The 73rd Annual Meeting of the JSRT
Saturday , Apr 15 , 2017

The Relationship Between Attenuation Curve of Radio Frequency Wave (RF) and Opening Size of Electromagnetic Wave Protective Clothing for Capsule Endoscope

Tatsuya Kuwagaki , Masanari Taniguchi , Toshihiko Nishida

Hidekazu Niikawa , Daichi Shimokawa , Akira Tamada

Sumitomo Hospital　Dept. of radiologic technology

Hideki Matsui

MEDICAL-AID CO.,LTD

Disclosure of conflict of interest

- Author Mr. Hideki Matsui is an employee of MEDICAL-AID CO., LTD , Osaka, Japan.
- Devices (the electromagnetic wave protective clothing) used in this study was provided by MEDICAL-AID CO., LTD , Osaka, Japan.

【 Background 】

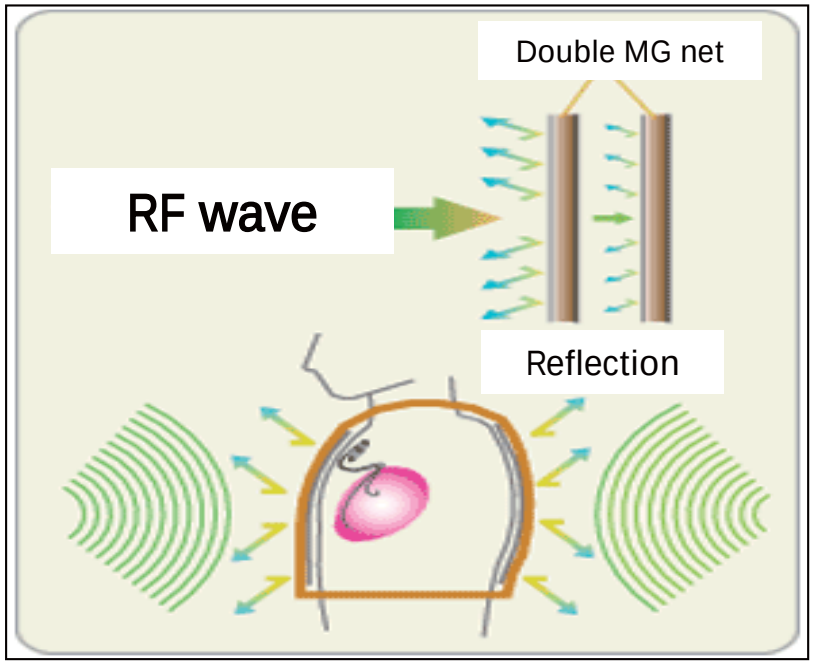
Magnetic resonance imaging (MRI) examinations are problem of metal devices heat generation by radio frequency waves (RF waves).

Using electromagnetic waves protective clothing for capsule endoscope (protective clothing) prevent risk of heat generation.

Protective clothing

Characteristics of protective clothing

- RF waves reflection and shield effect.
  (⇒Area : Neck, Upper limbs, Trunk)
- The opening sections can be opened and closed.
  [Opening sections : Collar, Sleeves, Hem]



Characteristic of protective clothing

http://www.medical-aid.co.jp/company/gaiyo.html

Characteristics of protective clothing

Problem

- Difficult to shield RF waves as opening sections becomes wider.
- When is metal devices in the opening sections, possibility that RF waves reaches metal devices and generates heat.

It is necessary to know how much RF waves penetrates into the body from opening sections of protective clothing.

【 Purpose 】

In this study, correlation between circumference of opening sections and RF waves attenuation curve was measured.

An effective shield distance that can be inspected safely we examined from RF waves attenuation curve.

Definition of effective shield distance

Distance that average signal values in RF waves attenuation curve decreases to 10%.

【 Materials 】

MRI Unit
SignaHDxt1.5T (GE)
MagnetomSkyra3.0T (SIEMENS)

