# Optimized Image Planning in CMR: A Practical Guide for Technologists

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## Introduction

Image planning in CMR is a fundamental skill that technologists must master to ensure accurate cardiac image capture and assessments. Optimal image planning helps enhance workflow efficiency, reduces scan time, and ensures reproducibility. This article outlines the essential steps in planning a CMR study, focusing on best practices and real-world application, and has been based on standards set by EACVI[1] and a recommendation document from SCMR.[2]

## 1. Pre-Scan Preparation

**Review Patient Information**

- Confirm the indication for the scan and review prior imaging, ECG, and clinical history.
- MR Safety Checklist: Check for implanted metallic devices such as pacemakers, ICDs, aneurysm clips, cochlear implants etc.
- Check for contraindications including severe renal dysfunction, pregnancy and hypersensitivity or known allergic response to gadolinium-based contrast agents if contrast is to be administered.
- If the patient is referred for an adenosine stress perfusion evaluation, check for 24-hour caffeine abstinence, presence of severe asthma or COPD, second- or third-degree heart block, symptomatic bradycardia or severe hypotension.
- Educate the patient on breath-holding instructions and scanning duration.

## 2. Patient Positioning

- Guide the patient to a supine, head-first position.
- Position the cardiac coil over the heart for optimal signal reception.
- Place ECG leads securely to reduce motion artifacts and ensure accurate cardiac gating. Administer contact gel if necessary. Check ECG signal strength.
- Place blood pressure cuff around upper arm. In the setting of adenosine stress perfusion, position over the arm connected to contrast power injector.
- Ensure the magnet's isocentre is aligned with cardiac position for optimal image quality before advancing the patient into the bore.

## 3. Localizer Sequences

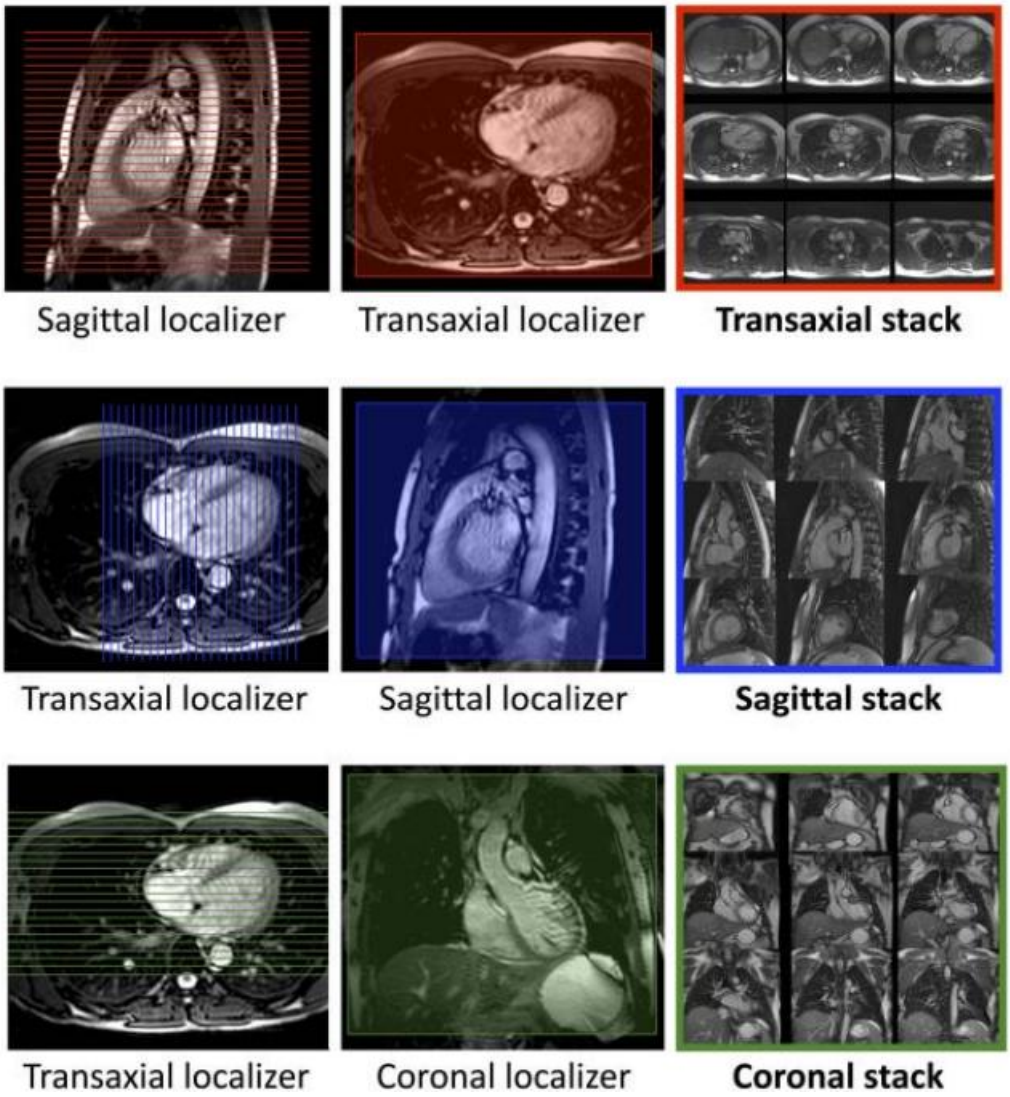
Localizers act as the GPS for cardiac imaging, ensuring accurate scan plane selection.

