

Compact Symmetric Objects in the VLBA Imaging and Polarization Survey

A study of half-pint radio galaxies

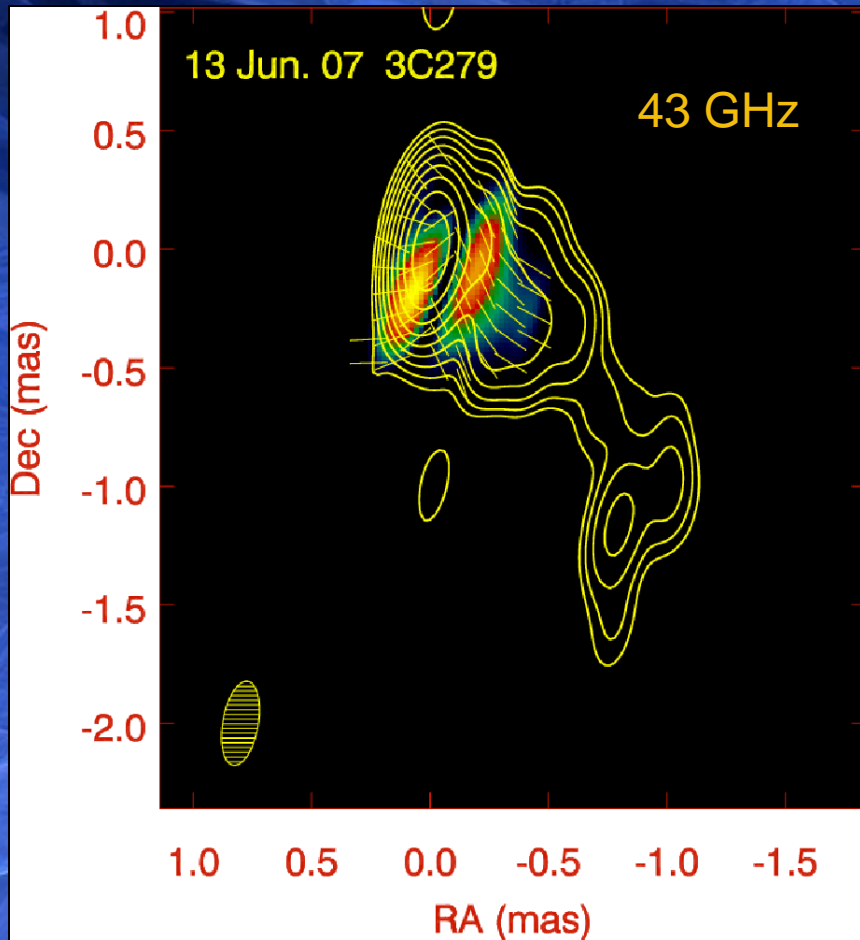
Steven Tremblay (UNM)

Greg Taylor (UNM, NRAO) , Joe Helmboldt (NRL), Roger Romani (Stanford)

NM Research Symposium
November 5, 2010

Compact Radio Sources

Blazars



Marscher et. al

Size:

No Limit

Orientation:

Looking down the jet

Characteristics:

High Variability

High Polarization

Superluminal Motion

CSOs

Compact Symmetric Objects

Size:

< 1 kpc (projected)

Orientation:

'Close' to the plane of the sky

Characteristics:

Low Variability

Low Polarization

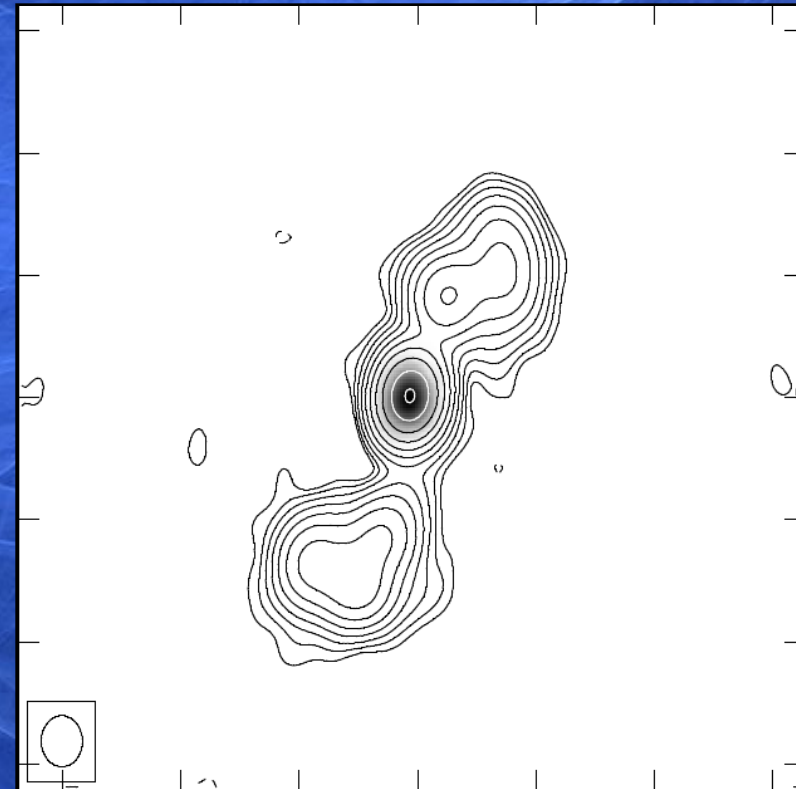
Often CSS/GPS sources

Sources could be:

Young

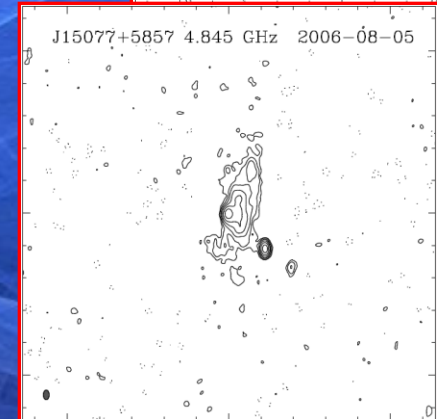
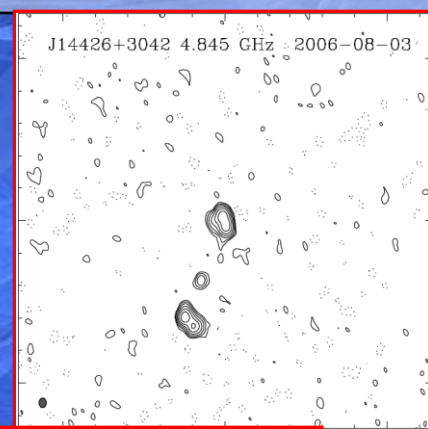
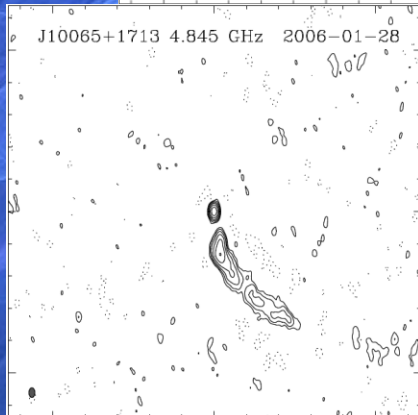
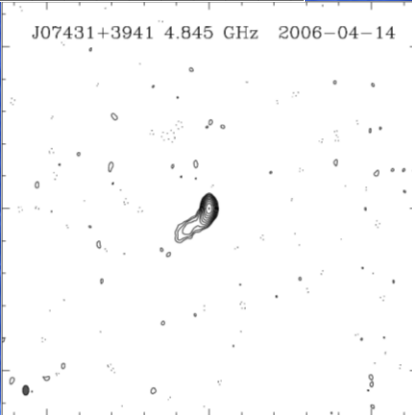
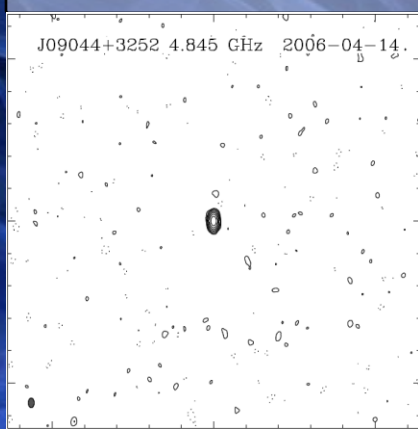
Frustrated

Periodic



B2352+495; Araya et al. 2010

VIPS: Source Classification



- Point Source 276
- Short Jet 241
- Long Jet 471
- CSO Candidate 103
- Complex 17
- Not Detected 11

