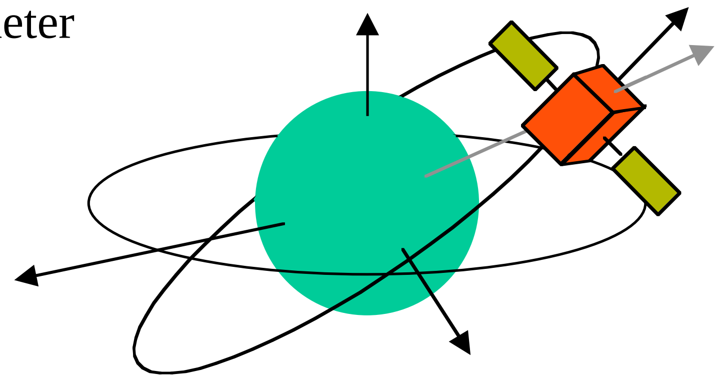
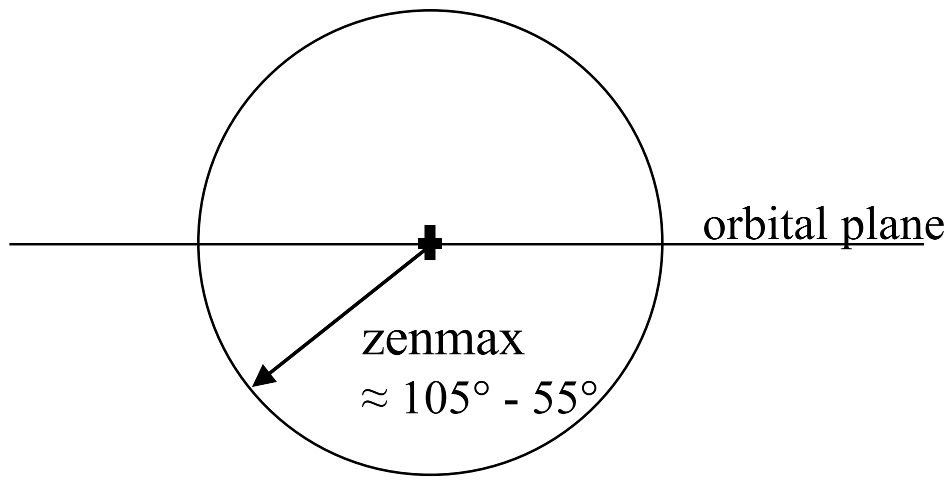
Exposure Simulations

- **Not rocket science**
- **Constraints:**
  - 28.5° inclination orbit, SAA perimeter
  - Slewing profiles
  - Maximum angle from zenith
  - Others?



- **Degrees of freedom:**
  - Define where GLAST spends its time within this circle:



  - Examples...

‘rocking’

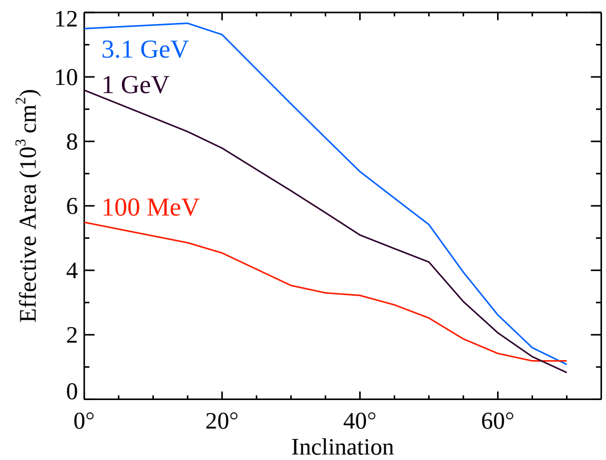
‘zenith pointed’

Issues for Planned Pointed Observations

- **Likely duration - (guess > weeks)**
- **Scheduling to optimize coverage/efficiency**
  - with respect to the 55-day precession period
  - multiplexing targets separated by > FOV
- **What to do in between times that the target is observable?**
  - slew back to be in position to catch the rise (minimum angular rate)
  - 'rock' about this great circle segment
  - slew to (or quite likely just toward) alternate target
  - slew to a celestial pole?
- **How closely to track the source**
- **How far (in zenith angle) to track the source**
  - Lost efficiency to earth occulation
  - Albedo gamma rays (reject onboard?)

