DME Arcs

Tiziano Bernard, CFII

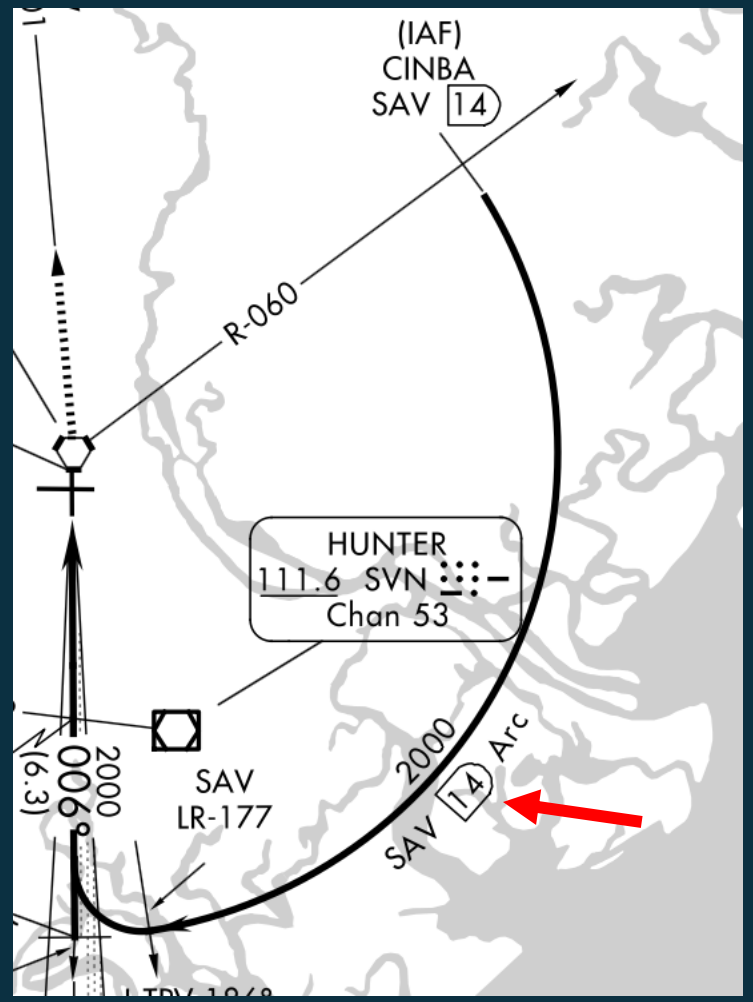
"... this is black magic."

Mission Objectives

- Understand the purpose of DME arcs
- Understand WHY we need to know them
- Understand the three basic methods to fly them
  - Turn 10, twist 10
  - The Dr. Bill – Tizi Method
  - The GPS Method (aka cheating)

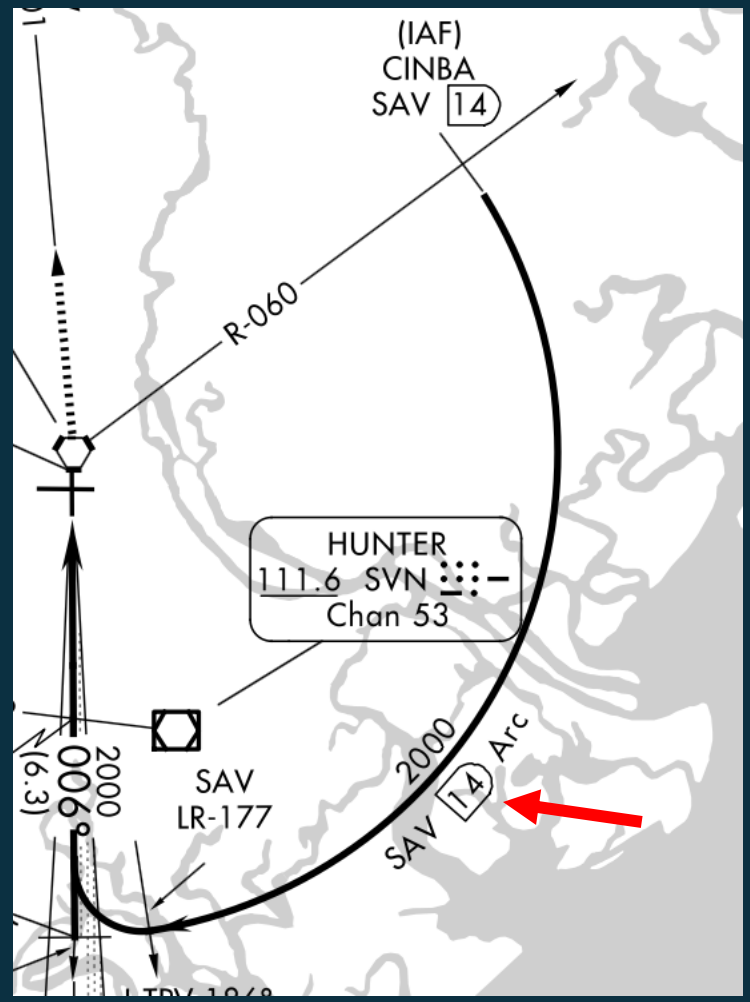
Definition

- A DME arc is a constant radius turn performed by the pilot at a certain distance (DME) and altitude from a Navigational Aid.
- The arc is labeled and charted on instrument plates with all pertinent information.
- They are part of a procedure, but not a procedure “type” (e.g., VOR, ILS, LOC, etc.).