CSO Candidates

VIPS CSO Candidates

Follow-up Observations

- 5, 8, 15 GHz VLBA
- Full polarization

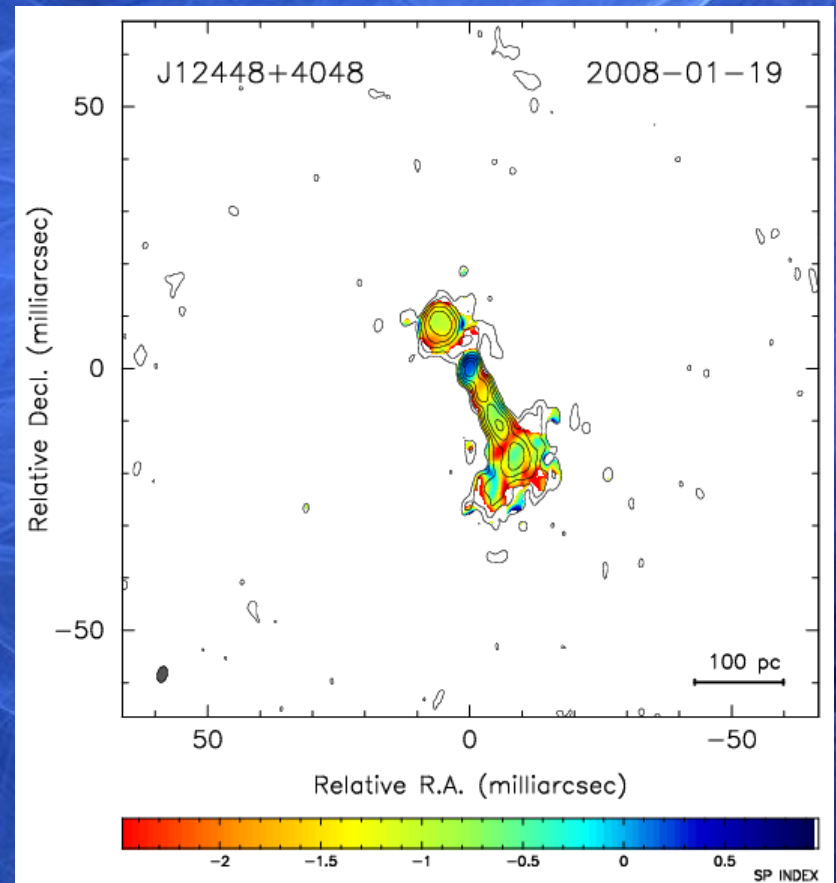
Spectral classification:

$$F_{\nu} \propto \nu^{\alpha}$$

Kinematic Analysis

Ages/Dynamics

Polarization Analysis

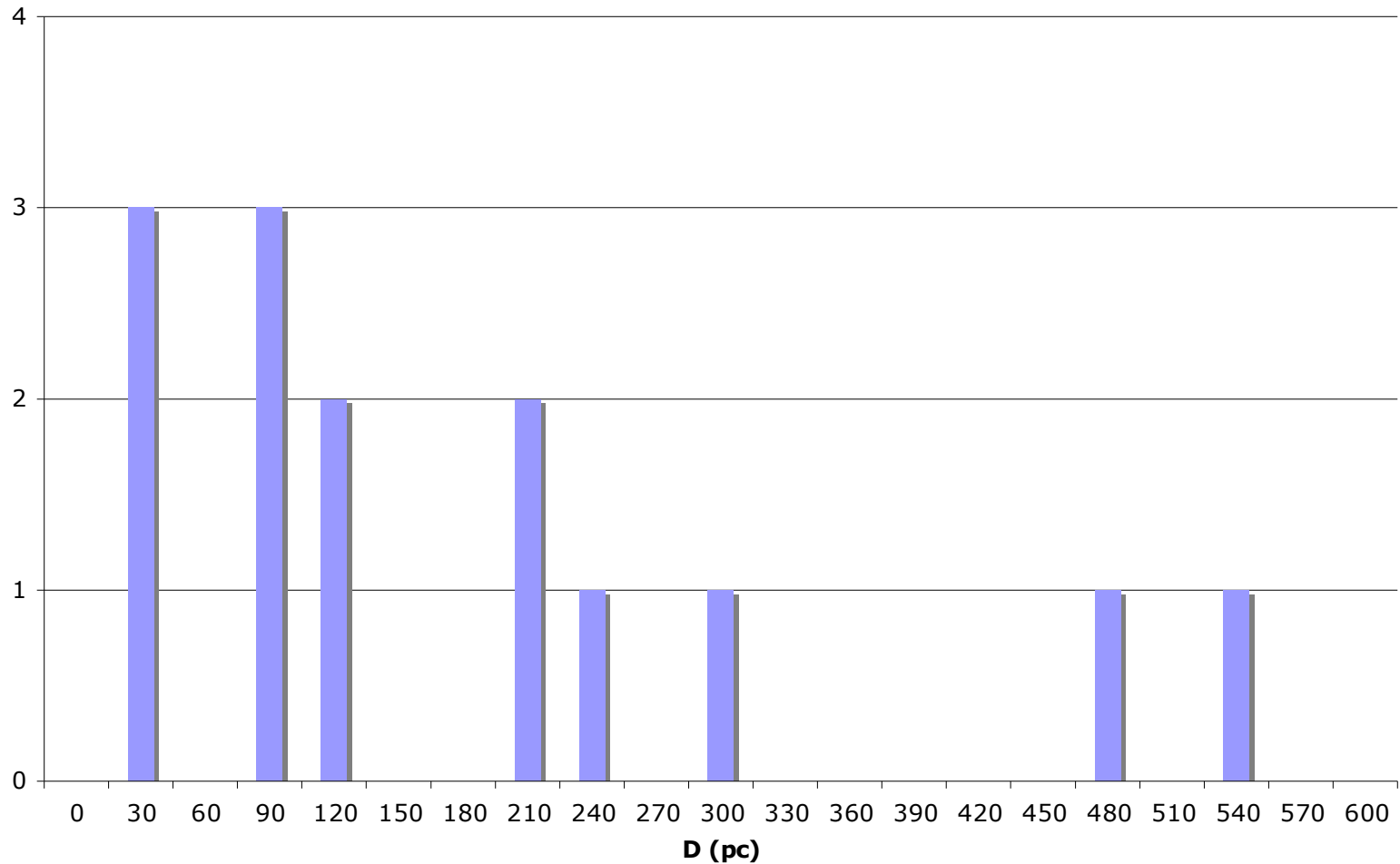


The Numbers

- Confirmed CSOs - 24 (~2% VIPS)
- FR1 morphologies - 4 (~17%)
- Cores detected - 16 (~67%)
- Redshifts - 16 (~67%)
- Detected @ 15 GHz - 15 (~63%)
- Polarized - 2 (~8%)
- CSO Candidates - 33 (~3% VIPS), 5 'Hybrid'

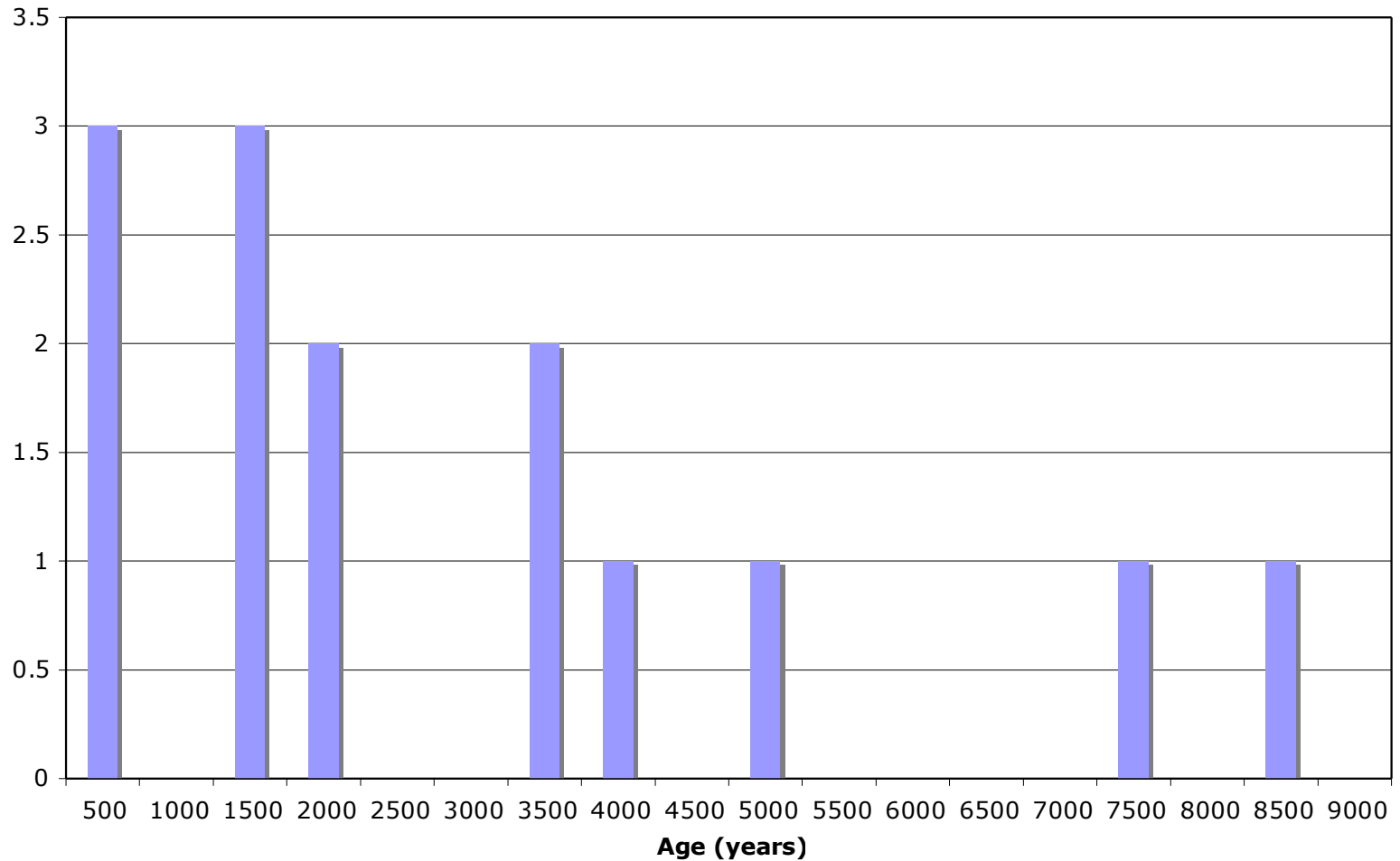
CSO Sizes (Hotspot-Hotspot)

