Why Build Stellar Interferometers?

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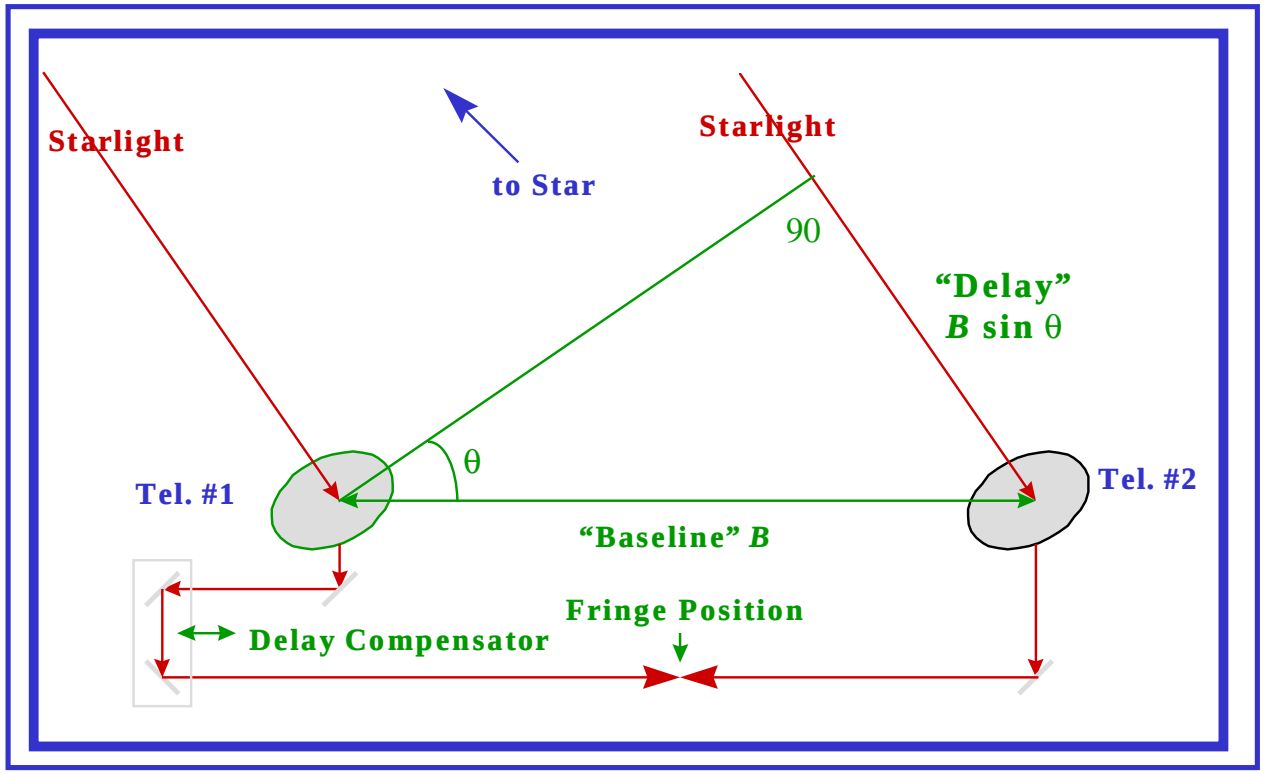
Because they are there!?

Challenge & Opportunity

“Simple” Long-Baseline Interferometer



Current Ground-Based Interferometers

Name	Institution	Site	Number of Elements	Element Aperture (cm)	Max. Baseline (m)	Operating Wavelength (microns)	Operating Status
GI2T	CERGA	Calern	2	150	35	0.4 - 0.8 & >1.2	since 1985
COAST	Cambridge U	Cambridge	4	40	100	0.4 - 0.95 & 2.2	since 1991
SUSI	Sydney U	Narrabri	13	14	640	0.4 - 0.66	since 1991
IOTA	CfA	Mt. Hopkins	3	45	38	0.5 - 2.2	since 1993
ISI	Berkeley U	Mt. Wilson	3	165	30(+)	10	since 1990
NPOI	USNO/NRL	Anderson Mesa	6	60	435	0.45 - 0.85	since 1995
PTI	JPL/Caltech	Mt. Palomar	2	40	110	1.5 - 2.4	since 1995
CHARA	Georgia St. U	Mt. Wilson	6	100	350	0.45 - 2.4	initial 1999
Keck	CARA	Mauna Kea	2(4)	1,000(150)	165	2.2 - 10	initial 2001?
VLTI	ESO	Cerro Paranal	4(3)	840(250)	200	0.45-12	initial ??