Purpose for DME Arcs

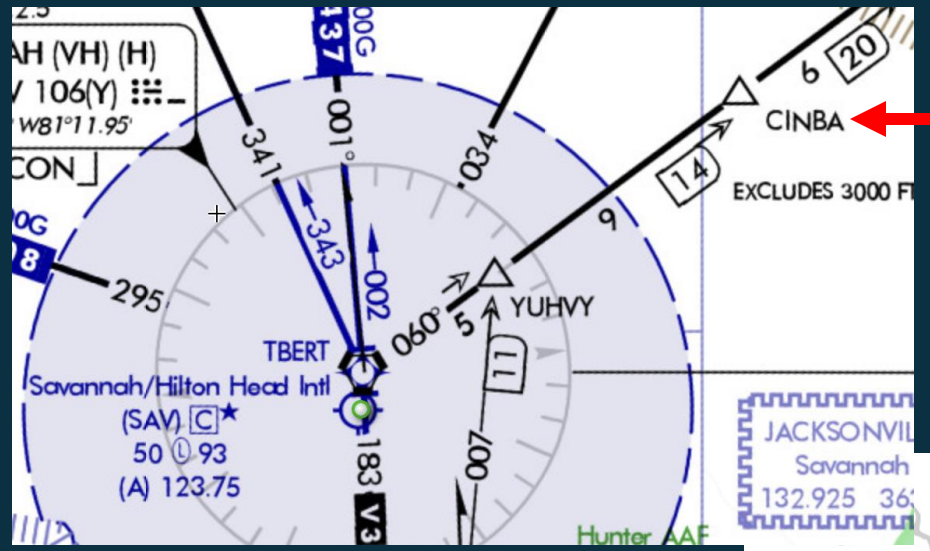
- DME arcs are designed for ground-based navigation approaches.
- There needs to be a way to align the airplane on the final approach course (FAC).
- The arc allows traffic to flow towards the FAC.
- They often connect the enroute world to the terminal world (airway to approach).



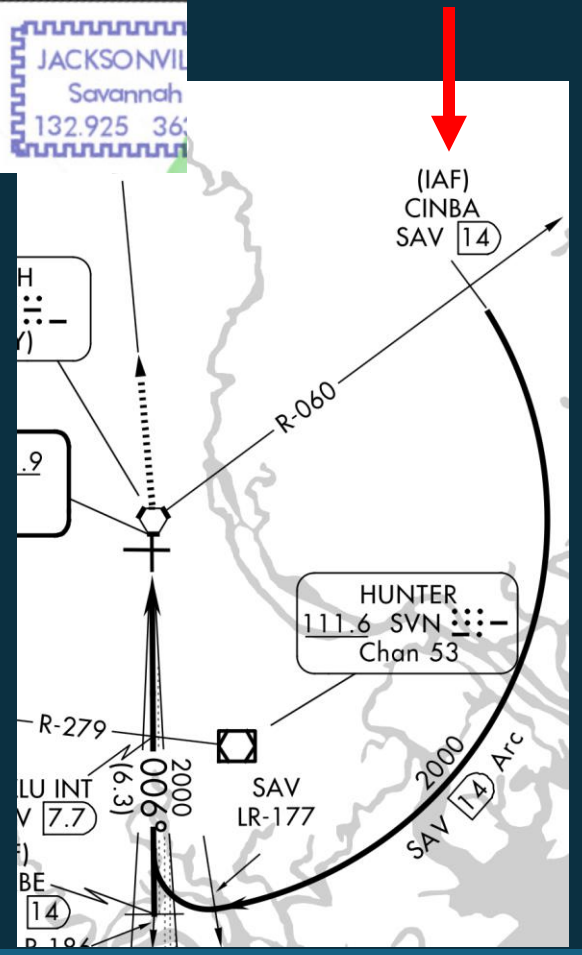
Enroute to Terminal

Approach: KSAV ILS or LOC 01

- IAF is CINBA
- CINBA is on V437
- Exit the airway at CINBA to join the approach!
- You don't need GPS to fly that, as long as you have a DME.