Histogram of CSO Size

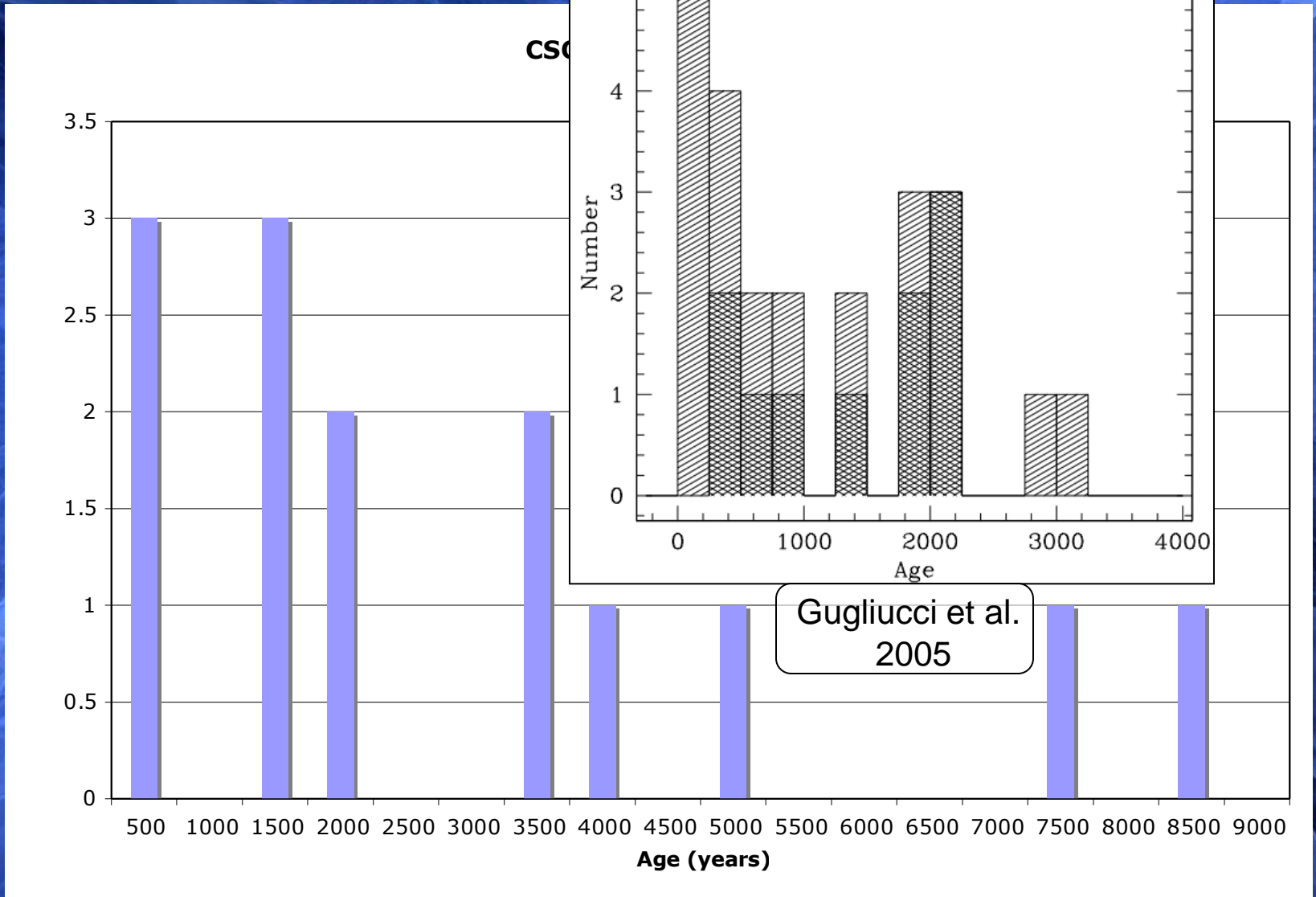


Q&D Age Estimates

CSO 'Age' Histogram

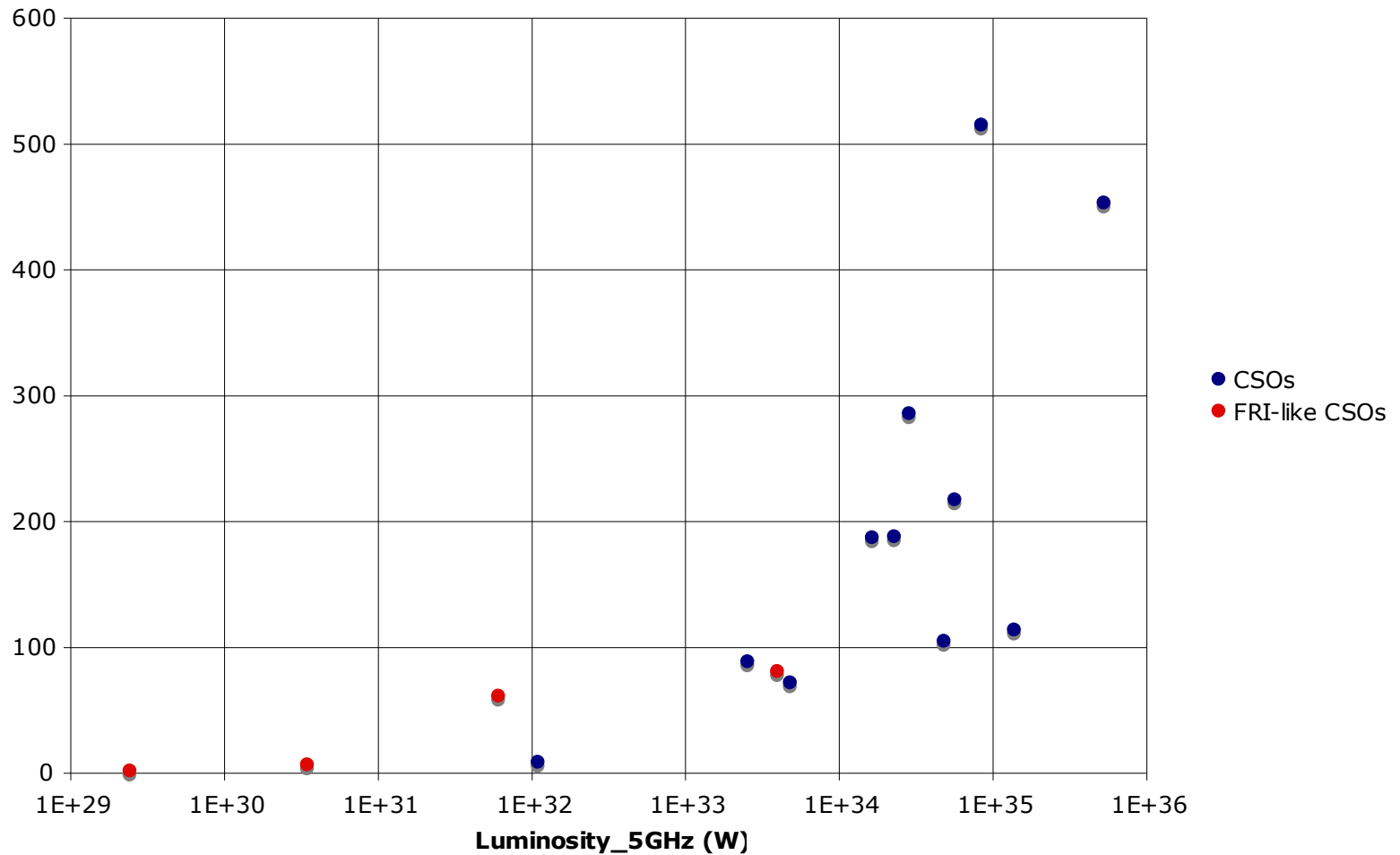


Q&D Age Estimates

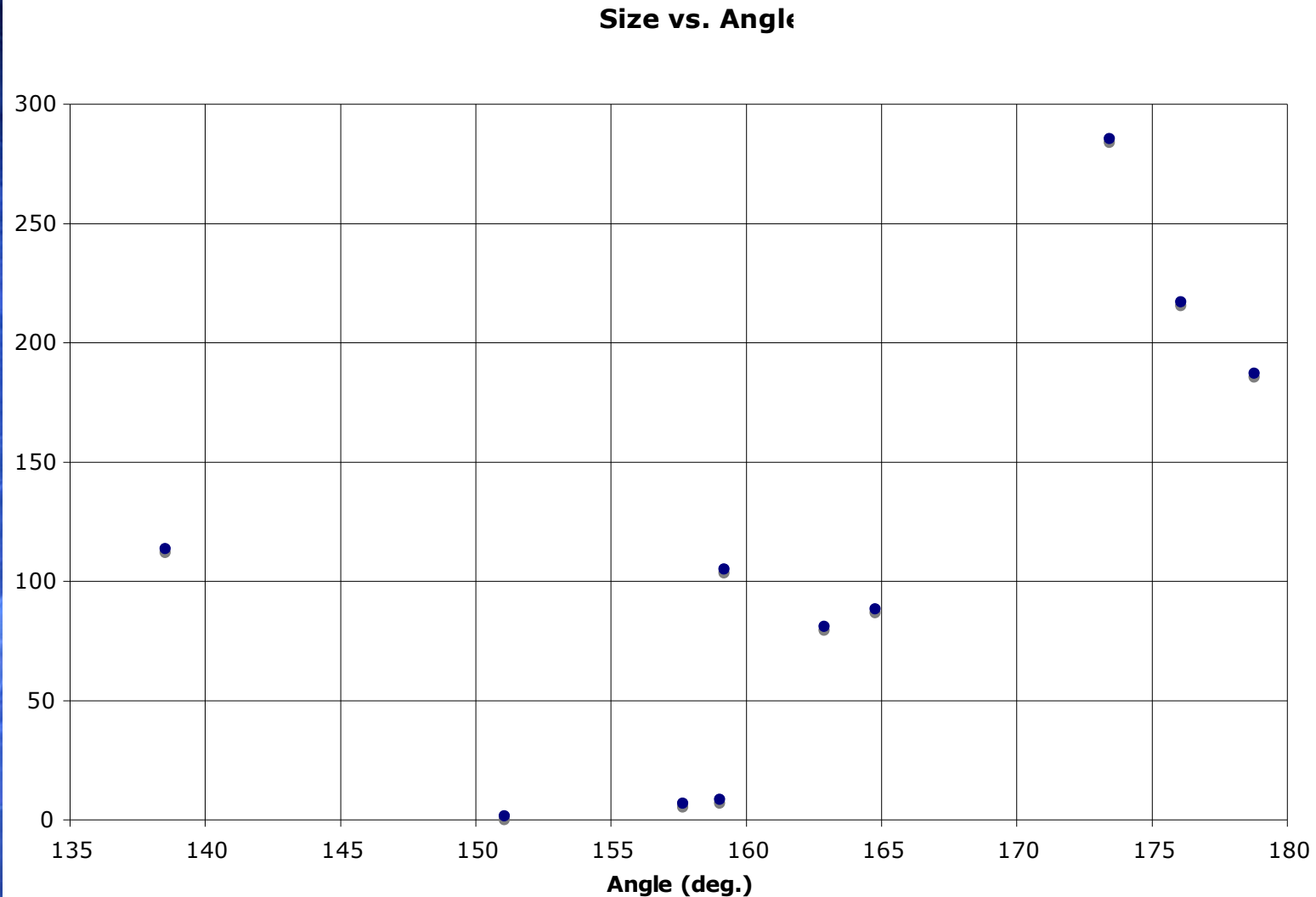


