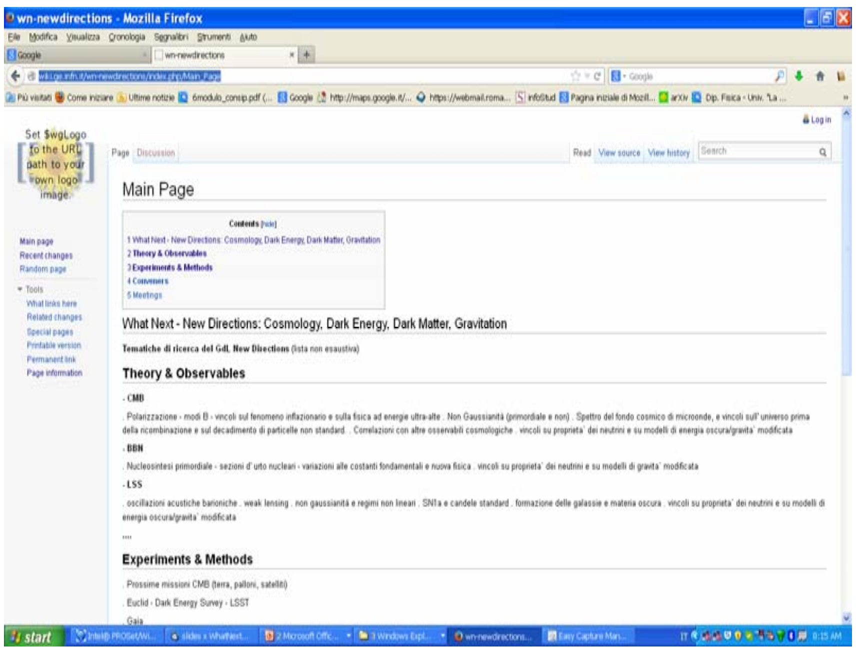
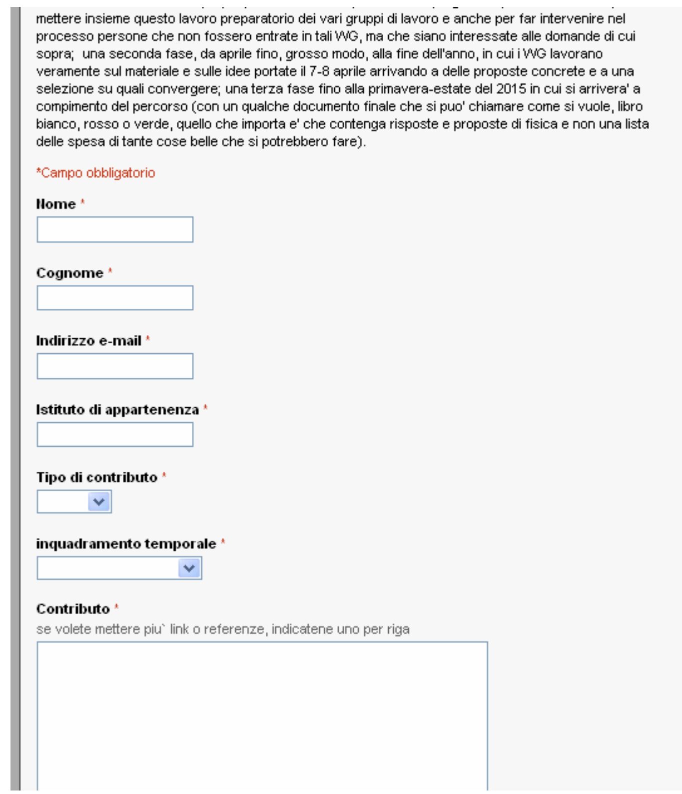
GdL New Directions

- Conveners :
  M. Battaglieri, N. Bartolo, P. de Bernardis, A. Melchiorri
- Raccolta idee tramite pagina wiki, form google, e-mail, telefonate …
- http://wiki.ge.infn.it/wn-newdirections/index.php/Main_Page





Raccolte 28 idee, ovviamente molte in direzioni diverse

Microsoft Excel - risposte2.xls

	A	B	C	D	E	F	G	H
1	Informazioni	Nome	Cognome	Indirizzo e-mail	Istituto di	Tipo di	inquadrame	Contributo
2		Carlo	Baccigalupi	via e-mail				CMB-LSS Cross Correlation for Dark Energy and Modified Gravity
3		Marco	Baldi	via e-mail				Simulation of non.standard cosmologies
4	3/7/2014 9:25:08	walter	Bonivento	walter.bonivento	INFN Cagliari	CSN2	attività futura	http://ship.web.cern.ch/ship/
5	3/9/2014 17:36:49	Fabio	Bossi	fabio.bossi@lnf.i	lnf	CSN1	attivtà già in	dark photons searches at colliders
6		Enzo	Branchini	via e-mail				The Large Scale Structure of the Universe as a probe to Dark Energy and Gravity
7		Livia	Conti	via e-mail				CMB in a non-equilibrium universe
8	4/6/2014 7:58:42	Paolo	de Bernardis	paolo.debernardi	Dipartimento	CSN2	attività futura	Studio sperimentale della polarizzazione del fondo cosmico di microonde allo
9	4/3/2014 12:36:00	Eleonora	Di Valentino	eleonora.divalenti	Roma	CSN4	attivtà già in	Studio delle non gaussianità del CMB dovute ad interazione tra lensing ed effetto
10	3/14/2014 11:22:59	Angela D.	Di Virgilio	angela.divirgilio@	INFN-Pisa	CSN2	attivtà già in	G-GranSasso-RD è un R&D di GruppoII che ha lo scopo di costruire GINGER, un
11	3/24/2014 17:24:16	Antonaldo	Diaferio	diaferio@ph.unito	Universita' di	CSN4	attivtà già in	La strategia che InDark-Torino intende perseguire con le sue competenze e'
12	3/14/2014 17:02:16	Daniele	Fargion	daniele.fargion@r	Phys Depart	CSN2	attività futura	"Horizontal Upward Airshower by Plane and Balloons:
13	3/14/2014 17:14:12	Daniele	Fargion	daniele.fargion@r	Dipt Fisica	CSN4	attivtà già in	1) Oscillazioni:
14		Fabio	Finelli	via e-mail				Implication of BICEP2, inflation, and new physics
15	3/26/2014 15:49:02	Nicolao	Fornengo	fornengo@to.infn.	Universita' di	CSN4	attività futura	Volevo segnalarvi un tipo di studio per la ricerca di DM che può mettere in
16	4/3/2014 12:33:57	Martina	Gerbino	martina.gerbino	Roma	CSN4	attivtà già in	Vincoli a modelli inflazionari tramite misure di radiazione di fondo cosmico
17		Michele	Liguori	via e-mail				new pathways to primordial non-Gaussianity and inflationary models
18	4/3/2014 13:46:27	Andrea	Marchini	andreaAbout Get	Sapienza -	CSN5	attivtà già in	Alternative theories of Gravity -- Marchini, A., & Salvatelli, V. (2013). Updated
19	4/3/2014 12:31:59	Alessandro	Melchiorri	alessandro.melc	Roma	CSN4	attivtà già in	Mi propongo di vincolare la fisica del neutrino e di particelle leggere come assioni
20		Edoardo	Milotti	via e-mail				Gamma-gamma scattering
21		Lauro	Moscardini	via e-mail				and Extreme Early Universe through CMB B modes
22		Paolo	Natoli	via e-mail				CMB as a laboratory for new physics
23		Anna	Nobili	via e-mail				GG & GGG fondamenti della relatività generale - principio equivalenza
24		Massimo	Pietroni	via e-mail				Understanding the Large Scale Structure of the Universe
25		Nicola	Poli	via e-mail				Interferometri e orologi atomici con atomi ultrafreddi per tests di fisica
26		Antonino	Pullia	via e-mail				Geyser - tecnica nuova di ricerca DIRETTA e TERRESTRE di Materia Oscura
27	4/3/2014 20:24:37	Najla	Said	najlasd@gmail.c	università di	CSN4	attivtà già in	dark energy properties
28	4/3/2014 14:26:38	Valentina	Salvatelli	vale.salvatelli@g	La Sapienza,	CSN4	attivtà già in	Dark matter- dark energy interactions
29		Matteo	Viel	via e-mail				Probing the Universe at mildly non-linear scales
30								
31								
32								

