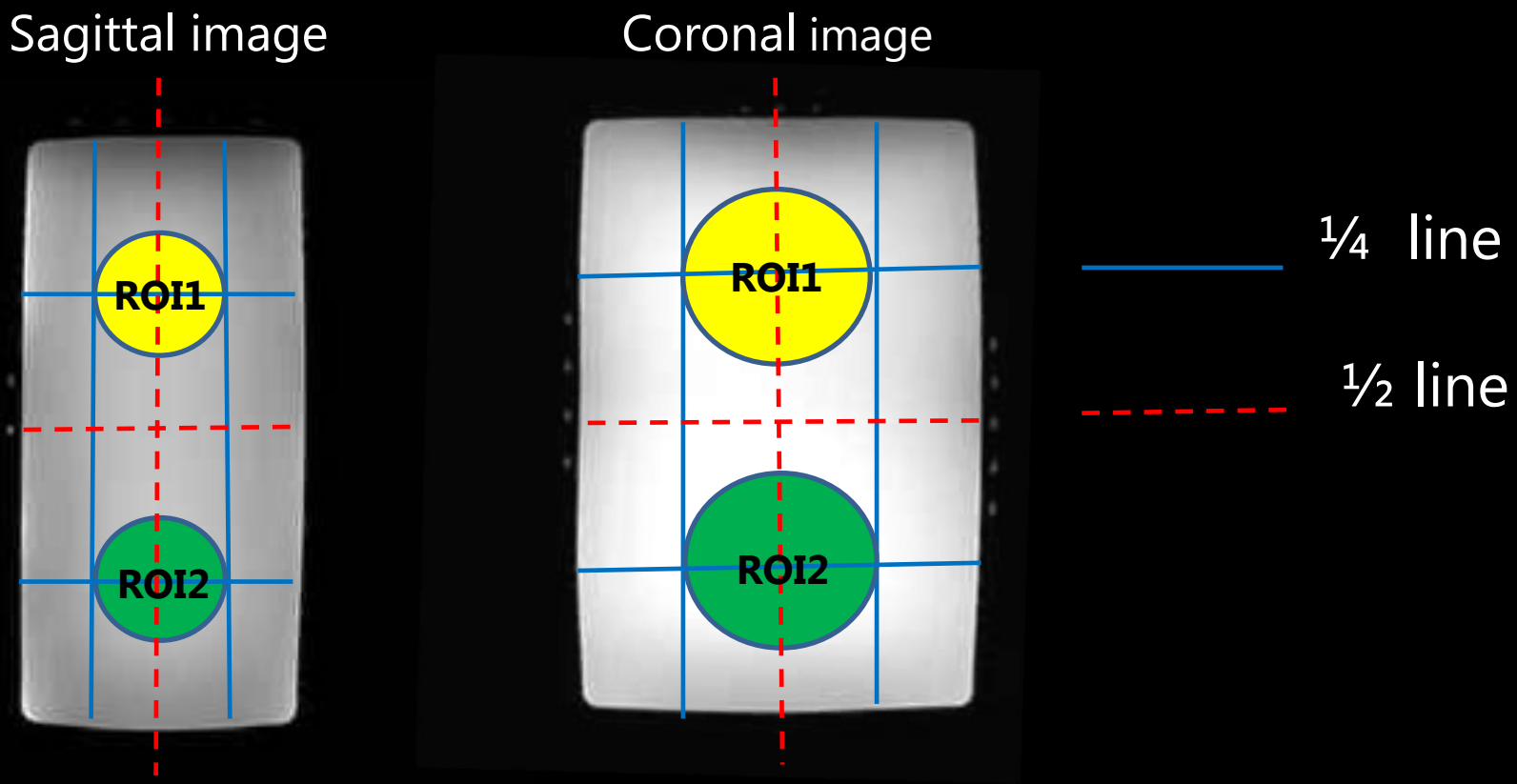
Study of contents

1. **Sensitivity distribution**(RF wave attenuation curve)

2. **SNR** SNR（ROI2）＝Mean（ave.）/SD(ave.)

