

DWI

(拡散強調画像)

しんみどり

横浜新緑総合病院 金森正典

病院紹介：横浜新緑総合病院

しんみどり



病院紹介：横浜新緑総合病院

しんみどり



診療科目	消化器センター 消化器内科・消化器外科 脳神経センター 脳神経外科 内科・外科・整形外科・婦人科・眼科・泌尿器科・ 皮膚科・循環器科・麻酔科 放射線科・リハビリテーション科・肛門科・ 呼吸器科・神経内科
専門外来	糖尿病・肝臓病・婦人科特殊・乳腺・脳腫瘍・ スポーツ整形・男性更年期 パーキンソン病・下肢静脈瘤・リウマチ痛風

病床数

一般199床、療養37床(回復期リハビリテーション病棟) **計236床**

放射線技師 16名

当院のMRI装置



3 T
Philips製
Ingenia



1.5T
キヤノン製
EXCELART Vantage

DWI

拡散 強調画像

拡散とは？？

・広がり、散らばる事。

By コトバンク

拡散とは？？

水分子の動き
(ブラウン運動)



拡散

拡散とは??

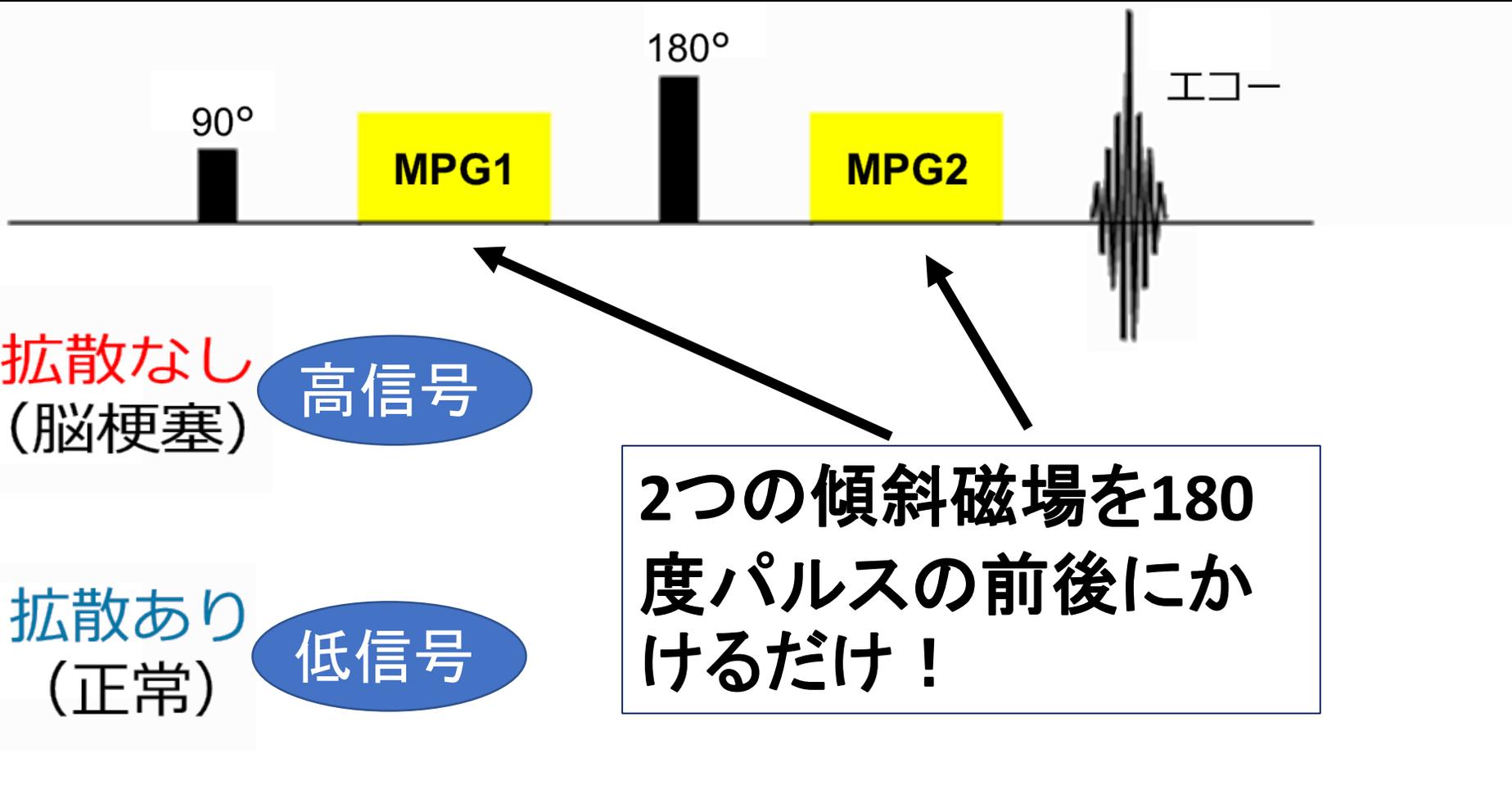


動ける！

動けない！

どうやって
拡散を画像化する？

原理

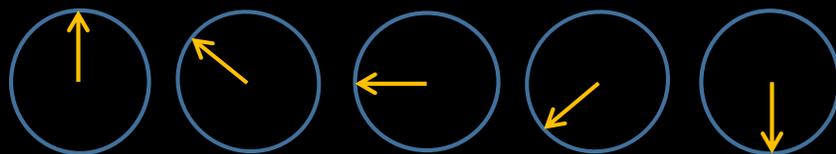


動き

探る

傾斜磁場

MPG: Motion Probing Gradient

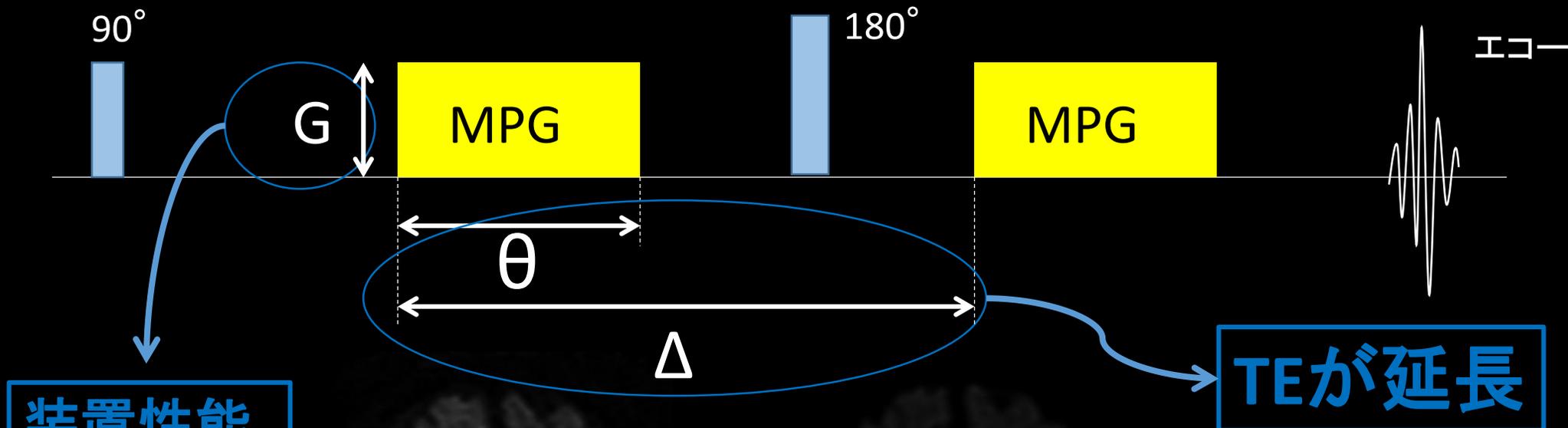


$$b \text{ 值} = \gamma_2 G_2 \theta_2 [\Delta - \theta/3] \quad \text{s/mm}_2$$

b値 =

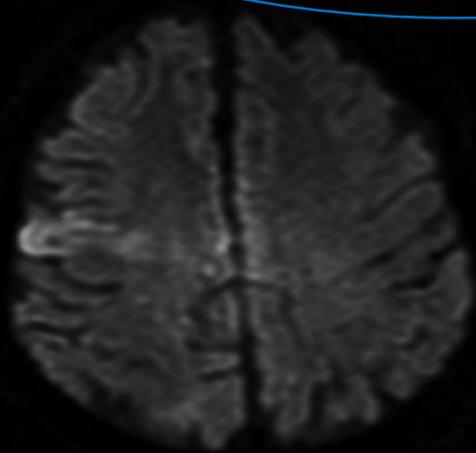
拡散強調の強さ

s/mm²

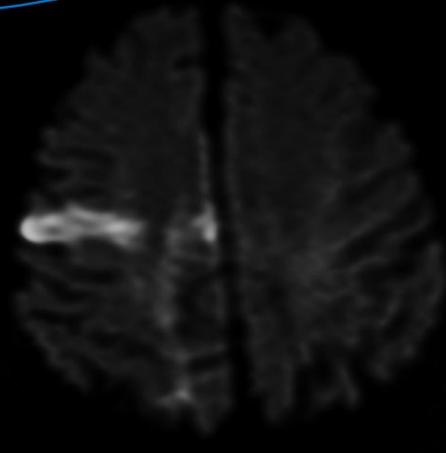