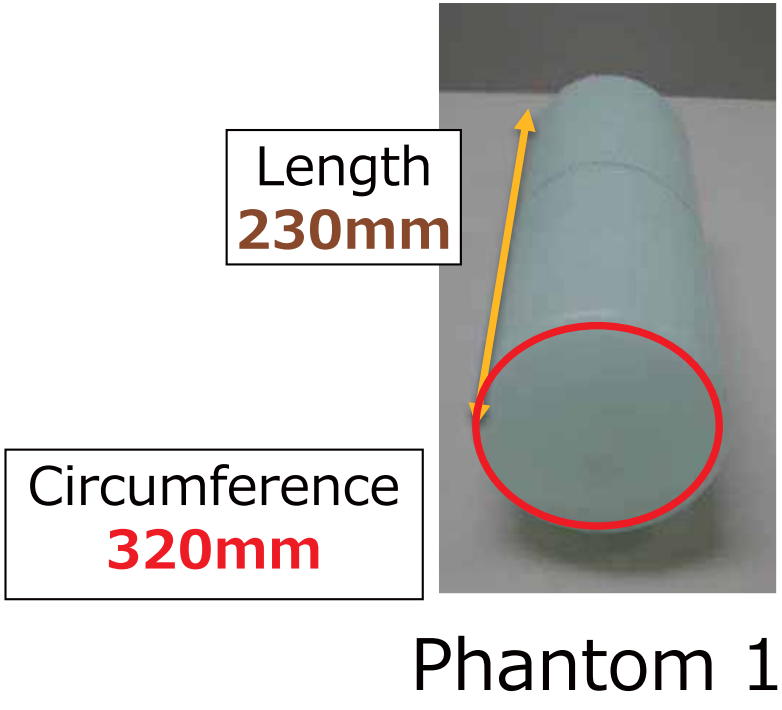
Coil
HD Body Array 12ch Coil (GE)
Body 18ch Coil (SIEMENS)
Spine Matrix Coil (SIEMENS)

Protective Clothing	Product Maker
MG vest CES	MEDICAL-AID

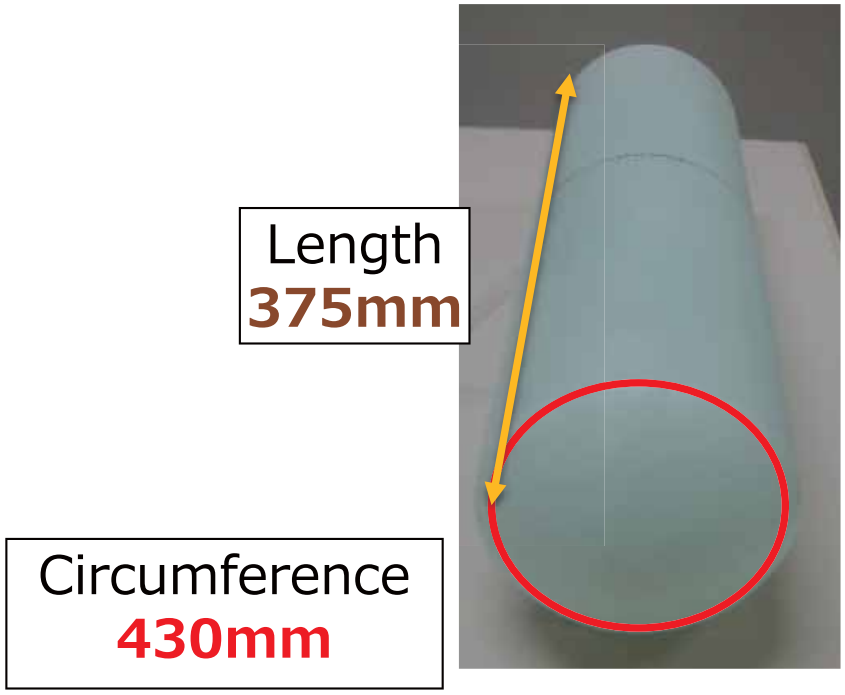
Image Analysis Software
Image J

Different circumference phantom

	Circumference	Phantom
Phantom 1	**320mm**	SNR Phantom Cylinder (GE)
Phantom 2	**430mm**	SNR Phantom Cylinder (SIEMENS)