Risposte del modulo

Di queste, 18 idee riguardano attività in ambito cosmologico

Microsoft Excel - risposte2.xls

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29		Matteo	Viel	via e-mail				Probing the Universe at mildly non-linear scales

Risposte del modulo

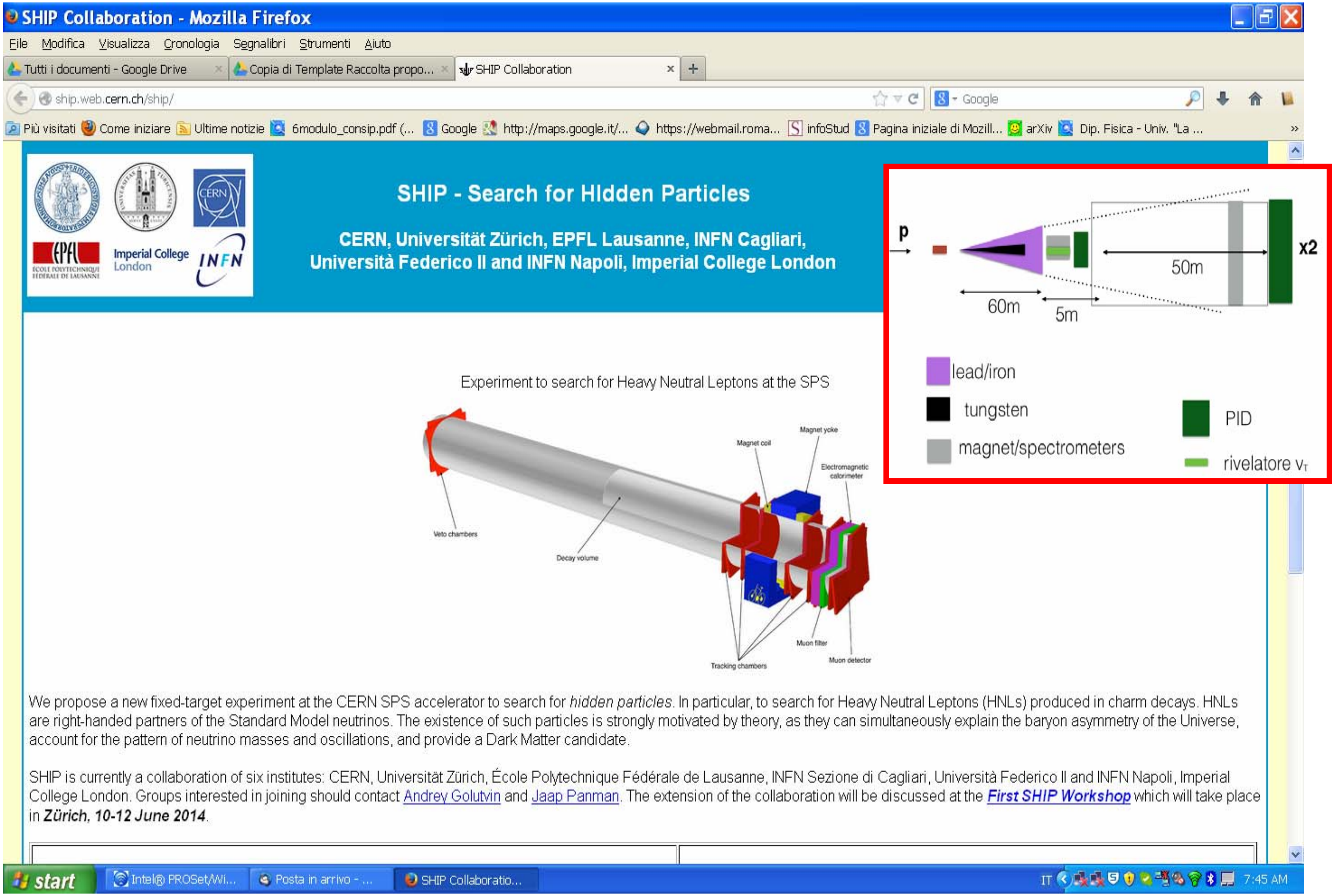
Programma di oggi

- Oggi è un punto di partenza.
- Stato della teoria
  - LSS & : Nicola Bartolo (10m)
  - CMB & : Alessandro Melchiorri (10m)
- Stato Esperimenti : Paolo de Bernardis (10m)
- Discussione generale

Nicola Bartolo
Alessandro Melchiorri

WHAT NEXT – new directions

- PROPOSTE SPERIMENTALI
  - SEARCH FOR HIDDEN PARTICLES
  - DARK PHOTONS @ COLLIDERS
  - VERTICAL ARRAYS FOR HORIZONTAL SHOWERS
  - NEUTRINO ASTRONOMY
  - EQUIVALENCE PRINCIPLE – GGG
  - GRAVITOMAGNETISM – LENSE-THIRRING
  - GAMMA-GAMMA SCATTERING
  - CMB POLARIZATION - INFLATON



Walter Bonivento

Dark photon searches using displaced vertices at low energy e^+e^- colliders

Fabio Bossi

Laboratori Nazionali dell'INFN Frascati

Abstract

The existence of a new, photon-like, massive particle, the γ' or dark photon, is postulated in several extensions of the Standard Model. These models are often advocated to explain some recent puzzling astrophysical observations, as well as to solve the unsofar unexplained deviation between the measured and calculated values of the muon anomaly. Dark photons can be produced at e^+e^- colliders both in continuum events and in vector meson transitions and can eventually decay into an electron-positron pair. For a proper choice of the parameters of the theory, a γ' can have a relatively long lifetime and can therefore be observed as an e^+e^- vertex well separated by the primary interaction point. This case is discussed in reference to very high luminosity e^+e^- colliders either in construction or under study in several laboratories in the world. It is shown that a search strategy based on the detection of displaced vertices can be in principle very effective in covering a rather wide and to date unexplored region of the theoretical parameters space