Size and Luminosity

Size vs. Luminosity

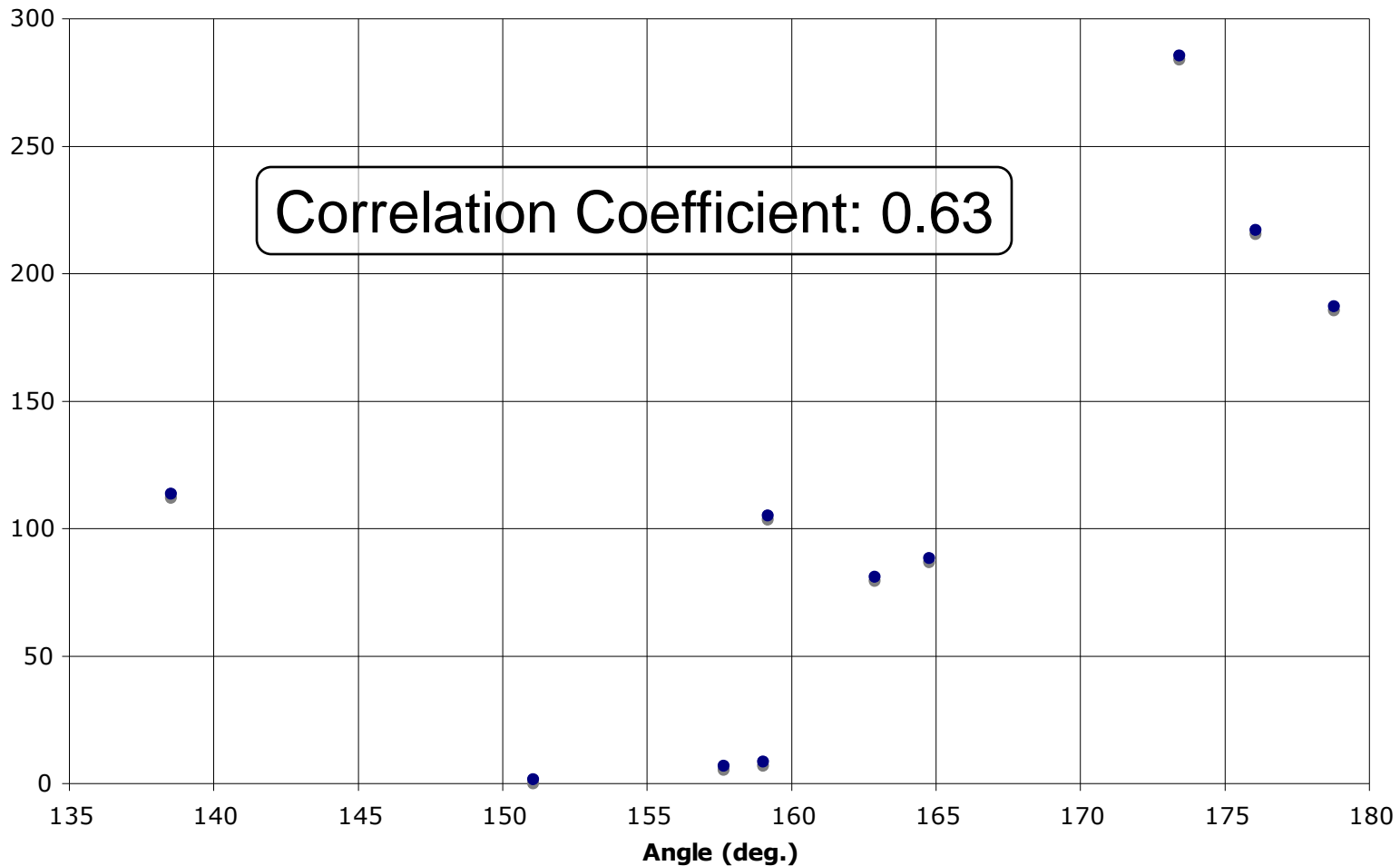


Size and Angle Subtended



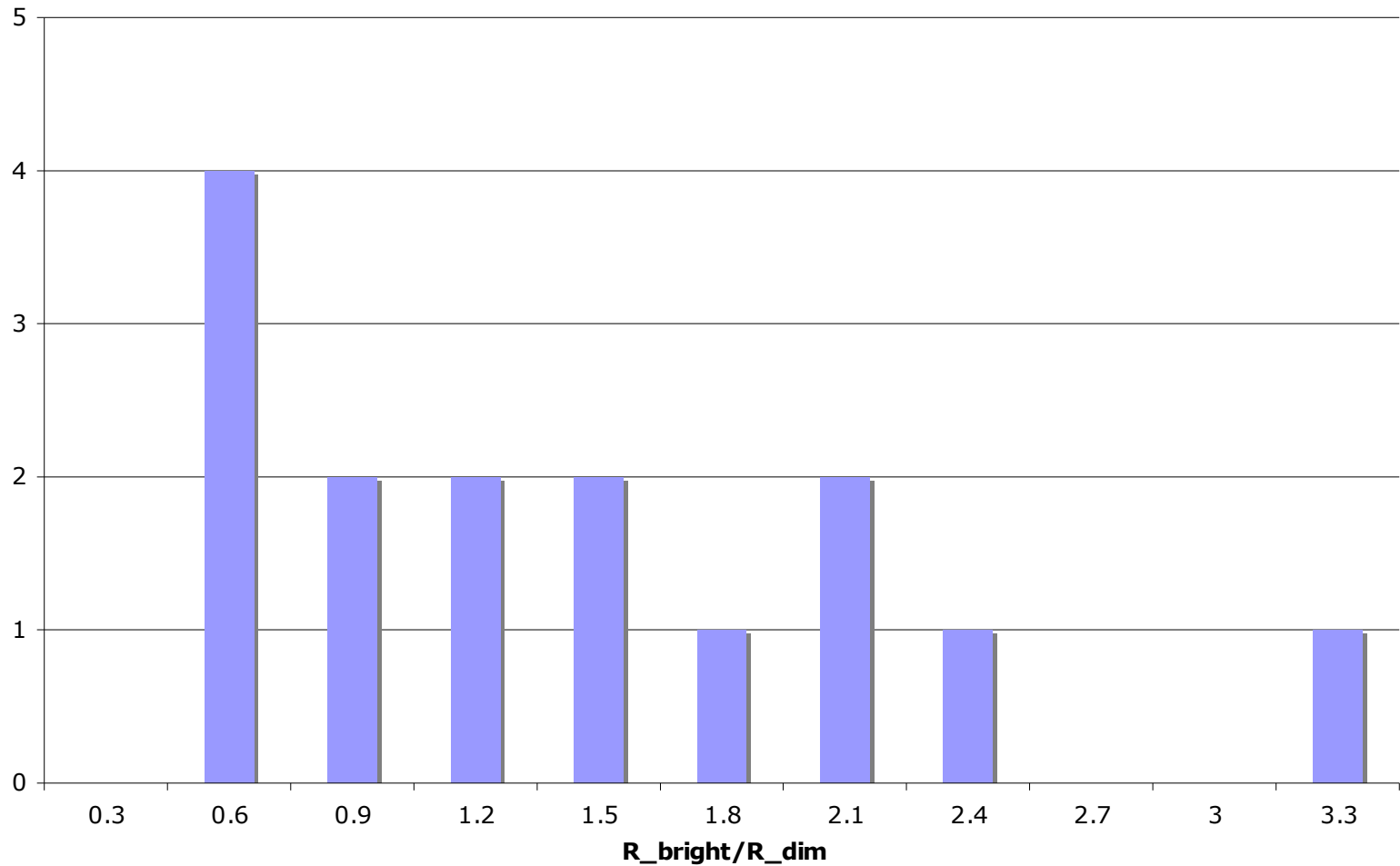
Size and Angle Subtended

Size vs. Angle



