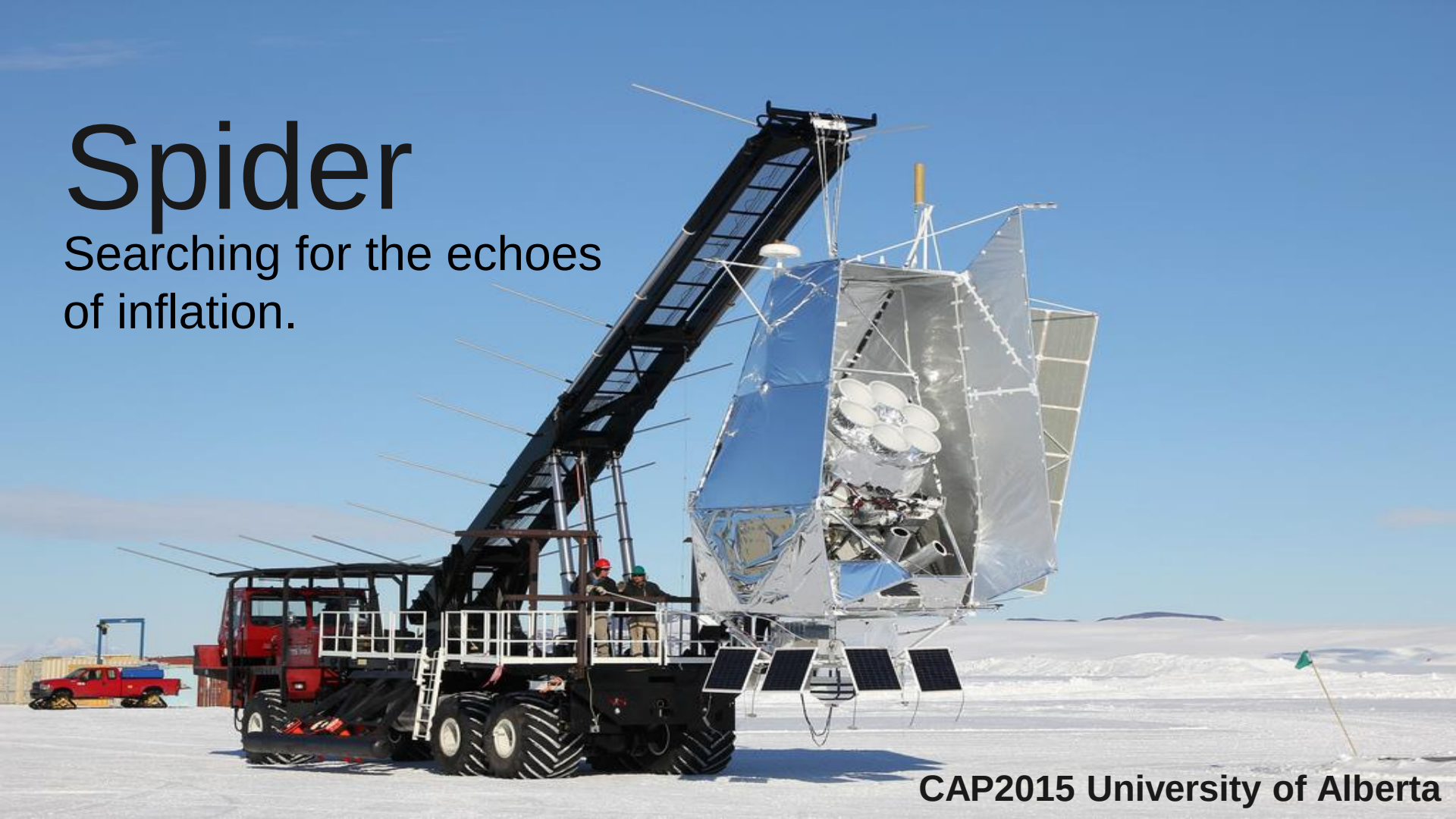
Spider

Searching for the echoes of inflation.