Challenges

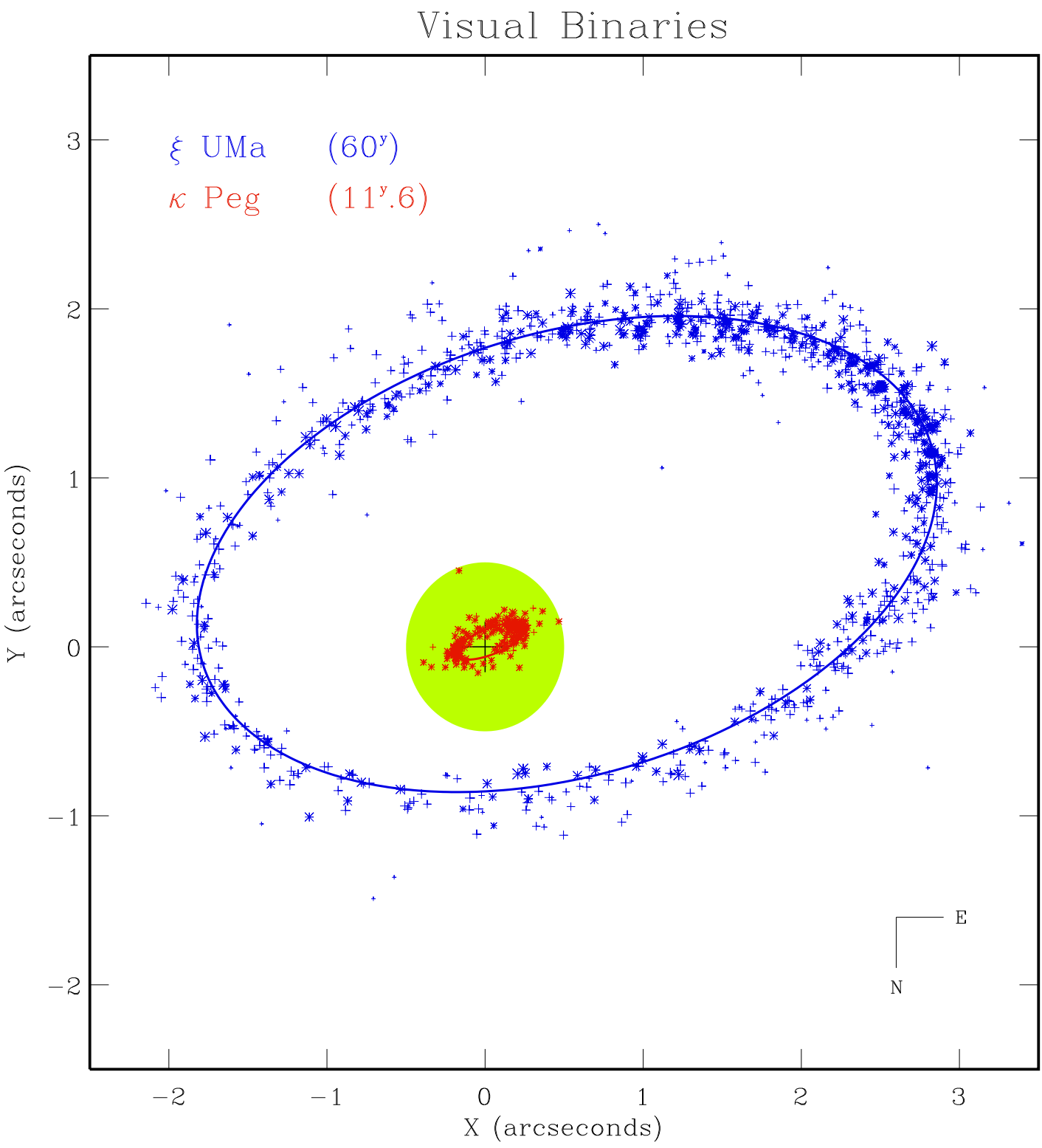
- **Interferometers are Complex & nested Systems**
  - **Numerous sophisticated subsystems**
    - ***Siderostats/Telescopes***
    - ***Delay Lines***
    - ***Beam Combiners***
    - ***Alignment and Metrology***
  - **All working together!**
  - **Lots of really cool hardware!**
- **Require New Tools & Algorithms**
    - ***Scheduling***
    - ***Archiving***
    - ***Imaging***