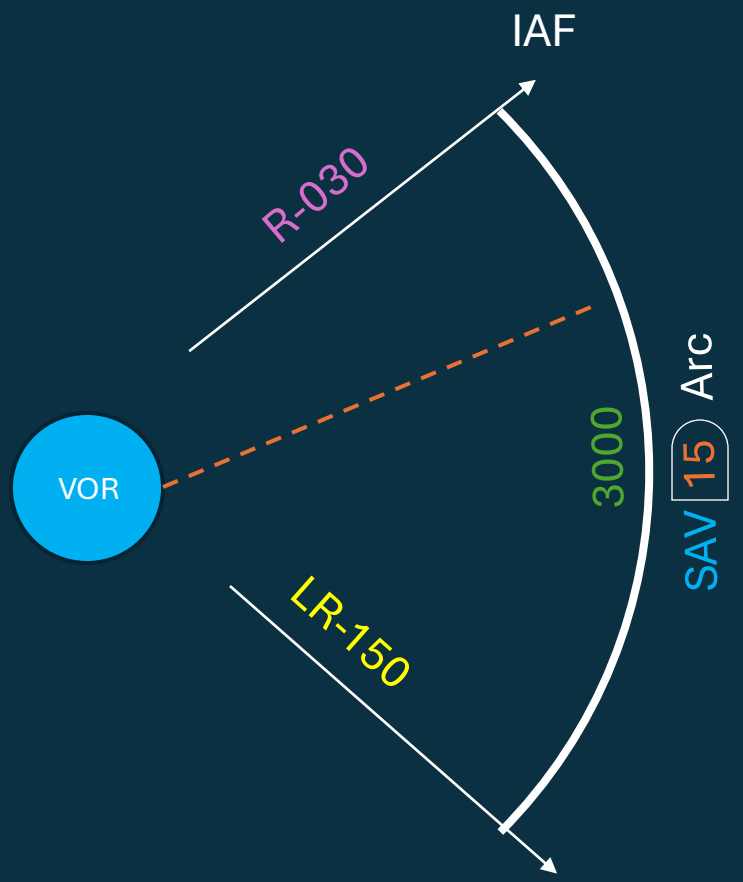


ILS or LOC RWY 1
SAVANNAH/HILTON HEAD INTL (SAV)



DME Arc Geometry

- DME Arcs are defined by their geometry:
- Distance from the reference point (VOR)
- Altitude
- Initial Point (radial)
- End Point (also known as Lead Radial)



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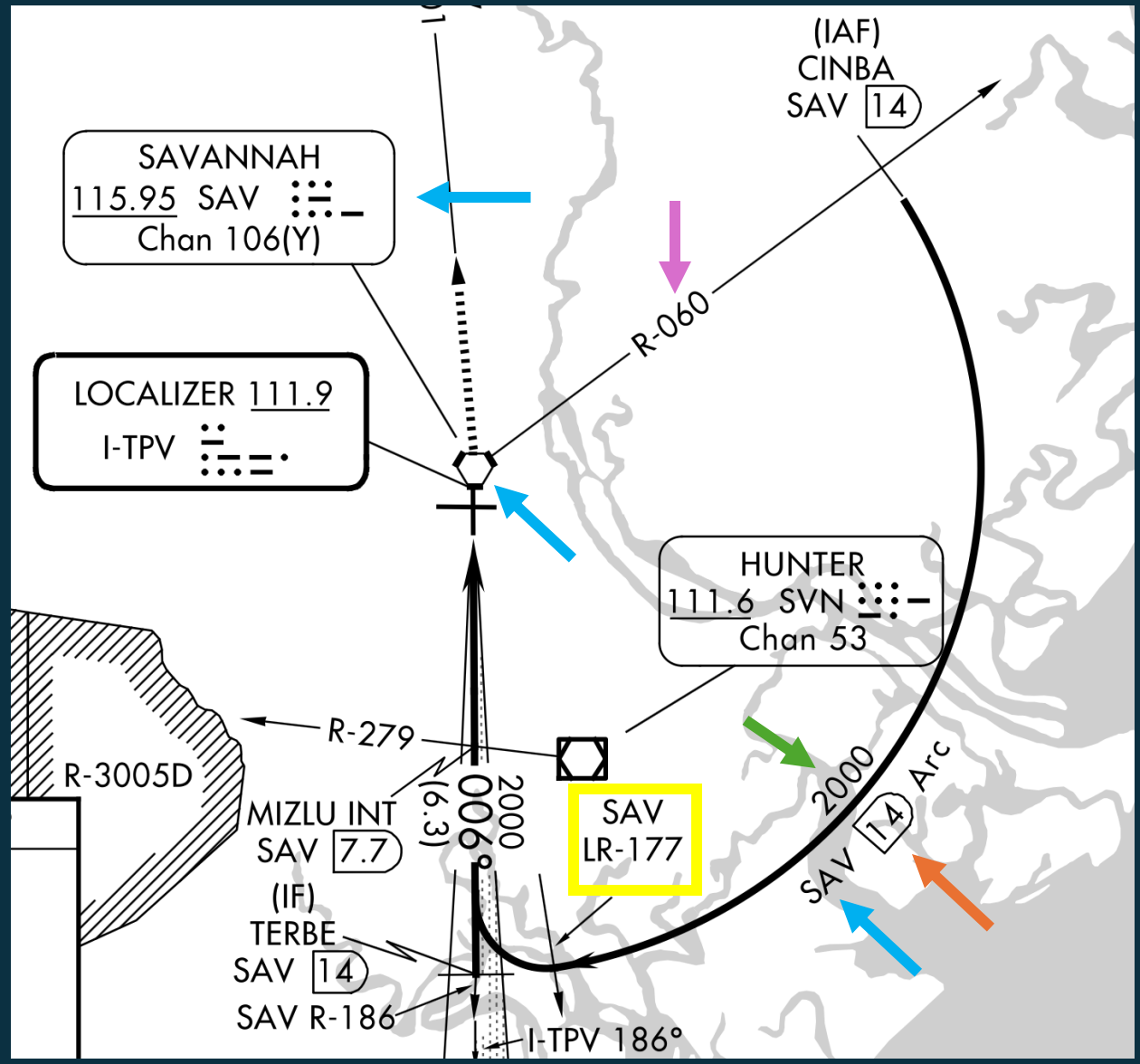


How to fly it… the fun begins!