装置性能
に依存

TEが延長



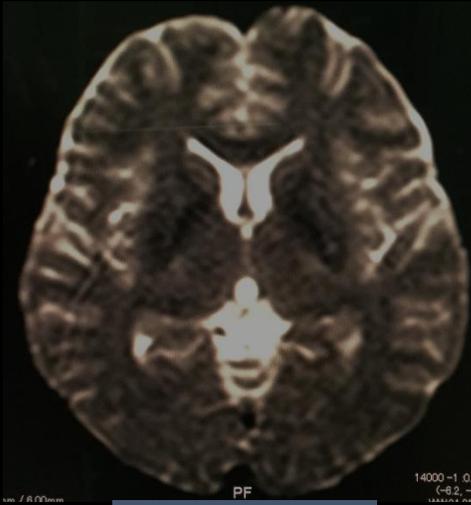
b値 = 500



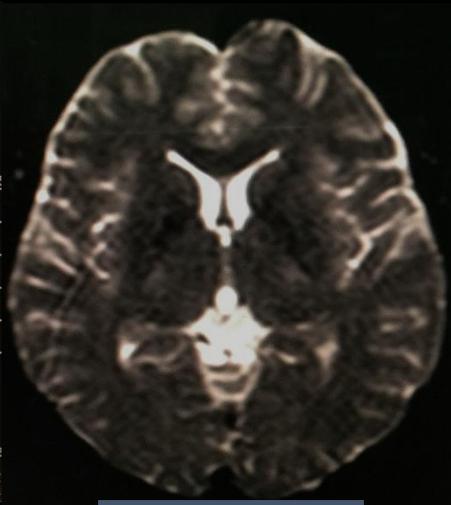
b値 = 1000

TEが短いほうがSNが高い

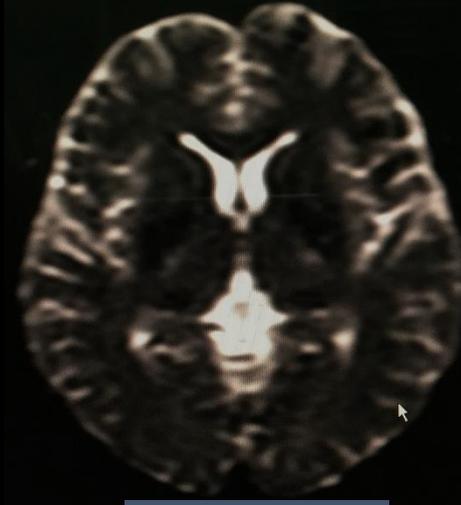
b=0



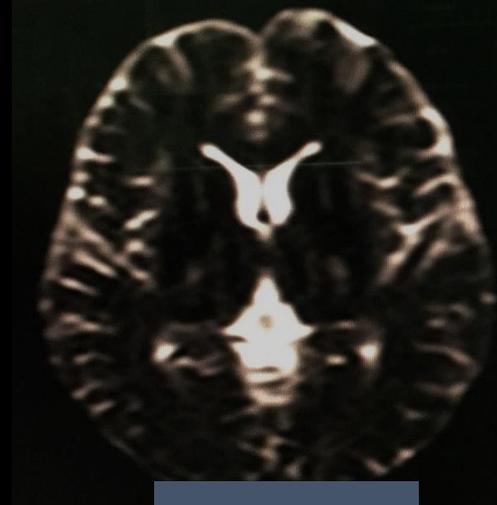
TE:100ms



TE:120ms

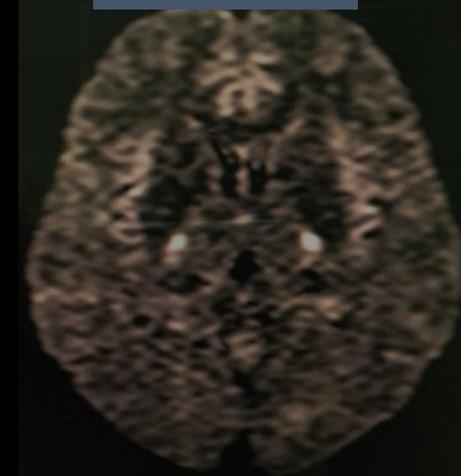
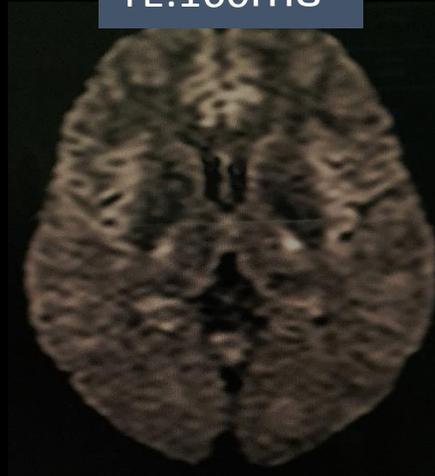
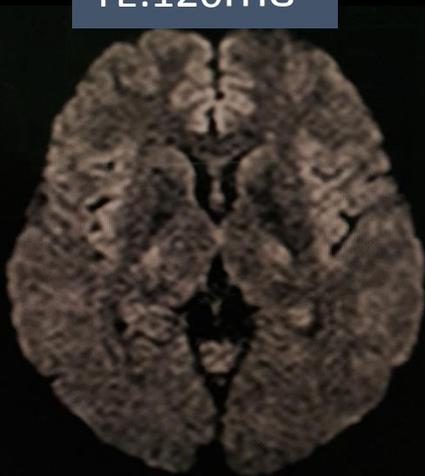
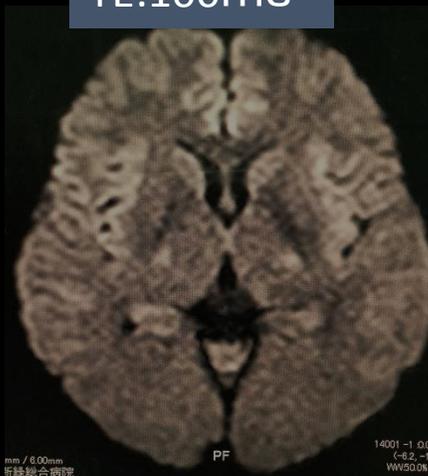


TE:160ms



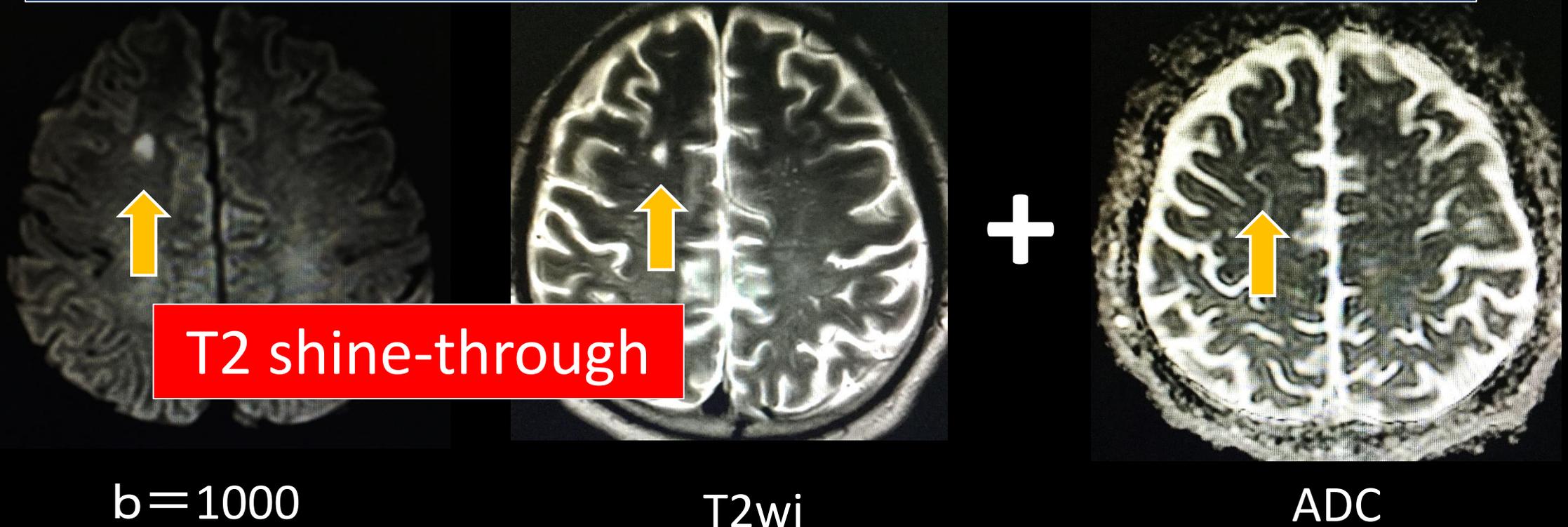
TE:200ms

b=1000



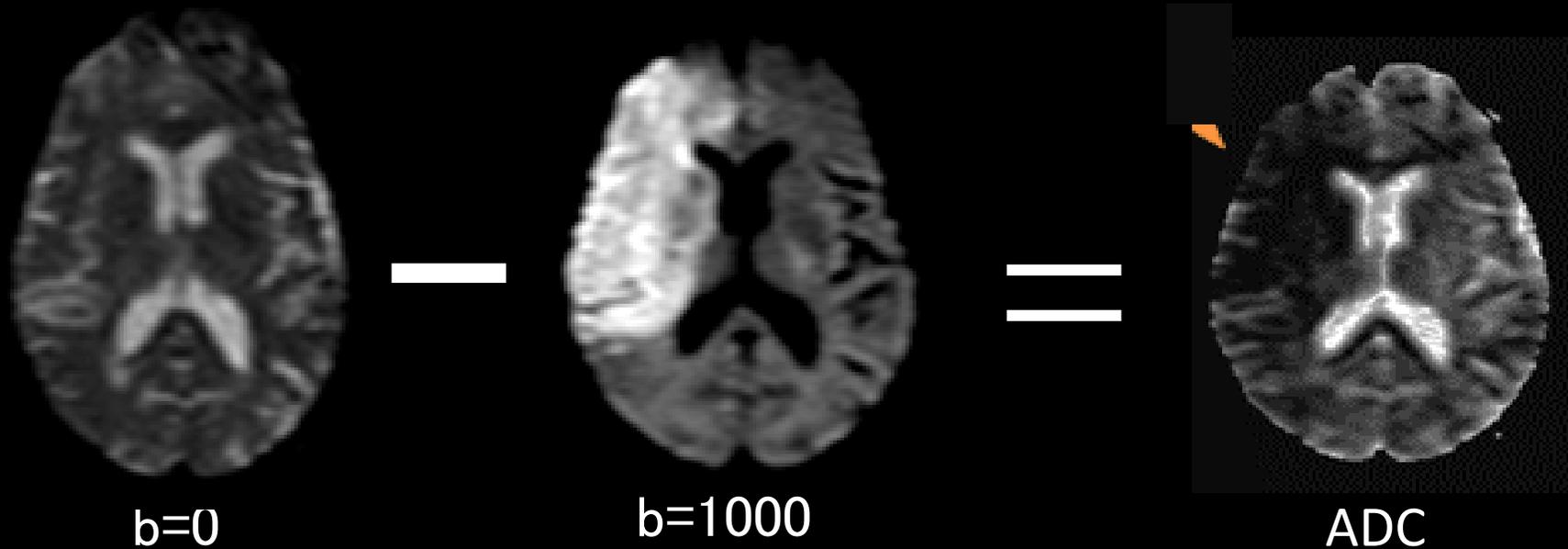
T2 shine-throughとは？

もと画像のT2wiで高信号がそのまま
dwiでも高信号になってしまう事



ADCとは？

Apparent Diffusion Coefficient
見かけの 拡散 係数



もと画像の信号の差をなくし、拡散だけを画像化

実際、撮影すると、、、



実際、撮影すると、、、

$b=0$

MPG X軸

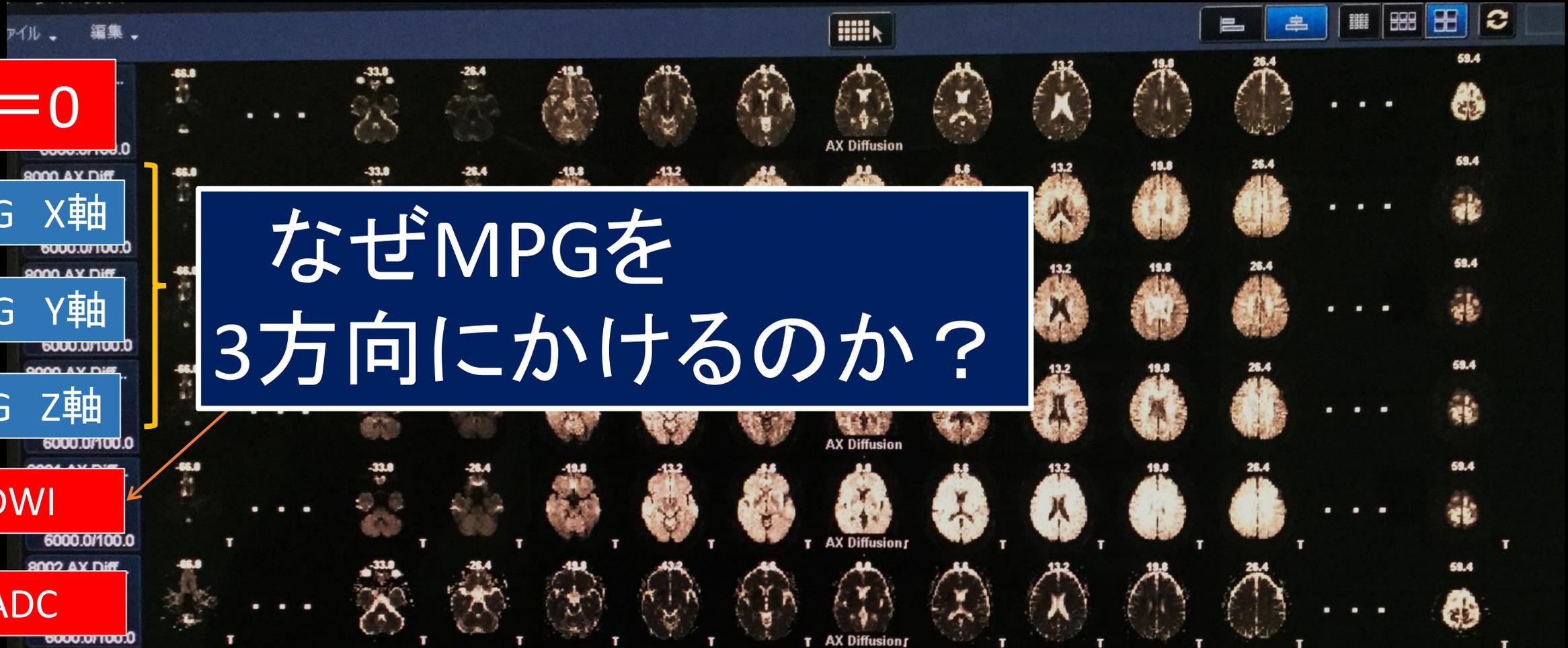
MPG Y軸

MPG Z軸

DWI

ADC

なぜMPGを
3方向にかけるとののか？



拡散 異方性 (Anisotropy)