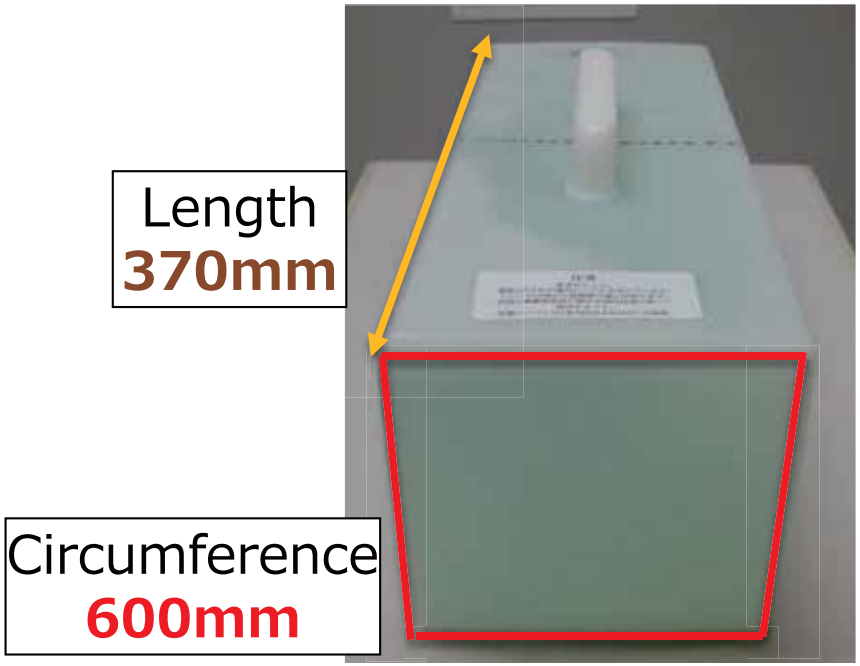
Phantom 1



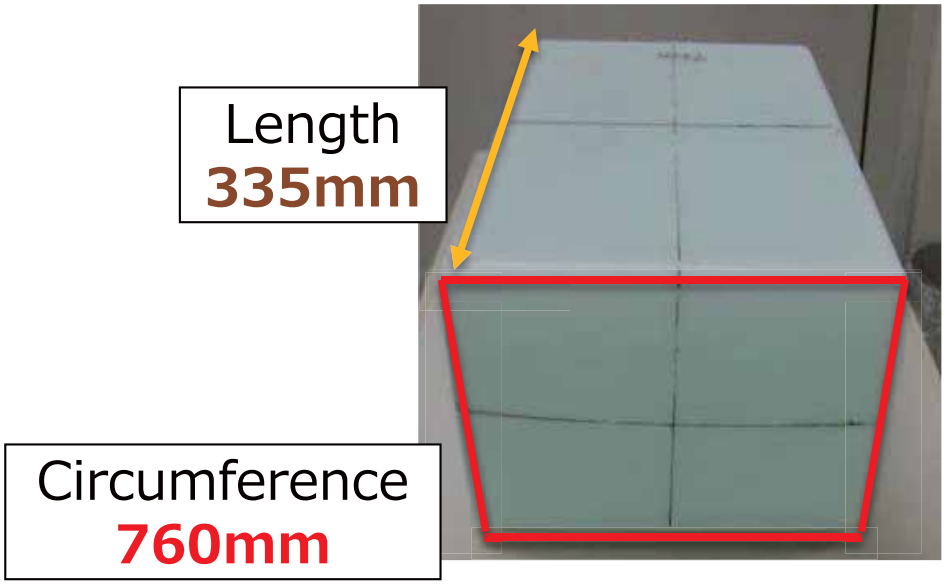
Phantom 2

Different circumference phantom

	Circumference	Phantom
Phantom 3	**600mm**	Phantom Square 4 CHANNEL (GE)
Phantom 4	**760mm**	SNR Phantom Square (GE)



Phantom 3



Phantom 4

【 Methods 】

1：The landmark of each phantoms made position of **115**mm from upper end of phantom.

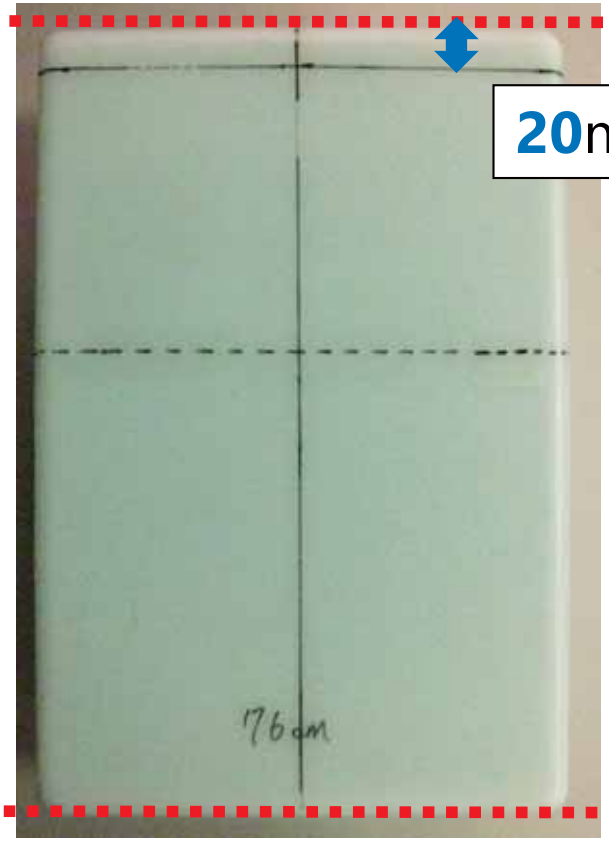
2：Used 1.5T MRI unit and 3.0T MRI unit with different resonance frequencies.

3：Each phantom images (Control, Protect) were acquired three times using T1-weighted (T1W) sequence.

