



ZAP-X[®]におけるガフクロミックフィルム

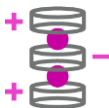
ZAP Surgical Japan

Mitsuhiro Inoue

ZAP-X® GYROSCOPIC RADIOSURGERY



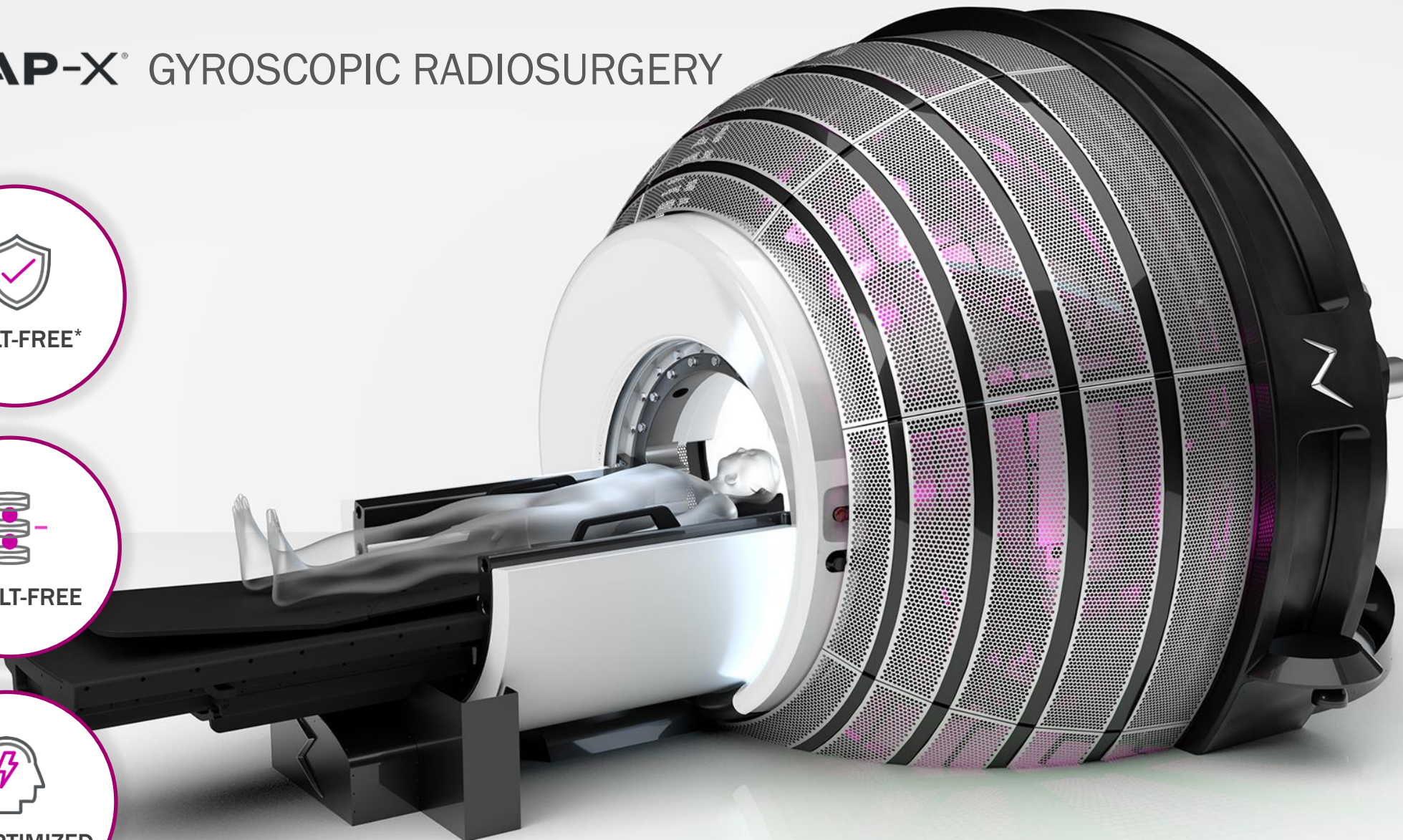
VAULT-FREE*



COBALT-FREE



SRS-OPTIMIZED



VAULT-FREE*

- 自己遮蔽、大がかりな遮蔽不要
 - 建築コスト削減
- 高い設置場所の自由度
 - ロビースペース、会議室からの変換
 - 小規模病院やクリニック



VAULT-FREE*

宇都宮脳脊髄センター シンフォニー病院

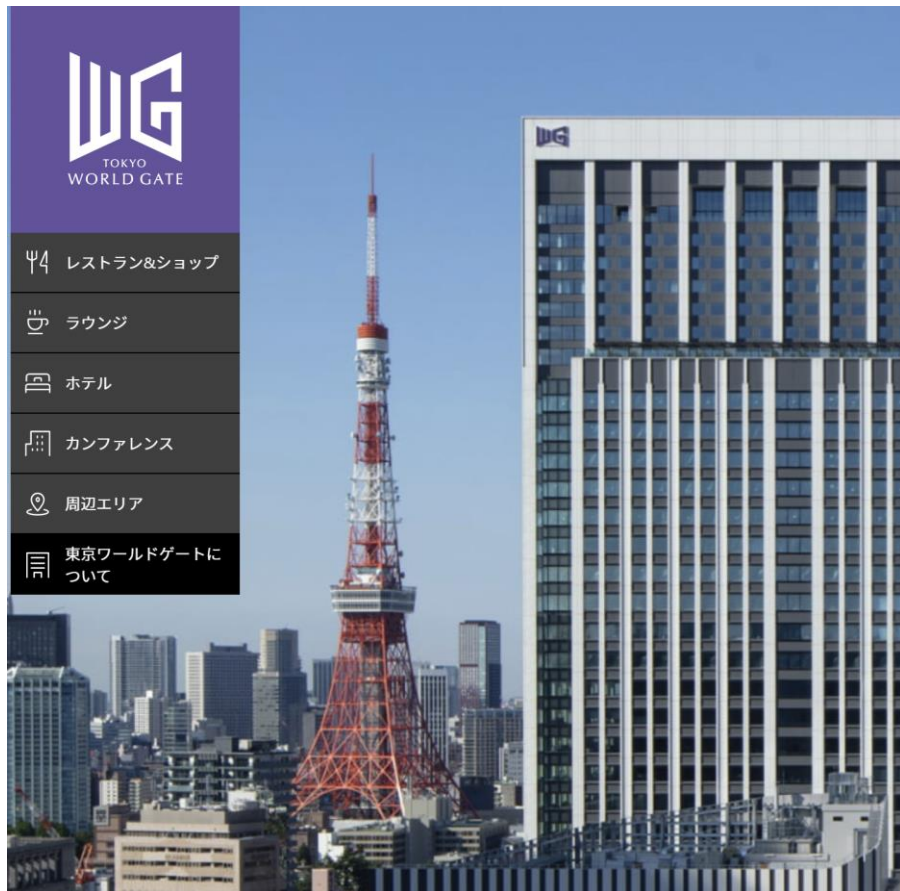


シンフォニー病院 HPより



VAULT-FREE*

神谷町脳神経外科クリニック



東京ワールドゲート HPより