**Acquiring Localizers**

- Localizers should be acquired in transaxial, sagittal, and coronal planes.
- Use low-resolution, free-breathing sequences to get an overview of the heart's position and orientation.

**Practical Tips for Localizer Optimization**

- Ensure the heart is in the field of view and adjust accordingly.
- If signal drop-out occurs, check coil selection and ECG triggering.
- Always verify patient positioning and coil placement before proceeding.



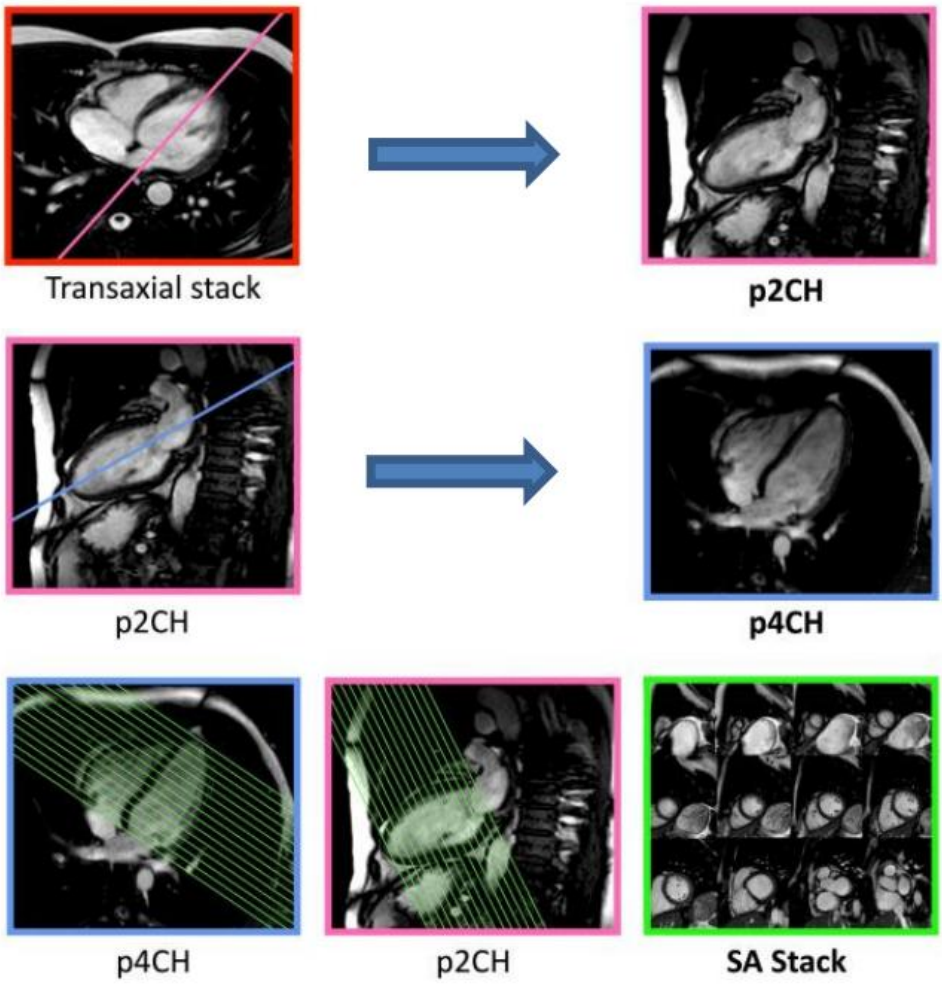
## 4. Standard Cardiac Views: Left Ventricle (LV)

Once localizers are obtained, the next step is planning the standard cardiac views used for functional and anatomical assessment.