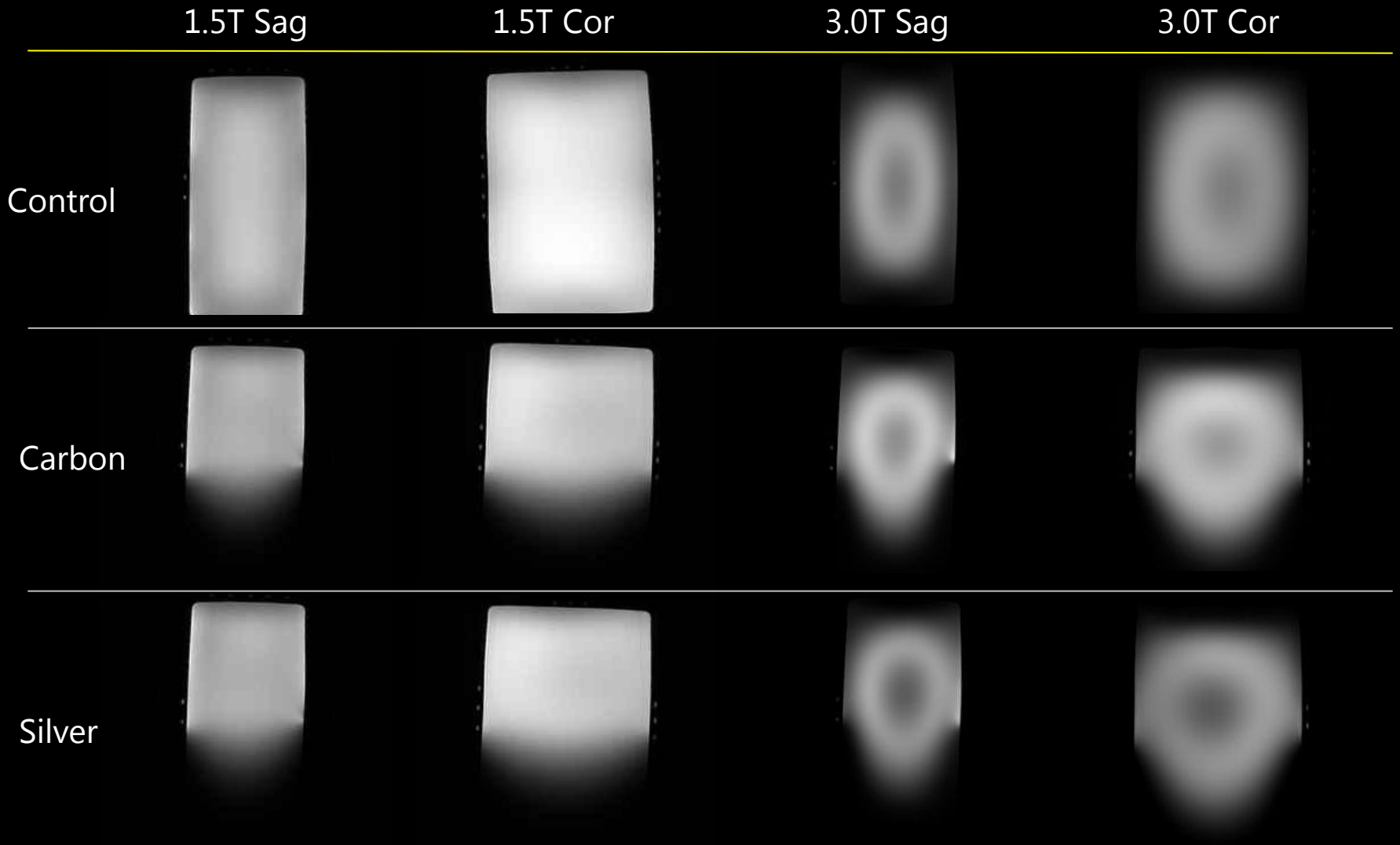
Measured by image analysis software(Image J)