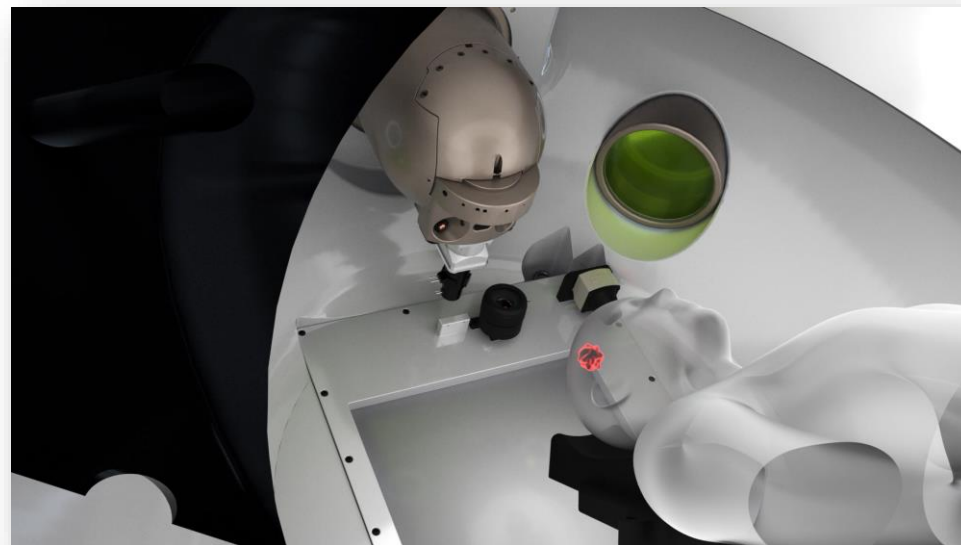
VAULT-FREE*

神谷町脳神経外科クリニック



COBALT-FREE

- 3MV, 1500 MU/min, S-band LINAC
 - 減衰のない一定した線量率
 - 線源交換によるコストが不要
 - 放射性同位元素に対する安全性へのリスクや廃棄など不要



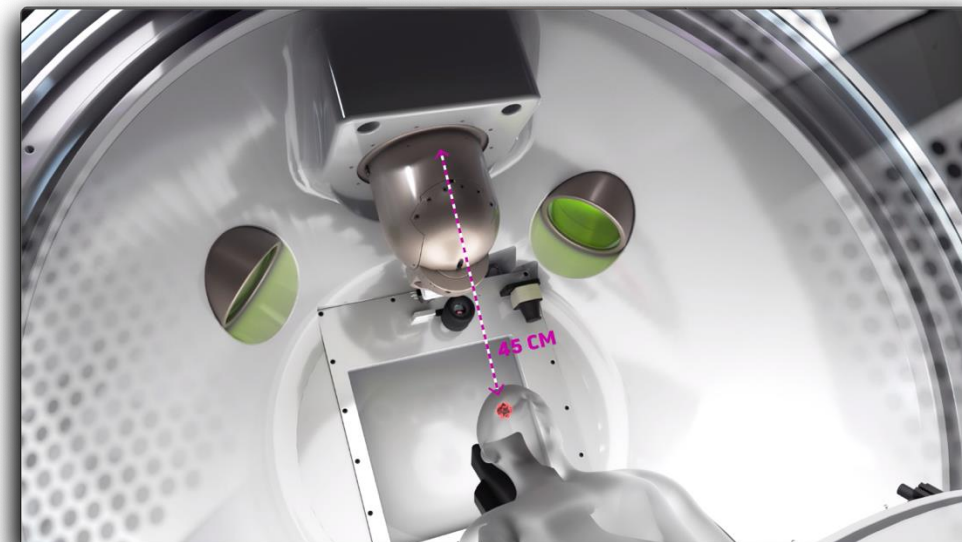
SRS-OPTIMIZED

- Dual-gimbaled gantries
 - ノンコプラナー照射
 - 2π ステラジアンをカバー
 - 高い照射位置精度

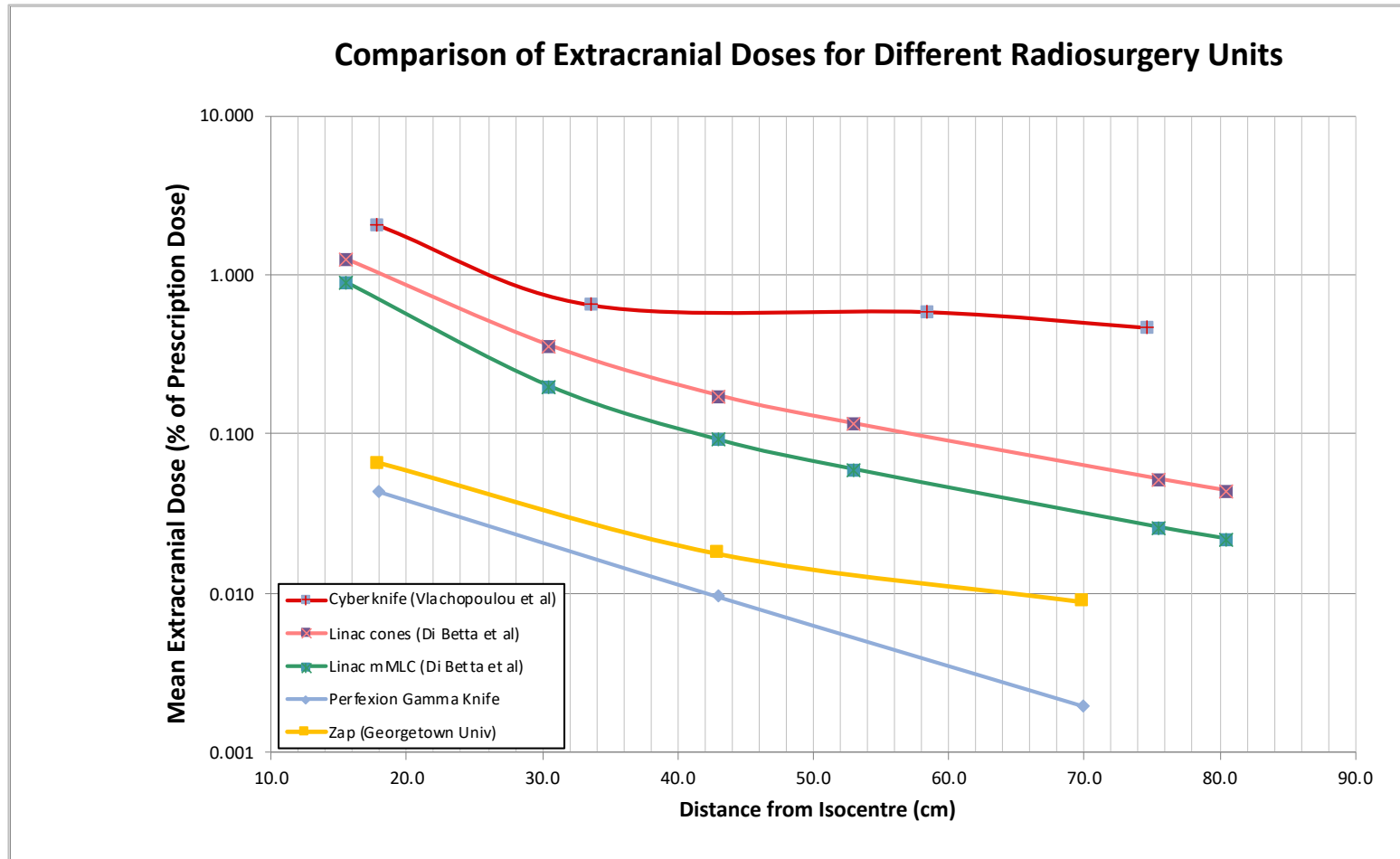


SRS-OPTIMIZED

- 260+ non-coplanar beam positions
 - 急峻な線量勾配、OARを避ける照射
- 3MV beam energy
 - 小さい散乱
- Ultra-low collimation leakage¹
 - 一般的な装置の1/50未満