Uniformity of Exposure on Short Timescales

- **Before discussing uniformity of exposure, should carefully define what exposure means, because the variation of effective area with inclination depends on energy. What is uniform at one energy might not be as uniform at a different energy.**



- **What are the scientific drivers for uniformity of exposure?**
  - As opposed to, say, uniformity of sensitivity
  - To not miss the bright AGN flares? (How often do they occur and how bright are they?)
  - To avoid exposure biases in likelihood analysis?
  - Bottom line uniformity requirement = ____% over ____ days
- **[Simulations do not include azimuthal dependence as yet.]**

Uniformity of Exposure

- **SRD says requirement is for <±20% uniformity of exposure on time scale of 7 days, *not including effects of SAA.***
- **Goal is <±10%.**
- **Results for simple 'step rocking' with 35° rocks and AO-response A_{eff} profile for 100 MeV are encouraging.**
- **Real life uniformity, i.e. including the SAA, can be improved beyond step-rocking**
  - Short timescales: East-West rocking toward and away from SAA
  - Longer timescales: Adjust dwell time at southern declinations.

No SAA

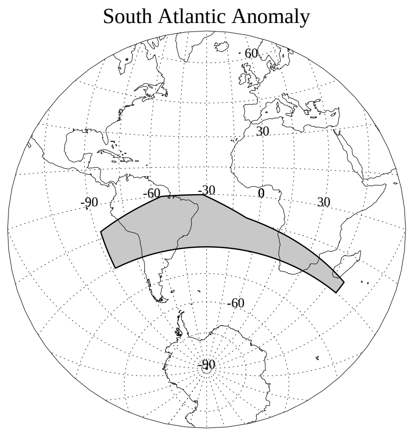
	Exposure (cm^2 s)			Frac. Range	
Duration	Min.	Max.	Avg.	Min.	Max
2 orbits	1.84E+07	2.45E+07	1.97E+07	93.5	124.2
4 orbits	5.52E+07	7.34E+07	5.91E+07	93.5	124.2
8 orbits	1.84E+08	2.45E+08	1.97E+08	93.6	124.2
16 orbits	6.64E+08	8.80E+08	7.09E+08	93.7	124.2
2 days	9.42E+08	1.25E+09	1.01E+09	93.7	124.3
4 days	1.50E+09	1.97E+09	1.60E+09	93.7	123.1
1 week	**2.47E+09**	**3.17E+09**	**2.64E+09**	**93.7**	**120.4**
2 weeks	4.42E+09	5.38E+09	4.71E+09	93.8	114.2
55 days	7.76E+09	8.29E+09	8.14E+09	95.3	101.9

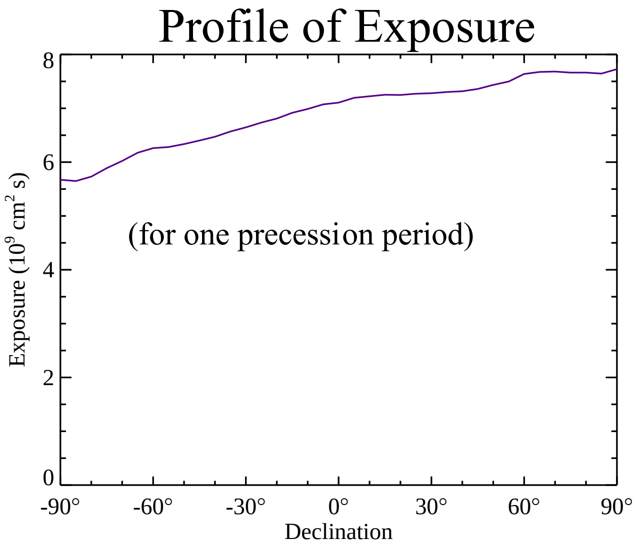
With SAA

	Exposure (cm^2 s)			Frac. Range	
Duration	Min.	Max.	Avg.	Min.	Max
2 orbits	5.55E+06	2.06E+07	1.52E+07	36.5	135.5
4 orbits	1.60E+07	6.16E+07	4.43E+07	36.1	139.2
8 orbits	6.77E+07	2.05E+08	1.49E+08	45.3	137.6
16 orbits	3.89E+08	7.38E+08	5.84E+08	66.6	126.2
2 days	5.86E+08	1.05E+09	8.39E+08	69.9	125.1
4 days	9.75E+08	1.67E+09	1.35E+09	72.4	124.2
1 week	**1.65E+09**	**2.75E+09**	**2.24E+09**	**73.9**	**123.0**
2 weeks	3.04E+09	4.89E+09	4.01E+09	75.9	121.8
55 days	5.65E+09	7.73E+09	6.98E+09	80.9	110.7