Setting conditions of ROI

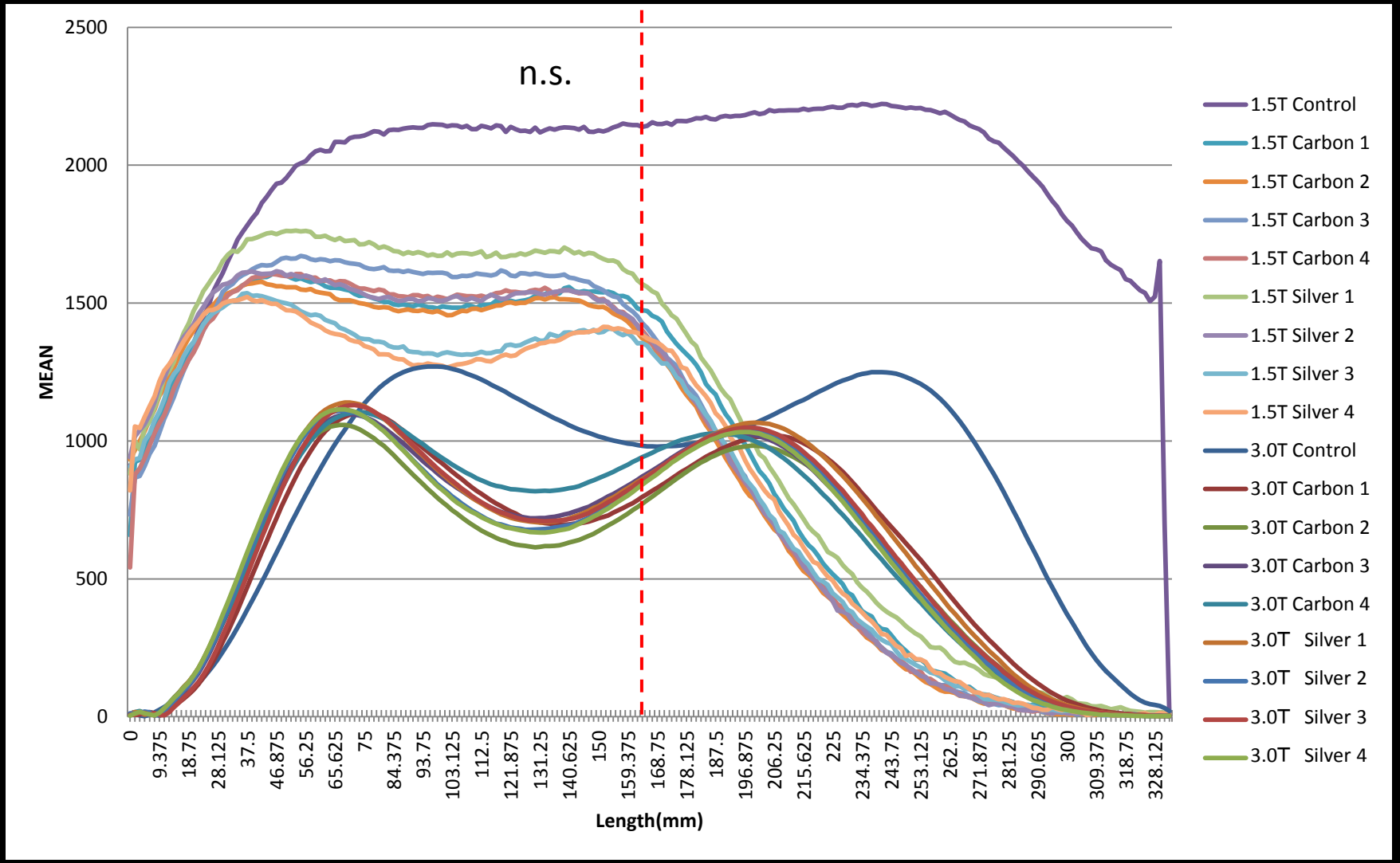


Results

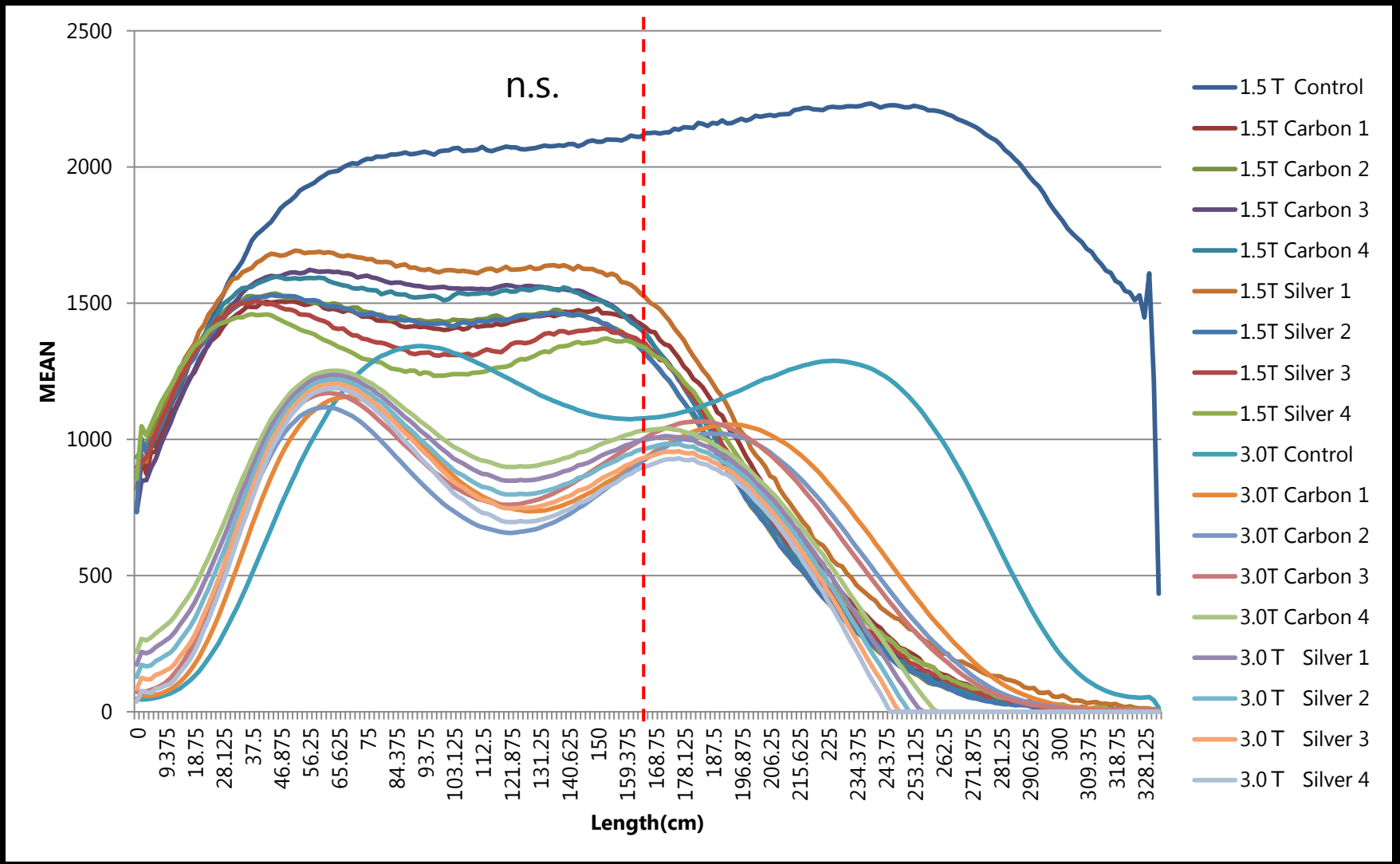
By using a T1 weight fast SE method, Sagittal image and Coronal image were taken.