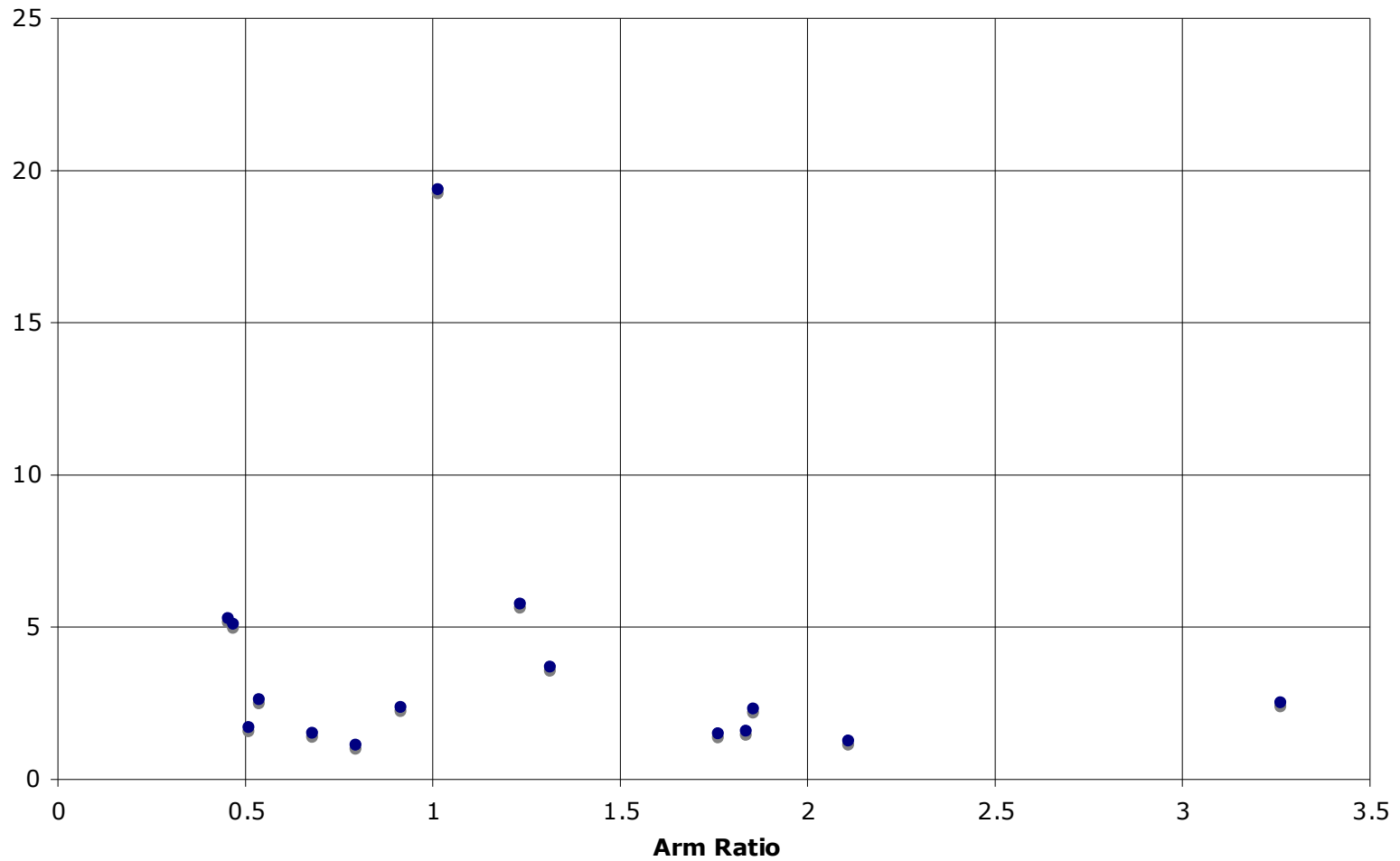
Core to Hotspot Length Ratios

CSO Arm Ratio Histogram



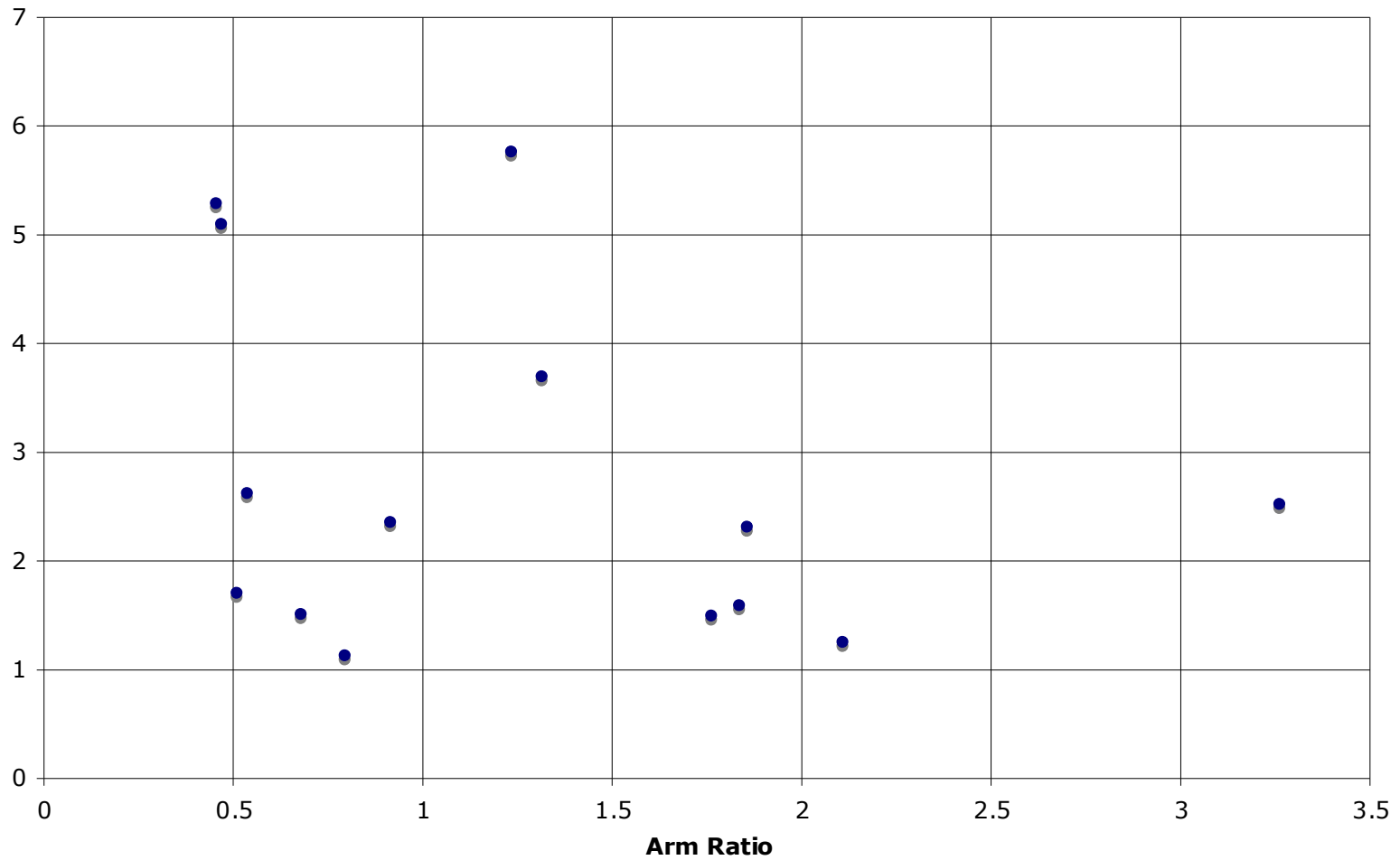
Hotspot Flux and Arm Ratios

Flux Ratio vs. Arm Ratio



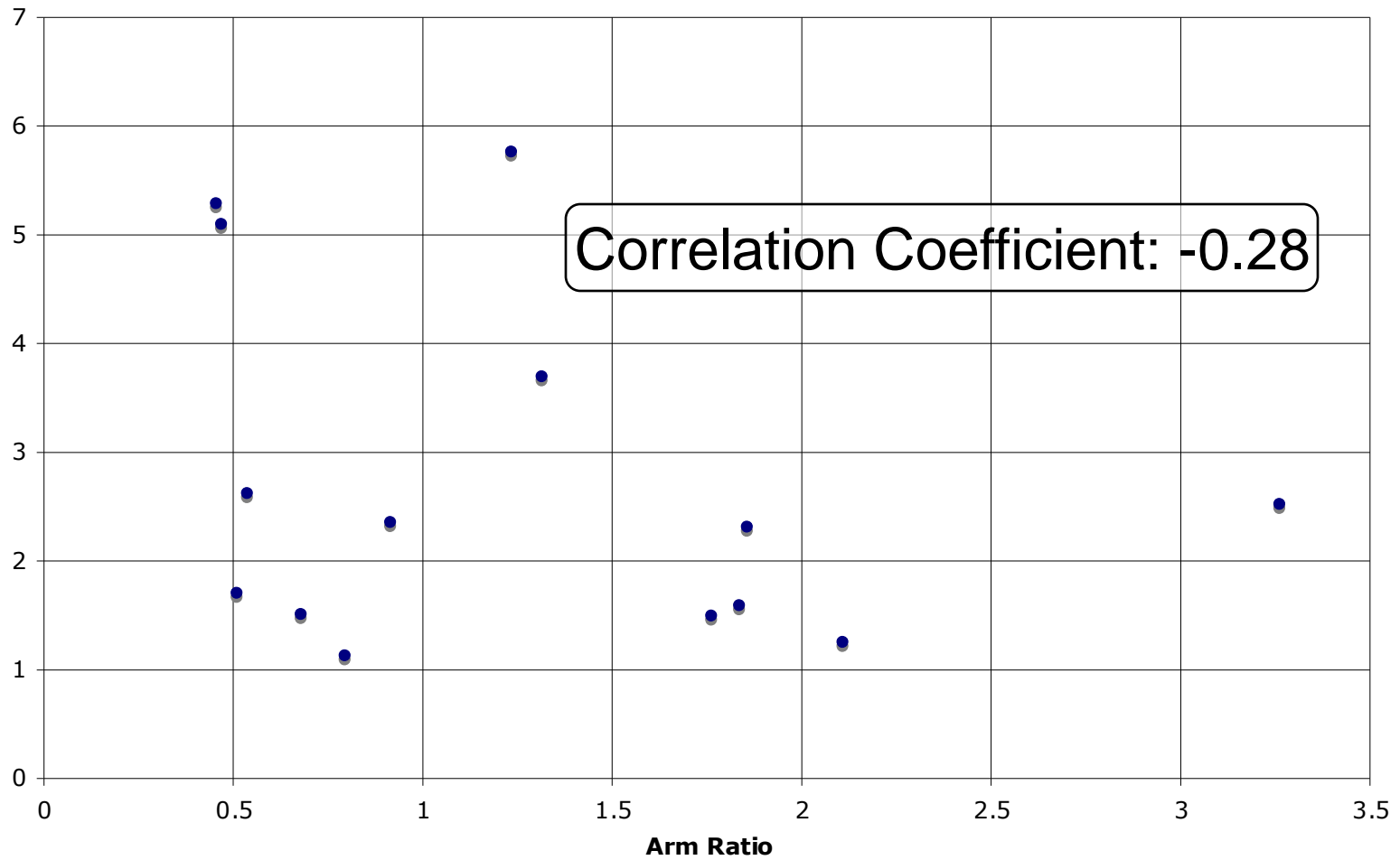