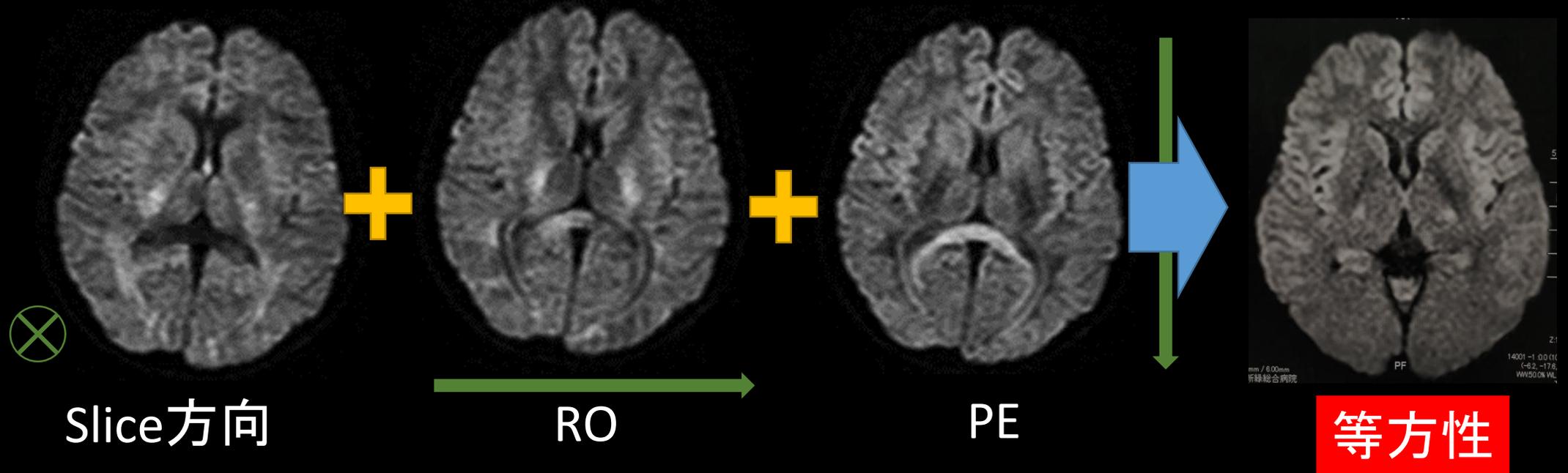
神経線維に垂直

拡散しにくい

神経線維に水平

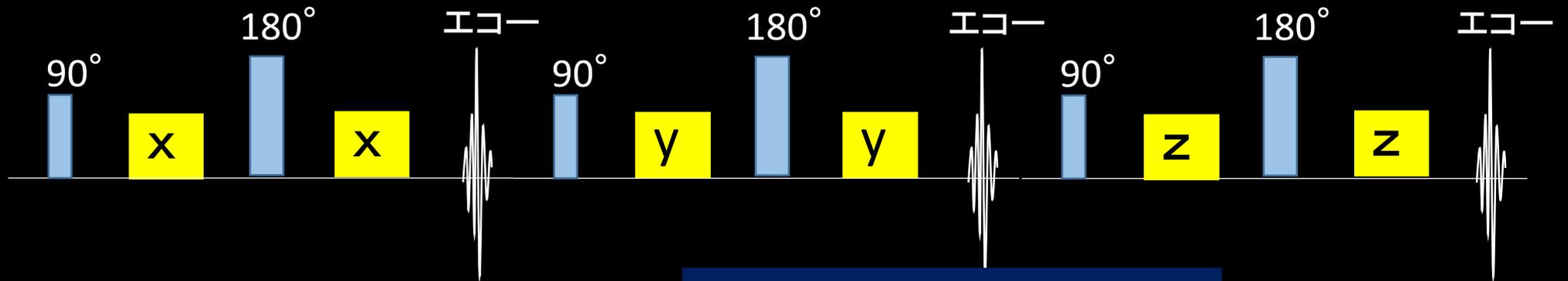
拡散しやすい

拡散異方性

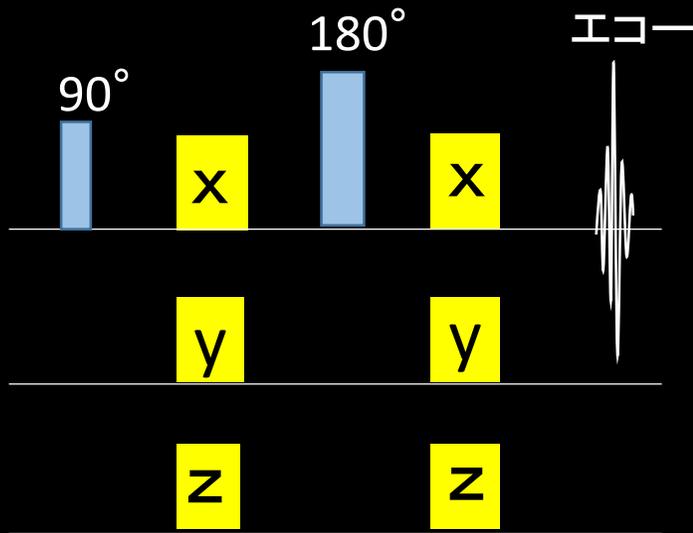


MPG の印加方法

3軸
別印加



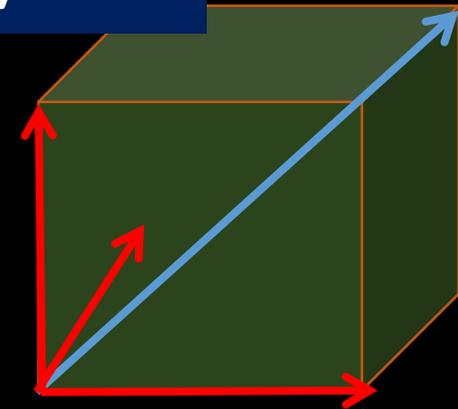
3軸
同時
印加
(3in1)



1軸あたり $1/\sqrt{3}$

$B = 1000$

TEを短くできる！



$B = 1000$

Gradient overplus

DWI_NSA1	Voxel	Tra	Rel. SNR	TE	TR		
00:31 ↑	1.83 x 1.73 x 5.00		0.84 ↓	88 ↑	5184 ↑	←	→
Accept							
Summary	Geometry	Contrast	Motion	Dyn/Ang	Postproc	Offc/Ang	Coils
Diffusion mode	DWI						
<u>gradient overplus</u>	no (yes)						
direction							
nr of b-factors	2						
b-factor order	ascending						
max b-factor	1000						
average high b	user defined						
b-factor averages							
Total scan duration							00:31.1
Rel. SNR							0.844
Act. TR (ms)							5184
Act. TE (ms)							88
ACQ matrix M x P							120 x 128
ACQ voxel MPS (mm)							1.83 / 1.73 / 5.00
REC voxel MPS (mm)							0.69 / 0.69 / 5.00
Scan percentage (%)							106.2

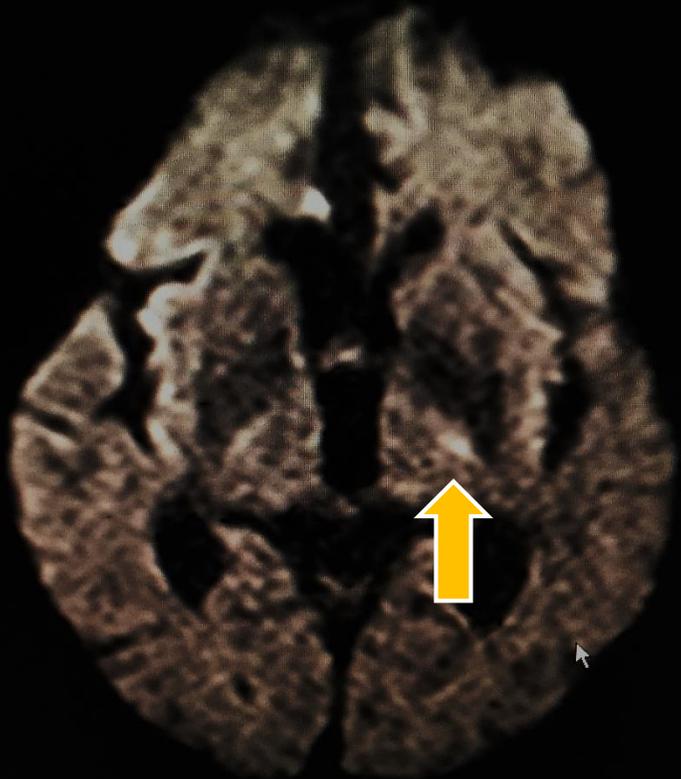
DWI_NSA1	Voxel	Tra	Rel. SNR	TE	TR		
00:27	1.83 x 1.73 x 5.00		1.00	72	4563	←	→
Accept							
Summary	Geometry	Contrast	Motion	Dyn/Ang	Postproc	Offc/Ang	Coils
Diffusion mode	DWI						
<u>gradient overplus</u>	yes						
nr of b-factors	2						
b-factor order							
max b-factor							
average high b							
Total scan duration							00:27.4
Rel. SNR							0.999
Act. TR (ms)							4563

3軸
別印加

3軸
同時
印加
(偏重)

欠点：異方性が得られない！

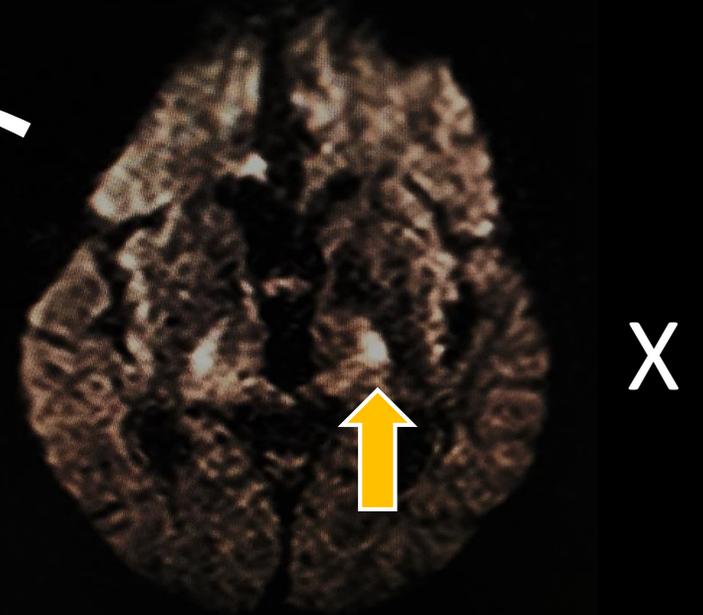
異方性のメリット



Isotropic
(b=1000)



