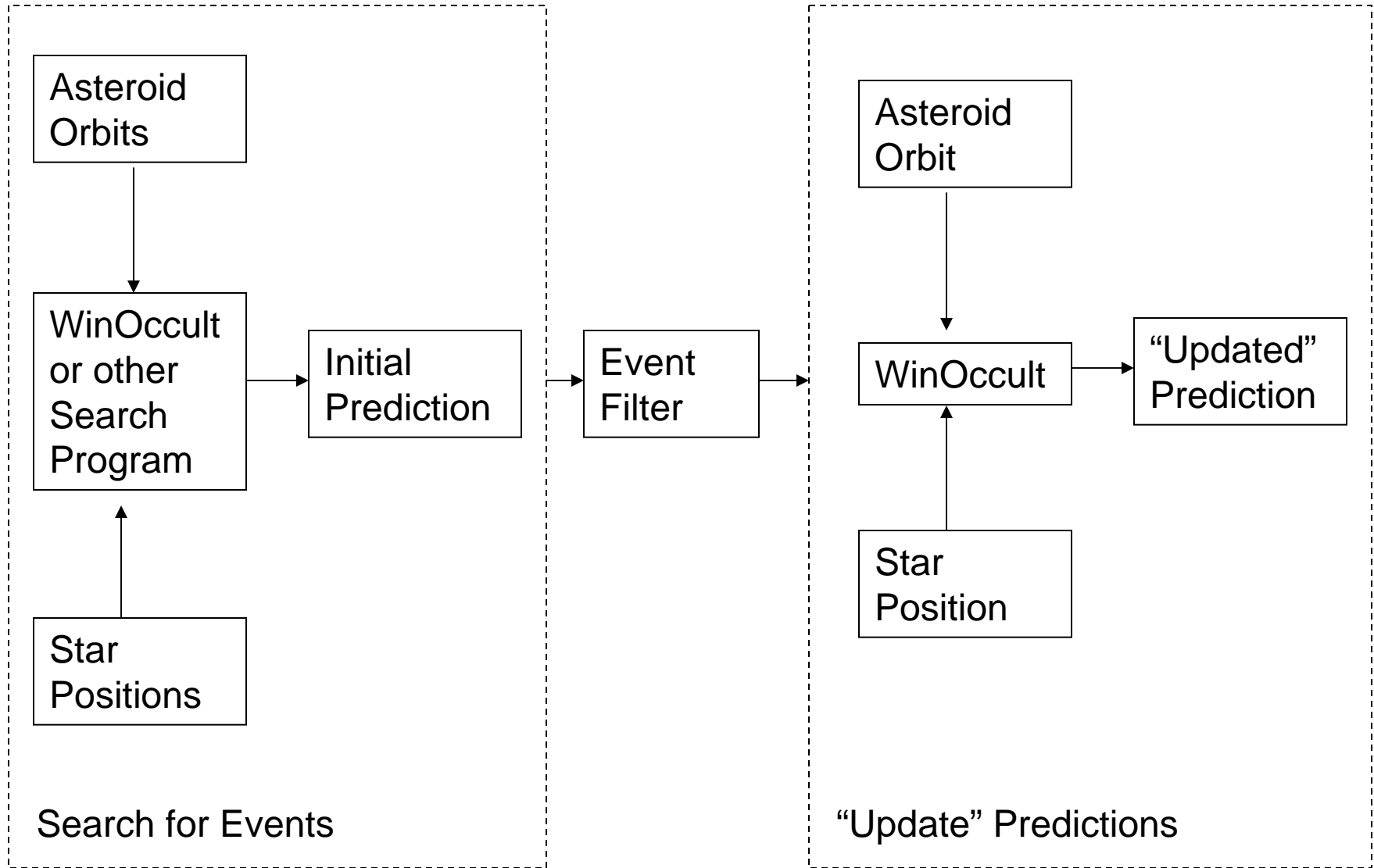


# Asteroid Occultation Prediction Process

Steve Preston

# Asteroid Occultation Prediction Process Overview



# Searchers

- **Edwin Goffin**

- Asteroids: 40km or larger diameter plus some distant objects.
- Orbits: computed by Goffin & MPCORB
- Star Catalog: Compiled catalog primarily based on Tycho2 + TAC plus additional positional info from FK6, Hipparcos, UCAC2 and other source catalogs. Magnitude limit of about 12.
- Timing: 2007 events posted by Apr 2006
- Coverage: Worldwide

# Searchers

- **Scott Donnell / Derek Breit**
  - Asteroids: 10km or larger
  - Orbits: Recent astorb.dat
  - Star Catalog: WinOccult Tycho2 (Tycho2 + Hipparcos + UCAC2). Mag limit of about 12.
  - Coverage: Worldwide
  - Timing: Two search modes
    - Best Events: full year window - six months in advance with bright stars.
    - Deep search: 3 month window - two months in advance.