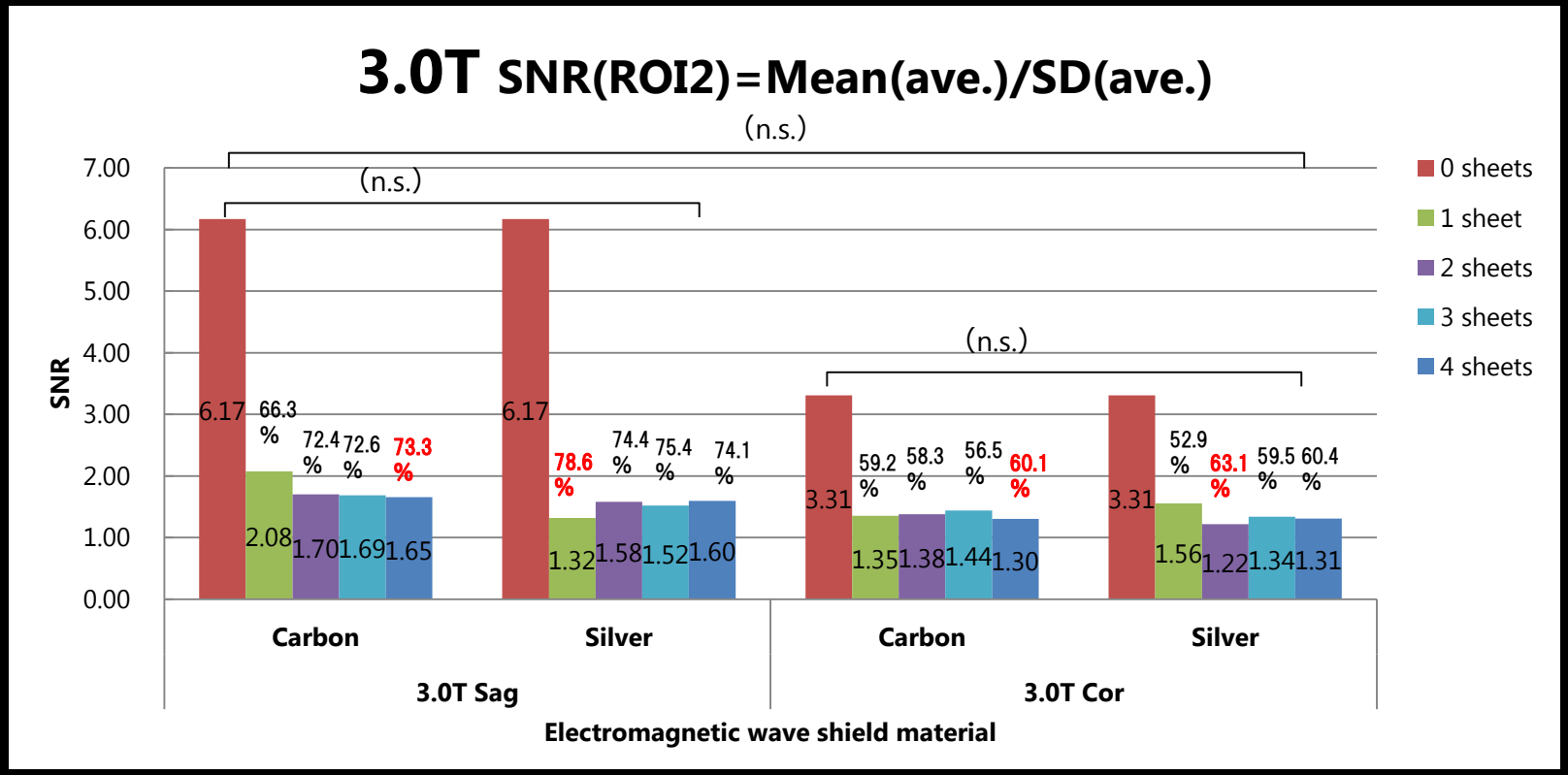
Sensitivity distribution in the Sagittal image of 3.0T MRI and 1.5T MRI (RF wave attenuation curve)