ADC



X



Z

異方性による偽病変！

TE ⇒ 短い、良

Gradient モード

DWI_NSA1				DWI_NSA1													
00:27	Voxel 1.83 x 1.73 x 5.00	Tra	Rel. SNR 1.00	TE 72	TR 4563	00:27 ↓	Voxel 1.83 x 1.73 x 5.00	Tra	Rel. SNR 1.27 ↑	TE 61 ↓	TR 4414 ↓						
Summary	Geometry	Contrast	Motion	Dyn/Ang	Postproc	Offc/Ang	Coils	Conflic	Summary	Geometry	Contrast	Motion	Dyn/Ang	Postproc	Offc/Ang	Coils	Conflicts
Diffusion mode		DWI							Diffusion mode		DWI						
gradient overplus		yes							gradient overplus		yes						
nr of b-factors		2							nr of b-factors		2						
b-factor order		ascending							b-factor order		ascending						
max b-factor		1000							max b-factor		1000						
average high b		user defined							average high b		user defined						
b-factor averages									b-factor averages								
T1 mapping		no							T1 mapping		no						
SAR mode		high							SAR mode		high						
B1 mode		default							B1 mode		default						
SAR allow first level		yes							SAR allow first level		yes						
Patient pregnancy		no							Patient pregnancy		no						
Patient WB SAR [W/kg]		0							Patient WB SAR [W/kg]		0						
Patient Head SAR [W/kg]		0							Patient Head SAR [W/kg]		0						
Patient max. dB/dt [T/s]		0							Patient max. dB/dt [T/s]		0						
Max slewrate [T/m/s]		0							Max slewrate [T/m/s]		0						
Max. B1+rms [uT]		0							Max. B1+rms [uT]		0						
PNS mode		high							PNS mode		high						
Gradient mode		maximum							Gradient mode		enhanced (maximum)						
Sort one mode		no							Sort one mode		no						

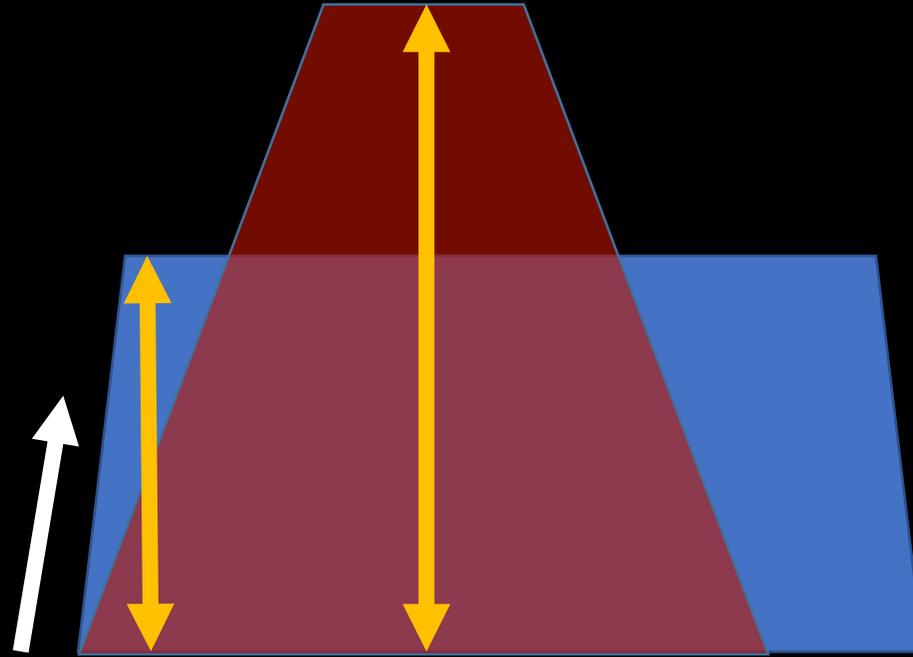
Gradient モード

Gmax 33(mT/m)

Slew rate

200 (mT/m/ms)

マキシマム



Gmax 45(mT/m)

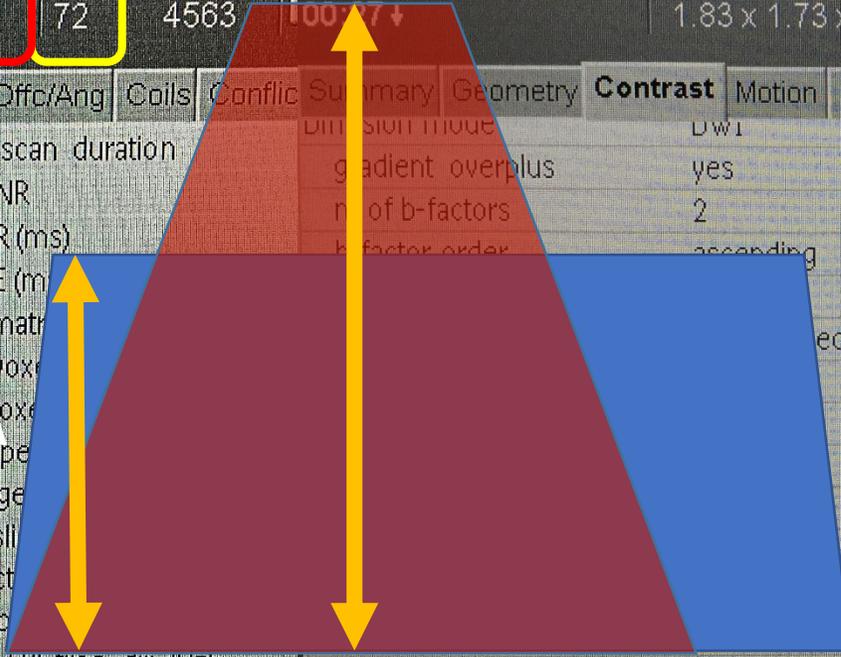
Slew rate

120 (mT/m/ms)

エンハンスド

Gradient モード

DWI_NSA1				DWI_NSA1														
00:27	Voxel 1.83 x 1.73 x 5.00	Tra	Rel. SNR 1.00	TE 72	TR 4563	100%	Rel. SNR 1.27↑	TE 61↓	TR 4414↓									
Summary	Geometry	Contrast	Motion	Dyn/Ang	Postproc	Offc/Ang	Coils	Conflic	Summary	Geometry	Contrast	Motion	Dyn/Ang	Postproc	Offc/Ang	Coils	Conflicts	
Diffusion mode	DWI								Diffusion mode	DWI								
gradient overplus	yes								gradient overplus	yes								
nr of b-factors	2								nr of b-factors	2								
b-factor order	ascending								b-factor order	ascending								
max b-									max b-									
averag									averag									
T1 mapping	no								T1 mapping	no								
SAR mo									SAR mo									
B1 mode									B1 mode									
SAR allo									SAR allo									
Patient									Patient									
Patient									Patient									
Patient Head SAR [W/kg]	0								Patient Head SAR [W/kg]	0								
Patient max. dB/dt [T/s]	0								Patient max. dB/dt [T/s]	0								
Max slewrate [T/m/s]	0								Max slewrate [T/m/s]	0								
Max. B1+rms [uT]	0								Max. B1+rms [uT]	0								
PNS mode	high								PNS mode	high								
Gradient mode	maximum								Gradient mode	enhanced (maximum)								
software mode	no								software mode	no								



Gmax 33(mT/m)

Slew rate 200 (mT/m/ms)

Gradient mode maximum

Gmax 45(mT/m)

Slew rate 120 (mT/m/ms)

Gradient mode enhanced (maximum)

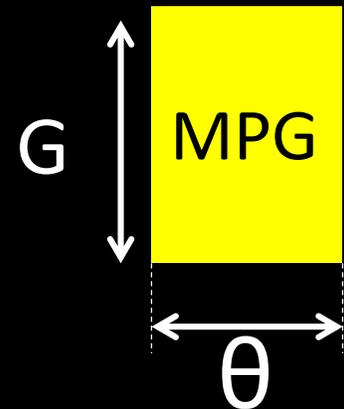
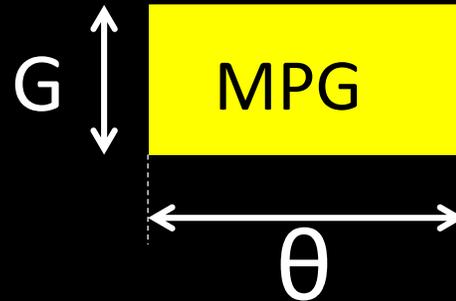
TEが短すぎると、拡散時間が短くなり、
描出が悪くなる

$$b \text{ 値} = \gamma_2 G_2 \theta_2 \underline{[\Delta - \theta/3]} \text{ s/mm}_2$$



拡散時間 t

同じB値でもMPGのかけ方で、描出が異なる！



OGSE-DWI

Oscillating gradient SE (OGSE)

振動 磁場勾配 スピンエコー法
MPGを波形、台形に振動させて印加する事により
数msという短い拡散時間を実現した。

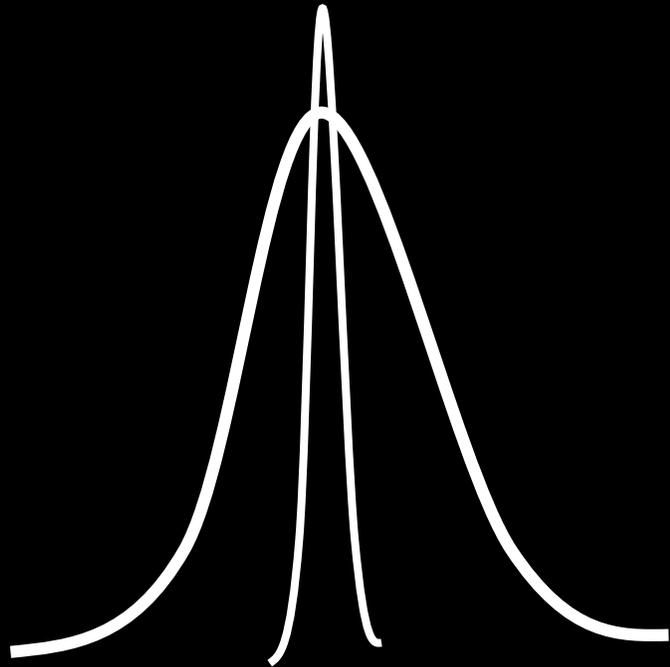
通常のMPGはパルス状
(PGSE)