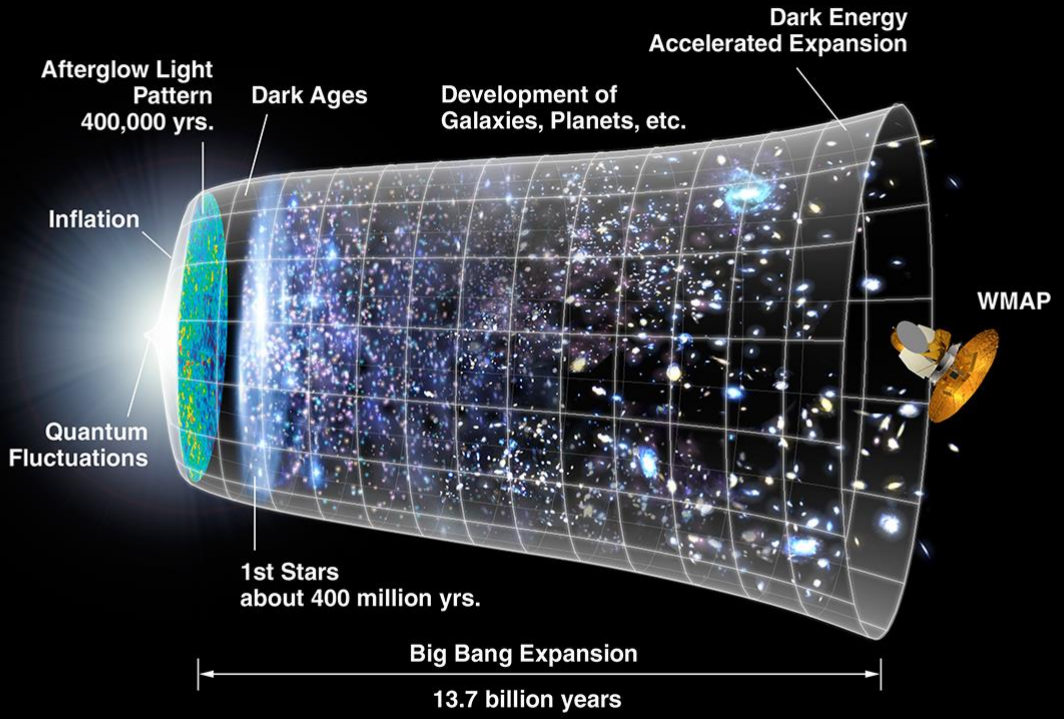


CAP2015 University of Alberta

Outline of this talk.

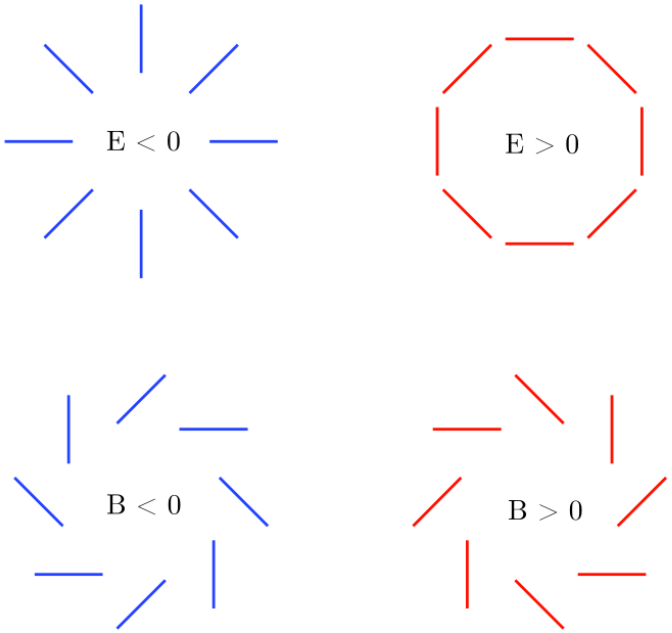
1. Inflation
2. Ballooning
3. Spider

Inflation nicely ties up our cosmological model.