Hotspot Flux and Arm Ratios

Flux Ratio vs. Arm Ratio w/o J07414+270



Hotspot Flux and Arm Ratios

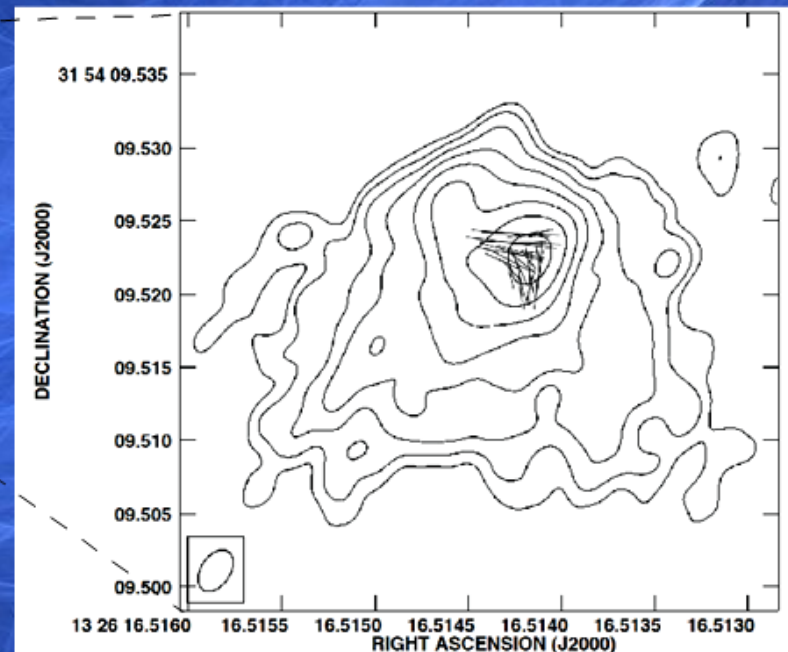
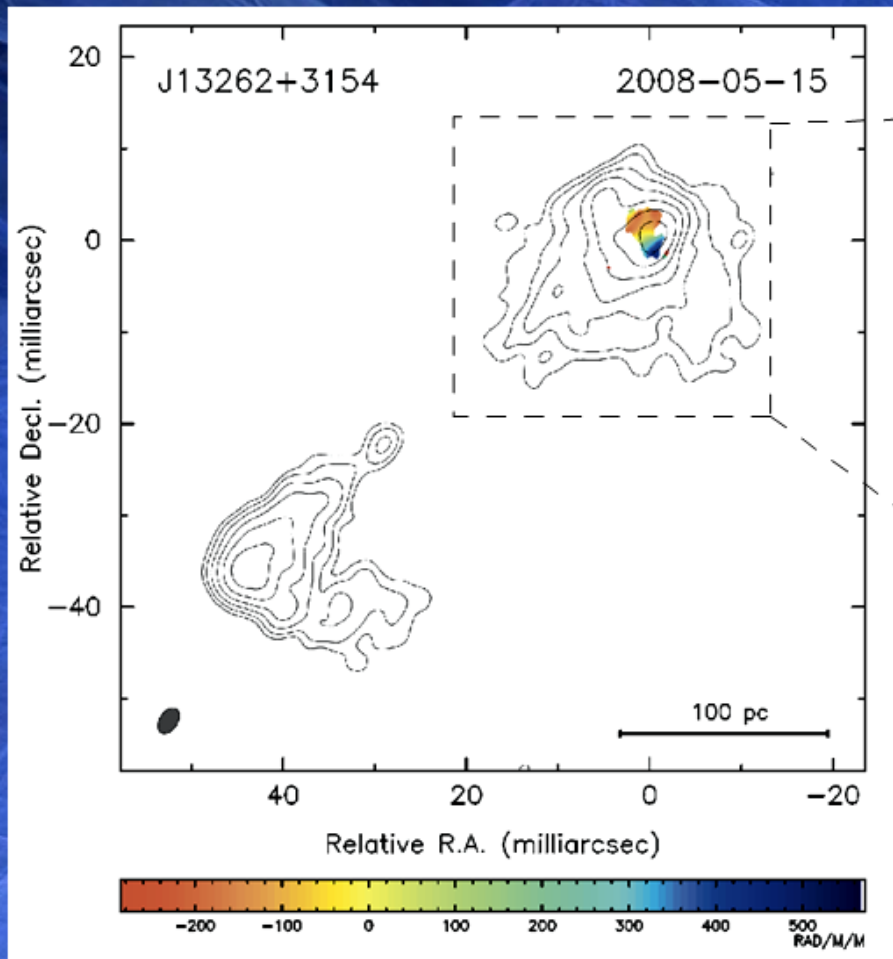
Flux Ratio vs. Arm Ratio w/o J07414+271