b値だけでなく、

拡散時間 t 、傾斜磁場強度 G_{max}

画質向上

磁場の均一性

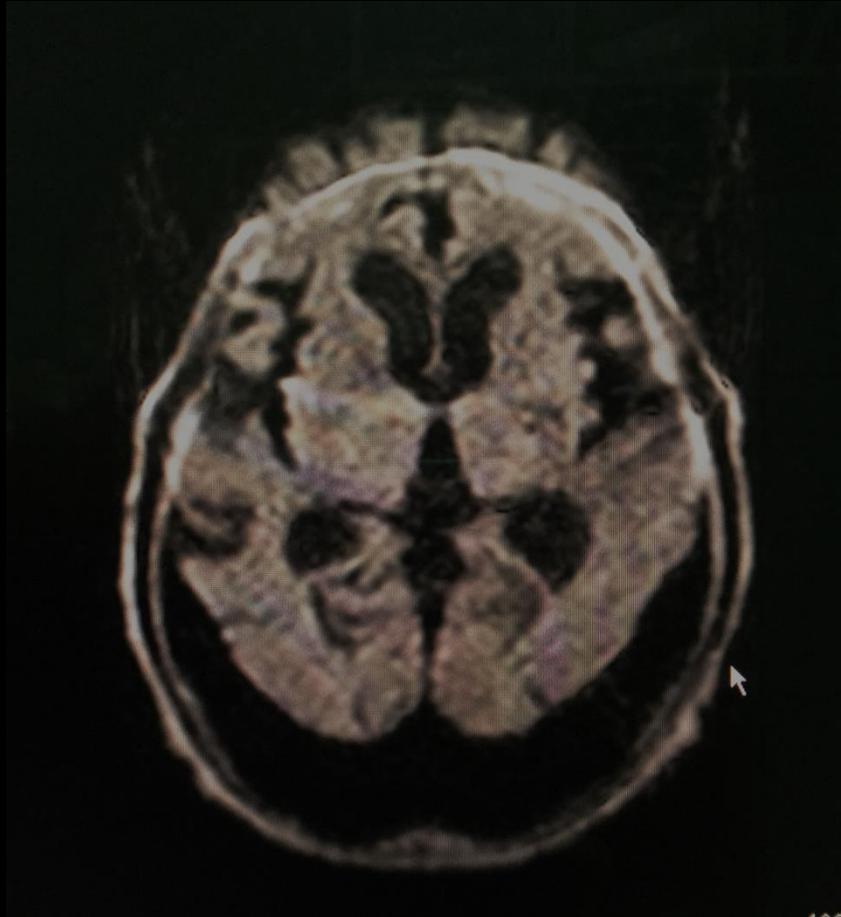


画質を左右する。

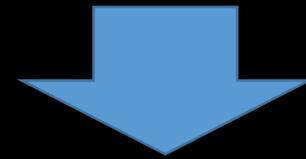


- ① 脂肪抑制
- ② 歪み

脂肪抑制

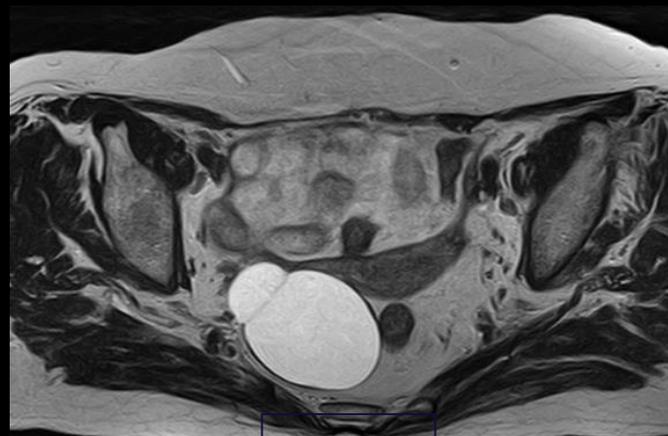


拡散が少ない！

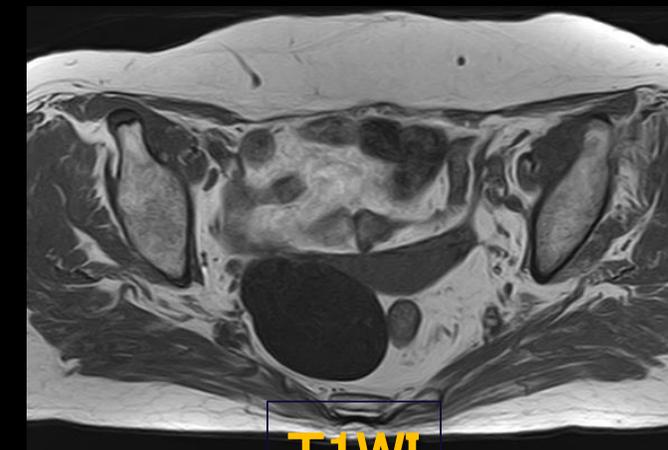


邪魔になってしまう

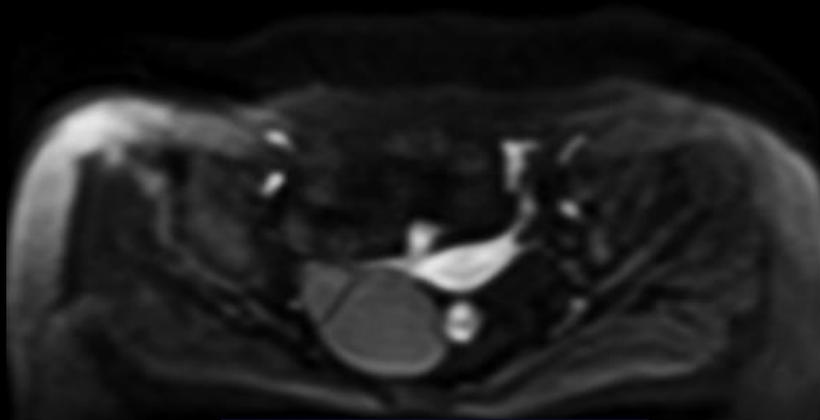
脂肪抑制 法による違い



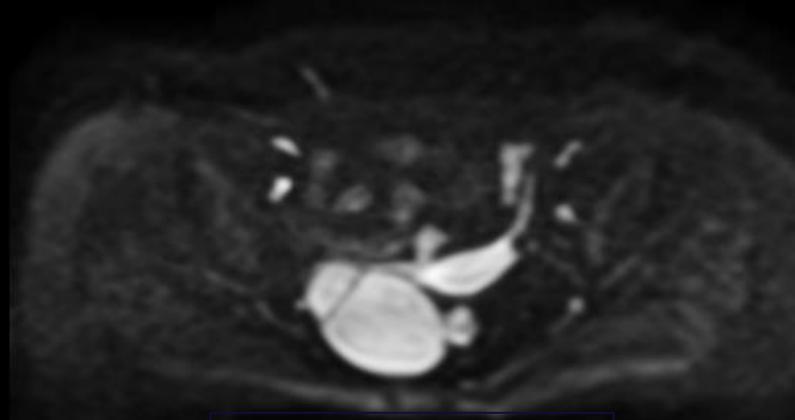
T2WI



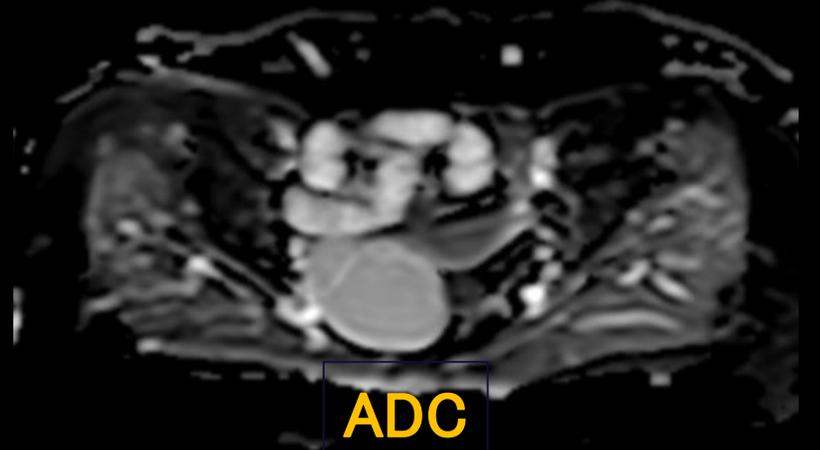
T1WI



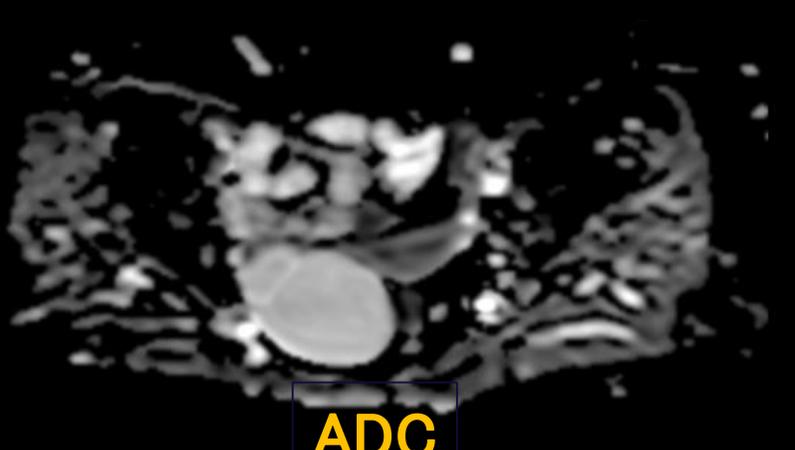
CHESSのみ



PASTA+STIR

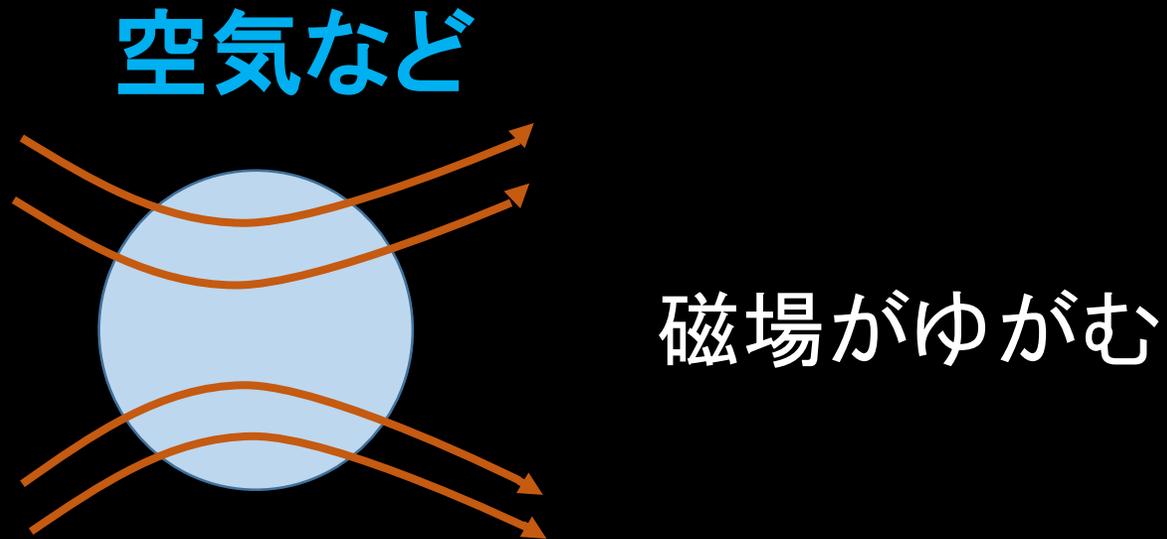


ADC



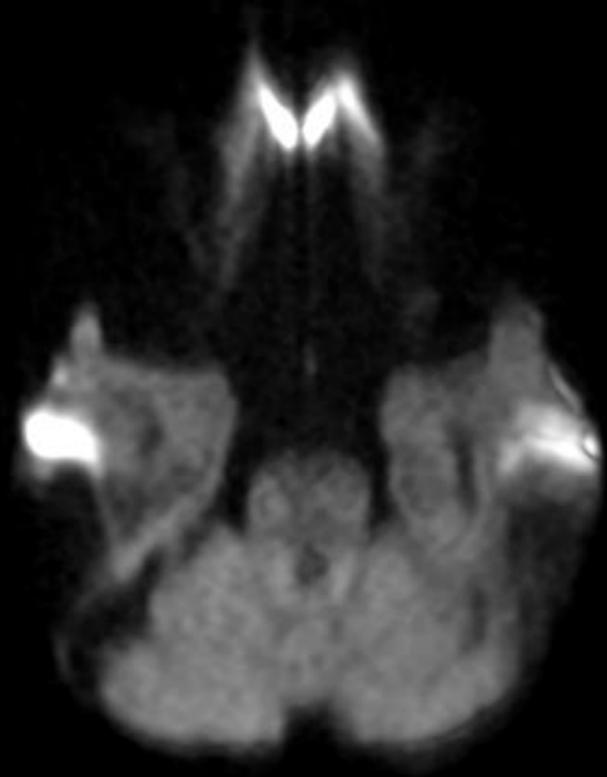