### 4a. LV Pseudo-Views: Setting the Stage

Using localizer images, pseudo-views give an initial look at the LV before moving to true anatomical views:

- **Pseudo 2-Chamber (p2CH) View** (aka **Vertical Long Axis View**): Plane is positioned perpendicular to the transaxial plane through the LV apex and mitral valve.
- **Pseudo 4-Chamber (p4CH) View** (aka **Horizontal Long Axis View**): Created by cutting an orthogonal plane through the apex and mitral valve.
- **True Short Axis (SA) View**: Planned orthogonally to both p2CH and p4CH views, capturing the heart's cross-section.
  A **stack of SA cine images** typically covers the entire LV for full functional assessment.

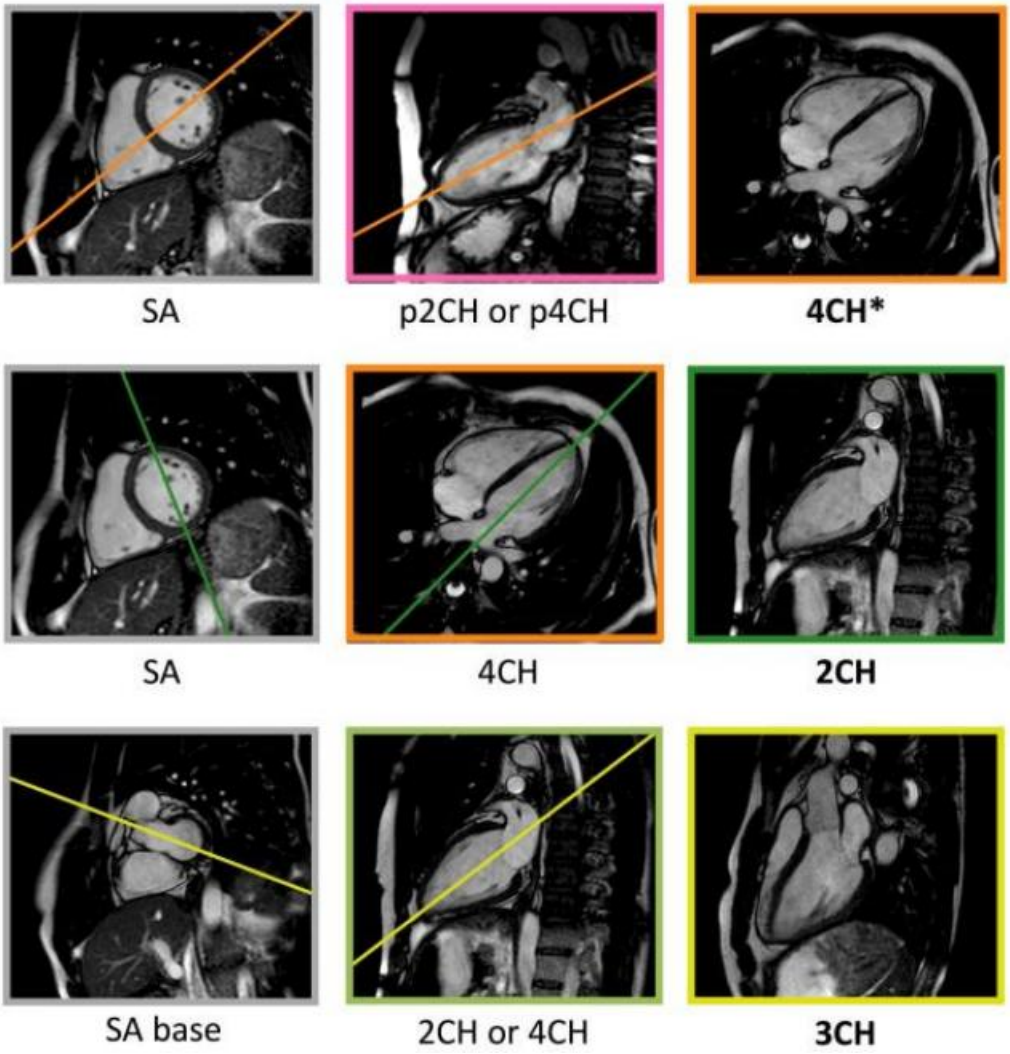


**4b. LV True-Views: The Real Deal**

- **4CH View**: Planned orthogonal to the SA and p2CH views, slicing through the RV at its widest point and the LV below the anterolateral papillary muscle.
- **2CH View**: Planned orthogonal to the 4CH or p4CH and SA views, slicing the inferior and anterior LV wall parallel to the septum.
- **3CH View**: Planned orthogonal to the 2CH or 4CH view and the basal SA view, showing the aortic valve and posterior wall.

**Practical Tips for LV optimization**

- Always double-check anatomical landmarks before acquiring final sequences.
- Adjust slice thickness and spacing for optimal coverage.
- Use breath-hold techniques to minimize motion artifacts.
- For simplified planning, use p2CH and p4CH instead of 2CH and 4CH
- In certain patients, the aortic root may be challenging to eliminate in the 4CH