# Searchers

- **Takashi Setoguchi**
  - Asteroids: probably 15km or larger
  - Orbits: Computed by Setoguchi
  - Star Catalog: Tycho2 + Hip + UCAC2
  - Uses his own search program
  - Timing: One month search window one month in advance.
  - Coverage: Japan

# Searchers

- **Denis Denissenko**

- Asteroids: probably 15km minimum
- Orbits: from astorb.dat
- Star Catalog: Occult Tycho2 plus UCAC2 stars down to mag 13
- Searches far into the future for spectacular events
- Searches several months out for interesting events over Russia and other parts of the world.

# Searchers

- **Andrey Plekhanov**

- Use LinOccult (written by Andrey)
- Asteroids:  $e > 0.95$
- Orbits: from astorb.dat & orbit
- Star Catalog: Tycho2, Hipparcos, UCAC2 ?
- Provides list of events for given location – on request.

# Event Filtering

- Goffin
  - Include all of the events from Goffin's list.
  - Compute updates for all events except many of the TNO events and events with un-numbered asteroids.
- Donnell / Breit
  - Include all events with meet "Dunham's criteria"
  - Derek reviews all events to remove events that don't pass over land.

# Dunham's Criteria

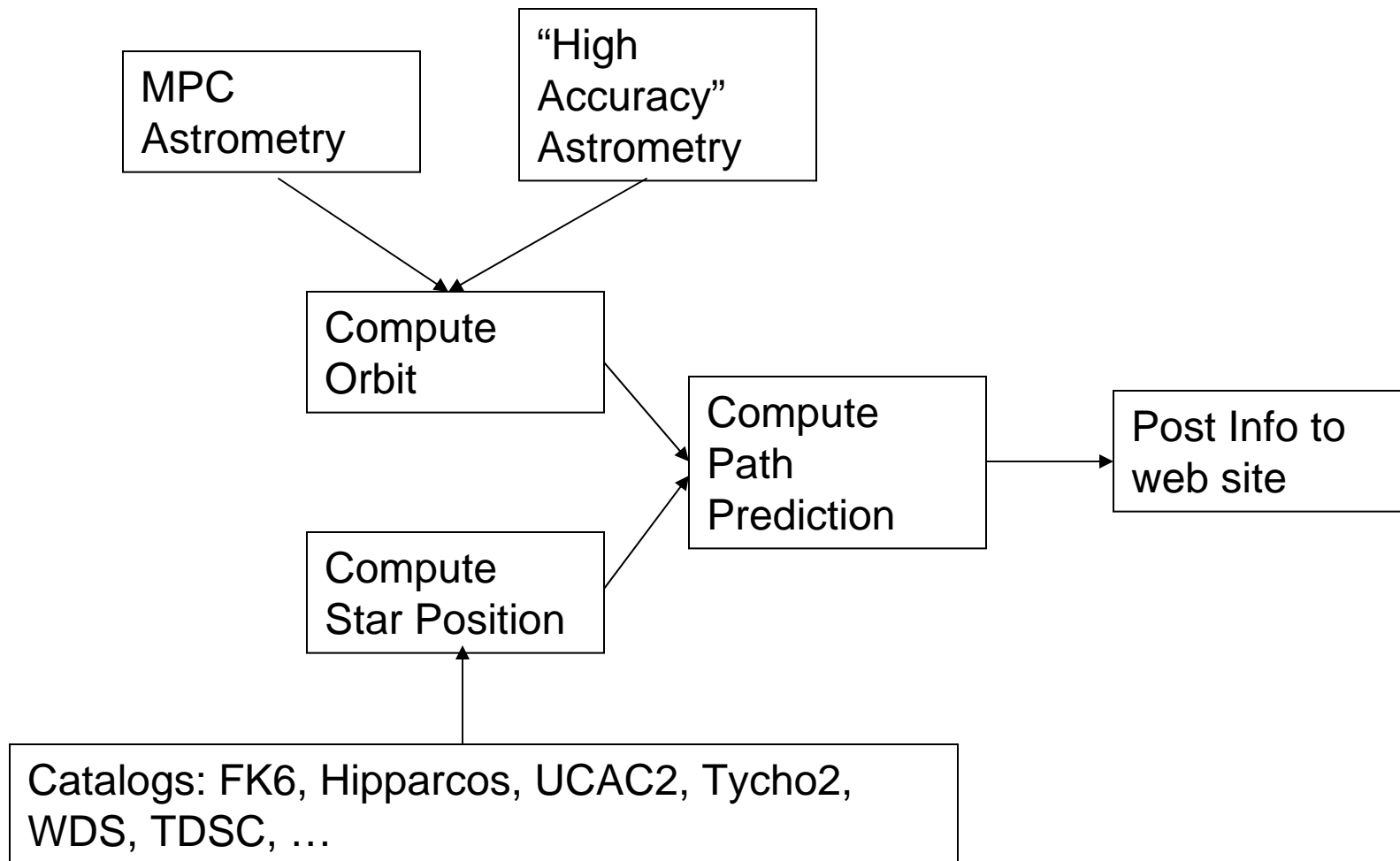
Star Magnitude Lower Limit	Star Magnitude Upper Limit	Asteroid Minimum Subtended Angle (mas)	Minimum Duration (sec)	Minimum Magnitude Drop	Non-FASTT Asteroids?
None	6.5	None <sup>1</sup>	0.33	0.1	Yes
6.5	8.5	10 <sup>1</sup>	0.33	0.1	No <sup>2</sup>
8.5	9.5	10 <sup>1</sup>	0.5	0.1	No <sup>2</sup>
9.5	10.5	20 <sup>1</sup>	0.5	0.1	No <sup>2</sup>
10.5	11.5	20 <sup>1</sup>	1.0	0.1	No <sup>2</sup>
11.5	12.5	40 <sup>1</sup>	1.0	0.1	No <sup>2</sup>