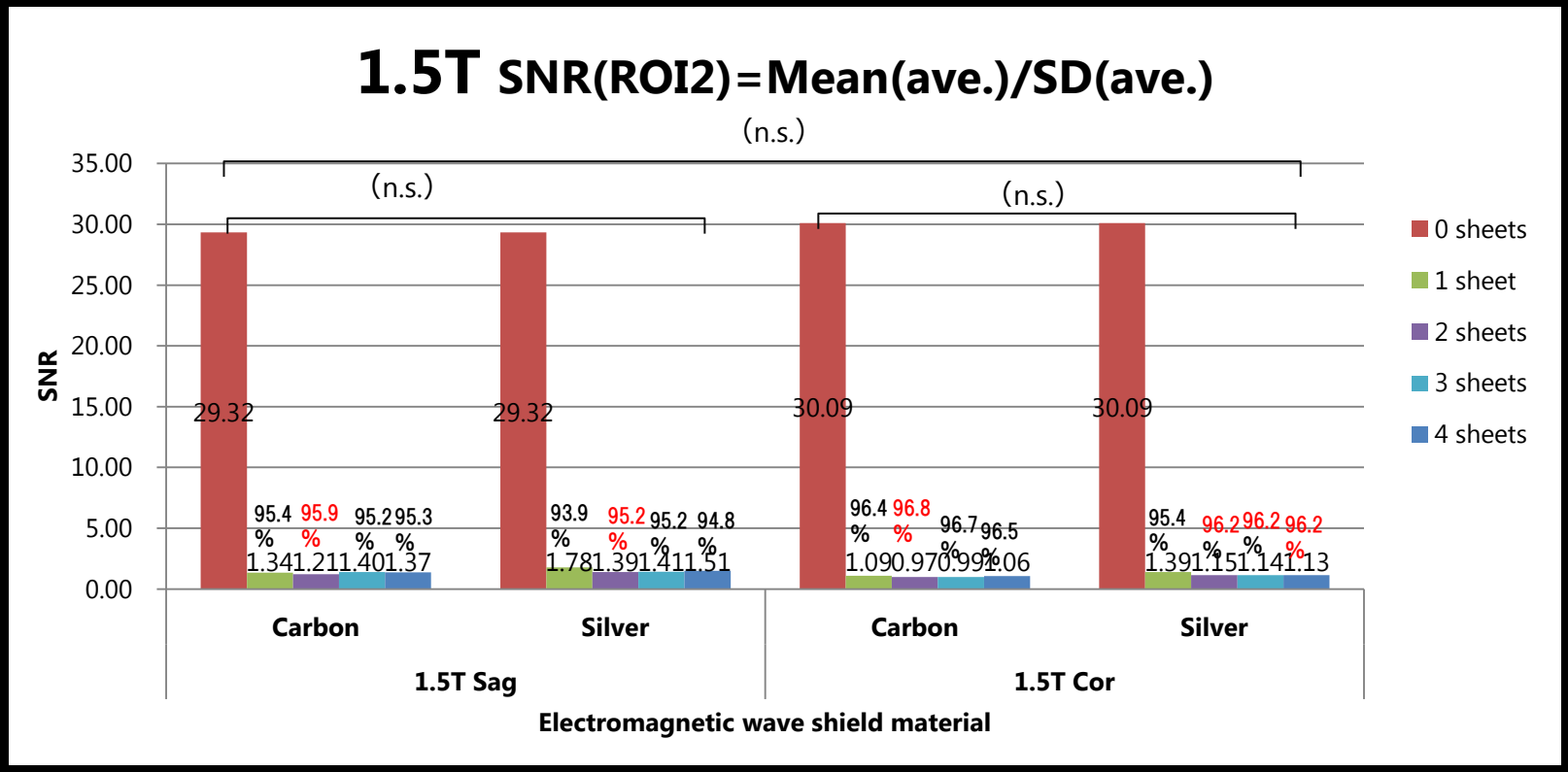
Sensitivity distribution in the Coronal image of 3.0T MRI and 1.5T MRI (RF wave attenuation curve)