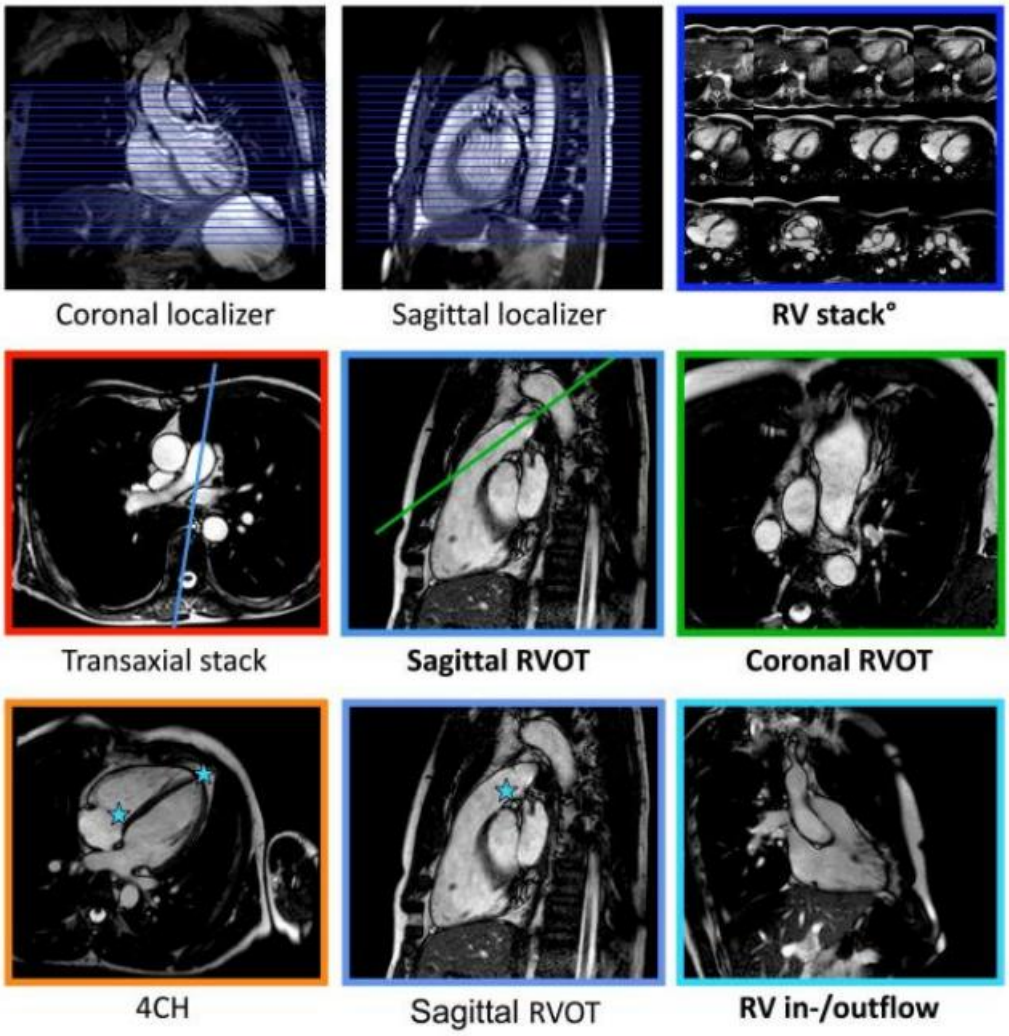


## 5. Standard Views: Right Ventricle (RV)

- **RV Transaxial Stack:** Acquired from the diaphragm to the pulmonary bifurcation or via 4CH cine stack.
- **Sagittal RVOT View:** Planned through the main pulmonary artery, pulmonary valve, and RV cavity in the transaxial stack or localiser images.
- **Coronal RVOT View:** Orthogonal plane to the sagittal RVOT.
- **RV In-/Outflow View:** Uses 3-point planning: Place 3 points at the Tricuspid valve, RV apex in 4CH, and pulmonary valve in RVOT.

