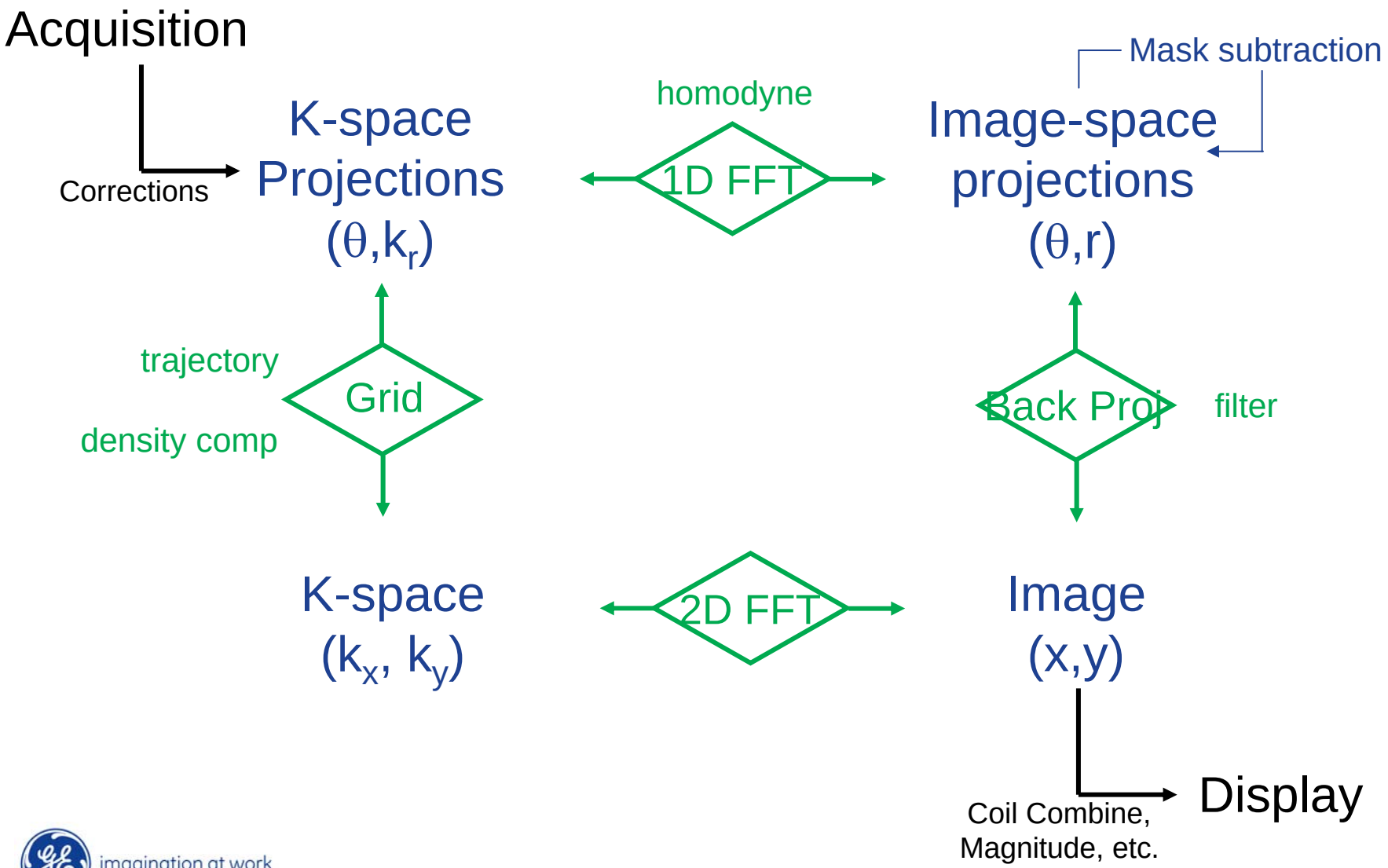
HYPR
Mathematical Overview

Data Spaces – Radial MRI



HYPR – Orig. Algorithm: $I_h = I_c \cdot I_w$

Composite Image:

$$I_c = FB[\{P\}_c]$$

Set of all projections in composite

Filtered back projection

Weighting Image:

$$I_w = B\left[\left\{\frac{P}{P_c}\right\}_t\right]$$

Set of projections for timeframe t

projection recomputed from composite

(Unfiltered) back projection

HYPR – Wright Algorithm: $I_h = I_c \cdot I_w$

Composite Image:

$$I_c = FB[\{P\}_c]$$

Set of all projections in composite

Filtered back projection

Weighting Image:

$$I_w = \frac{B[\{P\}_t]}{B[\{P_c\}_t]}$$

Ratio calculated pixel-by-pixel in image space

HYPR – LR Algorithm: $I_h = I_c \cdot I_w$

Composite Image:

$$I_c = FB[\{P\}_c]$$

- $\{P\}_c$: Set of all projections in composite
- FB: Filtered back projection

Weighting Image:

$$I_w = \frac{\Phi[f \cdot \{K\}_t]}{\Phi[f \cdot \{K_c\}_t]} = \frac{F * I_t}{F * I_{c,t}}$$

- $\{K\}_t$: K-space data (e.g. projections, or k_x-k_y)
- f: K-space filter (e.g. low-res apodization)
- Φ: Generalized reconstruction operator (e.g. BP, F

HYPR – LR Algorithm: $I_h = I_c \cdot I_w$

Composite Image:

$$I_c = FB[\{P\}_c]$$

- $\{P\}_c$: Set of all projections in composite
- FB: Filtered back projection

Weighting Image:

Apodize at Nyquist:

$$I_w = \frac{\Phi[f \cdot \{K\}_t]}{\Phi[f \cdot \{K_c\}]} = \frac{F * I_t}{F * I_c}$$

- I_t: Low-res timeframe
- I_c: Low-res composit
- $\{K\}$: K-space data (e.g. projections, or k_x-k_y)
- f: K-space filter (e.g. low-res apodization)
- Φ: Generalized reconstruction operator (e.g. BP, F

I-HYPR Algorithm:

Composite Image:

$$I_c = FB[\{P\}_c]$$

iterate

Weighting Image:

$$I_w = B\left[\left\{\frac{P}{P_c}\right\}_t\right]$$

Update Composite:

$$I_c = I_h$$

HYPR Image:

$$I_h = I_c \cdot I_w$$

I-HYPR-LR Algorithm:

Composite Image:

$$I_c = FB[\{P\}_c]$$

iterate

Weighting Image:

$$I_w = \frac{\Phi[f \cdot \{K\}_t]}{\Phi[f \cdot \{K_c\}]}$$

Update Composite:

$$I_c = I_h$$

HYPR Image:

$$I_h = I_c \cdot I_w$$

HYPR-Flow Algorithm: $I_h = I_c \cdot I_w$

Composite Image:

$$I_c = FB[\{P_{PC}\}_c]$$ PC-VIPR Acquisition

Timeframe Image:

$$I_t = B[\{P_{CE}\}_t]$$ Low-res VIPR (CE-MRA)

Weighting Image:

$$I_w = \frac{F * I_{CE}}{F * I_{PC}}$$

← CE-VIPR Images

← PC-VIPR Images

Apodize so CE, PC have equiv resolution