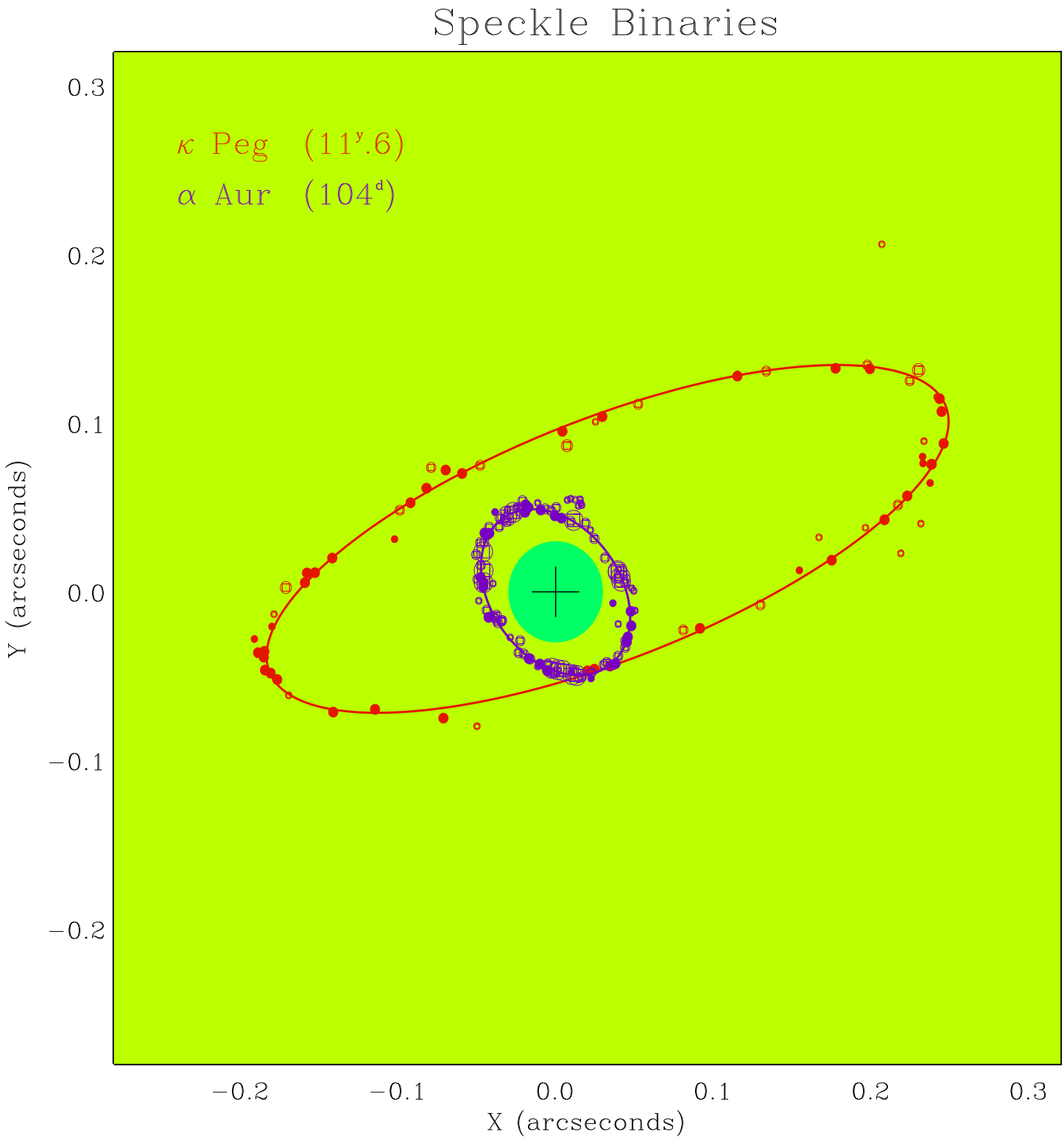
Challenges (Cont.)