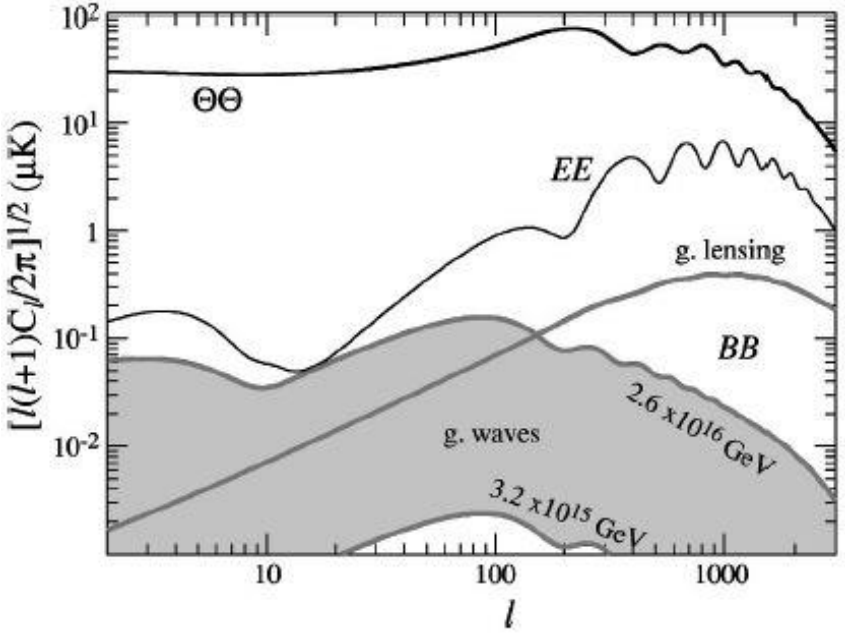


NASA/WMAP Science team

The B-mode amplitude depends on the energy scale of inflation.



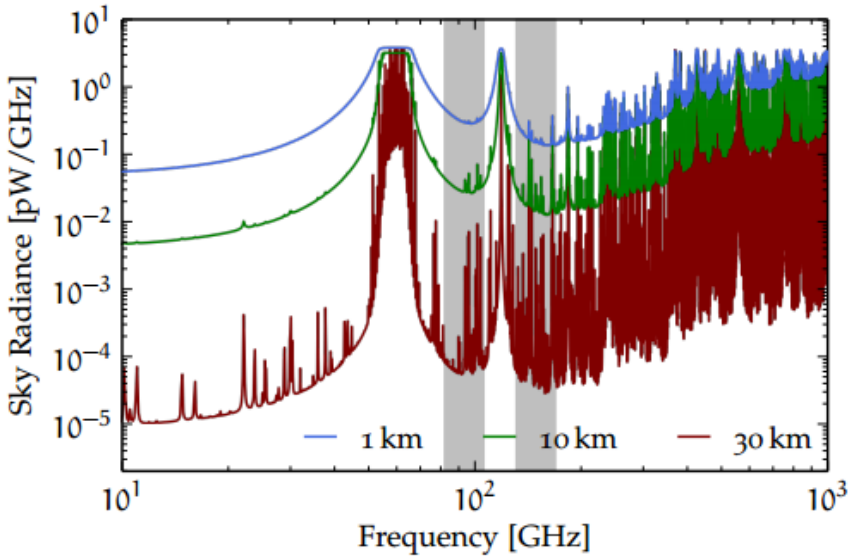
(Krauss et al, 2003)



(Hu et al, 2003)

Ballooning can be an affordable path to space-quality science.

- **The good**
  - Virtually no atmosphere (0.5%)
  - Good sky coverage
- **The difficult**
  - Mass/power constraints
  - Autonomous operation
  - Recovery!
- **The ugly…**
  - government shutdowns...