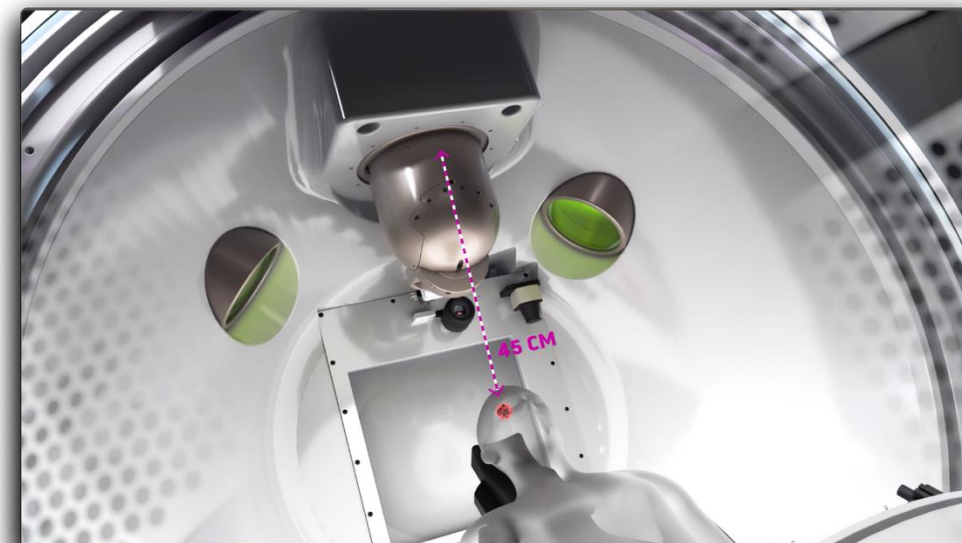


LOW WHOLE-BODY DOSE



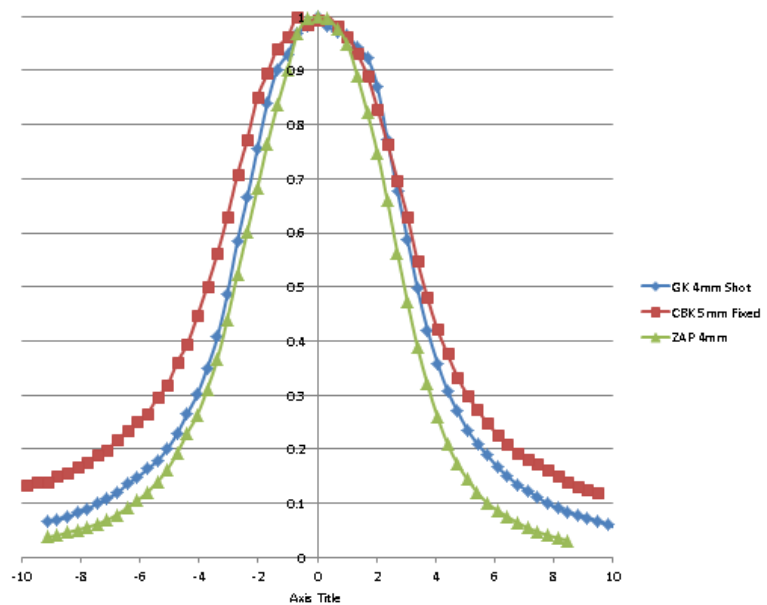
SRS-OPTIMIZED

- 260+ non-coplanar beam positions
 - 急峻な線量勾配、OARを避ける照射
- 3MV beam energy
 - 小さい散乱
- Ultra-low collimation leakage¹
 - 一般的な装置の1/50未満
- 45 cm source-axis distance (50% shorter)²
 - 小さな半影