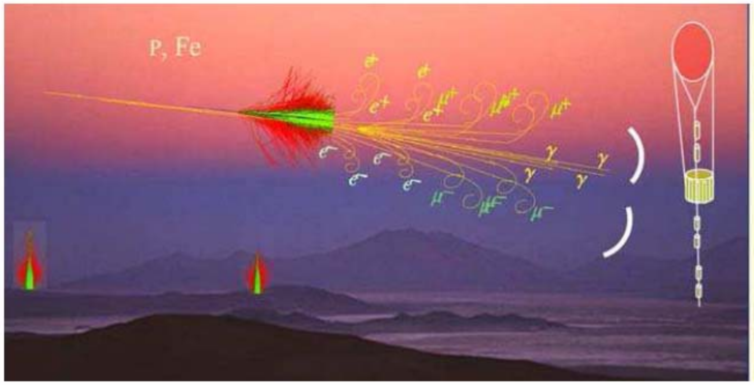
1 Introduction

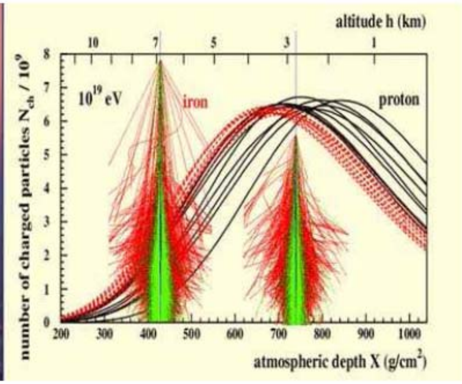
Fabio Bossi dark photons

Vertical Array in Space for Horizontal Air-Showers

Daniele Fargion[*†]
Author affiliation: Physics Department, Rome University 1 and INFN rome1, Ple. A. Moro 2, 00185, Rome, Italy
E-mail: daniele.fargion@roma1.infn.it

Since a century cosmic rays are based on direct cosmic particle detection in space (below PeV) or on secondary downward vertical airshowers (above TeVs). We consider the guaranteed physics of horizontal (hadron) air-showers, HAS, developing at high $(30-40)$ km altitudes, above and below these energy windows. Their morphology and information traces are different from vertical ones. Hundreds of km long HAS are often split by geomagnetic fields in a long (fan-like) showering with a twin spiral tail. The horizontal fan-like airshowers are really tangent and horizontal only at North and South poles. At different latitude their showering plane are turned and inclined by geo-magnetic fields. In particular at magnetic equator such tangent horizontal East-West airshowers are bent and developed into a vertical fan air-shower, easily detectable by a vertical array detector (hanging elements by gravity). Such *medusa* arrays maybe composed by inflated floating bal-loons chains. The light gas float and it acts as an calorimeter for the particles, while it partially





Daniele Fargion

Neutrino oscillations and high energy neutrino astronomy

- Beaming neutrino and antineutrinos across the Earth to disentangle neutrino mixing parameters
  - http://iopscience.iop.org/0004-637X/758/1/3/
  - http://arxiv.org/abs/1012.3245
- Astronomia con neutrini di alta energia
  - Tau airshowers prodotti da nu-tau
  - NIM A588:146-150, 2008 ;
  - arXiv:1402.4243

Daniele Fargion

Is General Relativity the last word in our understanding of gravity? Do new fundamental forces exist? Who is wrong: Einstein or the Standard Model?

- GR requires UFF (the Universality of Free Fall) or WEP (Weak Equivalence Principle) to hold
  (in a gravitational field all bodies must fall with the same acceleration regardless of their mass and composition)
- Experimental evidence of **UFF/WEP violation** $\Rightarrow$ **either** GR must be amended **or** a new force of Nature is at play
- UFF/WEP tests of GR are **null experiments** $\Rightarrow$ can reach very high sensitivity
  (many orders of magnitude better than tests of GR based on absolute measurements, such as light deflection, Lense-Thirring, gravitational redshift...)

Einstein quotes Eötvös tests as proof (*Einstein: "The foundation of the General Theory of Relativity"*, § 2, 1916)

1916: Eötvös torsion balance tests of UFF/WEP were at 10^{-8}
2008: Eöt-Wash tests with slowly rotating torsion balances are at 10^{-13}

slides from Anna Nobili

- ***What is going on?***

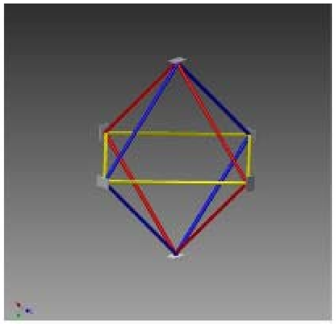
  μSCOPE: small, low cost, French mission with ESA contribution ready to fly in 2016 (anticipation to 2015 likely because of dual launch) to test UFF/WEP to 10^{-15} in low Earth orbit 9-month flight
  Integration time to reach 10^{-15}**:** $1.4\,\mathrm{d}$

  What if in 2015-2016 French scientists will announce evidence of UFF/WEP violation in the μSCOPE data?

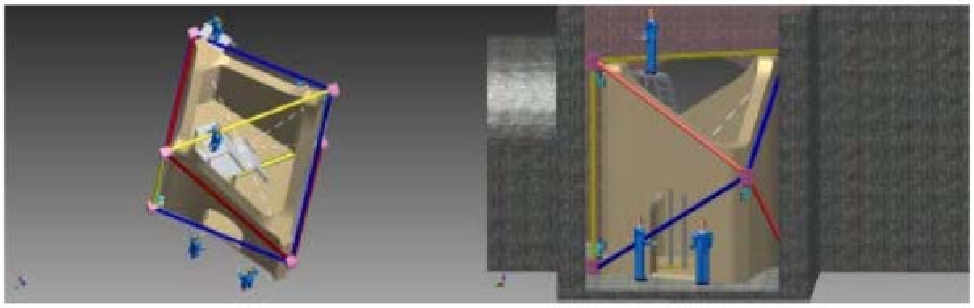
- ***μSCOPE results will need confirmation with more sensitive experiment. What next?***

  GG ("Galileo Galilei") small satellite similar to μSCOPE in size, duration and cost can test UFF/WEP 100 times better (to 10^{-17}) due to sensor physical design
  Integration time to reach 10^{-17}**:** $3.5\,\mathrm{hr}$ **(PRD, 2014)**
  μSCOPE sensor would need $39\,\mathrm{yr}$ ***of data to reach this sensitivity!***
  Noise level of GG lab prototype (GGG) can be further reduced in the meantime. . .

slides from Anna Nobili

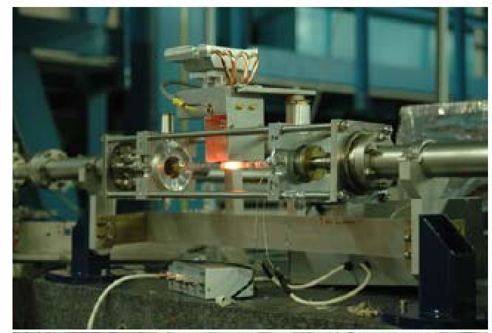


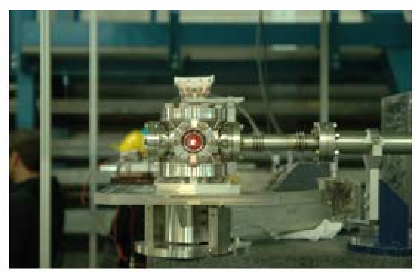
G-GranSasso
GInGeR (Gyroscopes In General Relativity)