(A. S. Rahlin)

SPIDER

Princeton University
W. Jones
A. Fraisse
Z. Kermish
M. Hasselfield
A.S. Rahlin
J. Gudmundsson
A. Gambrel
E. Young

Case Western Reserve Univesity
J. Ruhl
S. Bryan
J. Nagy
S. Wen
R. Bihary

UKZN
C. Chiang

University of Toronto
C.B. Netterfield
J.R. Bond
S. Benton
M. Farhang
L. Fissel
N. Gandillo
J. Hartley
I. Padilla
J. Soler
J. Shariff

University of British Columnbia
M. Halpern
M. Amiri
D. Wiebe

Caltech/JPL
J. J. Bock
B. P. Crill
O. Doré
J. P. Filippini
S. Golwala
W. Holmes
V. V. Hristov
R. O'Brient
P. V. Mason
L. Moncelsi
T. A. Morford
M. C. Runyan
A. Trangsrud
R. S. Tucker
A. D. Turner

APC
K. Ganga

Cardiff University
P. Ade
E. Pascale
C. Tucker

Imperial College
C. Contaldi
C. Clark

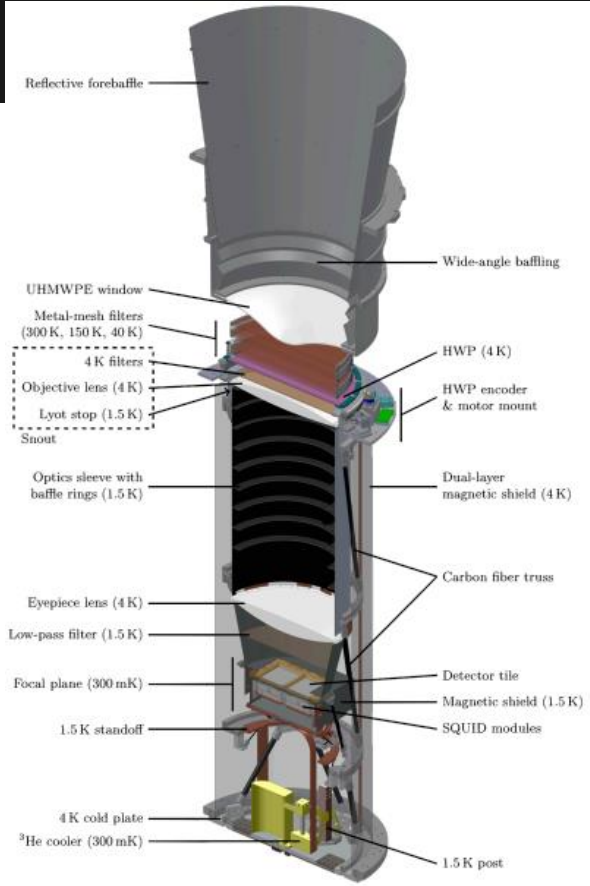
Cambridge
C. MacTavich

Stanford
K.D. Irwin
C.L. Kuo

NIST
Carl Reintsema
George Hilton

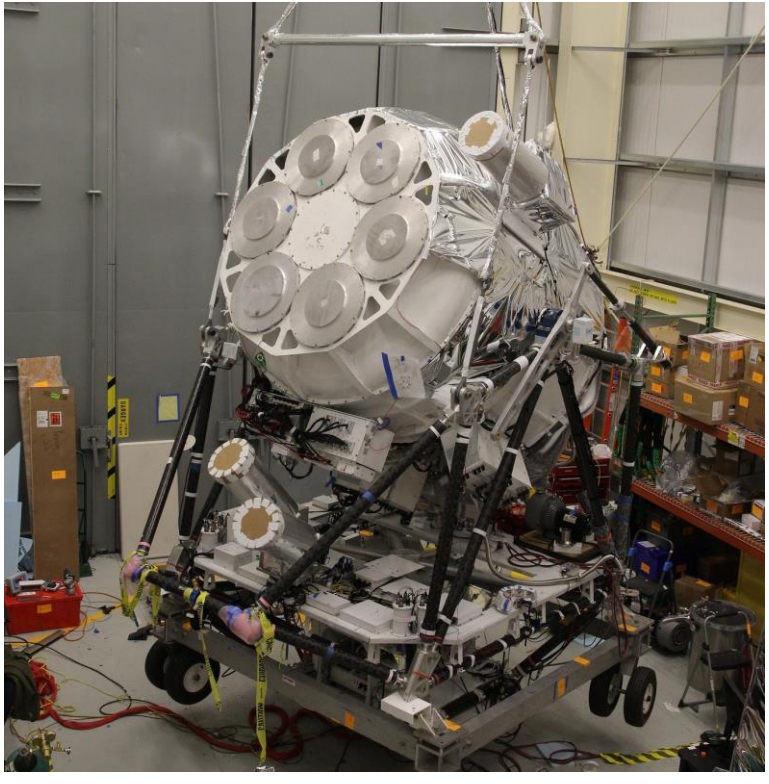
At its heart, a 1300 L liquid helium cryostat housing 6 telescopes.