- The idea is to fly -*as much as possible*- a constant turn from beginning to end maintaining a constant distance from the navigation aid (+/- 0.5 NM).

- There are three generic methods to do that.

1. **The GPS method** (aka cheating) – Only way that will guide you through a continuous turn.
2. **Turn 10, Twist 10** (painful) – Brake up the arc in "segments" so that you can make smaller heading changes rather than a continuous turn.
3. **The Tizi (& Dr. Bill) method** (painless) – fly a 90 deg angle to the station using a bearing pointer and your ground track.

The GPS Method

- Ok, let's not spend too much time on this…
- Load the procedure in your navigator (GPS unit) and the CDI will provide you with guidance.
- So… fly the CDI. Easy, huh?
- Be aware of your specific avionics.
  - Some avionics provide you with a continuous turn (i.e., the CDI needle will move continuously to help you track a curve (a GTN+G5 will do this).
  - Some other avionics will provide you with small turns every so often, breaking down the arc in smaller segments.
  - Know your avionics!

The GPS Method – How to fly it.

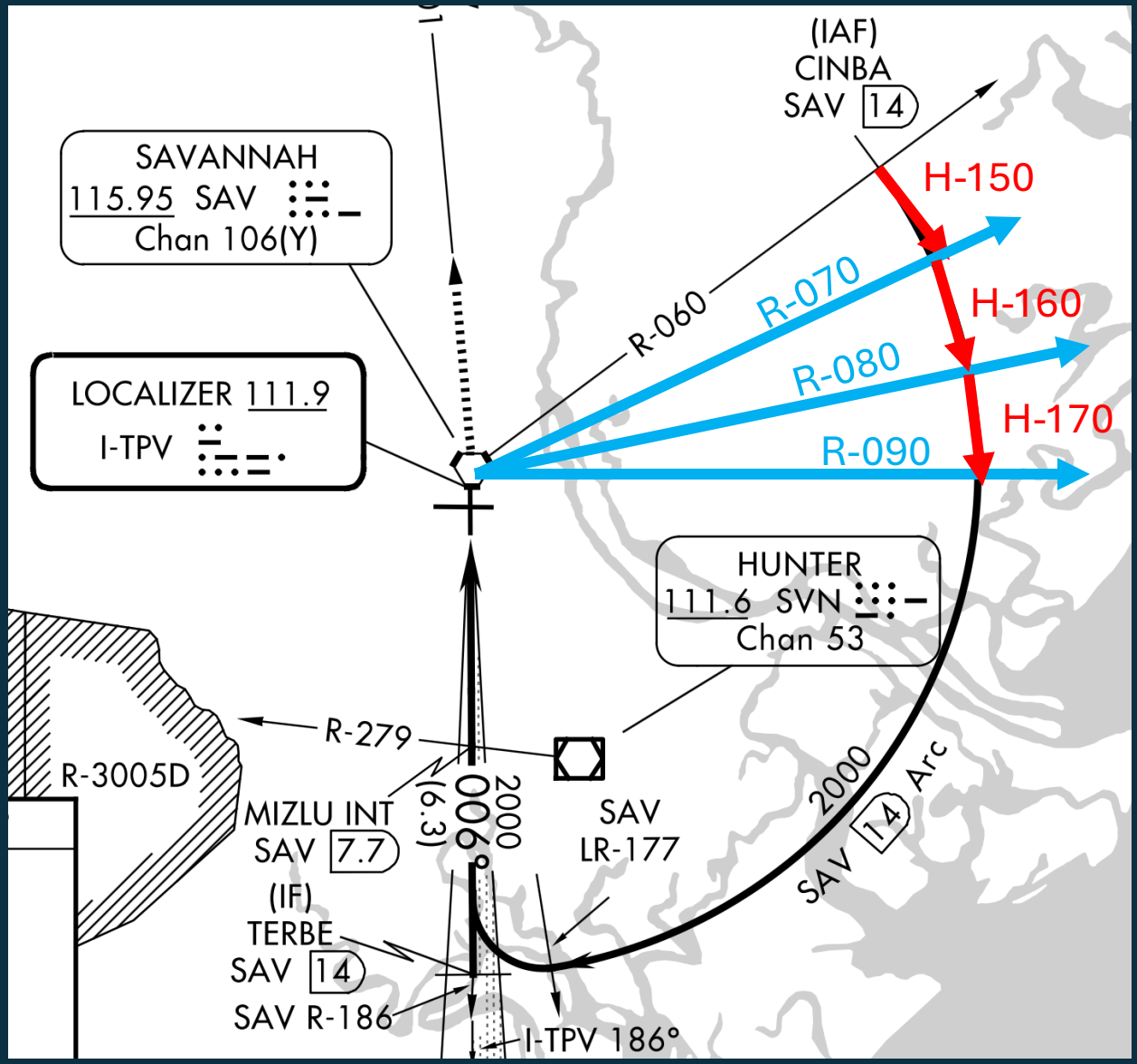
- FOLLOW THE NEEDLES!!
- Load the procedure and fly the CDI.
- That’s it.
- Tizi, out.