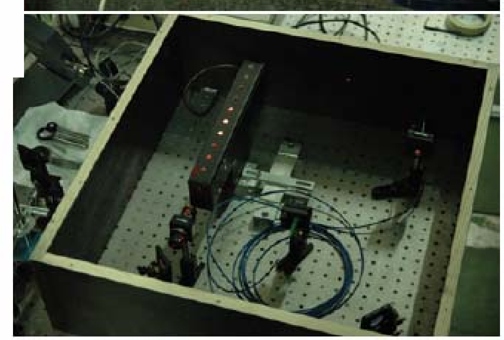


INFN TUM Technische Universität München LMU Ludwig-Maximilians-Universität München UC University of Canterbury

Test di Relatività generale con un esperimento underground, gravitomagnetismo terreste (lenseThirring) misurato con 1%
Geodesia: misura veloce della velocità della terra
Geofisica







Angela Di Virgilio

The $\gamma + \gamma \to \gamma + \gamma$ scattering in the range $\sqrt{s} \sim 1-2$ MeV could be a powerful probe into the structure of quantum vacuum, and its scattering cross section strongly depends on a regularization procedure. Therefore, accurate measurements of the polarized cross-sections of the gamma-gamma scattering process could yield important clues towards the solution of the cosmological constant problem.

There are different options to set up a gamma-gamma scattering experiment. One of them has been described in the recent IRIDE proposal [6] (see also [7]), and it utilizes two Compton-backscattered laser beams. Another, possibly much cheaper solution could utilize Compton-backscattered photons from the DAFNE electron beam and X-ray photons from SPARC-X.

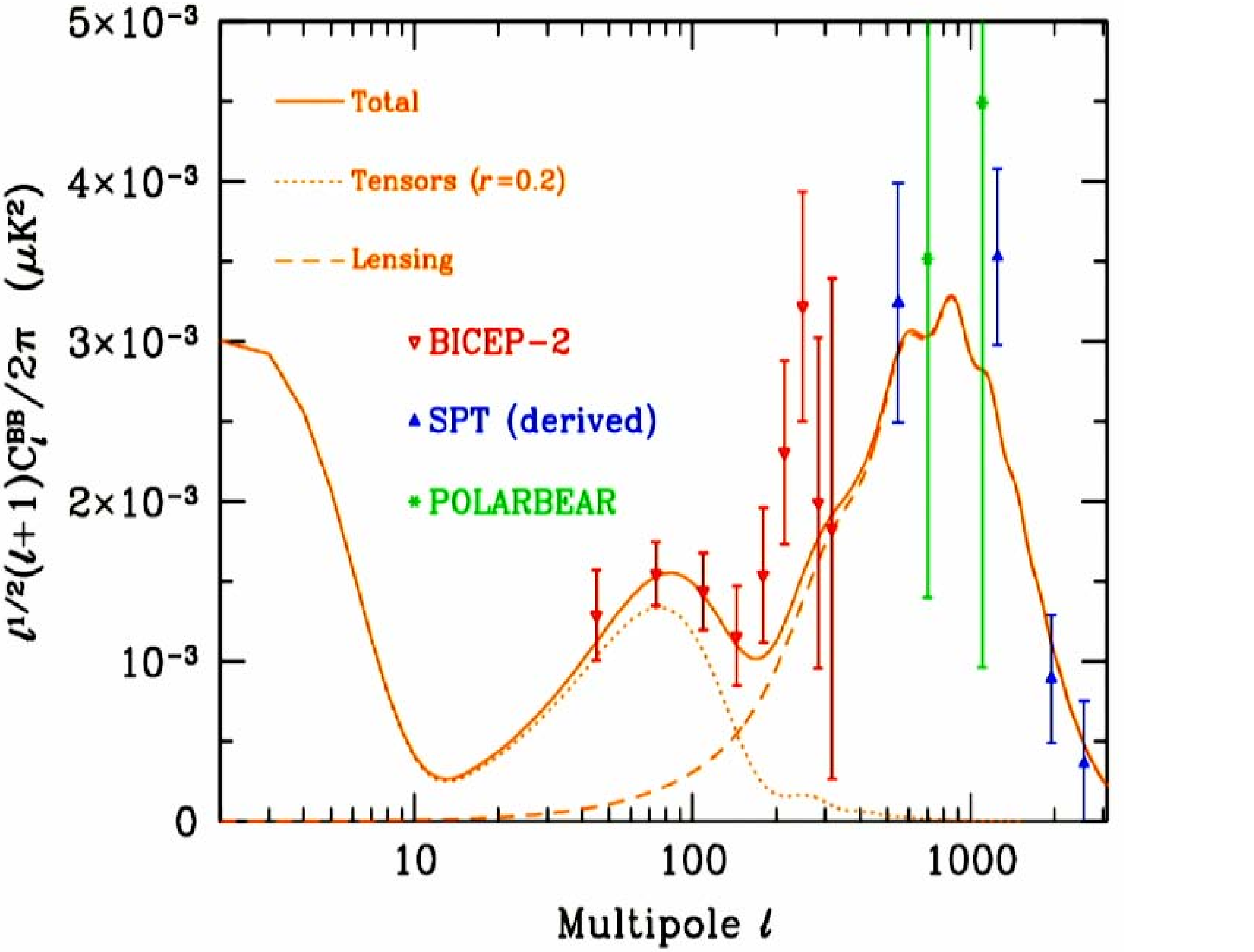
[6] M. Ferrario et al., NIM A **740** (2014) 138.

[7] E. Milotti et al., Int. J Quantum Information **10** (2012) 1241002.

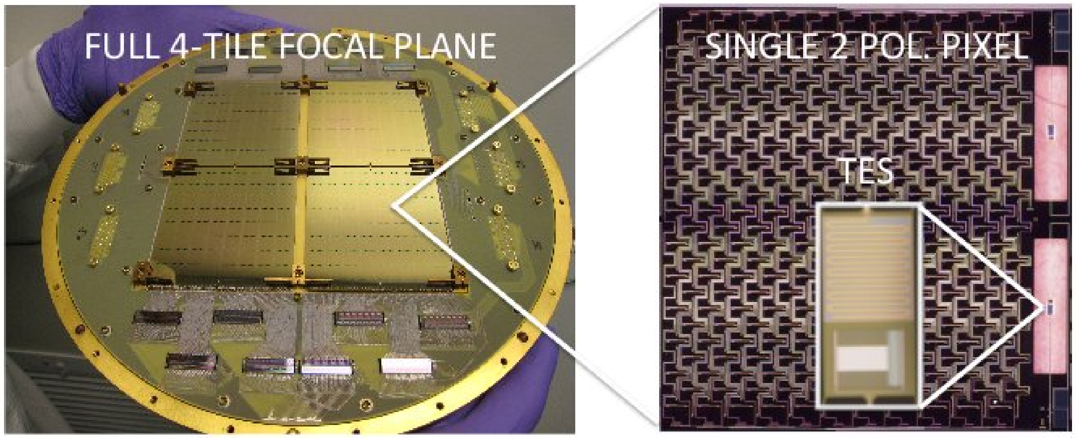
Edoardo Milotti gamma-gamma scattering

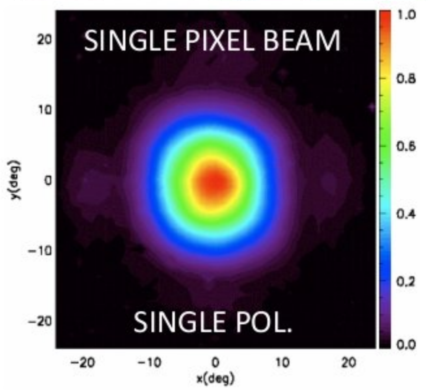
A medium-term observation program to study *cosmic inflation* and the *inflaton*