4：Analyzed images and made RF waves attenuation curves.

Wearing of protective clothing

Control



Phantom4
(760mm)

Protect

Sequence parameter(T1W)

MRI Unit	Siemens Skyra3.0T		GE Signa HDxt1.5T	
Coil	SIEMENS Co.Body 18ch Coil,Spine32		GE Co.HD Body Array 12ch Coil	
Pulse Sequence	T1_2D-quiet TSE		T1_2D-FSE XL	
Scanning Orientation	Sag	Cor	Sag	Cor
FOV(mm)	480	480	480	480
FOV Phase(%)	100	100	100	100
Matrix	256＊256		256＊256	
Repetition Time(TR:ms)	500	500	600	600
Echo Time(TE:ms)	16	16	24	24
Phase enc.dir	F >> H	R >> L	F >> H	R >> L
PAT Mode	GRAPPA 2.0		ASSET2.0	
TSE Factor	3	3	2	2
Averages	4	4	2	2
Band Width	300(Hz/Px)	300(Hz/Px)	83.3(KHz)	83.3(KHz)
Filter	Prescan normalize(Normal)		PURE	
Coil Elements	Body123,Spine123		HD/Body Full	

【 Analysis 】

1 : Analyzed images (coronal, sagittal) of each MRI units (1.5T, 3.0T) and made RF waves attenuation curves.

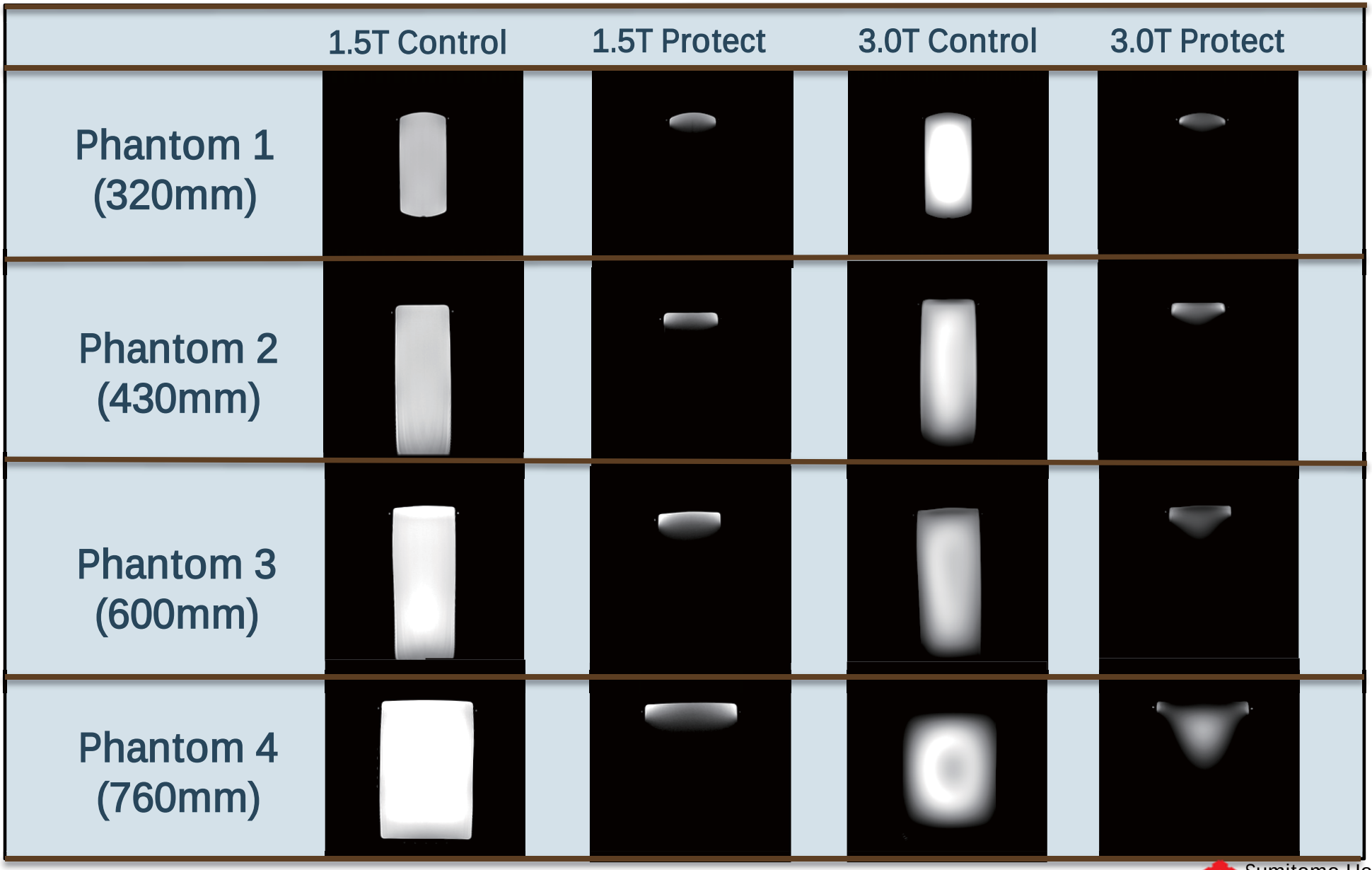
2 : The analysis result of each phantoms were (additive) averaged.