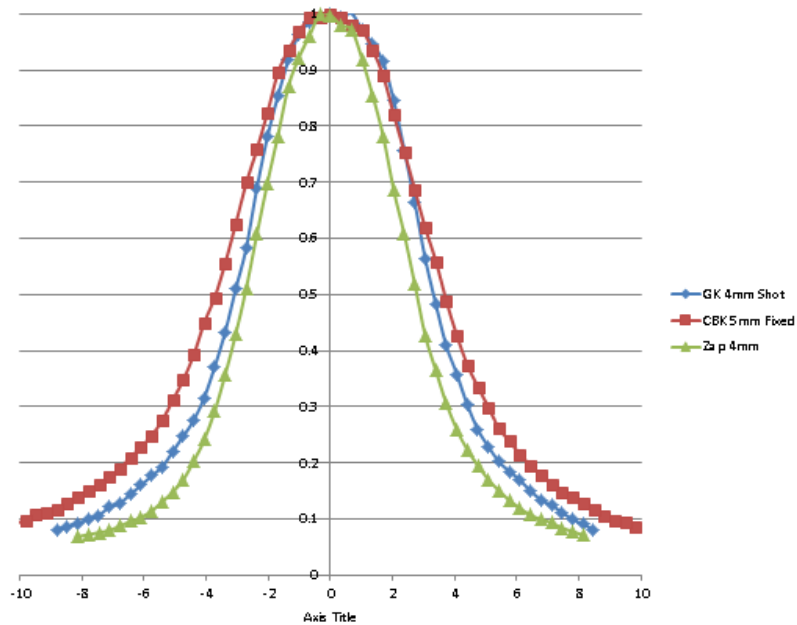


SHARP BEAM FALL-OFF

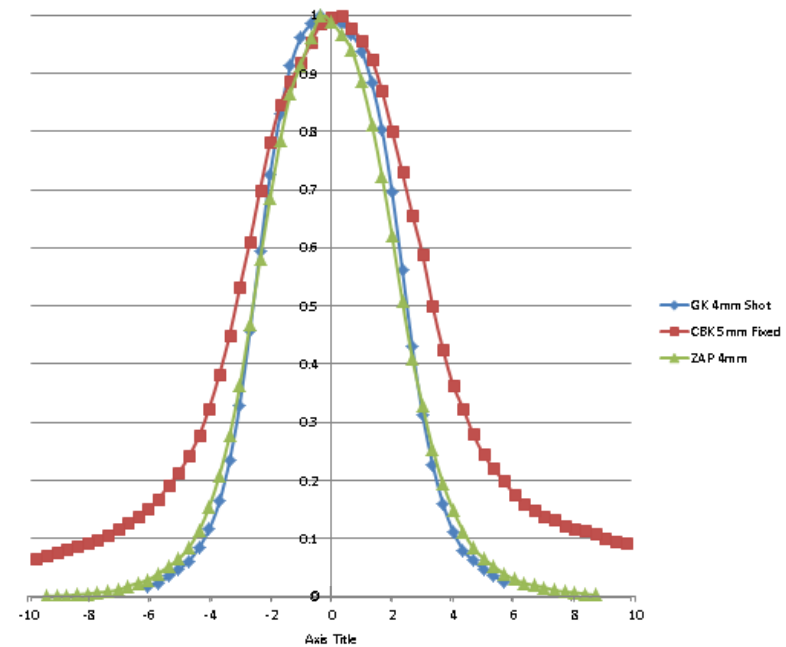
Profile Comparison in the X direction



Profile Comparison in the Y direction

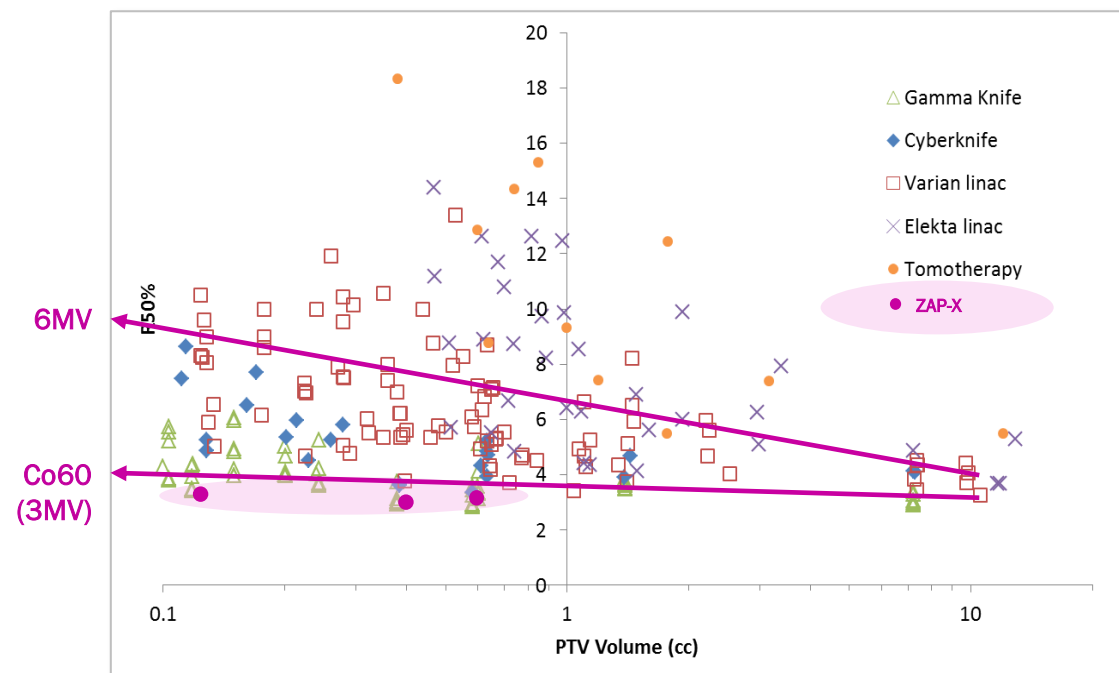


Profile Comparison in the Z direction



EXCEPTIONAL SELECTIVITY AND DOSE GRADIENT

- Multiple metastases case
- Volume of 50% of prescription dose
Volume of target



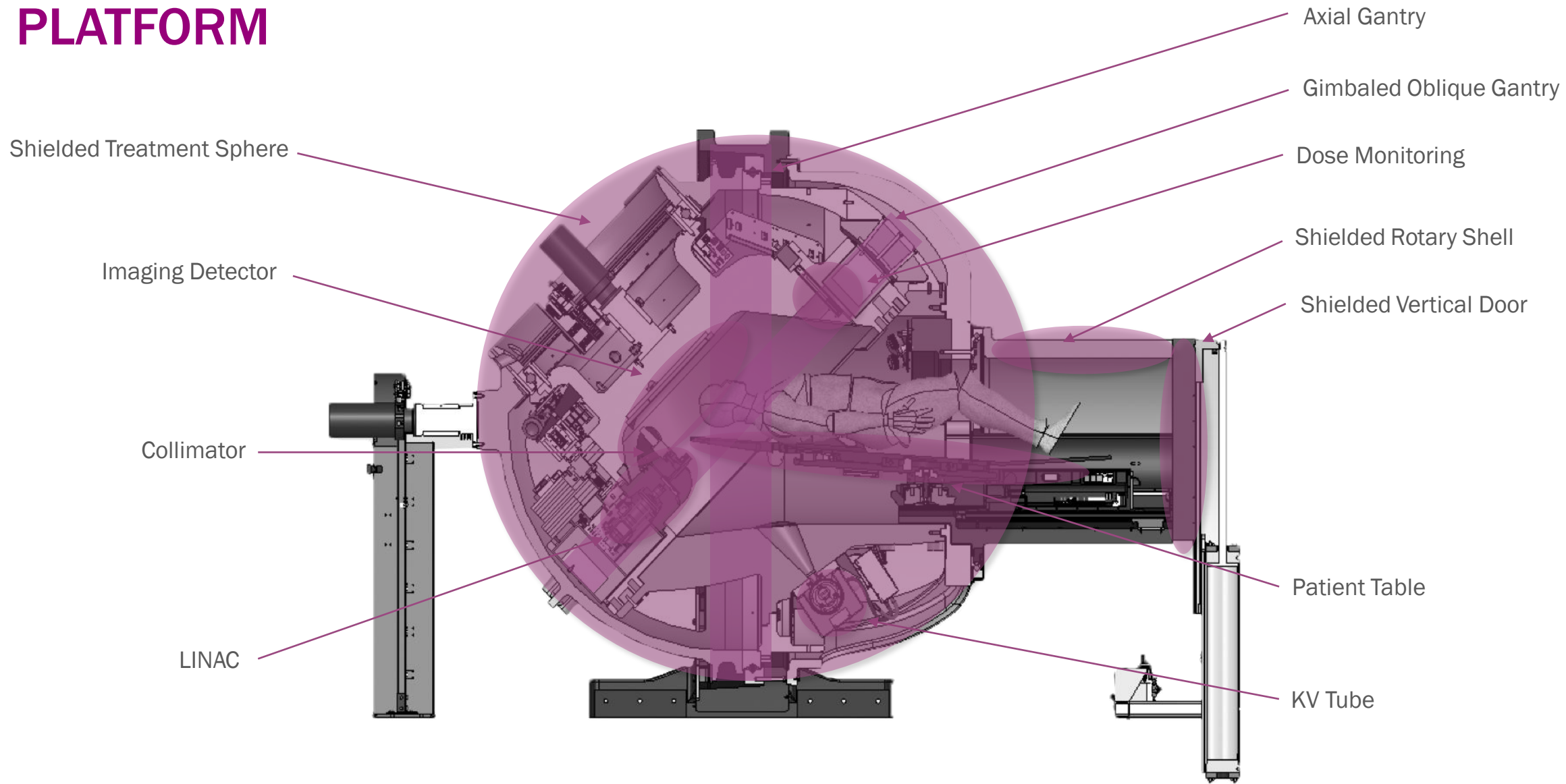


ZAP-X Gyroscopic Radiosurgery

COMPONENTS

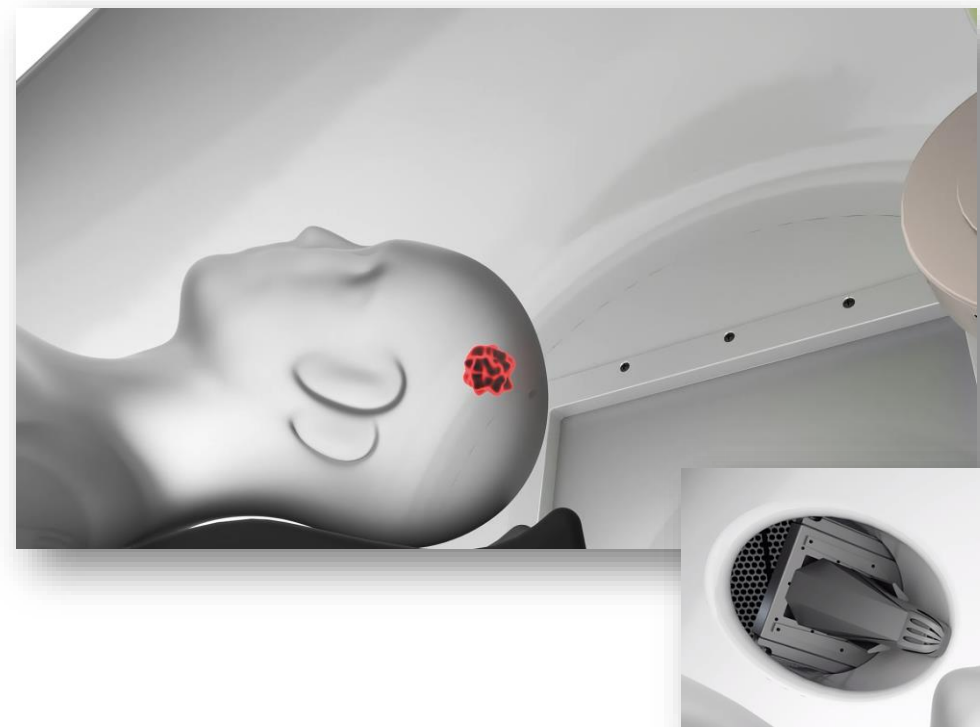


PLATFORM



ERROR MITIGATION

- Online patient safety system
 - 全てのビームで予測射出線量を計算
 - Megavoltage (MV) 検出器でビームごとに射出線量を確認
 - 誤差が閾値を超えた場合はシステム停止