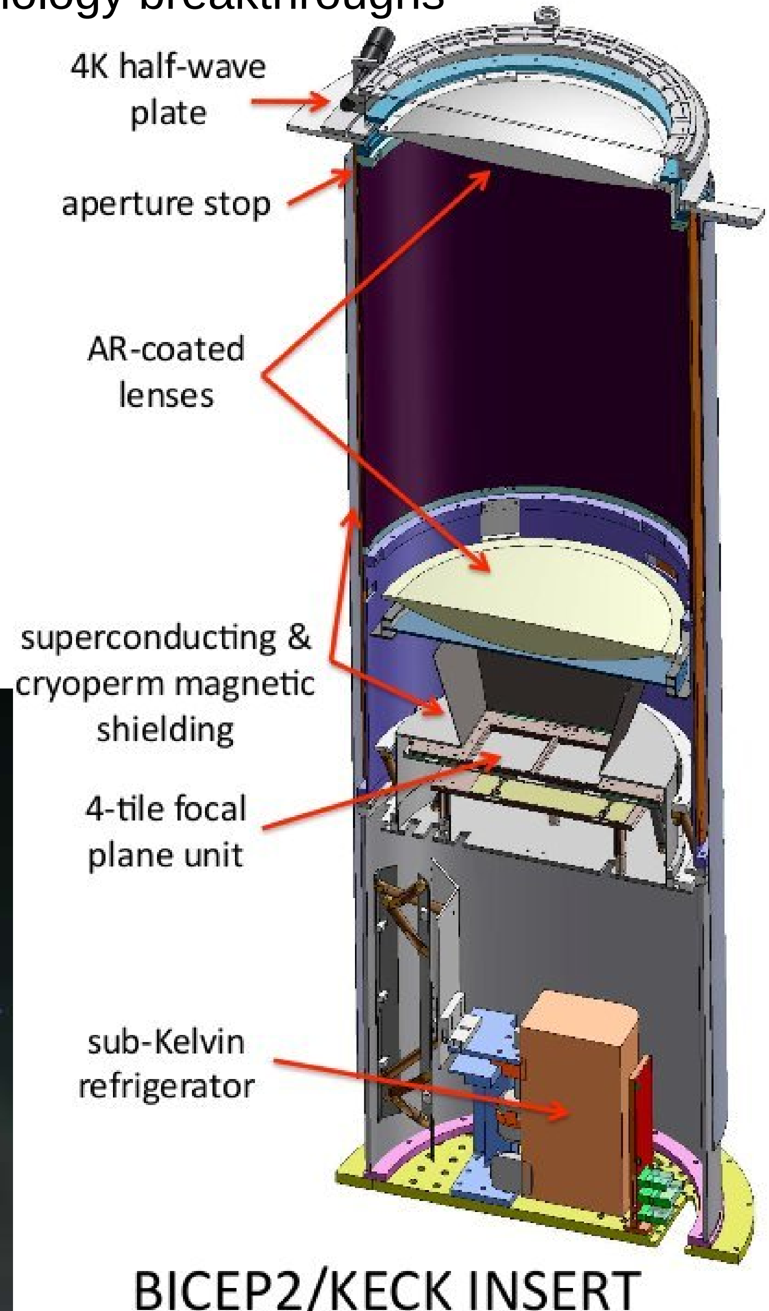
BICEP2 results



The BICEP2 discovery results from important technology breakthroughs

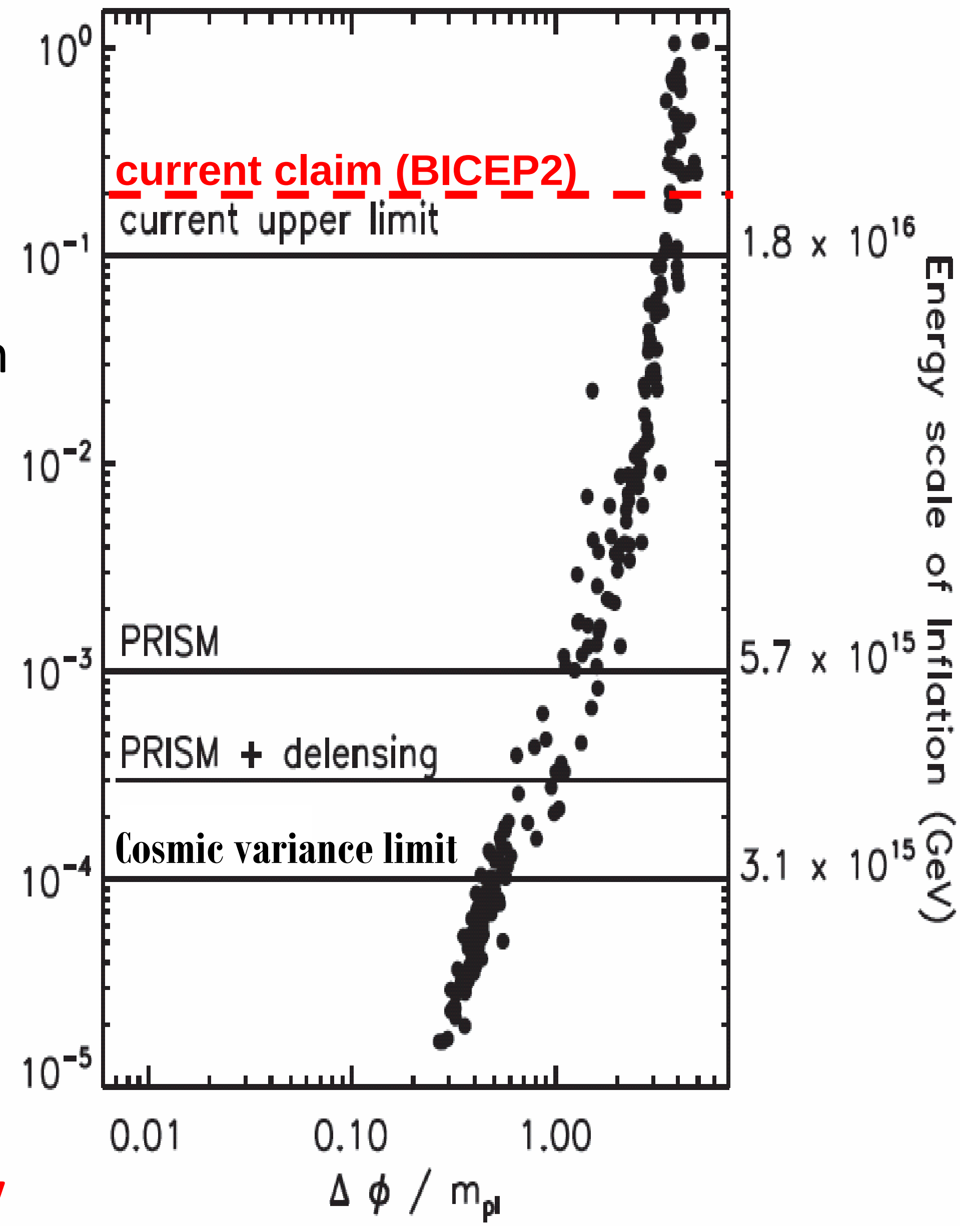




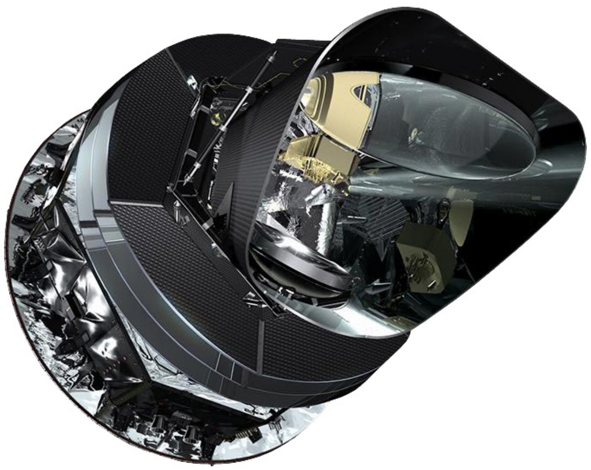


B modes are a unique probe of **new physics near the GUT and Planck scales**

- The generation of primordial gravitational waves with wavelength extending to very large scales near and beyond our horizon is a unique and spectular probe of inflation
- **If** the BICEP2 measurement is correct, the energy scale of inflation is already measured quite accurately
- A key aim of high-energy theory is to construct models of new physics near the Planck scale that include inflation.
- Knowing the slope of the spectrum of tensor perturbations would provide a **new observational constraint of physics in this energy range that CANNOT be probed by any other means**