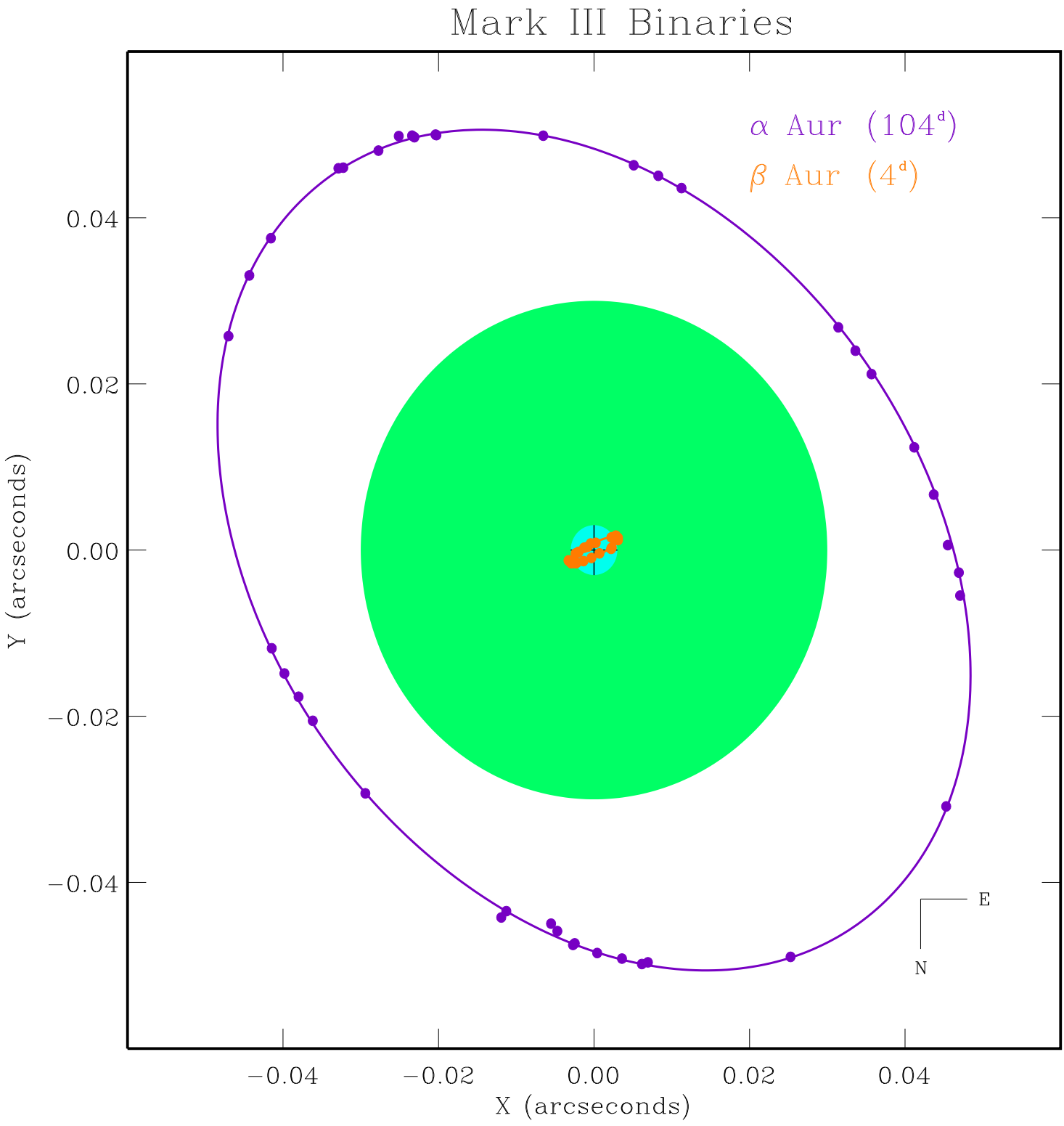
- **Science**
  - *What is optimal?*
  - *What is realistic?*
  - *Over heightened expectations?*
  - *Get theorists involved*
  - *Develop collaborations*
- **Funding**
  - *Still regarded as a developmental area*
  - *Specialized near-term science (no galaxy stuff!)*
  - *Patience & perseverance*