Things not (or weakly) Correlated

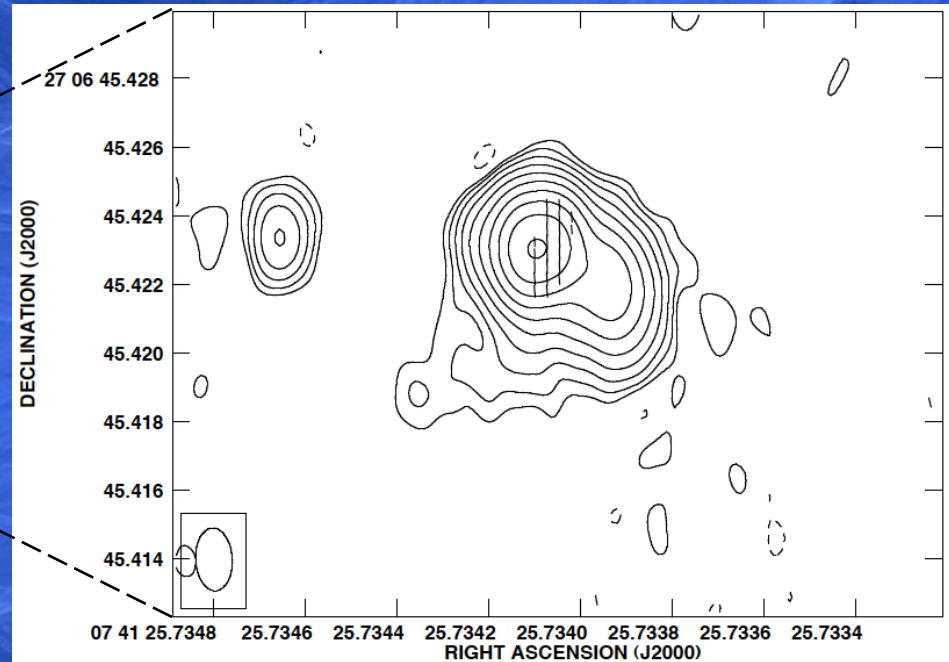
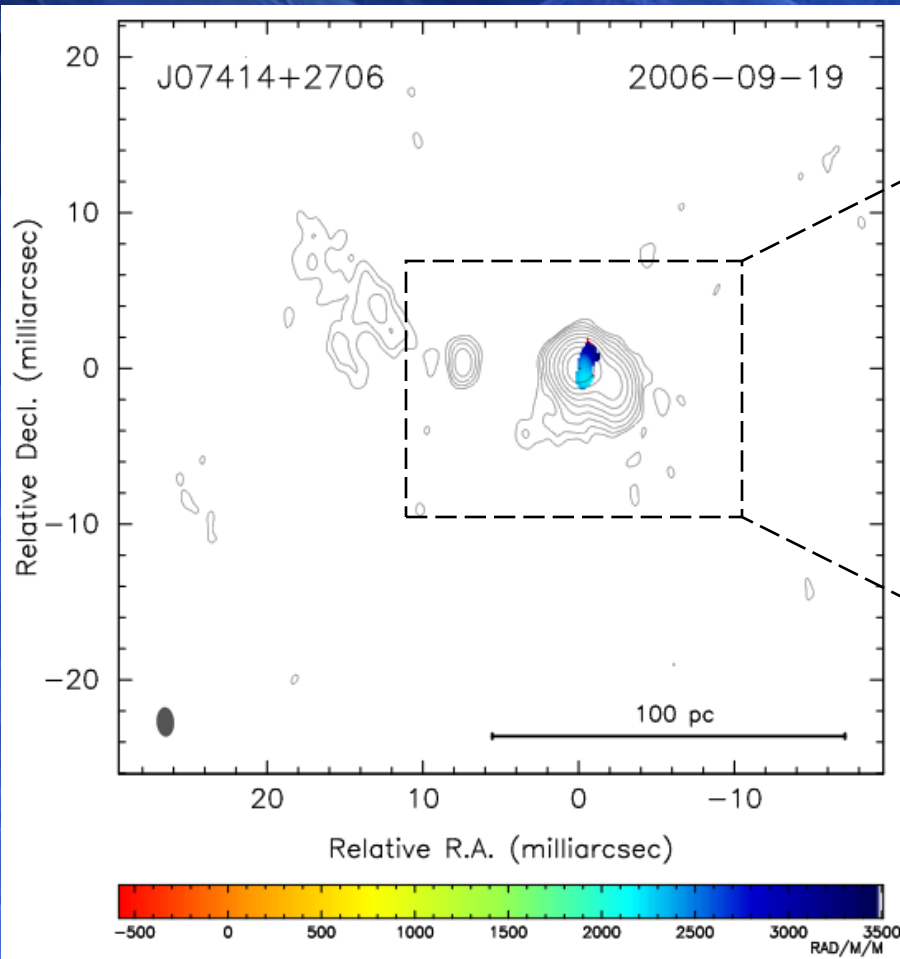
- Size & Flux Ratio: -0.07
- Angle & Flux Ratio: -0.1
- Angle & Arm Ratio: -0.17