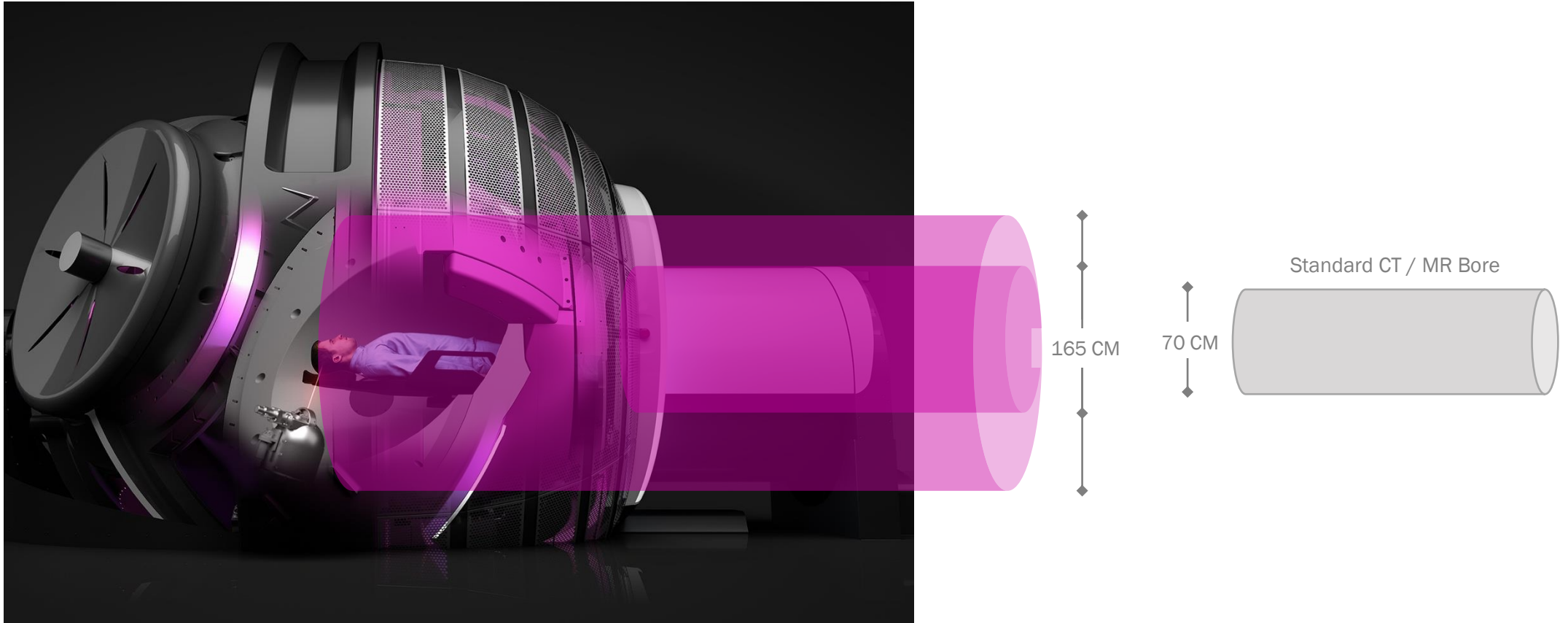


INTEGRATED KV IMAGING

- Intra-fraction motion management
 - ユーザーが設定した時間間隔でのDRRを利用した位置補正
- Frameless immobilization
 - 簡単な分割照射



PATIENT COMFORT



ZAP

** Lateral diameter at pre-treatment, start-up position*



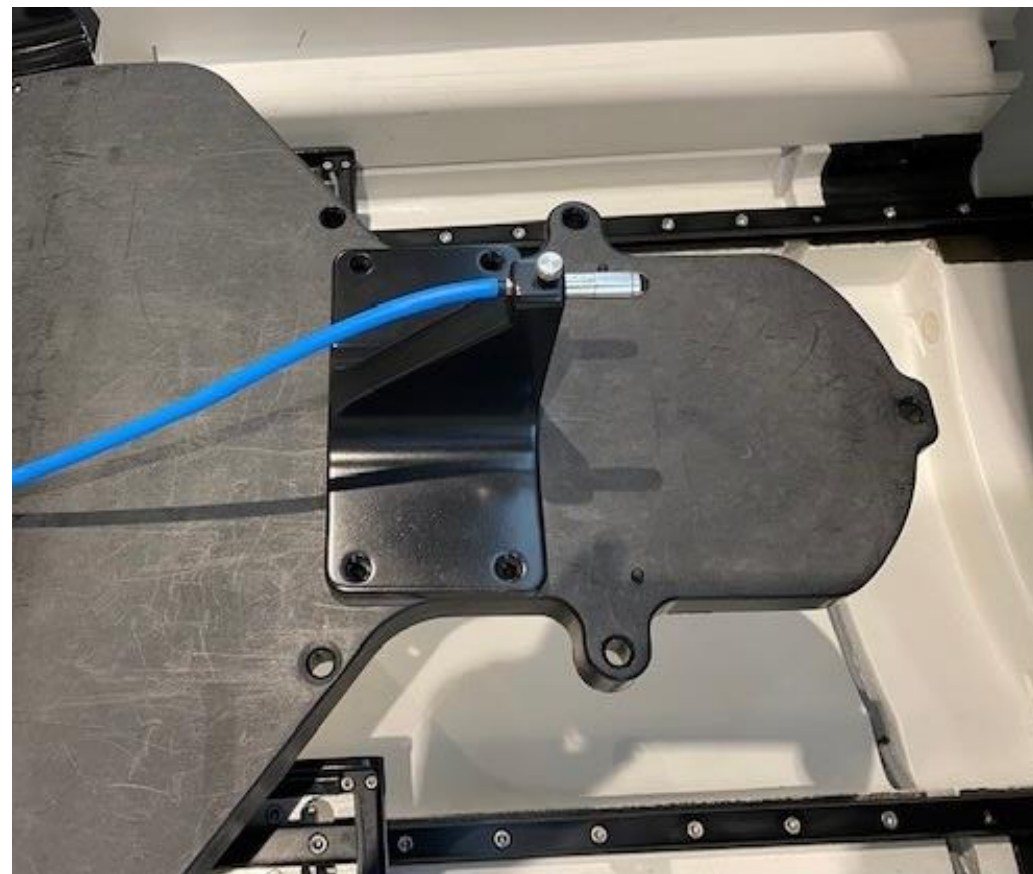
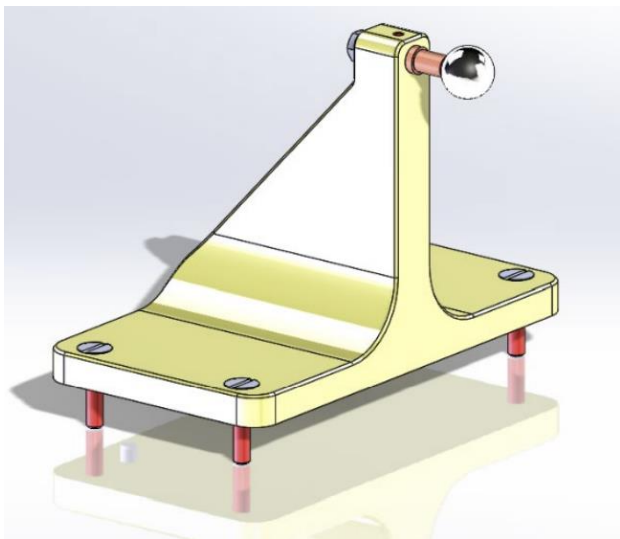
ZAP-X Gyroscopic Radiosurgery