3 : RF waves attenuation curve of protect images were normalized.

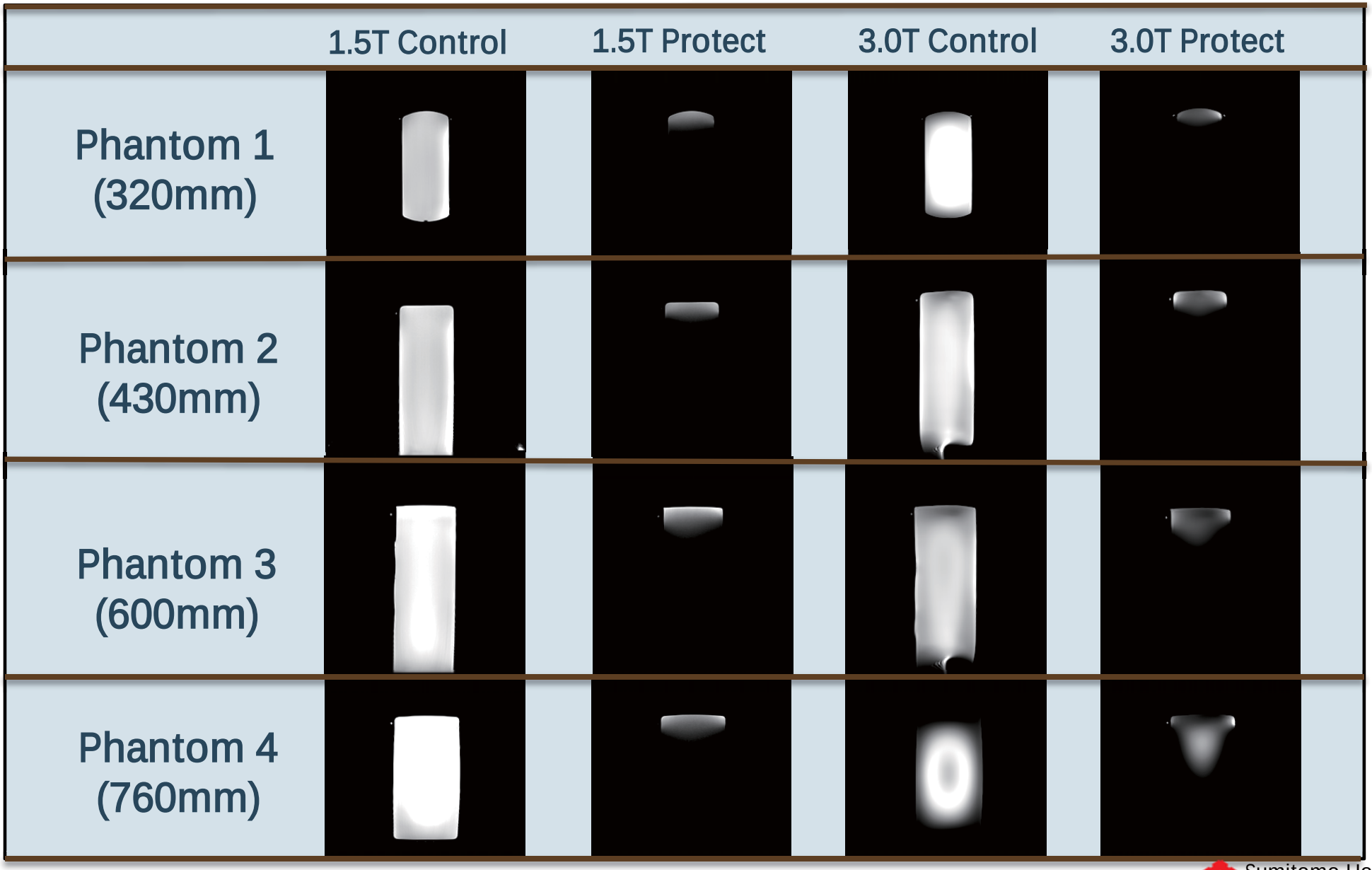
4 : Found effective shield distance from RF waves attenuation curves.