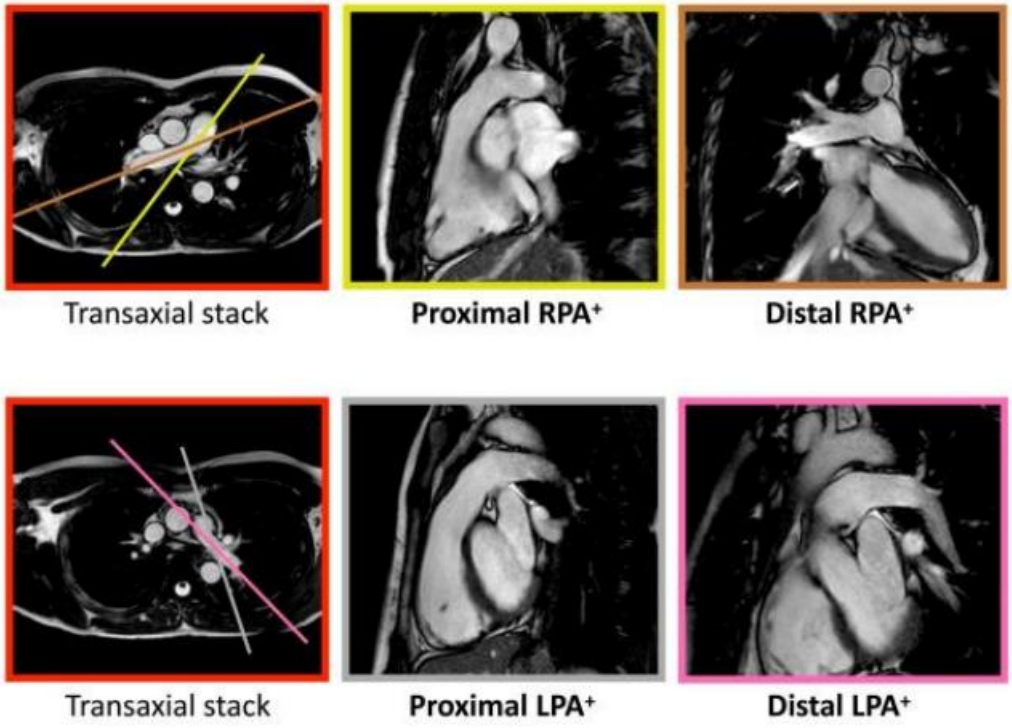
**Practical Tips for RV optimization**

- To obtain the RV transaxial stack, copy slice positions from the transaxial localizer.
- For extra measurements, RV dimensions can also be assessed from the SA LV stack.



## 6. Standard Views: Pulmonary Arteries (PA)

- **Left & Right PA Views:** Obtained by planning orthogonal planes through the pulmonary arteries in the transaxial stack or localizer.
- **Angulation Tweaks:** Adjusting angles provides proximal vs. distal views of the main pulmonary artery and its branches.