ADC

磁化率の影響を受けやすい

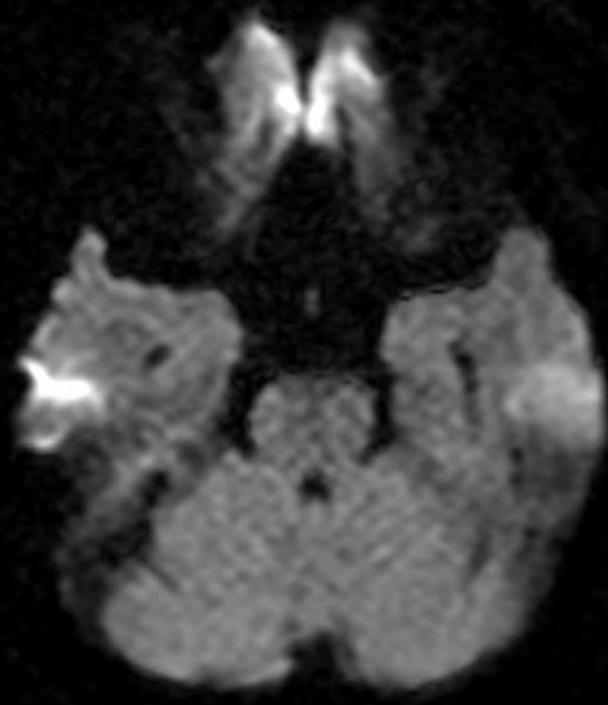


- ①シミングによる磁場の均一化
- ②パラレルイメーシングを使用

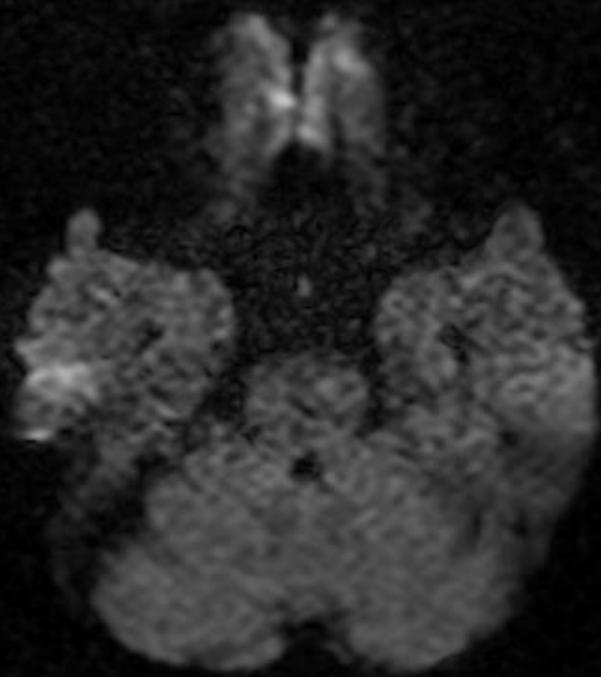
パラレル Factor



ファクター 0



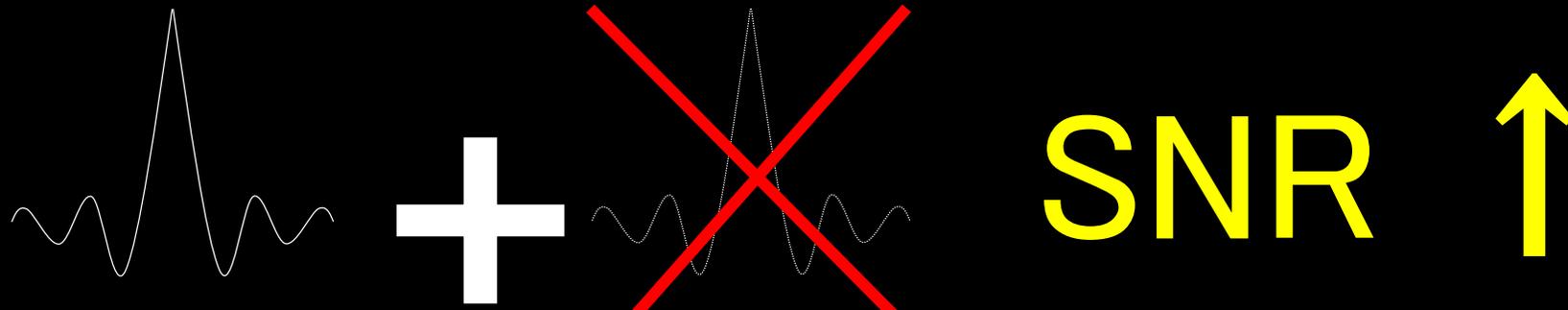
ファクター 2



ファクター 3

SPLICE

(Split-echo acquisition of TSE signals)

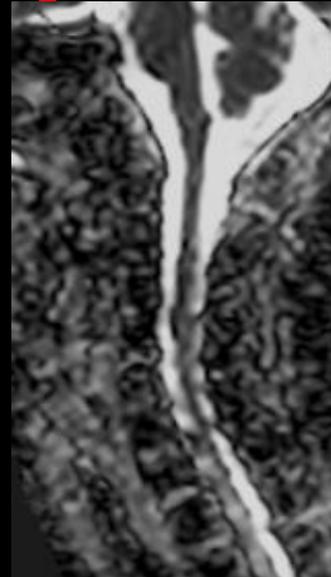


TSE

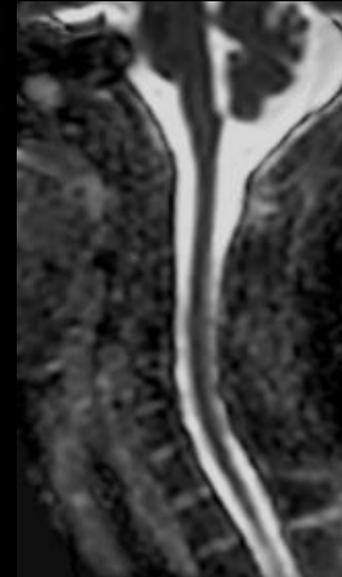


SPLICE

STE

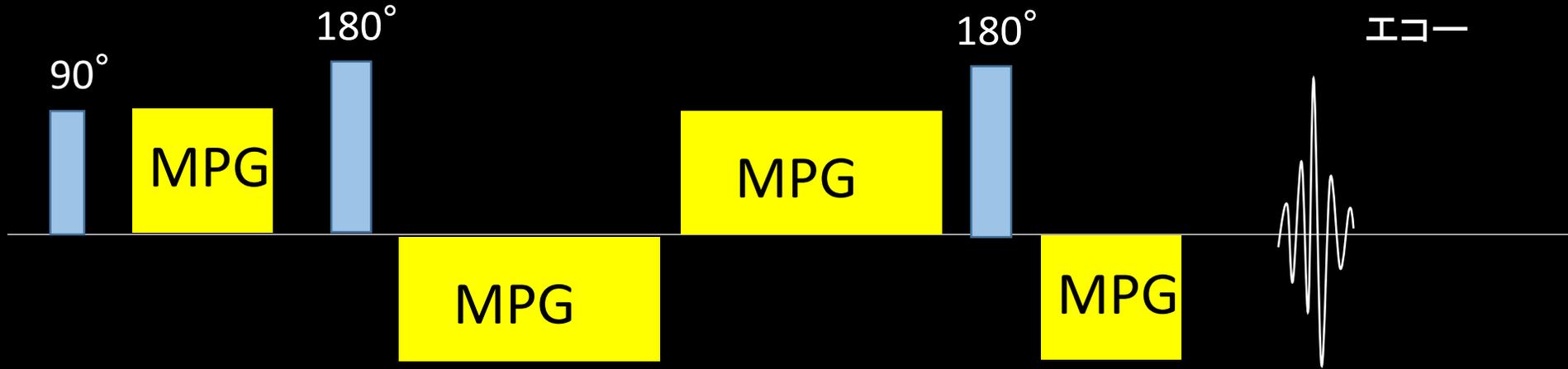


TSE



SPLICE

Twine refocused SE 法



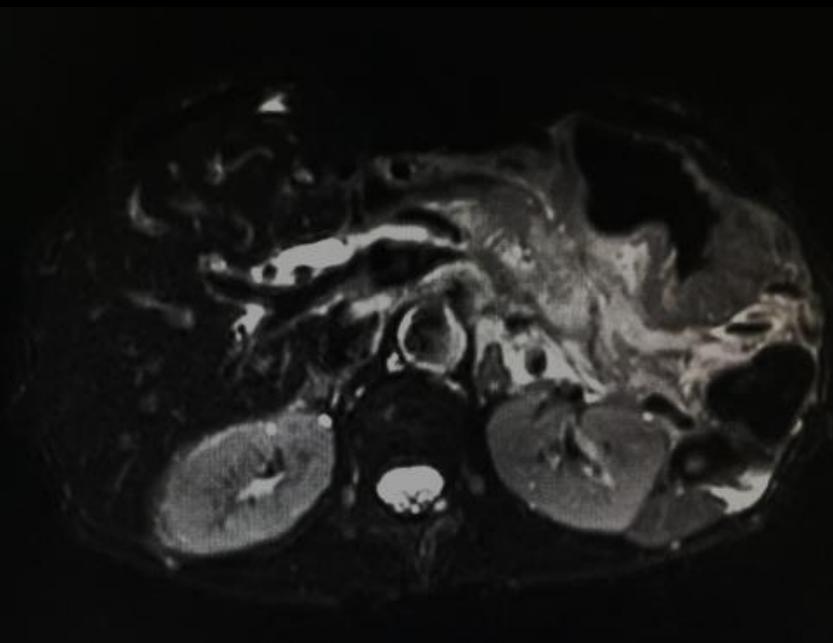
- ・2回のRefocusing の前後にBipolarでMPGを印加する
- ・Eddy currentの蓄積を抑える。