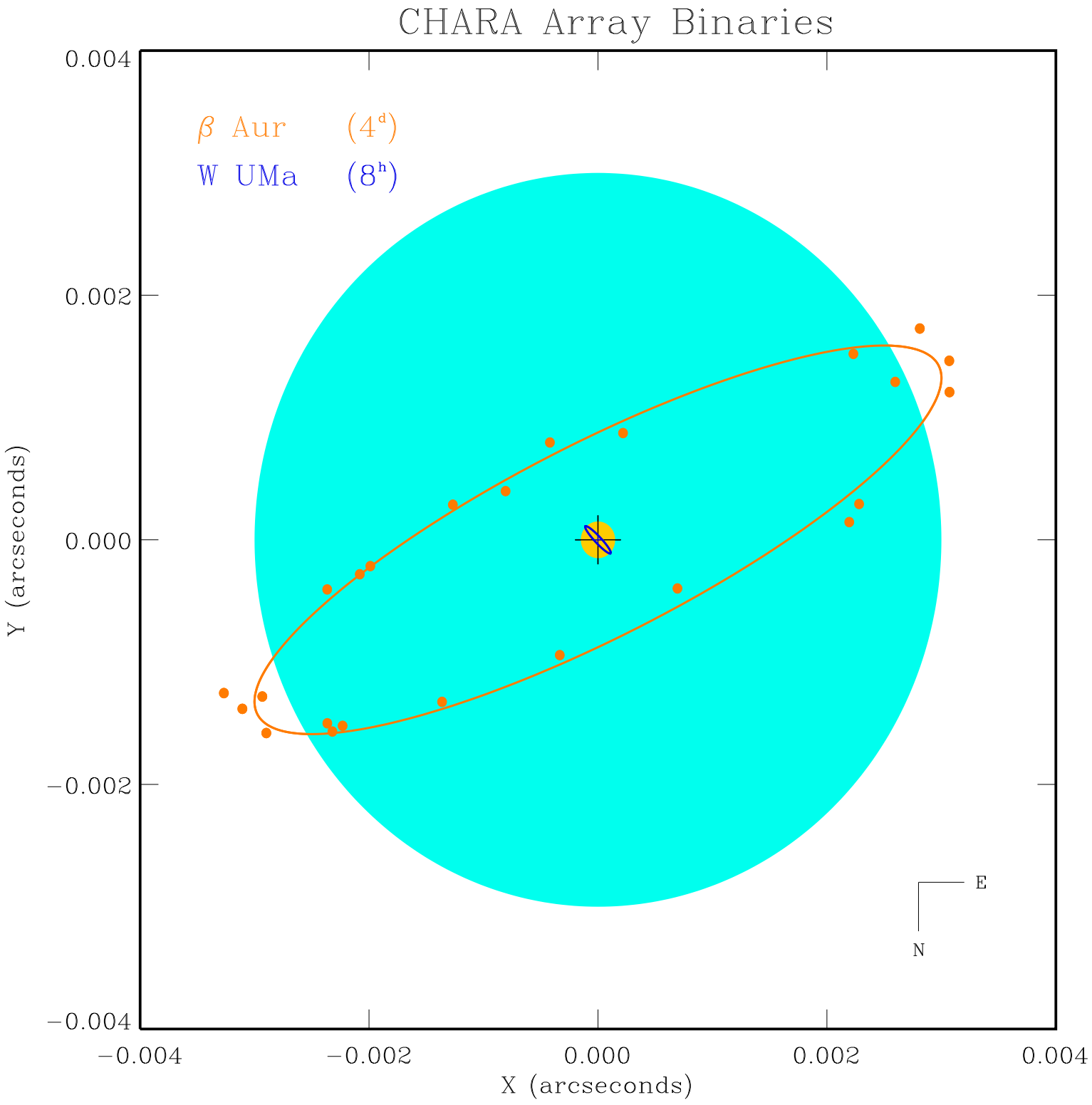
Opportunities

- **Wonderful Resolution**
  - *1,000 mas - classical imaging*
  - *50 mas - adaptive optics*
  - *10 mas - HST*
  - *0.1 mas - SUSI*
  - *2 orders gain over HST (but very narrow field)*
- **Access to New Science**
  - *Resolution & Accuracy*