【 Results 】

Coronal images

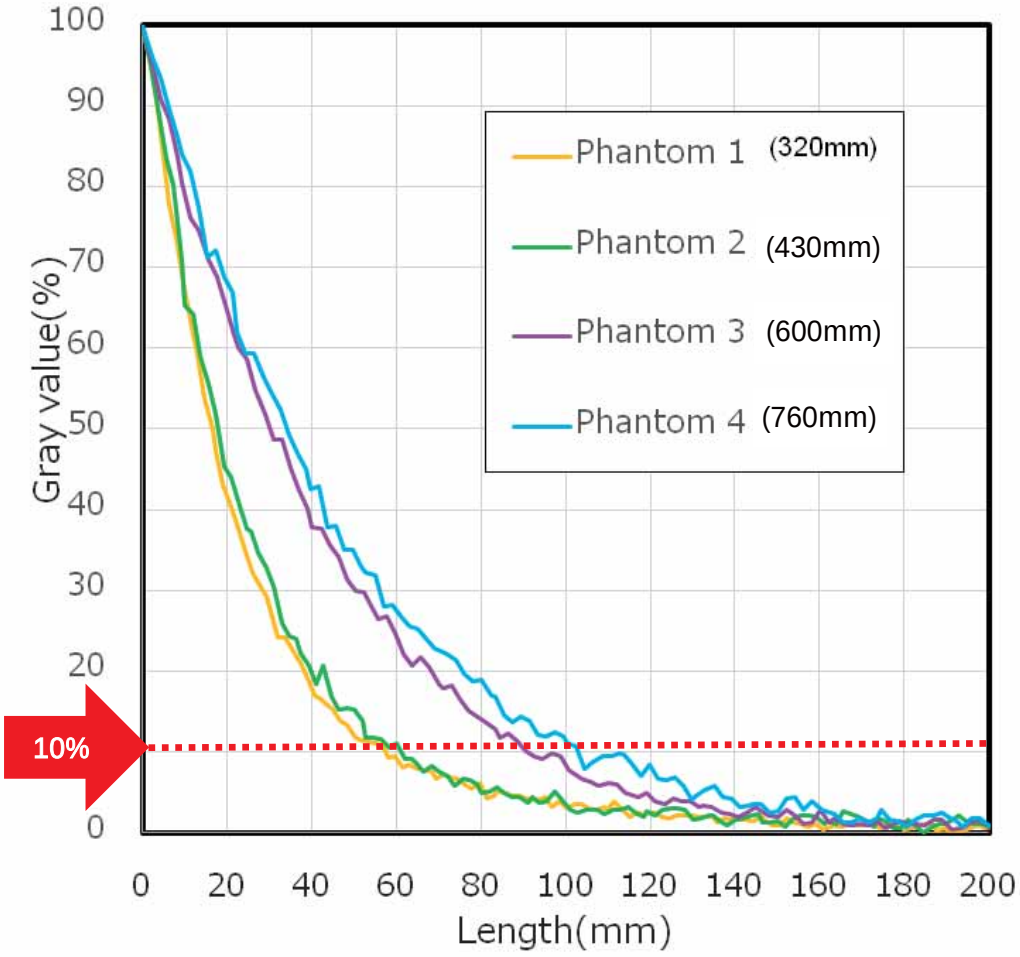


Sagittal images

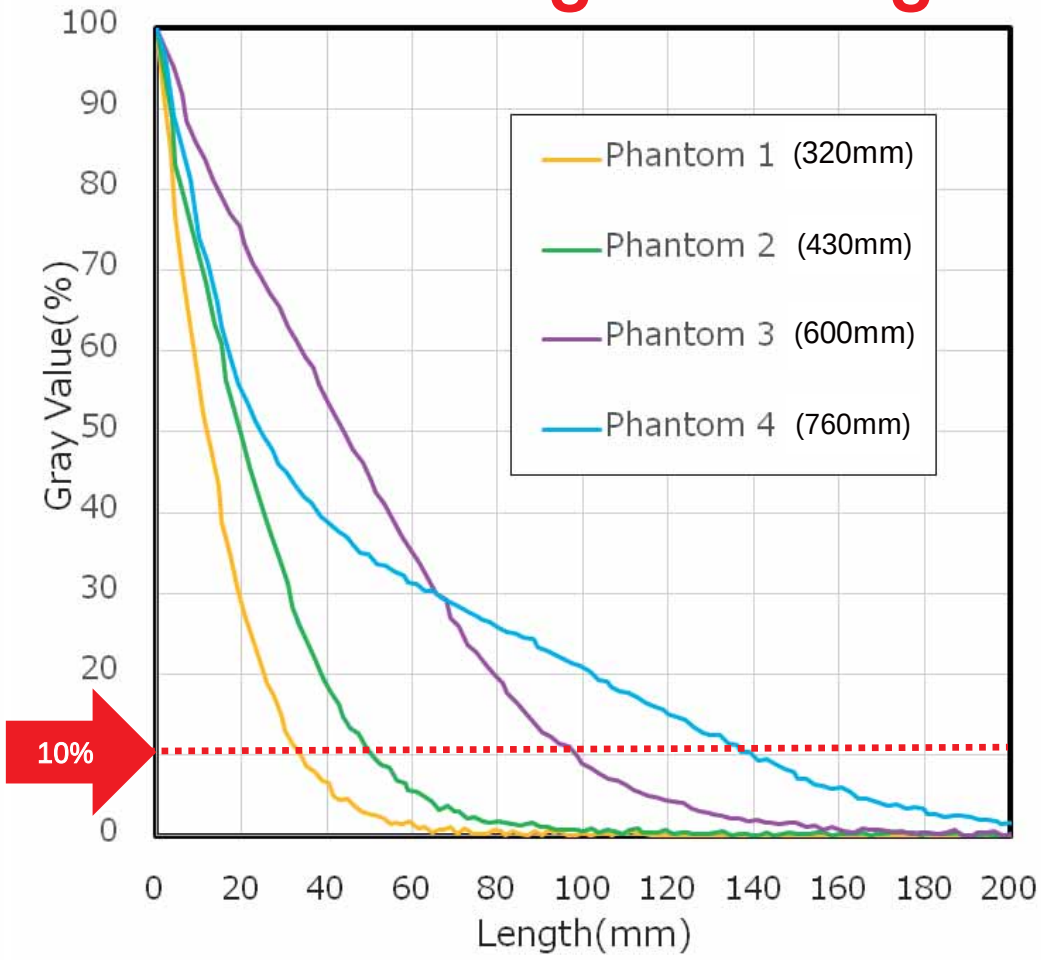


Attenuation curve of RF waves

Sagittal images



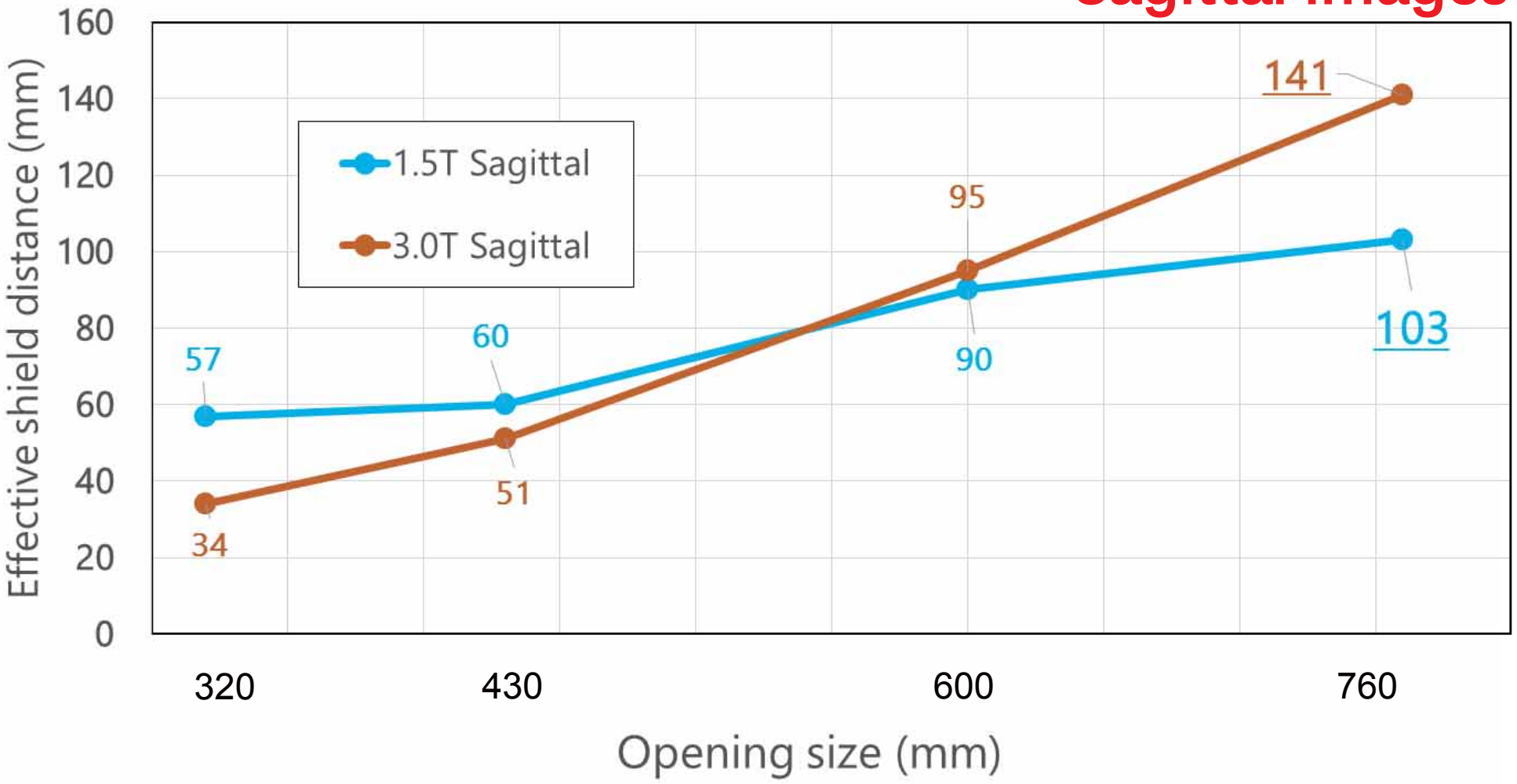
1.5T MRI unit



3.0T MRI unit

Values in effective shield distance due to various opening size