歪み ↓

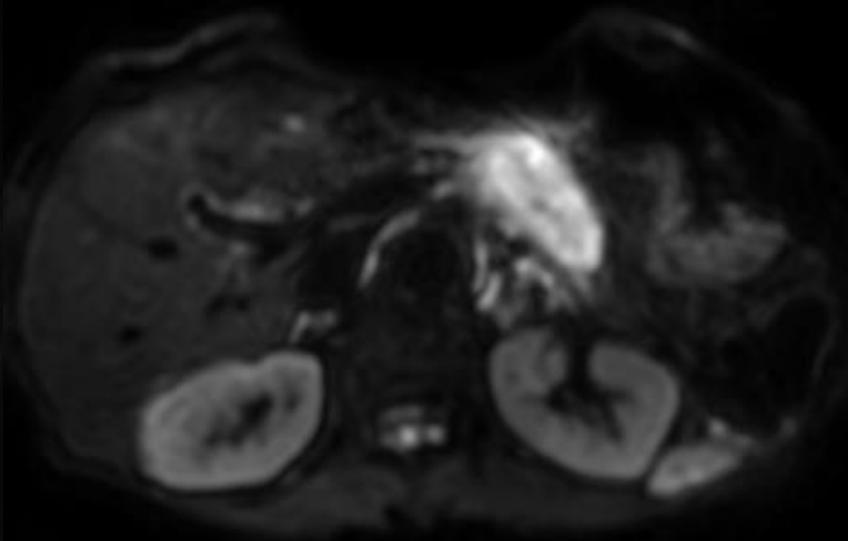
TEが長くなる！

当院での症例

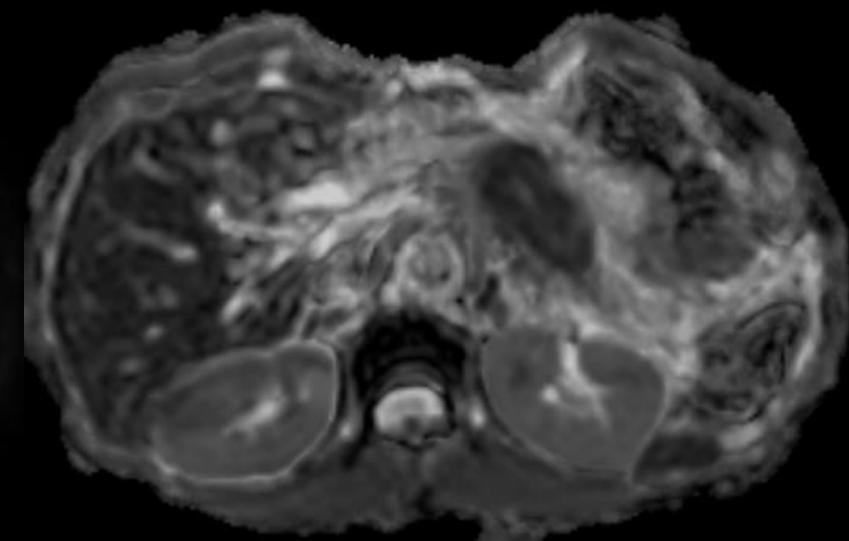
膵臓がん



T2WI FS

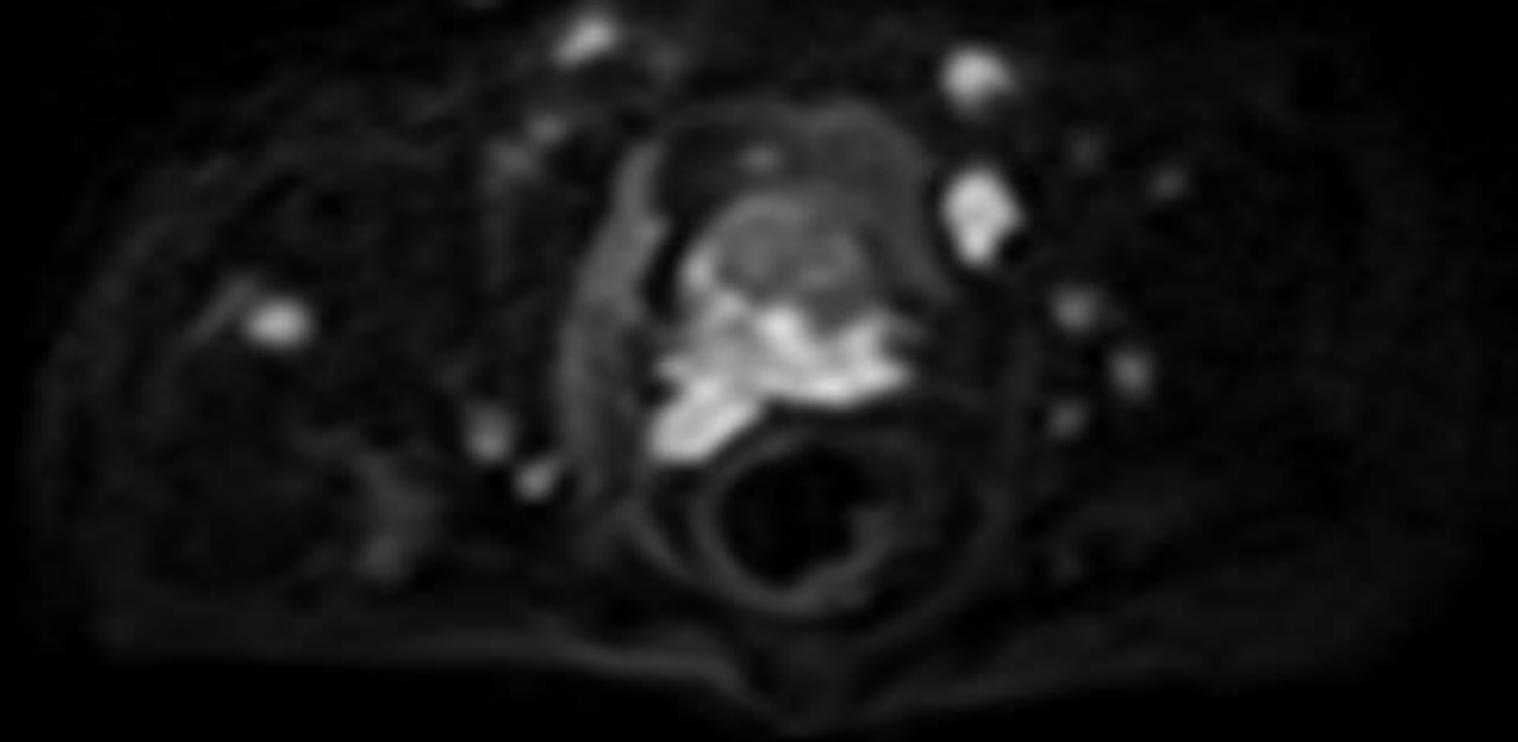


b=1000



ADC

前立腺がん

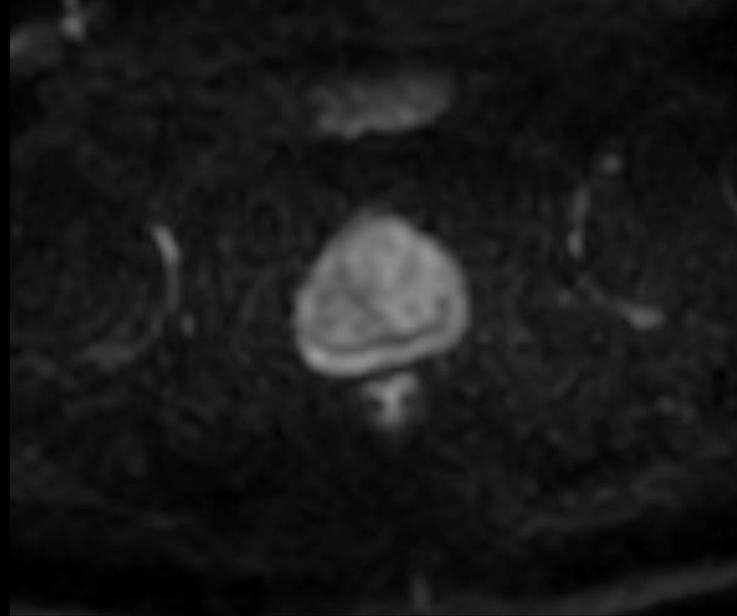


皮膜外浸潤、リンパ節転移

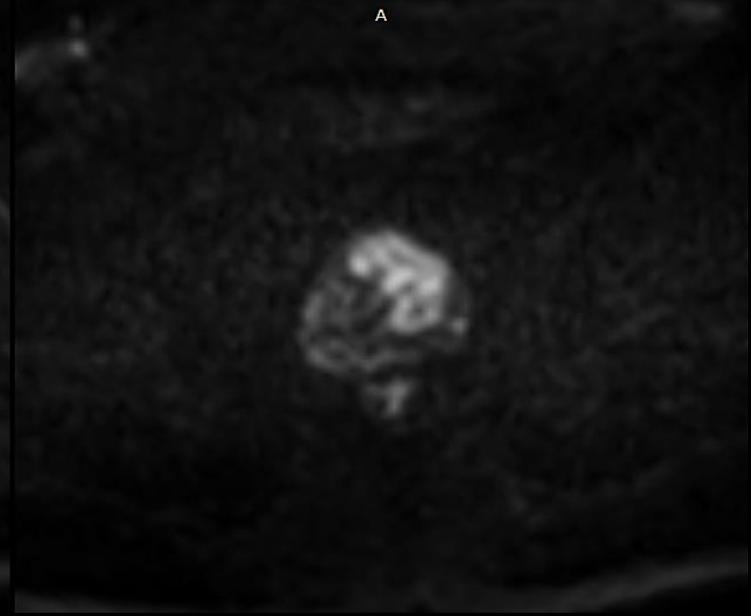
前立腺がん



T2WI

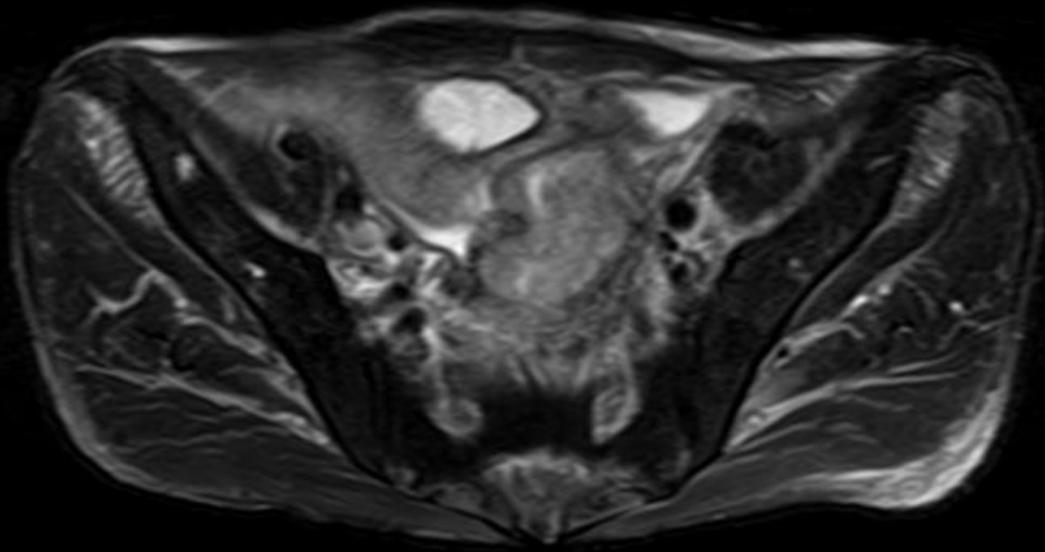


b=1000

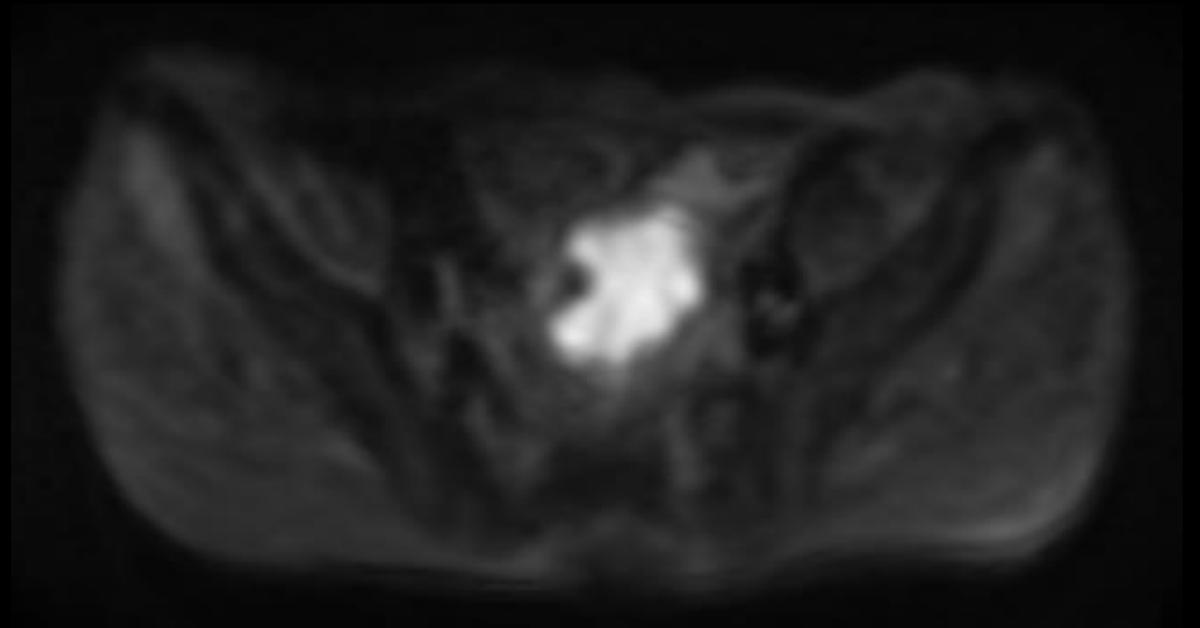