Making a comparison between SNR of the Carbon fiber and Silver fiber in 3.0T MRI



Making a comparison between SNR of the Carbon fiber and Silver fiber in 1.5T MRI



Measurement result of sensitivity distribution (RF attenuation curve)

Create a plot profile curve, RF wave attenuation rate is assumed.

✓ The difference of the resonant frequency.

RF wave attenuation rate ⇒ **3.0T< 1.5T**
Attenuation distance that MEAN value attenuates to 500.
⇒ **1.5T=6.05cm(ave.)**, **3.0T=9.2cm(ave.)**

✓ RF signal of the surface portion of the phantom was easily shielded.

✓ RF signal of the central portion of the phantom was absorbed into the phantom and was lost.

✓ By the action of Prescan-nomaraize image filter , the signal attenuated by the shielding materials was strongly corrected.

※ Statistically significant difference were not observed.

Results of SNR

- ✓ Both sagittal section and coronal section in 1.5T showed steady signals and uniform measurement results.
- ✓ Both sagittal section and coronal section in 3.0T showed uneven signals and non-uniform measurement results.

⇒Signal of the central part and the edges of the phantom

is low. Donut-like signal distribution.

- ✓ Shielding effects of the electromagnetic wave shielding materials were dependent on the resonant frequency.

⇒ RF wave attenuation curve rate

3.0T (128MHz) ＜ 1.5T (64MHz)

※ Statistically significant difference were not observed.

Results

SNR

Magnetic field strength	Cross section Image	Material	Good Number of sheets	Attenuation rate(%)
3.0T	Sagittal	Carbon fiber	4	73.3
		Siver fiber	1	78.1
	Coronal	Carbon fiber	4	60.1
		Siver fiber	2	68.1
3.0T MRI	***	***	**3**	**69.9**

Magnetic field strength	Cross section Image	Good material	Good Number of sheets	Attenuation rate(%)
1.5T	Sagittal	Carbon fiber	2	95.9
		Siver fiber	2	95.2
	Coronal	Carbon fiber	2	96.8
		Siver fiber	2	96.2
1.5T MRI	***	***	**2**	**96.0**

- ✓ Carbon：80.43%　Silver ：81.34%
- ✓ **Overall results in the SNR comparison was 80.89%(ave) .**

Conclusion

We must use sealed carbon fiber in plastic bags because of prevention of scatter of carbon fiber.

Carbon fiber has a negative impact on the human body through direct contact,such as itch and rash.

Therefore, Care should be taken when handling carbon fiber.

カーボン繊維は、飛散する恐れがあるため、ビニール袋に封入してから使用する必要があった。また、人体に直接触れるとかぶれや痒みを伴うため、カーボン繊維の取り扱いには注意が必要である。

Conclusion

In contrast , silver fiber has a strong affinity for the human body , and offers great flexibility.
Because there is no risk of scattering, it is safe and easy for us to handle silver fiber.

Therefore, silver fiber is suitable for use in an electromagnetic wave shield material in MRI, for the reason of diamagnet and high heat dissipation with the help of honeycomb structure.

それに比べ、銀繊維は、人体との親和性が高く、柔軟性に富み、飛散する恐れがなく、安全で取り扱いも簡便であった。ハニカム構造のため放熱性が高く、反磁性体であるためＭＲＩにおける電磁波遮蔽材として適材である。

“Thank you for your attention.”