Quality Assurance



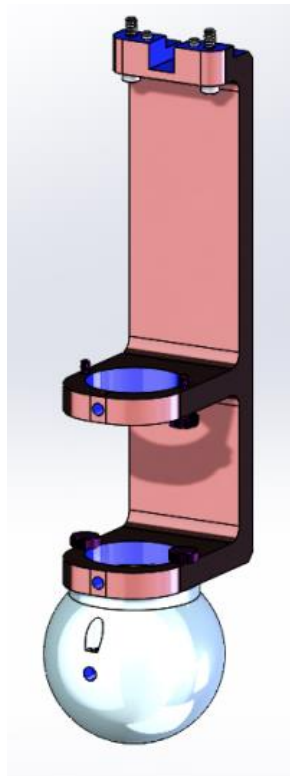
QA using Chamber

- Isocenter Fixture
 - 毎日の出力の不変性
 - 出力の再現性、直線性等



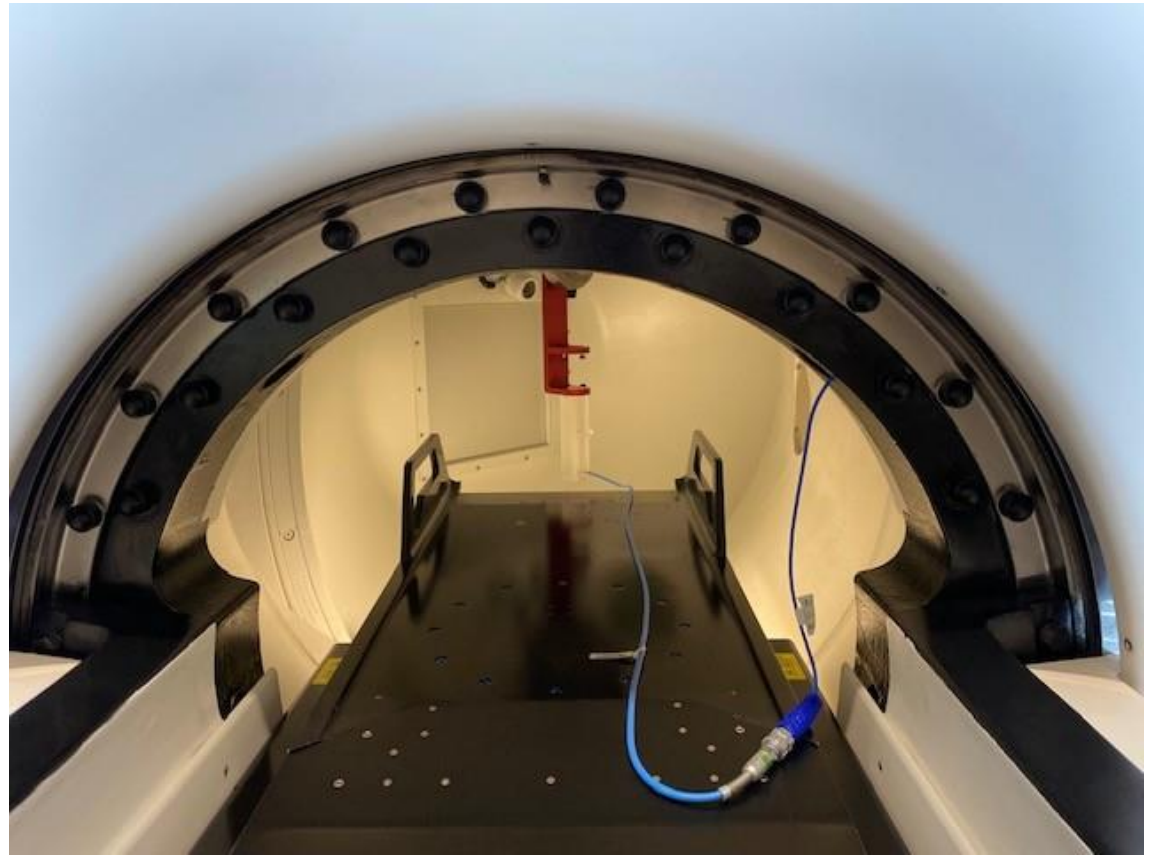
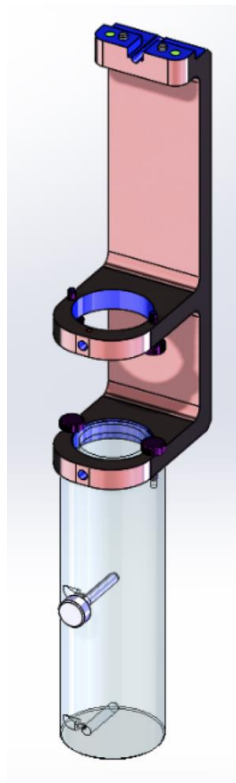
QA using Chamber