## 7. Standard Views: Aortic Valve (AV) & Aorta

### 7a. Aortic Valve Views

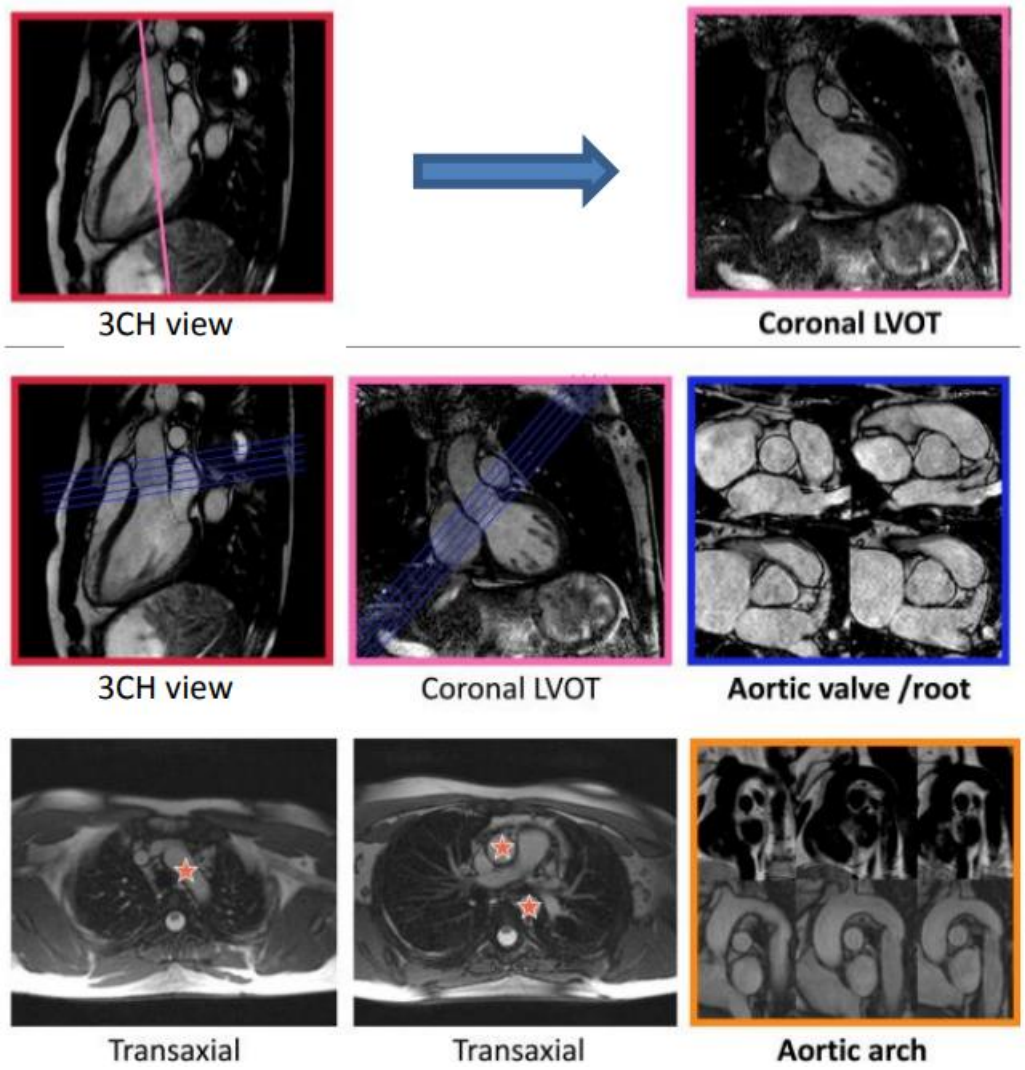
- **Coronal LVOT/AV View:** Orthogonal plane to the aortic root in the 3CH view.
- **In-Plane AV View:** Planned perpendicular to the aortic root and parallel to the aortic valve in both the 3CH and coronal LVOT views. Acquire 4-5 slices to provide an en face view of the AV.

### 7b. Aorta Views

- **Aortic Arch:** Acquired using 3-point planning, with points placed in the ascending aorta, descending aorta, and aortic arch level. This view is also referred to as the" candy cane" view.