J13262+3154



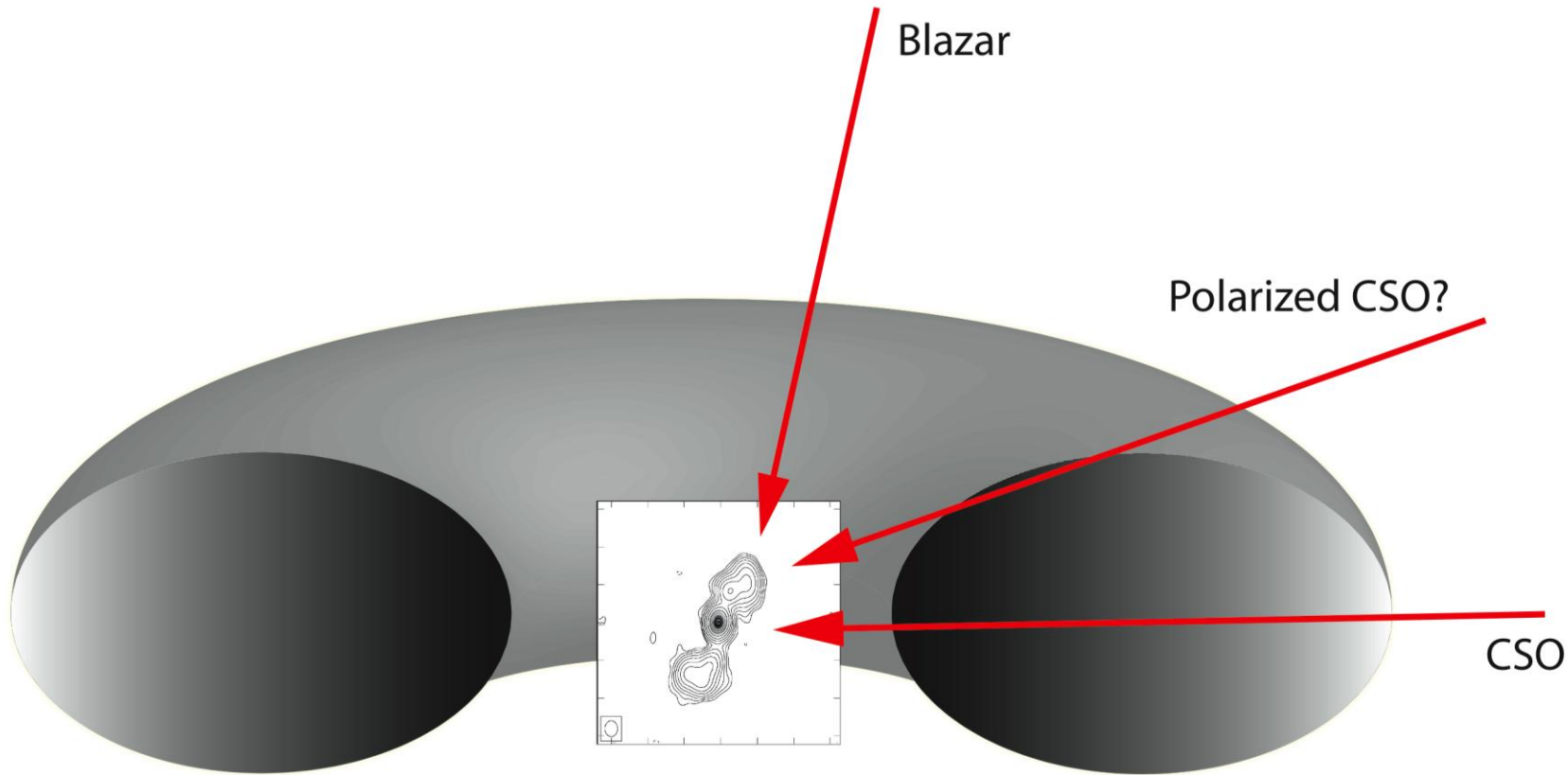
- 4.1% of 5 GHz total lobe flux density is polarized
- B-Fields $\sim 0.06 - 2 \mu\text{G}$
- Lobe flux density ratio (5 GHz): 1.59

J07414+2706



- 1.1% of 8 GHz total lobe flux density is polarized
- B-Fields $\sim 0.36 - 12 \mu\text{G}$
- Lobe flux density ratio (5 GHz): 19.36

Polarization & CSOs



VIPS CSOs

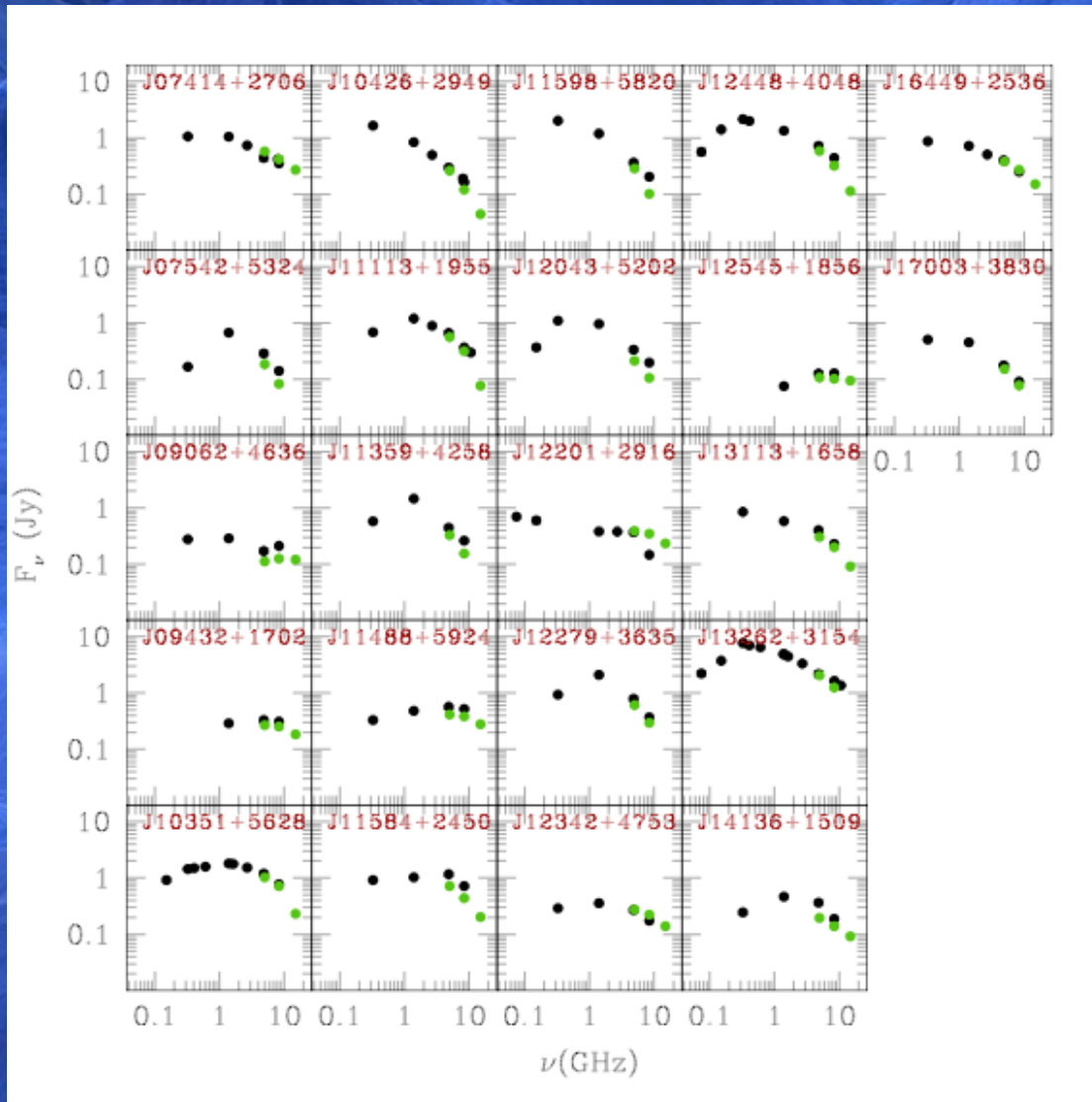
- Increases number of known CSOs by at least 1/2
- Gives 'complete' sample to study
- Indicates CSOs tend to 'straighten out' with size
- Polarization results consistent with Unification
- Needs further multi-frequency, multi-epoch 'follow up'

Backup Slides

VIPS CSOs

Source Name	Obs. Core?	FR1 Morphology?	Auto Class.	Redshift
J07414+2706	Y		LJET	0.77
J07542+5324	N		CSO	?
J09062+4636	Y	Y	CPLX	0.0848
J09432+1702	Y		CSO	1.598
J10351+5628	N		CSO	0.45
J10426+2949	Y		CSO	?
J11113+1955	N		CSO	0.2991
J11359+4258	N		CSO	?
J11488+5924	Y	Y	LJET	0.010751
J11584+2450	Y		CPLX	0.2016
J11598+5820	N		CSO	1.278
J12043+5202	Y		CSO	?
J12201+2916	Y	Y	CSO	0.002165
J12279+3635	N		LJET	1.973
J12342+4753	Y	Y	CSO	0.373039
J12448+4048	Y		LJET	0.813
J12545+1856	Y		LJET	0.1145
J13113+1658	Y		CSO	?
J13262+3154	Y		CSO	0.37
J13354+5844	?		CSO	?
J14136+1509	Y		CSO	?
J14142+4554	?		CSO	0.186
J16449+2536	Y		LJET	0.588
J17003+3830	Y		LJET	?

Multi-scale SEDs



Polarized CSOs

- 3/4 Show abnormally high flux density ratios
- 4/4 Polarization detected in brightest Hotspot
- 1/4 additional detection of jet polarization closer to core as well
- 2/3 Exhibit low (100s rad m^{-2}) RMs