Visual Binaries
ξ UMa (60ʸ)
κ Peg (11ʸ.6)
Y (arcseconds)
X (arcseconds)
3
2
1
0
−1
−2
−2
−1
0
1
2
3
E
N


Speckle Binaries
κ Peg (11^y.6)
α Aur (104^d)
0.3
0.2
0.1
0.0
−0.1
−0.2
Y (arcseconds)
−0.2
−0.1
0.0
0.1
0.2
0.3
X (arcseconds)


Mark III Binaries
α Aur (104d)
β Aur (4d)
0.04
0.02
0.00
−0.02
−0.04
Y (arcseconds)
−0.04
−0.02
0.00
0.02
0.04
X (arcseconds)
E
N


CHARA Array Binaries
β Aur (4^d)
W UMa (8^h)
0.004
0.002
0.000
−0.002
−0.004
Y (arcseconds)
−0.004
−0.002
0.000
0.002
0.004
X (arcseconds)
E
N

Opportunities (Cont.)

Current Projects are Stepping Stones to an OVLA

Prerequisites

Significant science must be forthcoming

Imaging must be demonstrated

Partnerships must be established

More black-belt interferometrists needed

May be built in the 2010 decade

"History has taught us that whenever a new technique enters a new realm of observational phase space, the most striking and productive results tend to those not anticipated by even the most prescient thinkers"

- Daniel Popper, 1990

Interferometry Science
Most Favorable Areas

- **Single Stars**
  - Effective Temperatures & Fluxes
  - Young Stars' Structure & Morphology
  - Stellar Surface Features
  - Novae/Supernovae

- **Binary & Multiple Stars**
  - Resolved Spectroscopic Binaries
    - *Stellar Masses and Luminosities*
    - *Distance Calibrations*
    - *Radii of Components*
  - Detection of Low-Mass Companions

- **Astrometry**
  - Ground (NPOI) & Space (SIM)

Nice Example of a Revolution
Resolved Spectroscopic Binaries

- **Double-Lined Binaries**
  - **Spectroscopy gives mass ratio & *a*sin*i***
  - **Interferometry gives *a* and *i***
  - **Together yield masses & distances**
  - **~200 DSB's have *a*" > 1 mas**
- **Single-Lined Binaries**
  - **Accurate parallaxes give individual masses**
    - ***Hipparcos & SIM***
- **70% of SB's are Resolvable**

Interferometry Science
Other Areas

- **Single Stars**
  - Limb Darkening
  - Linear Diameters
  - Star Formation Phenomena & Dynamics
  - Pre-Main Sequence Objects
  - Absolute Rotation
  - Flare Star Phenomena
  - Cepheid P-L Calibration
  - Mira Pulsations
  - P-Mode Oscillations
  - Hot Star Phenomena (shells, winds, etc.)
  - Cool Star Shells
- **Binary & Multiple Stars**
  - Duplicity Surveys
  - Close Binary Phenomena
- **Star Clusters**
  - Proper Motions
  - Duplicity Surveys
- **Extragalactic**
  - Binaries in Magellanic Clouds
  - AGN Structure
- **Solar System**
  - Planetary Satellites
  - Minor Planets & Comets
  - Solar Surface
- **Extrasolar Planets**
  - *Astrometric Detection*

Interferometry Science
Other Areas (Cont.)

- **You'll Think of Something** ***(Get the theorists involved!)***

Remember Dan Popper's Words!

Interferometry Science
In Perspective

- **Presently Sensitivity Limited**
  - **Low Throughput is Inevitable**
  - **Adaptive Optics May Help**
- **Stellar Stellar Science**
- **Little or No Extragalactic Science**