PLANCK



B-mode polarization results before the end of 2014

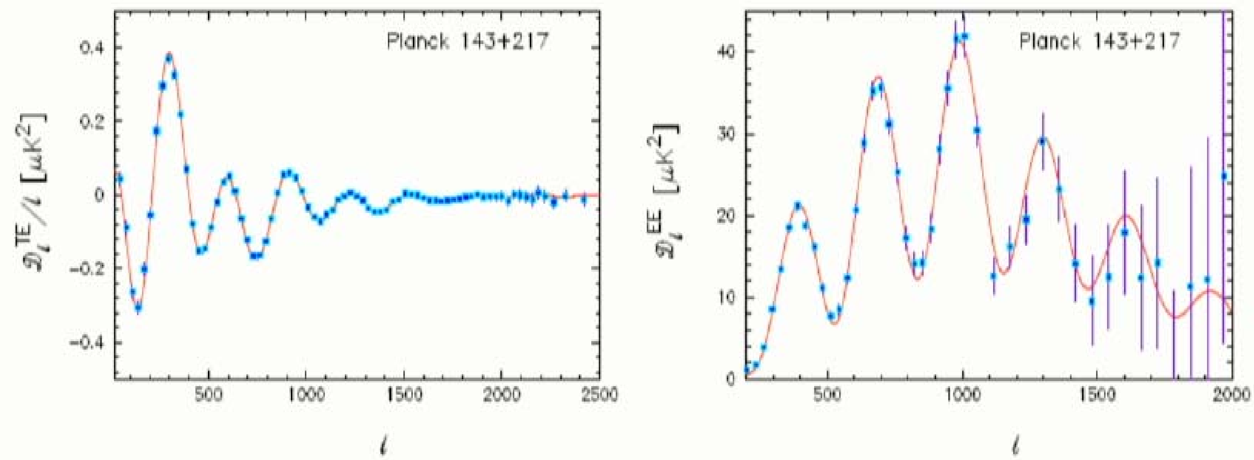


Fig. 11. *Planck TE* (left) and *EE* spectra (right) computed as described in the text. The red lines show the polarization spectra from the base ΛCDM *Planck*+WP+highL model, *which is fitted to the TT data only*.

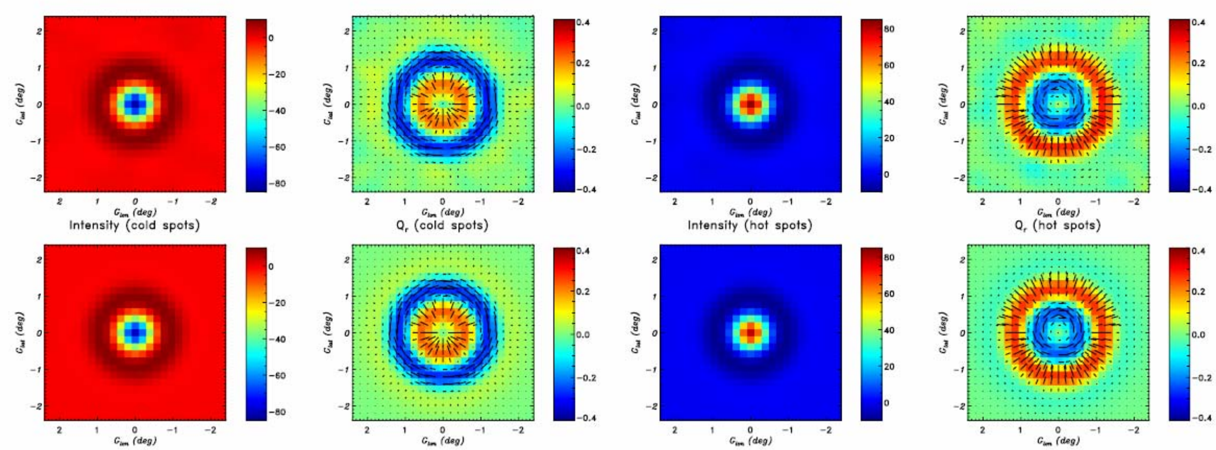
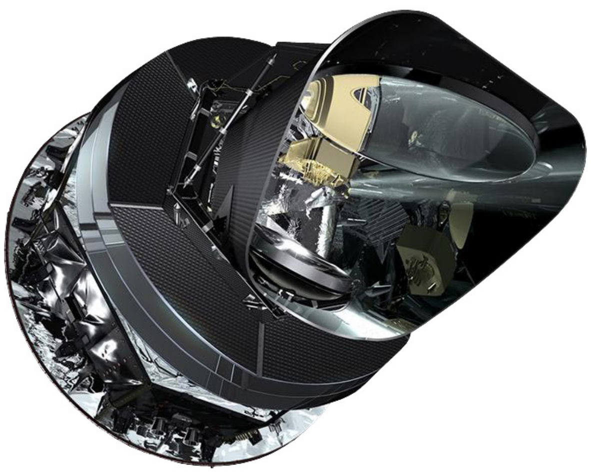


Fig. 27. Stacked maps of the CMB intensity I and polarization Q_r at the position of the temperature extrema, at a common resolution of 30 arcmin. Maps are displayed for CMB temperature cold spots (left) and hot spots (right) for the *Planck* CMB estimates (top row) and for the ΛCDM*Planck* best fit model prediction (bottom row).