Turn 10, Twist 10

- This is the traditional method of flying DME arcs.
- The generic concept is to break down the arc in multiple segments.
- Each segment is 10 degrees of radial.
- Every turn (At each segment) is 10 degrees of heading.
- So instead of making a continuous turn, we turn “every so often”
- Fun, huh?
- No.
- Let’s draw it out.

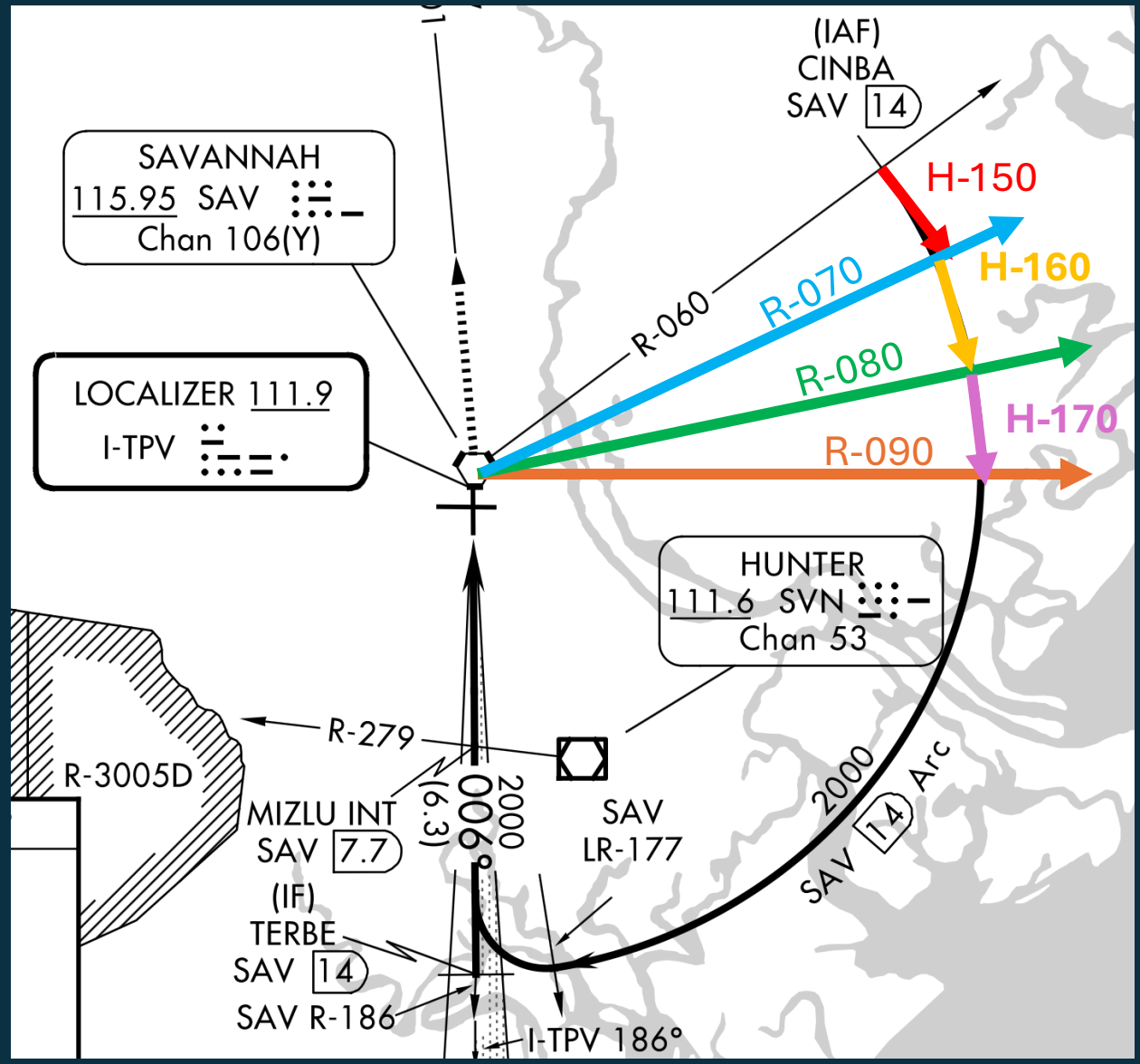
Turn 10, Twist 10

- We divide the arc in 10 degrees of radials.
- We begin the arc at R-060,
- Next segment begins at **R-070**,
- Next segment begins at **R-080**,
- Next segment begins at **R-090**,
- and so on.
- For each segment, we adjust our **headings** by 10 degrees.
- Begin with Heading **H-150**.
- Then **H-160** on the next segments
- And so on.
- Ok, now let's see how we fly it step by step.