- F-Bracket + Sphere phantom
 - 出力の不変性、再現性、直線性等



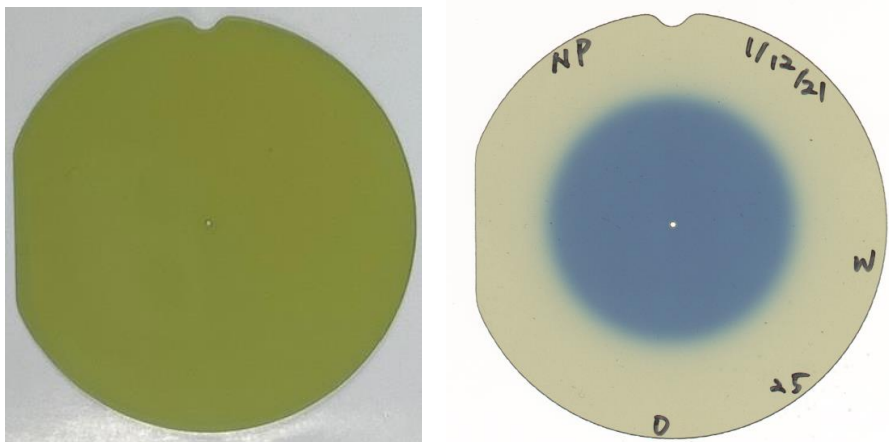
QA using Chamber

- F-Bracket + D10/D20 phantom
 - ビームエネルギーの変動

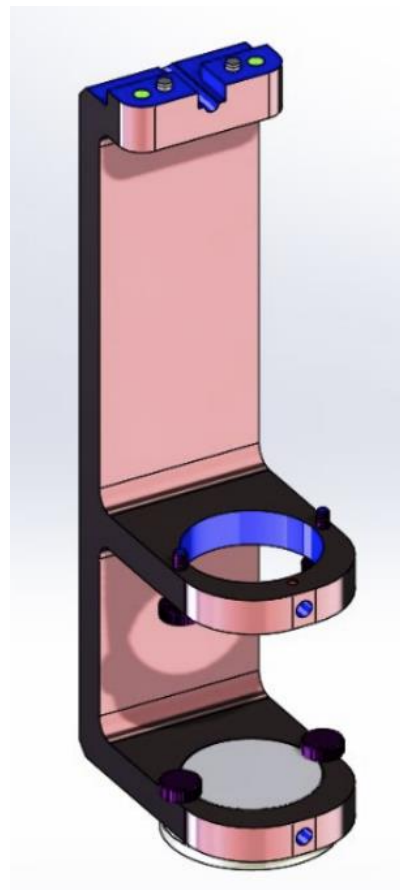


QA using GAFCHROMIC film

- F-Bracket + Film exposure phantom
 - ビーム中心とアイソセンタの一致度
 - ビームの対称性、半影など

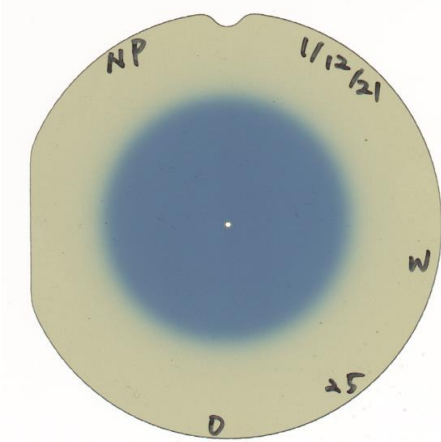


Disc Film



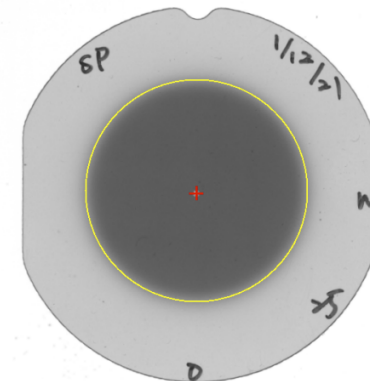
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 - ビームの対称性、半影など



Disc Film

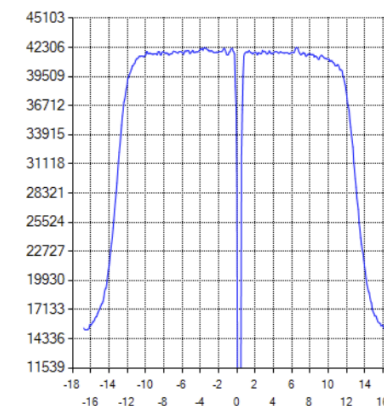
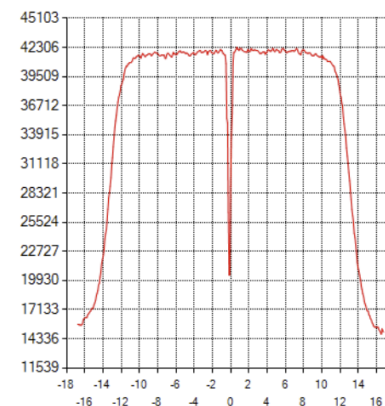
Beam Analysis Results



Date: 2022/10/31
File Name: SP_48BitRGB_202101
Position: North Pole
Collimator: 7.5 mm

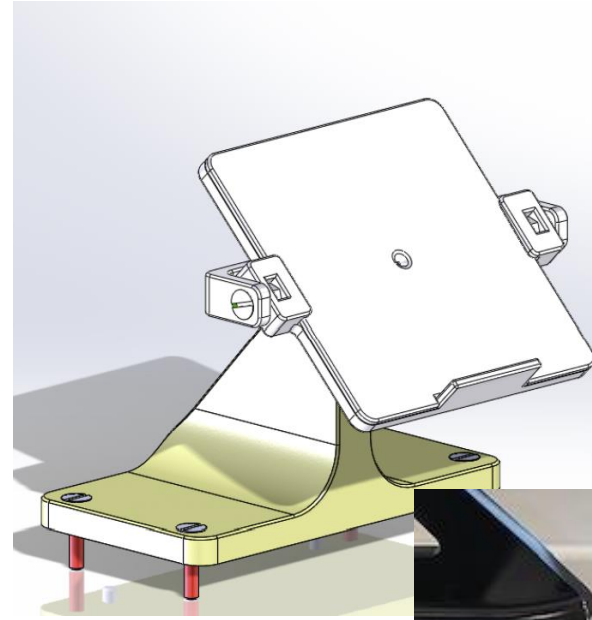
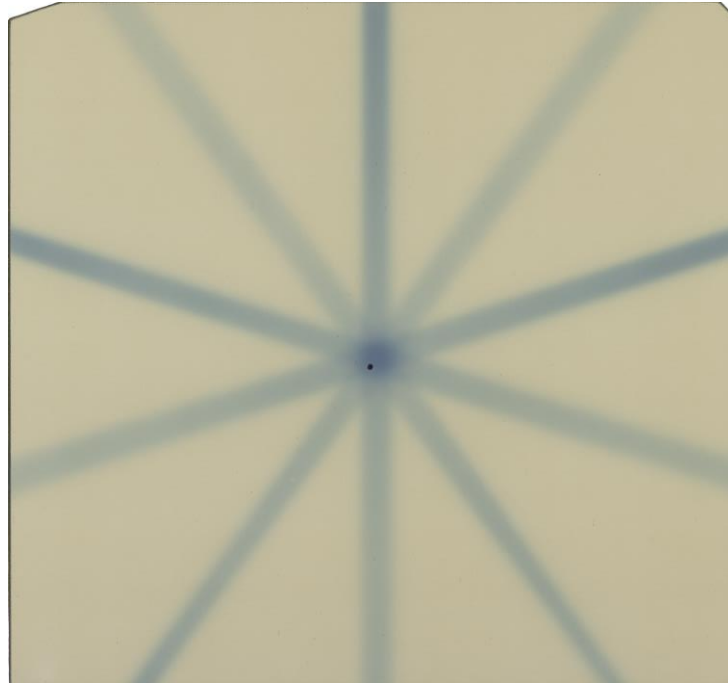
Results

X: 0.03 mm → error
Y: -0.02 mm ↑ error
dr: 0.04 mm



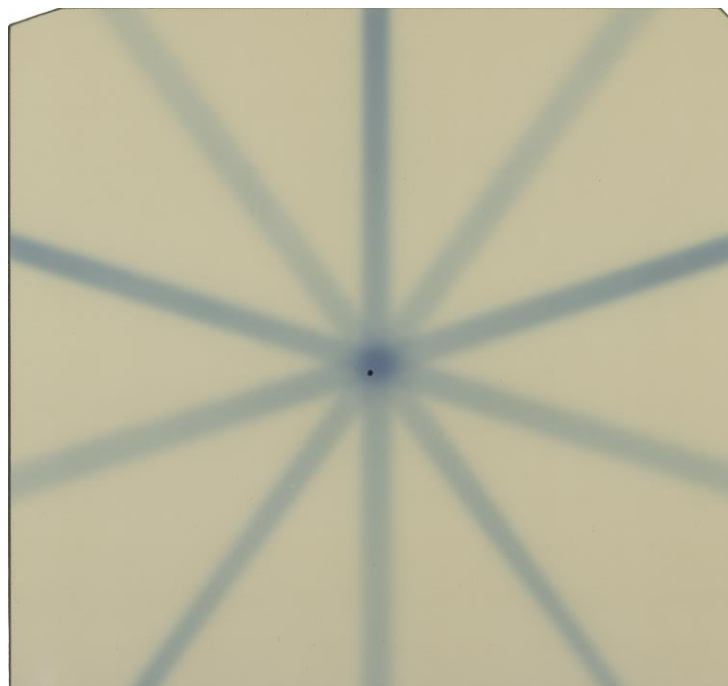
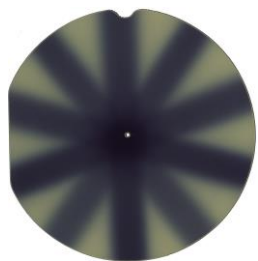
QA using GAFCHROMIC film