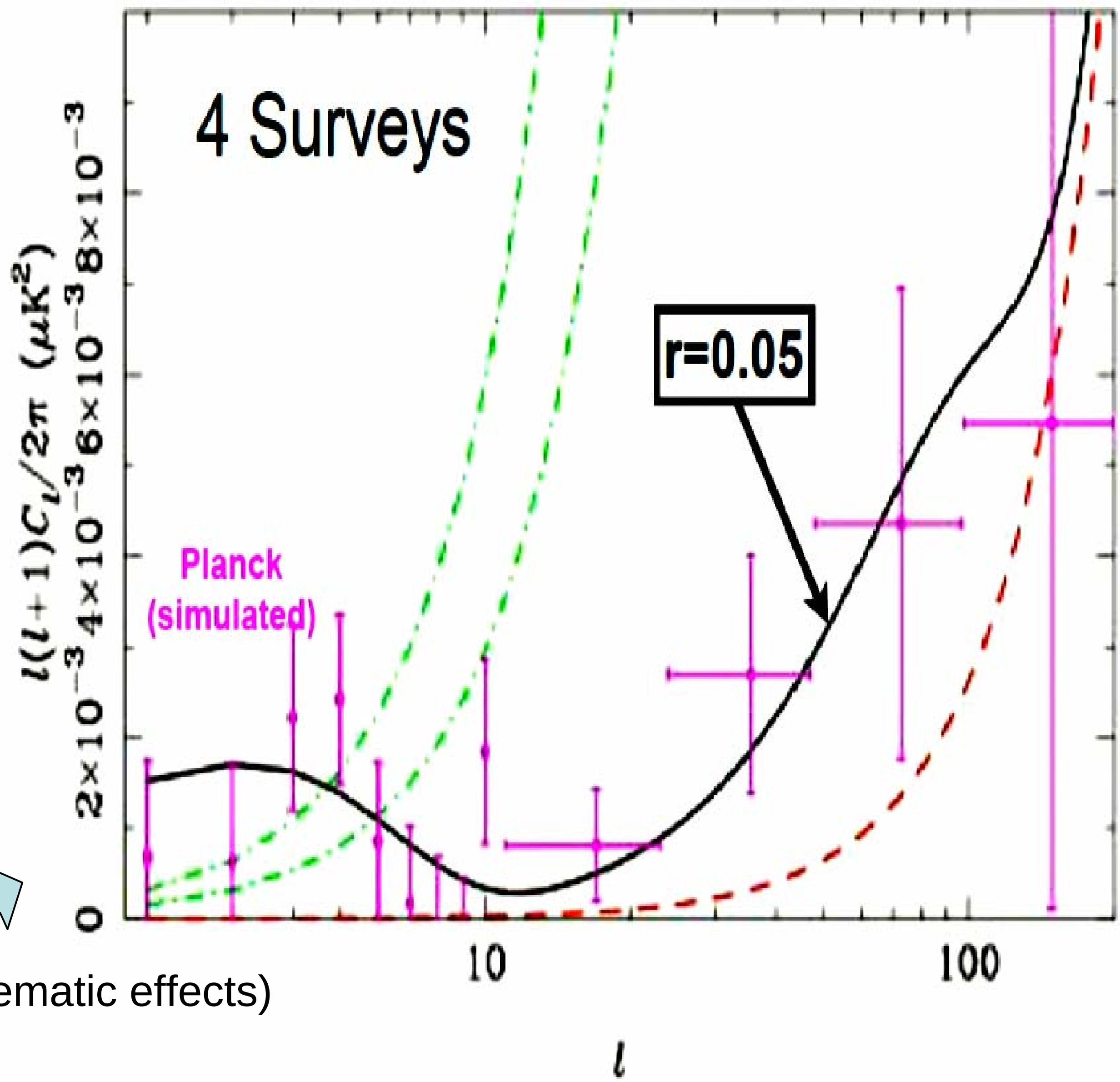
Planck E-modes : astro-ph/1303.5062

PLANCK



B-mode polarization results before the end of 2014

Expected performance (neglecting uncorrected systematic effects)

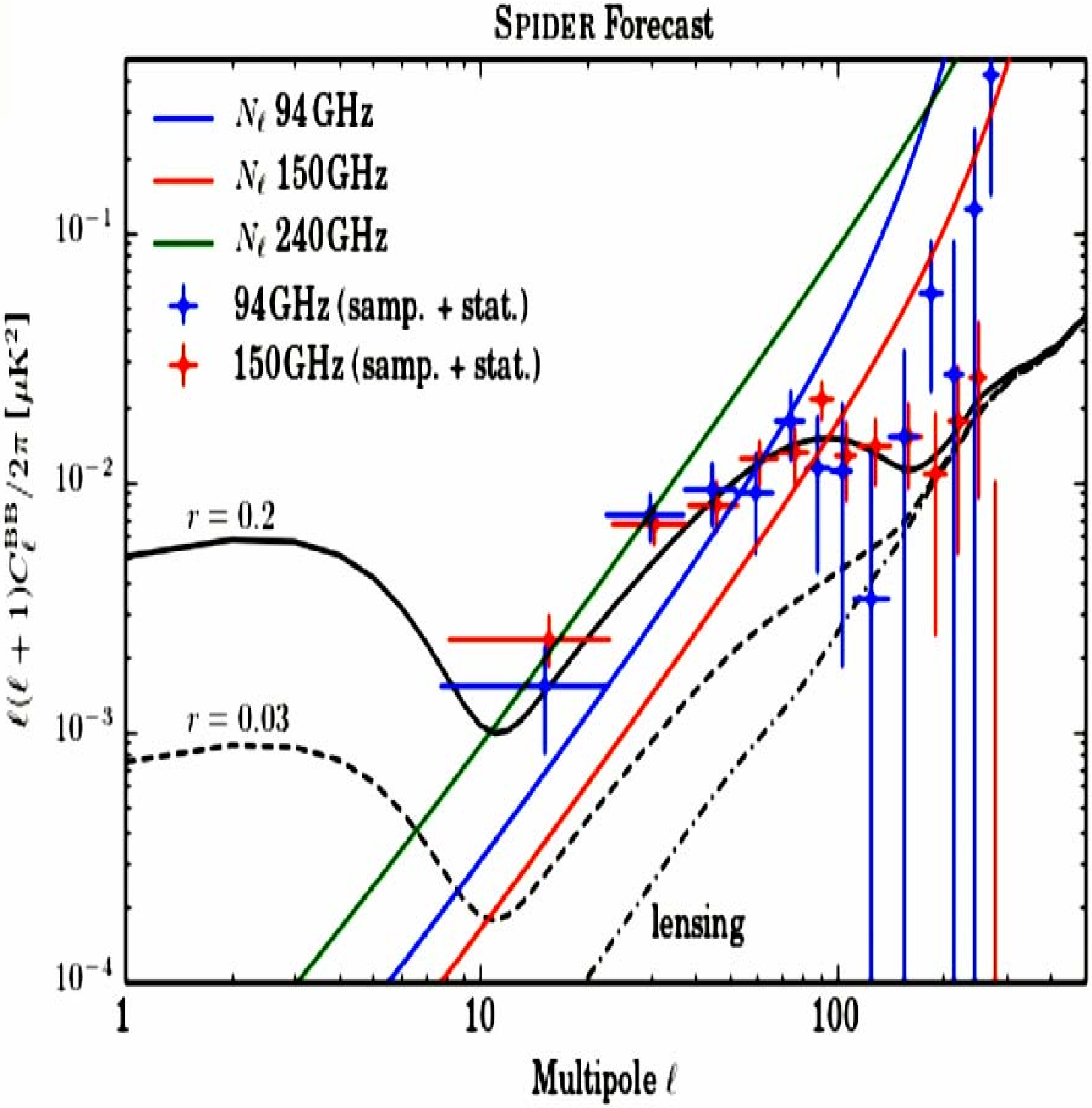


There are a lot of CMB polarization experiments already under way or very far along

- ACT
- KECK
- CLASS
- EBEX
- PIPER
- PIXIE
- POLARBEAR
- SPTpol
- SPIDER
- LSPE
- …..