- 1300 L, LHe cryostat
  - ~2 weeks hold time
  - houses 6 telescope
- Telescopes
  - 3 at 94 GHz, 3 at 150 GHz
  - 40cm aperture, refractive telescope.
  - Motorized, sapphire half-wave plate for polarization modulation
  - Focal plane cooled to 300 mK, consisting of lithographed, phased-array slot antenna coupled TES detectors.



The gondola is a 193kg carbon-fibre platform capable of steering a 1000kg cryostat.

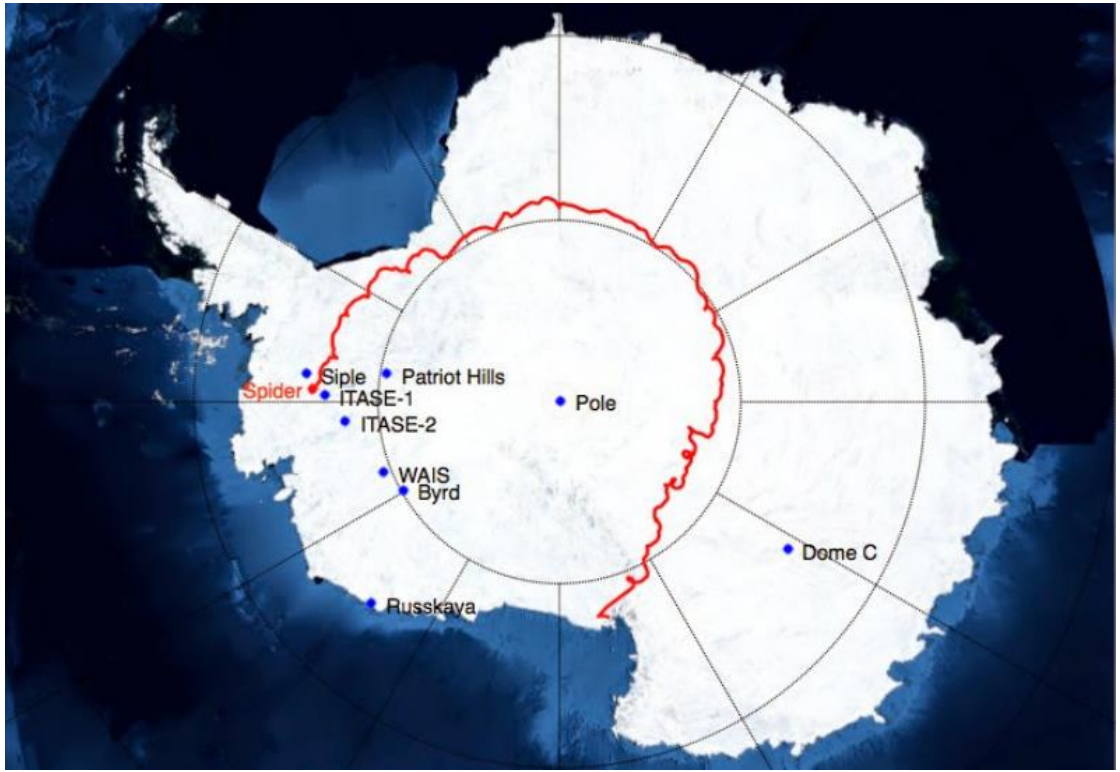
- Pointing control
  - Reaction wheel and Pivot in azimuth
  - Stepper motor in elevation
- Attitude determination
  - Star cameras
  - Differential GPS
  - Gyroscopes
  - Sun sensors
  - Magnetometer