Sagittal images



【 Discussion 】

Cause

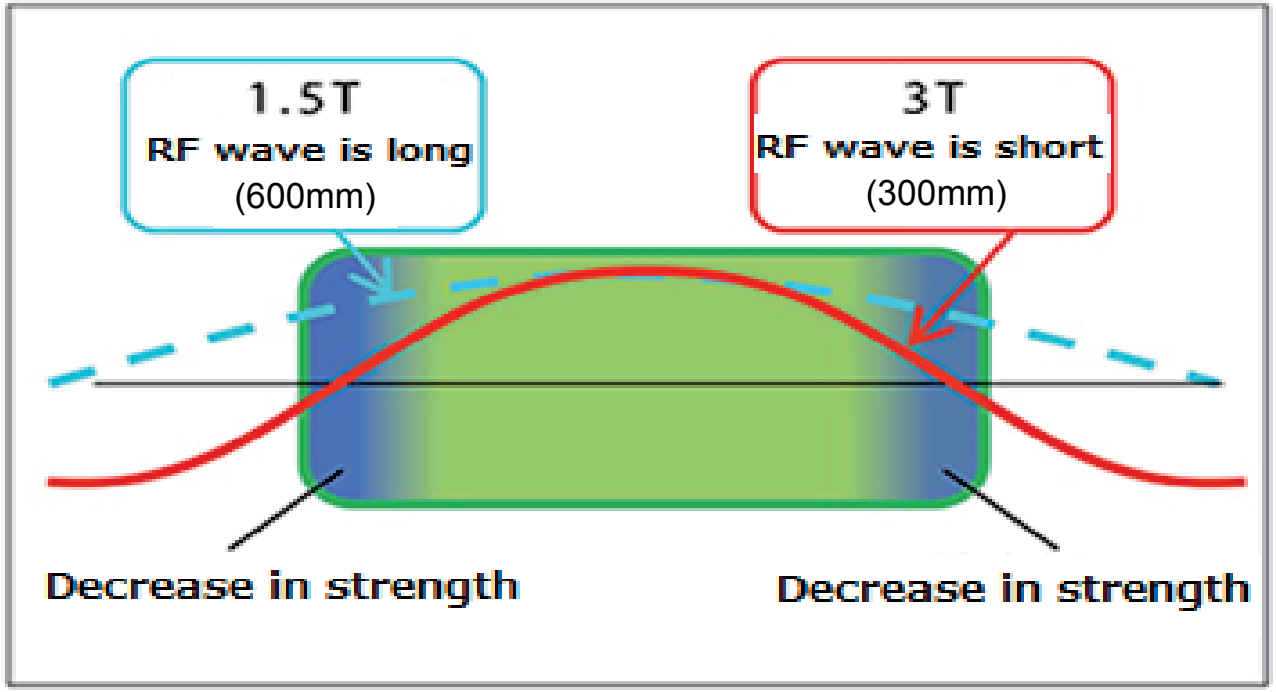
In the 3.0T MRI unit,

“ irradiation non-uniformity ”

of RF waves tends to occur.

Irradiation non-uniformity of the RF wave

Since the phantom has electrical characteristics, period of RF waves that interferes with phantom in 3.0T MRI unit apparatus is about 300mm.



Irradiation non-uniformity depends on period

http://www.innervision.co.jp/ad/suite/technical_notes/140982

【Conclusion】

The most effective shield distance was found to be “141 mm or more”.

Thank you for your attention