b=2000

大腸がん

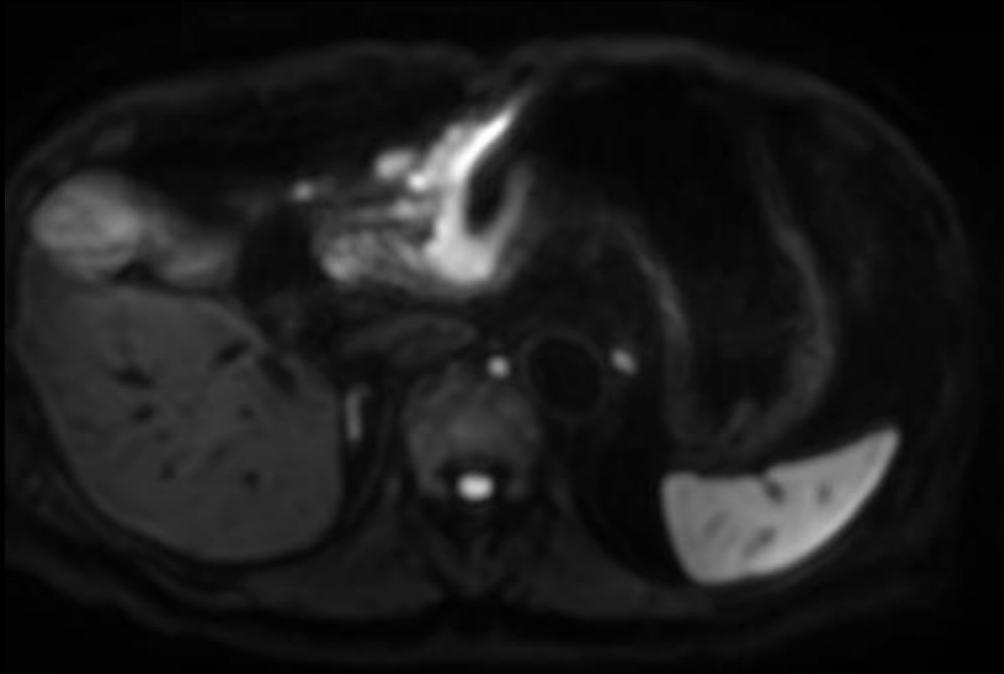


T2WI (脂肪抑制)

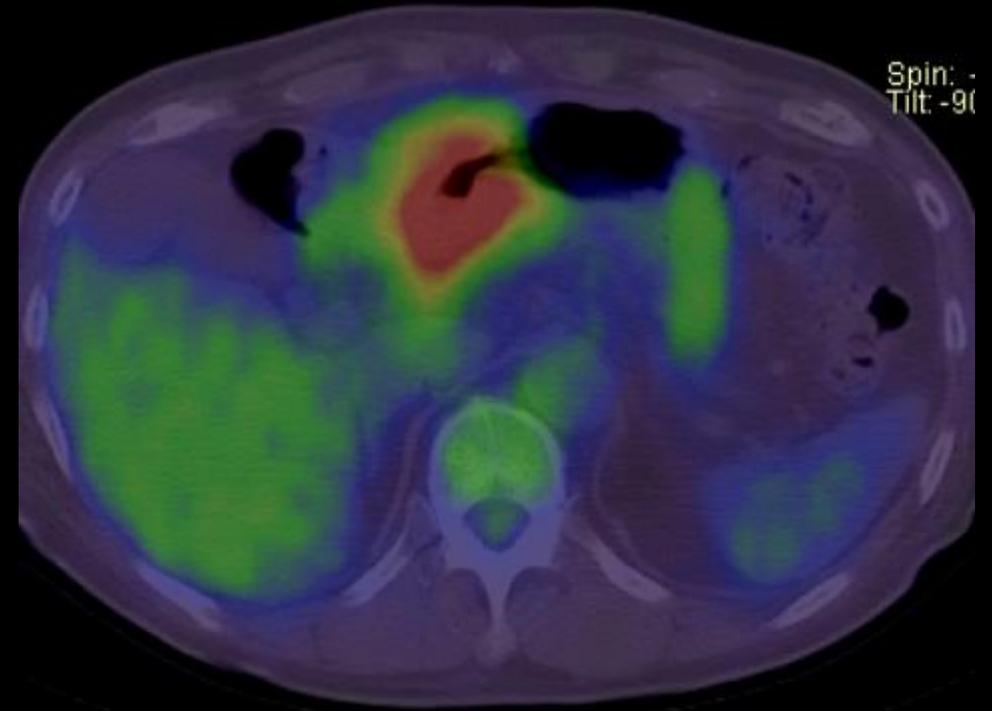


b = 1000

胃がん

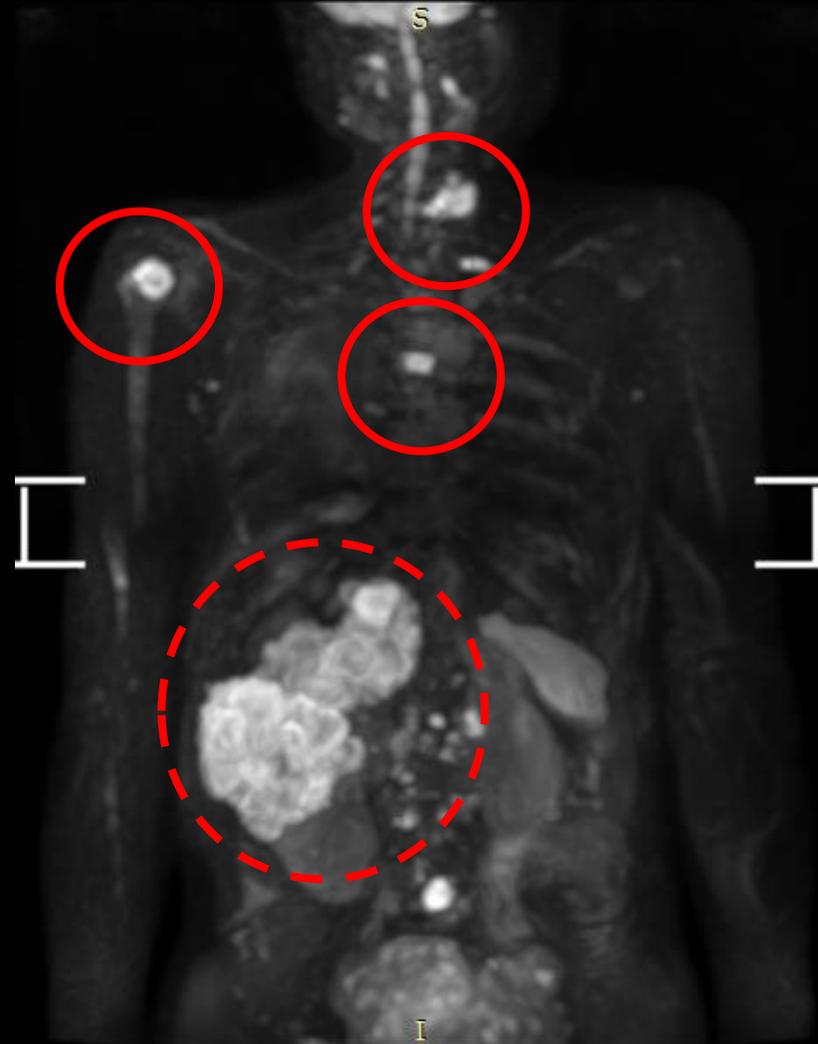


$b = 1000$

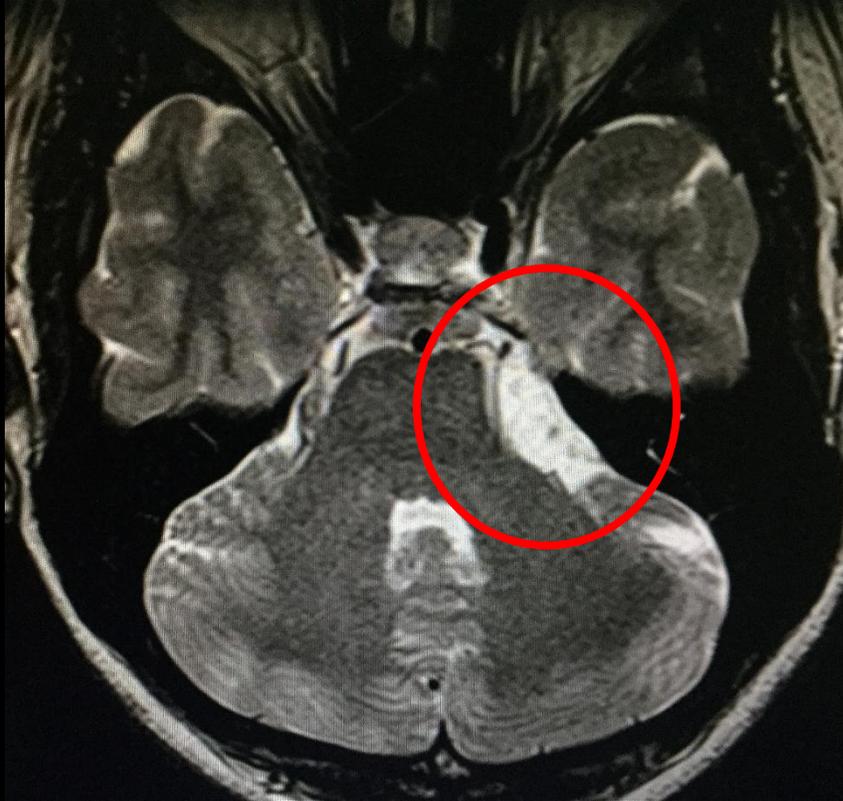


PET + CT

DWIBS



類皮腫



くも膜下のう胞との鑑別できる！

まとめ

① DWI → T2WI + MPG

② T2 shine-through → ADC

③ TE 短 → 歪み → Shimig, TSE,
パラレル、補正処理、
Twine refocused SE