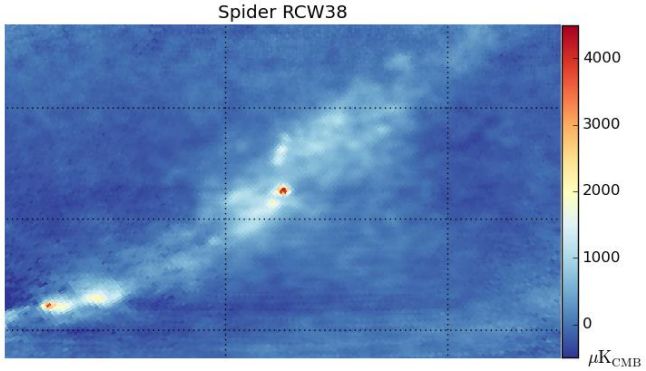
Spider had its first flight in January of 2015. It flew for 16 days.

Circumpolar winds take payloads around the continent. Orbital periods range from about 7 to 36 days.
Spider didn't have great (nor bad!) luck with its flight path.

Second flight scheduled for 2017/18!



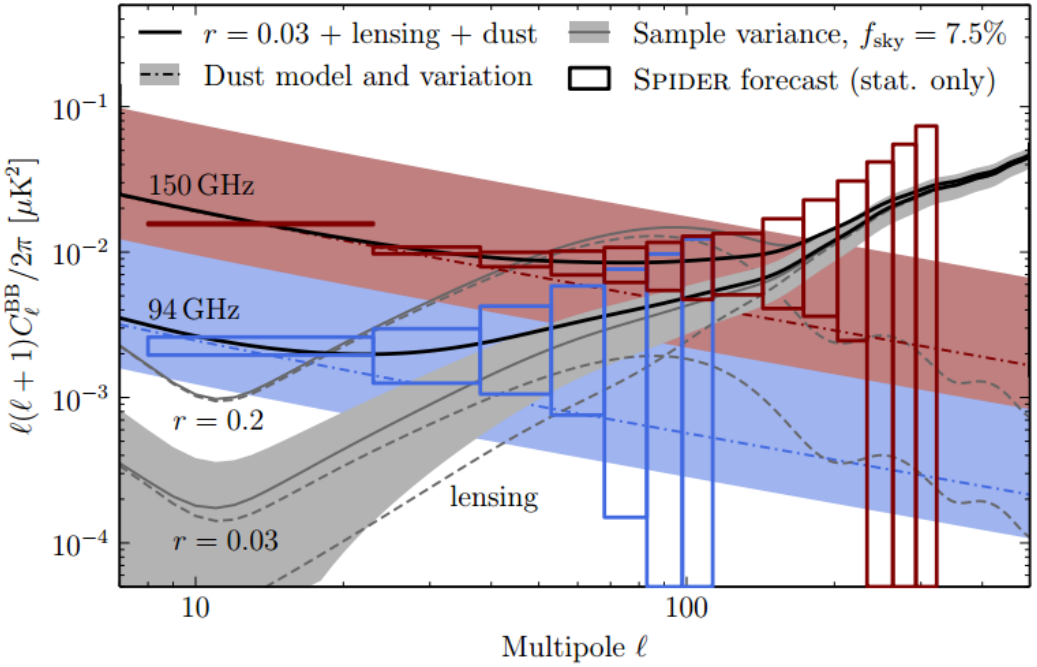
First flight preliminary performance overview:



Frequencies	94 / 150 GHz
Beam FWHM	42 / 30 arcmin
Sky fraction	6.5%
Flight 1	January 2015, McMurdo Station
Observation time	16 days
Pol modulation	Stepped HWP
# detectors	2400, 85% yield
NET/det*	110 – 140 uK-rts
Map depth*	14 / 11 uK-arcmin

Both Spider flights together can set an upper limit of r < 0.03.

- High r detection possible with first flight.
- r < 0.03 upper limit at 3**σ** with 200+GHz data.



(A. S. Rahlin)

Conclusion

- Spider is a powerful and exciting experiment capable of constraining $r < 0.03$.
- First flight complete, currently looking at data.
- Second flight soon!

Thank you.

Ivan Padilla - University of Toronto