1. No minimum subtended angle when asteroid diameter greater than 200 km.
2. The following asteroids are not filtered out: 2060 Chiron, 3200 Phaethon, 4015 Wilson Harrington and 5145 Pholus.

# Update Timeframe

- First updates of Goffin's events posted soon after Goffin's list is published.
- First updates of events from other searches soon after the events are added to my list.
- Subsequent updates approximately one month and one week prior to the event

# Update Process



# Computing Orbits

- Astrometry
  - All MPC data after 1900
  - All FASTT data (via email one month and 7 to 10 days before the event)
  - All other “High Accuracy” astrometry: Bill Owen/TMO, Gordon Garradd, Robert McNaught/Siding Springs, Manek/Ondrejov, Behrend/Geneva, Sposetti/Gnosca, Behrend/La Silla

# Computing Orbits

- Orbit fits computed with OrbFit software
  - freeware from <http://newton.dm.unipi.it/orbfit/>
  - Newest version is Unix only but source code is available for port to Windows
  - Supports weighting of astrometry via apriori RMS estimates
  - Computes a positional uncertainty statistic
  - Can include additional asteroids as potential perturbers
  - Uses JPL 405 ephemeris

# Computing Orbits

- Orbit Fit Computation
  - Let Orbitfit assign a default weight to all “normal” data (typically 1” apriori RMS for recent observations).
  - Assign 0.12” to 0.35” apriori RMS to all “high accuracy” data.
  - Include perturbations from all planets and the moon
  - Include 13 larger asteroids as potential perturbers
  - Compute orbital elements for approximate central time of event
  - Compute positional uncertainty for approximate central time of event

# Computing Star Position

- “Research” star positional info
  - Gather data from available catalogs
  - Look for problem areas: double stars, lack of proper motion estimate, unusually high uncertainties.
  - Use UCAC2 position whenever available – even dimmer Hipparcos stars
  - Double stars: look for existing orbit data or use individual positions from Hip or TDSC when available.
- Compute Star Position and uncertainty at time of event
  - Proper motion, parallax, radial velocity

# Compute Path Prediction

- WinOccult for path prediction
  - Input asteroid orbit in “user elements” file
  - Input star position as “one-off” star catalog position
  - Compute global view of path
  - Compute individual maps for areas with known observers
  - Compute lat/long path info

# Generate Prediction Output

- Event / Path Summary File
- Event HTML file for web
- Star Charts (via Guide)
- Path Maps (via WinOccult)

# Post Info to Web

- Generate summary tables for future and past events
- Upload individual event files to web
- Upload summary tables to web

# Issues

- Double stars are troublesome
  - Large positional uncertainty in most cases
  - Orbits rarely available
- Asteroid Satellites
- RMS/Weighting methodology
- Many cases of 2 sigma path shifts – too many?

# Future Work

- Research accuracy of current prediction methodology
- Orbit fit improvements
  - Add radar data & other positional sources
  - Close approaches
- Post predictions for TNOs and other un-numbered asteroids
- New features tbd for [asteroidoccultation.com](http://asteroidoccultation.com) website
  - Location based search
  - Personalized event info
  - “monitored” events
  - Flag asteroids with satellites