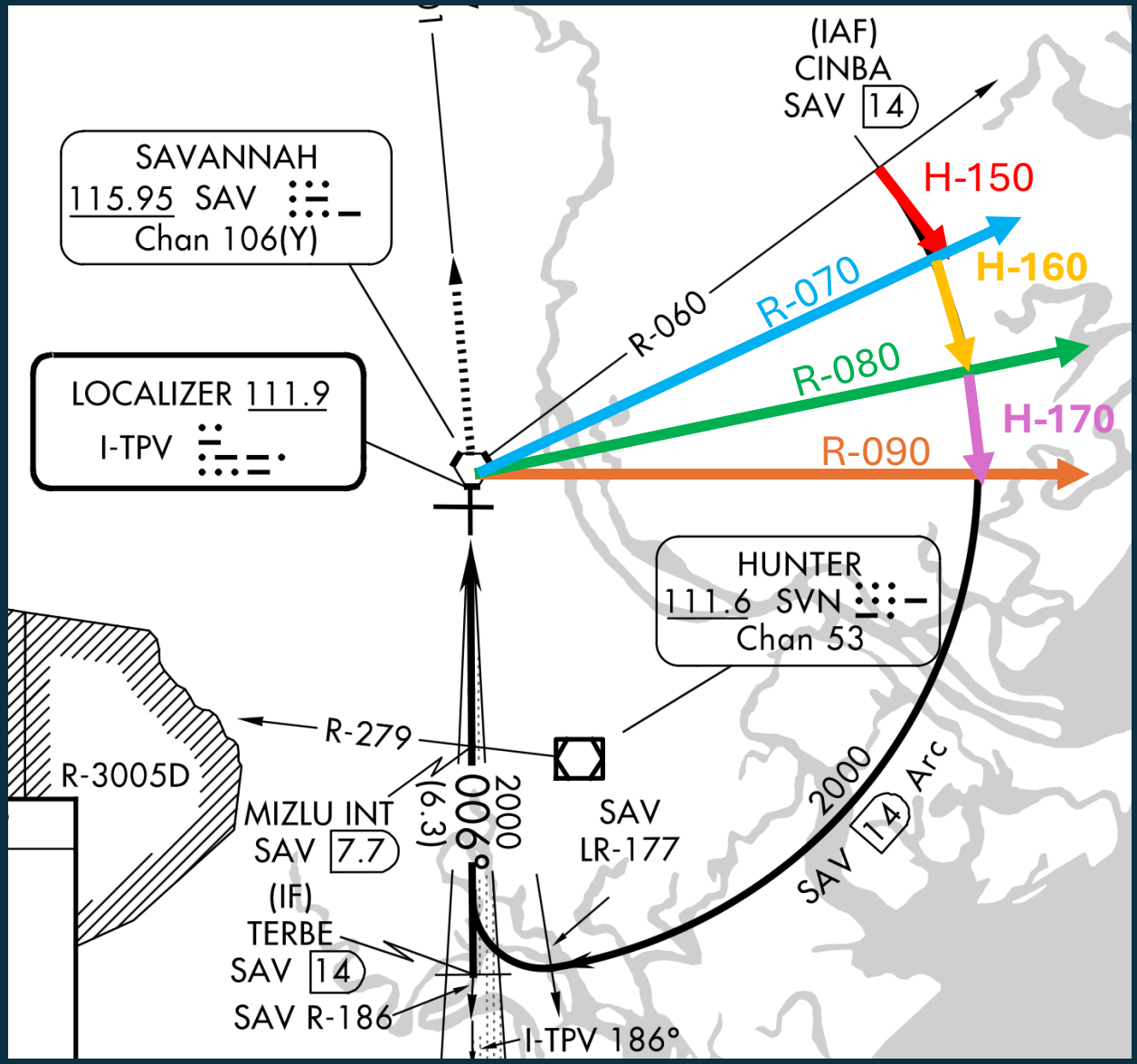
Turn 10, Twist 10 - How to fly it.

- We arrive at CINBA (somehow, not relevant to the technique).
- I monitor the distance from the VOR (nearest VOR page?)
- We turn heading **150** (that is 90 degrees to R-060). So, I can start the arc at a perfect 90 degree angle.
- I tune in **R-070**.
- When I reach **R-070** (the CDI will center) I will:
  - Turn right heading **160** (add 10 to my previous heading)
  - Dial the next course, **R-080** (add 10 to my previous course)
- When I reach **R-080**, I will:
  - Turn right heading **170** (add 10 to my previous heading)
  - Dial the next course, **R-090** (add 10 to my previous course
- Until I complete the arc!