**Practical Tips for image optimization**

**Double-Check!** Always review axial images for aorta evaluation.

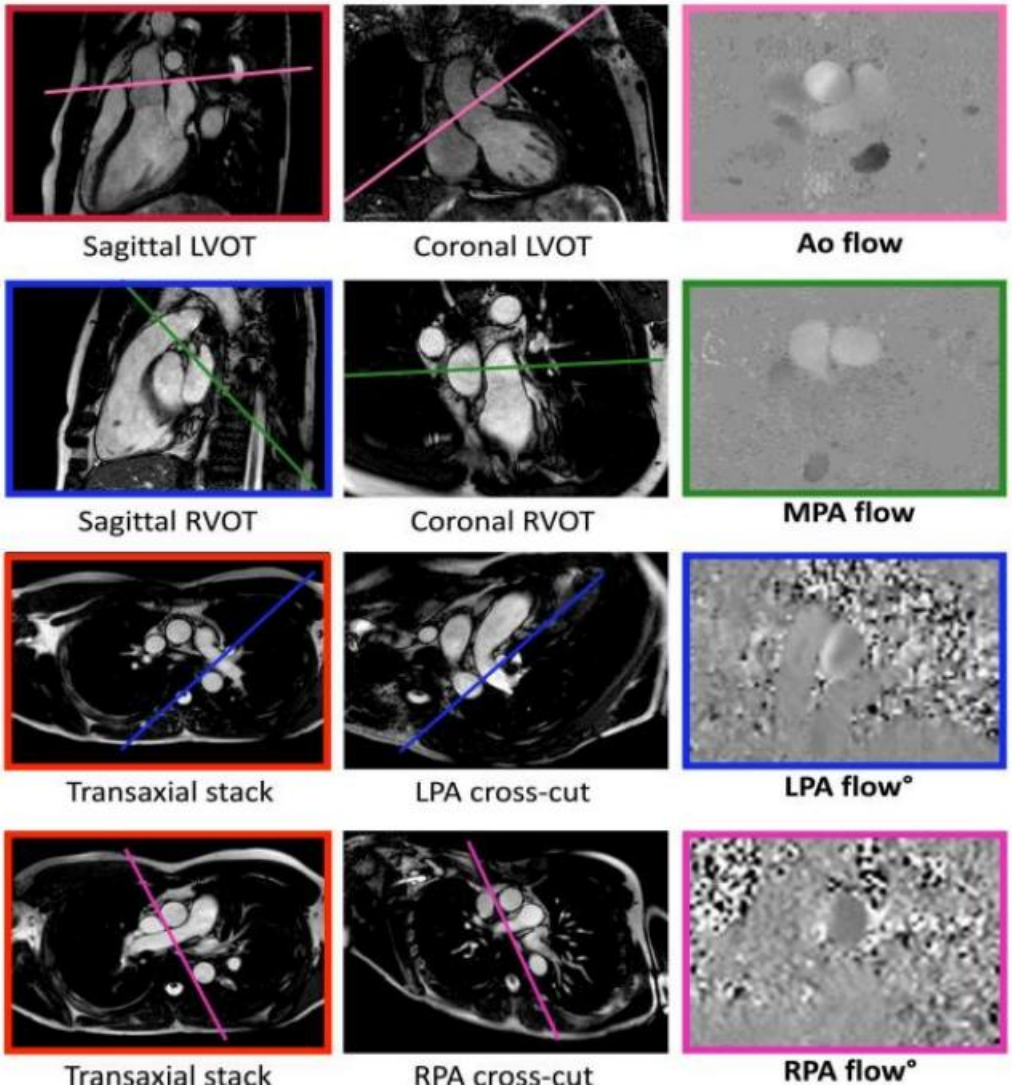



## 8. Standard Views: Flow Imaging (Aorta & PA)

- **Aortic Flow View:** Perpendicular to the aortic root in both sagittal and coronal LVOT views.
- **Main Pulmonary Artery (MPA) Flow View:** Perpendicular to MPA in sagittal and coronal RVOT views.
- **Left & Right PA Flow Views:** Perpendicular to each PA in transaxial and cross-cut views.

**Practical Tips for flow imaging**

- For quick setup, plan directly from coronal and axial localizers.
- Adjust velocity encoding (VENC) settings based on expected flow velocities to avoid aliasing (e.g., 150-200 cm/s for the aorta, 100-150 cm/s for pulmonary arteries)
- Ensure high temporal resolution (≥30 phases per cardiac cycle).
- In the setting of aortic regurgitation, the position of the aortic flow view affects regurgitation measurements, so plan wisely!




## 9. Conclusions

Mastering image planning in CMR is essential for obtaining high-quality, diagnostic images. By following best practices in localizer acquisition, standard view planning, and advanced imaging, technologists can optimize workflow efficiency and enhance patient care. Continuous learning and adherence to guidelines ensure ongoing improvement in CMR imaging outcomes.

## References

1. Herzog B, Greenwood J, Plein S, et al. Cardiovascular magnetic resonance pocket guide. *Eur Soc Cardiol* 2017
2. Kramer CM, Barkhausen J, Bucciarelli-Ducci C, et al. Standardized cardiovascular magnetic resonance imaging (CMR) protocols: 2020 update. *Journal of Cardiovascular Magnetic Resonance* 2020;22(1):17.