- Starshot Fixture
 - 照射系回轉中心精度

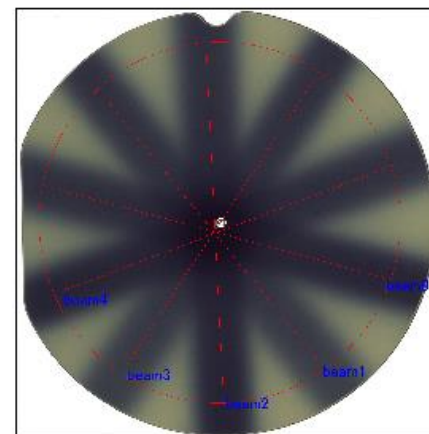


QA using GAFCHROMIC film

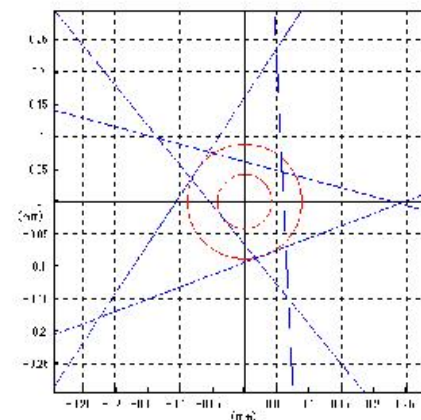
- Starshot Fixture
 - 照射系回轉中心精度



Starshot Results



Date: 2022/02/07
File Name: S11 E0260-00028013.tif
Rotation: Axial
Collimator: 7.5 mm



Results

Beam0 = 0.06 mm
Beam1 = 0.04 mm
Beam2 = 0.06 mm
Beam3 = 0.09 mm
Beam4 = 0.09 mm
Average = 0.07 mm

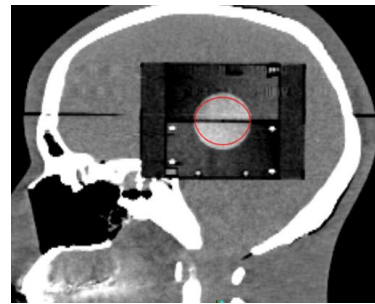
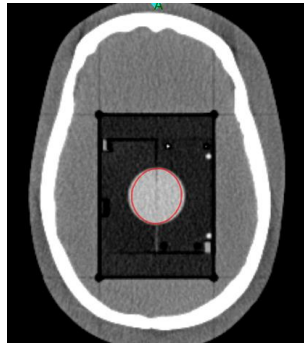
Radius = 0.09 mm

Isocenter offset = 1.25 mm



QA using GAFCHROMIC film

- Head shape phantom + Ball-cube
 - End to End (E2E) test



Film E2E App 1.8.52.13432

Analysis Results:

Parameter	Film AL	Film AS
A	-0.13mm	-0.23mm
L	-0.06mm	0.02mm
S	-	0.02mm
A ₂	-	-
Diameter X/Y	27.64/30.16mm	26.62/29.40mm
Total	-	0.19mm
DeltaA	-	0.10mm

Setup:

- Regular (selected) / Mini
- Film Size: 63.2968mm
- Collimator Size: 25mm

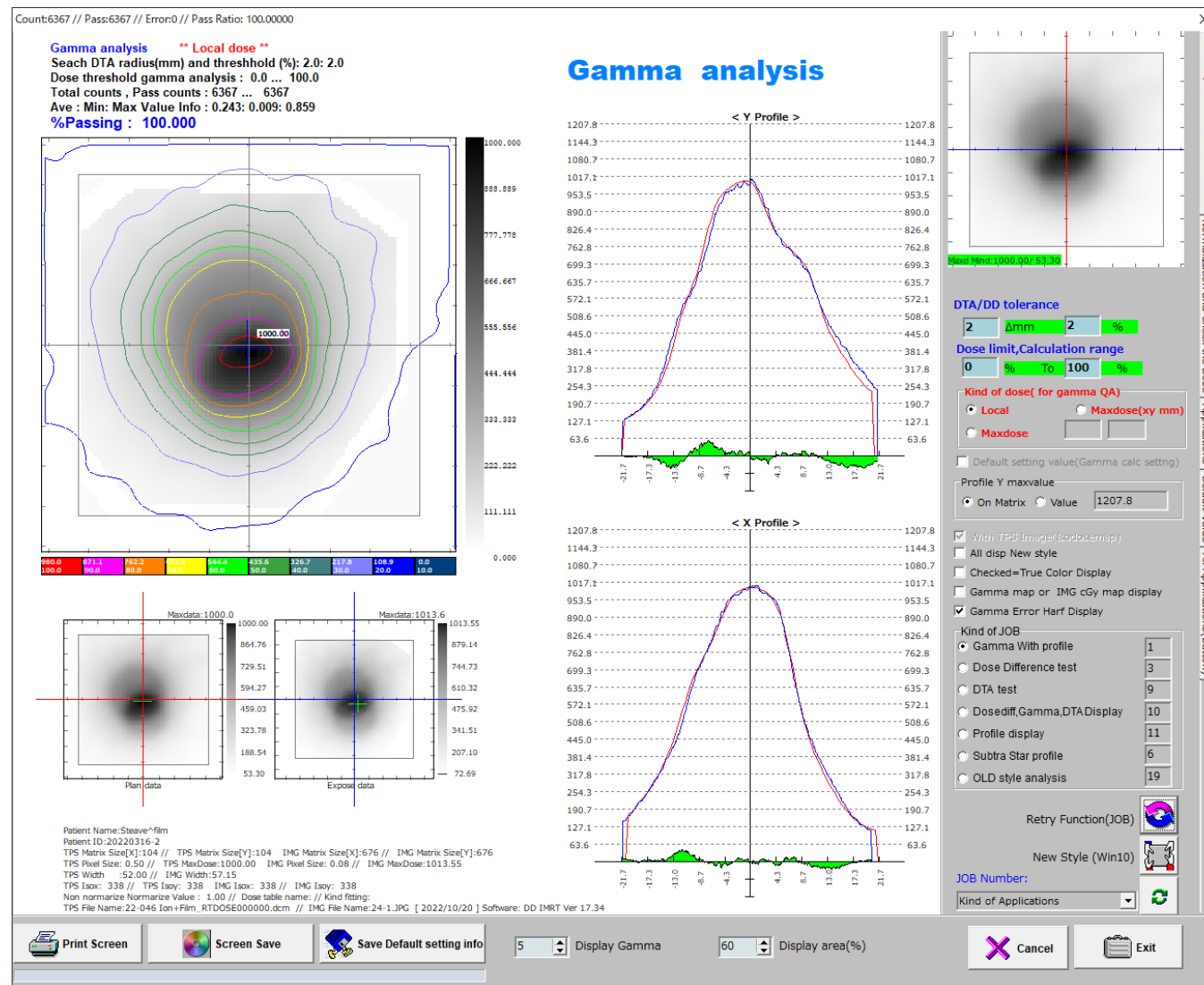
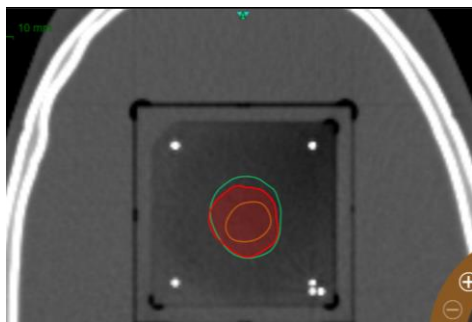
Analysis Result:

- L: -0.06mm
- S: 0.02mm
- A: -0.18mm
- Total: 0.19mm
- DeltaA: 0.10mm

02/23/2022 12:28:44

QA using GAFCHROMIC film

- Head shape phantom + Ball-cube
 - Patient Specific QA



謝 辞

画像提供頂きました宇都宮脳脊髄センター シンフォニー病院様と
神谷町脳神経外科クリニック様に感謝いたします。