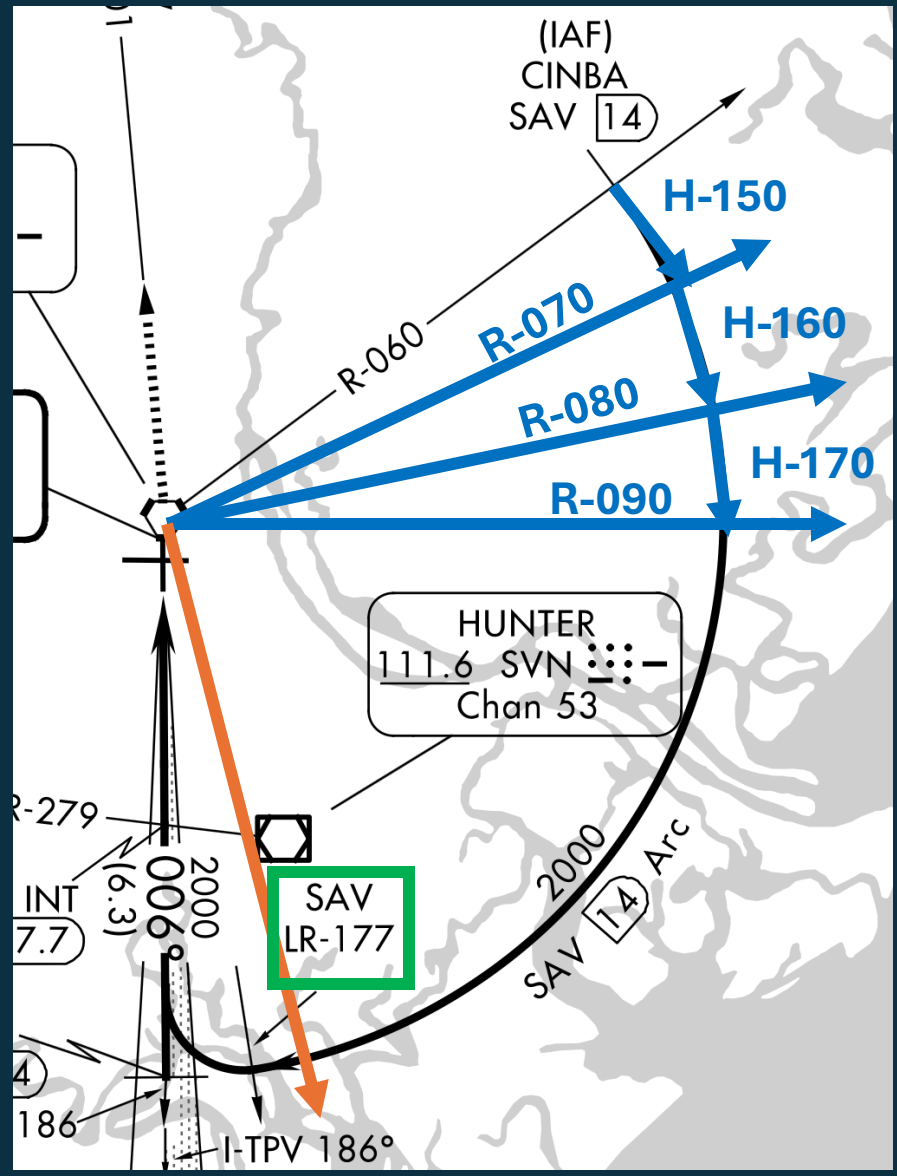
Turn 10, Twist 10 - Why it's painful

- Workload intensive
- Focused attention
- Requires more situation awareness
- Will not account for winds!
  - Based on your winds, you will need to turn more or less than 10 degrees to stay at a constant distance.
  - Monitor distance from the VOR and adjust headings as needed.
  - E.g., you are getting too far? Instead of turning right 10 degrees, turn 15! This requires your judgement.
  - The winds will be constantly changing direction (it's an arc!) so you will need to iterate constantly.
- You need to be ready to end the arc...