Uniformity of Exposure (2)

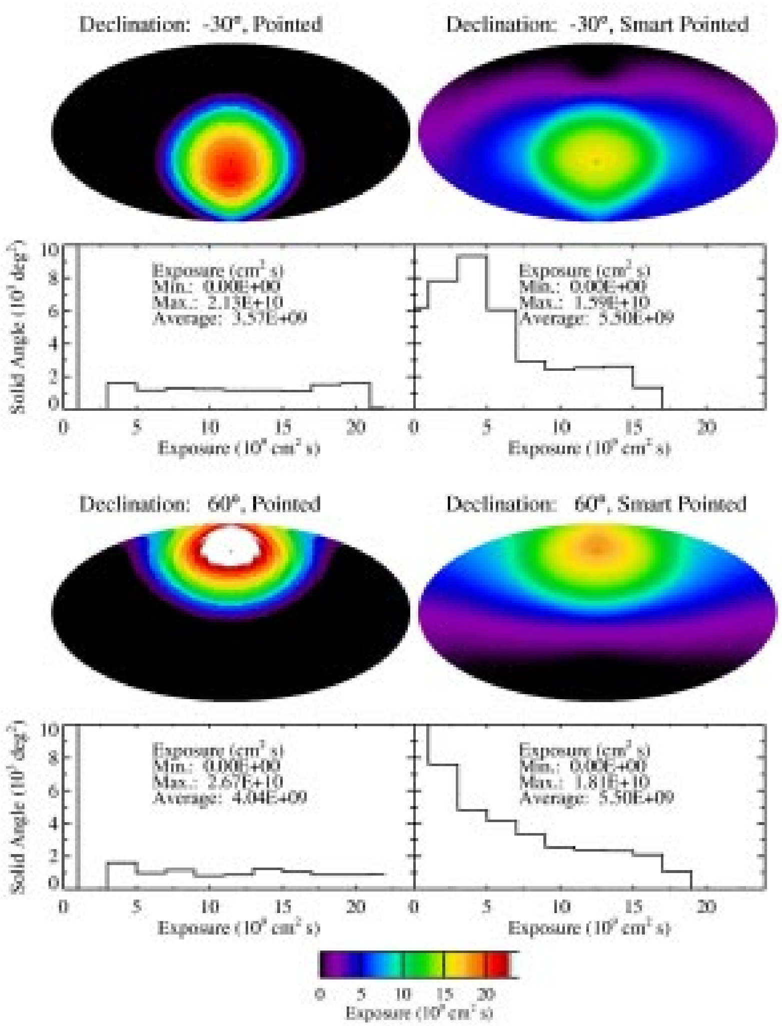
- **Real life uniformity, i.e. including the SAA, can be improved beyond step-rocking**
  - Short timescales: East-West rocking toward and away from SAA
  - Longer timescales: Adjust dwell time at southern declinations.





Pointd Observations: An Early Attempt

- **Simulation comparing inertial pointing with a 'smart' observing mode that kept the LAT as close as possible to the desired viewing direction with constraints**
  - no part of FOV occulted
  - slew rate < 15°/min
- **For illustrative purposes here**



Software for Simulation and Planning

- **Scheduling tool, and before that, orbit/exposure simulation tool to optimize scheme**
- **Commercial product - STK (www.stk.com, Analytical Graphics)**
  - advantages:
    - knows orbits (knows missles)
    - knows position of the sun (for rotating the spacecraft in azimuth),
    - code is tested
    - excellent vizualization
  - disadvantages:
    - doesn't know rocking (external attitude file with one entry per time step can be supplied)
    - doesn't know large FOV instruments (can define nested conical instruments)
    - exposure is via 'accesses' (must supply a list of coordinates for accesses and turn the report for each nested instrument into exposures)
    - costs ~$20k for single user license
- **Most of the work is in the attitude file - realistic angular accelerations, rocking, leaning into and out of the SAA**