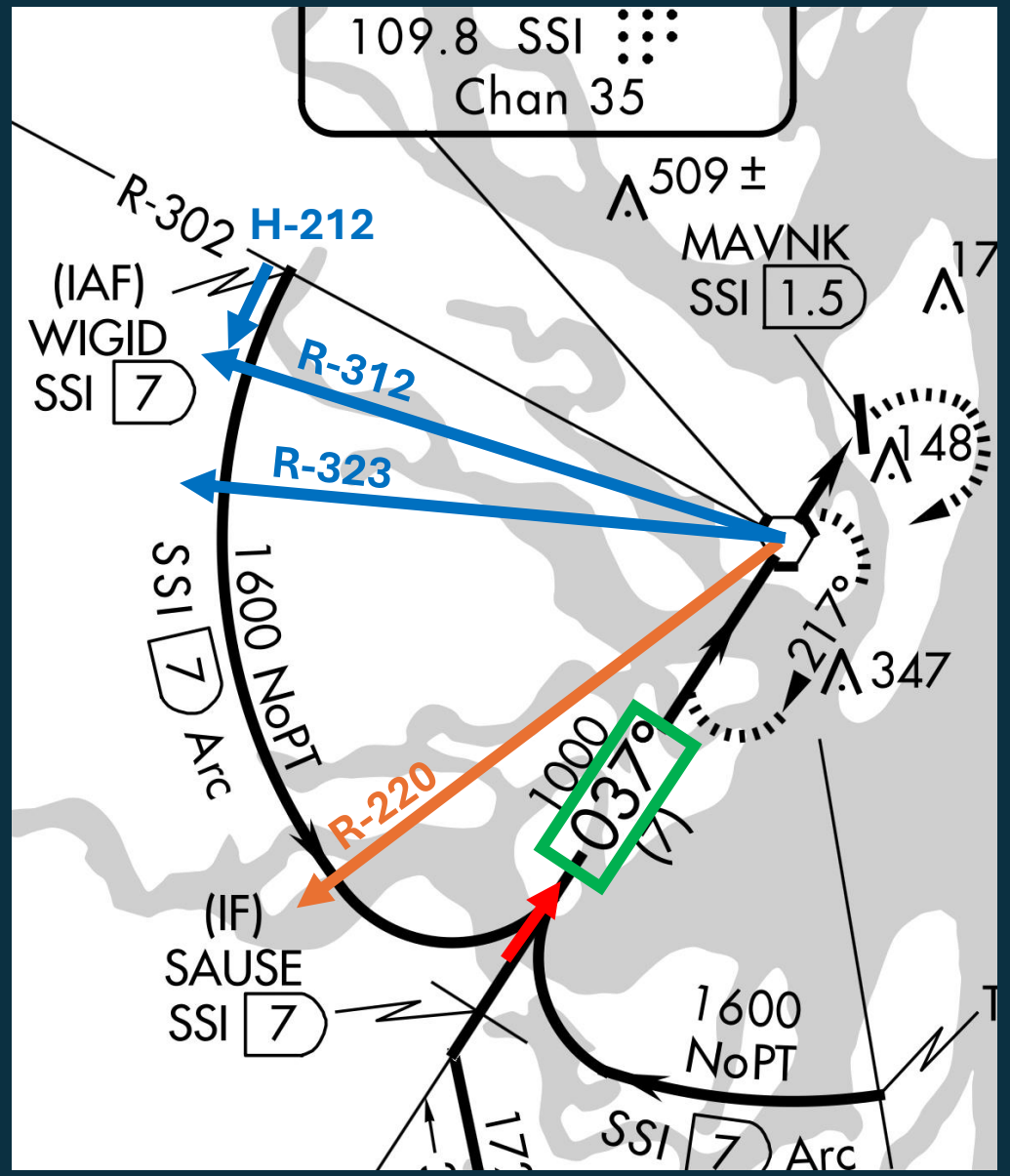
Turn 10, Twist 10 - Ending the Arc

- Ending the arc is not trivial.
- The end is defined by the Lead Radial (LR-177).
- You need to remind yourself what that is. Note also that it does not match a nice 10 degree increment.
- When you reach **R-170**, you need to remember not to set your course to R-180, but R-177!
- In the KSAV ILS 01 (right image), you will actually need to switch to the LOC to track it inbound.
- Other procedures may have a VOR inbound radial to track, so you may need to quickly switch courses to that...



Turn 10, Twist 10 - Ending the Arc

- Example: 09J VOR-A
- You make all your turn 10, twist 10 stuff.
- When you reach **R-220** (or sooner?) you will need to begin your turn and dial the inbound course, which is **R-037**!
- So, lots to keep track of!



The Tizi – method.

- The Tizi-method involves the use of:
  - A bearing pointer
  - A ground track marker (almost all digital avionics have this)
- The point is to keep a perfect 90 degree angle between a bearing pointer pointing to the VOR and your ground track marker.
- I call this the “painless” method.
- *Dr. Bill was involved in me learning this, but as a good academic I am taking all the credit*.

Tizi-Method - How to fly it

- We arrive at CINBA (somehow, not relevant to the technique).
- I engage a **bearing pointer** on the VOR (sourced on NAV will be the easiest)
- I monitor the distance from the VOR (nearest VOR page?)
- We turn heading **150** (that is 90 degrees to R-060). So, I can start the arc at a perfect 90 degree angle.
- I make **my ground track marker** (the magenta diamond on your HSI) stay at a 90 degree angle with the bearing pointer.
- I then set my Lead Radial on the VOR.
- And just keep going!
- The benefit is reduced workload as I just keep the **ground track** at a 90 degree angle and my **Lead radial is already tuned** so that when I reach it, I fly inbound. No need to keep track of what radial you are on.

Tizi-Method - How to fly it

- This is (kinda) how it would look like. I need a picture from the real airplane…
- Note the **bearing pointer** (thin blue arrowed line) is at 90 degrees with the **ground track marker** (magenta diamond).

These are not easy.

- DME arcs scare a lot of students.
- It's fundamental to learn the concept, not just "how to do it".
- As all things IFR, you may find yourself in need of using any one method and must figure out how to make it work with your avionics. That requires knowing the concepts.
- Note, we need to know how to do the Turn 10 Twist 10 method in case the GPS goes down. It's part of the MON and as IFR pilots we must be fluent in ground-based navigation techniques.
- Practice, practice, practice!
- Oh, and annotate your charts! I always do for these things!