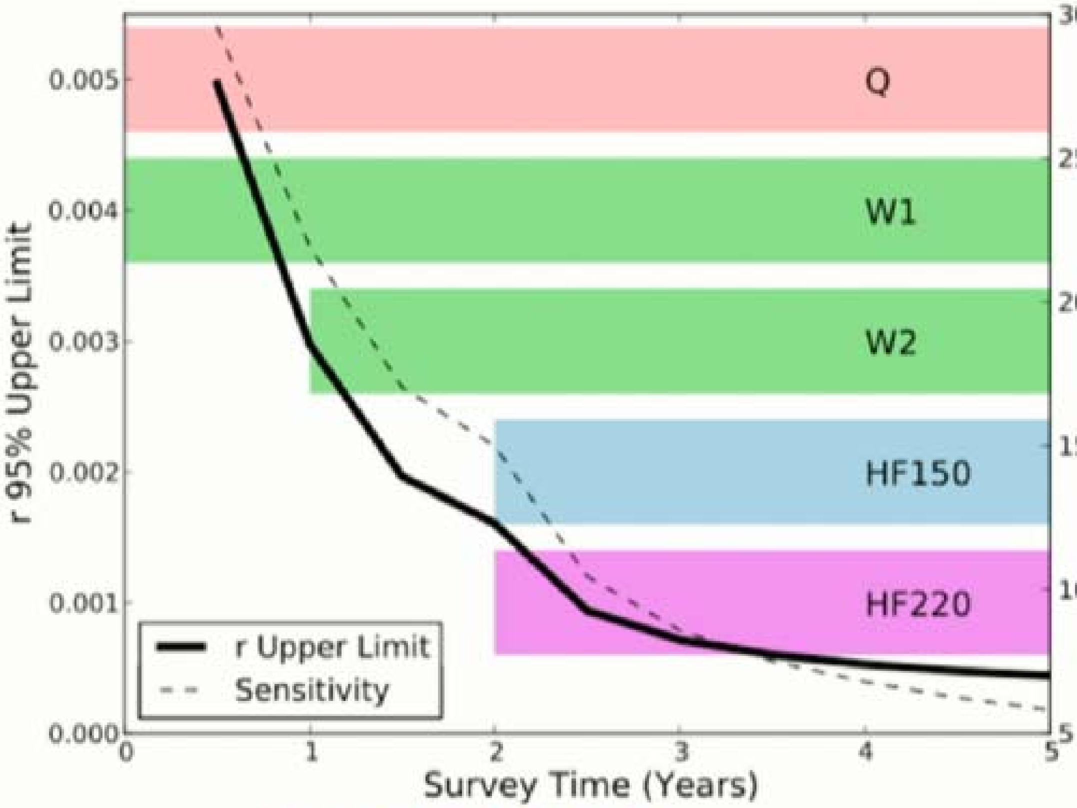

KECK
(spud)
2560 TES
5 cameras
Two colours
•Data from 2012 & 2013 seasons in hand.
•9.5 μK rt s
•Now with two cameras at 95 GHz

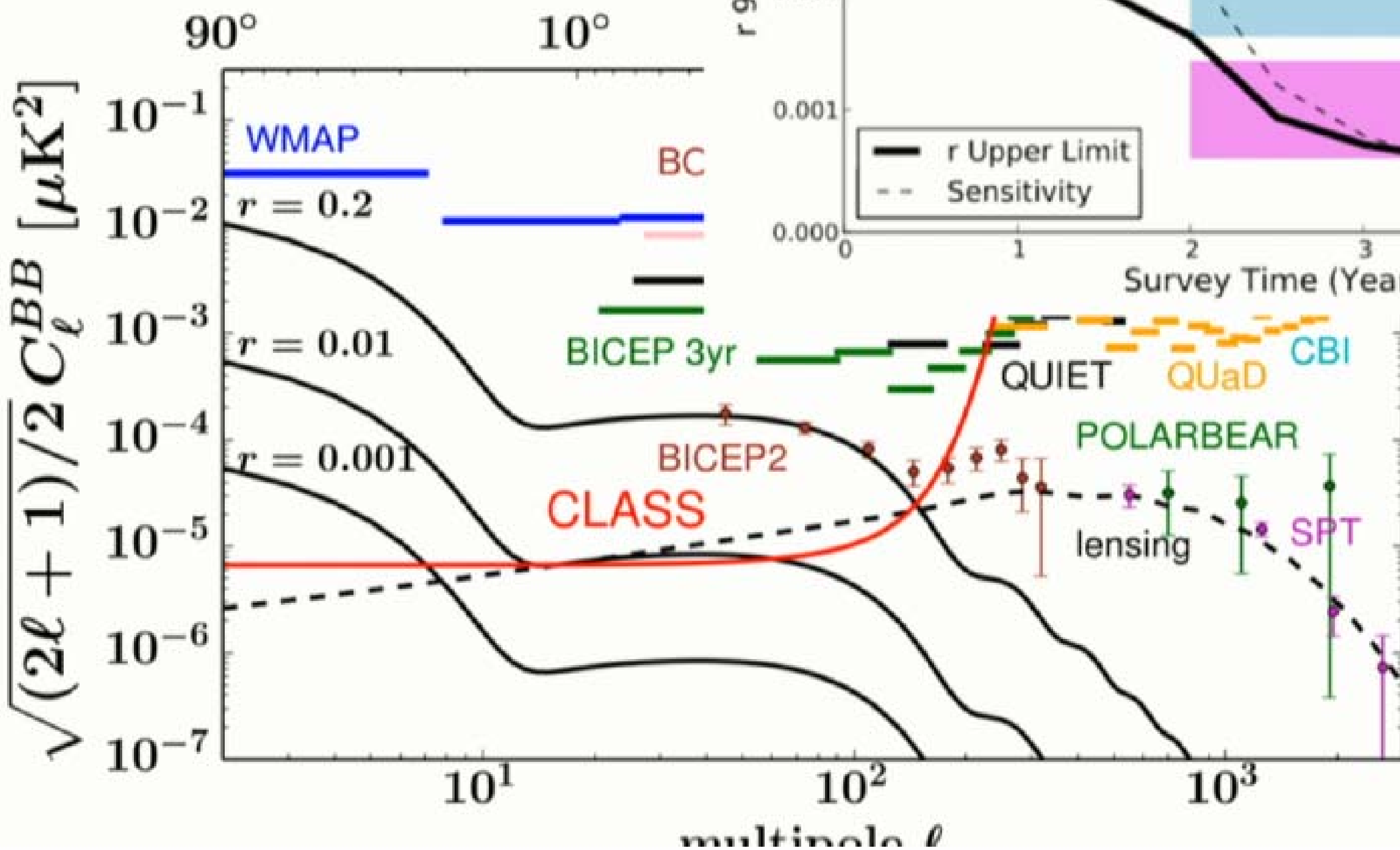
SPIDER

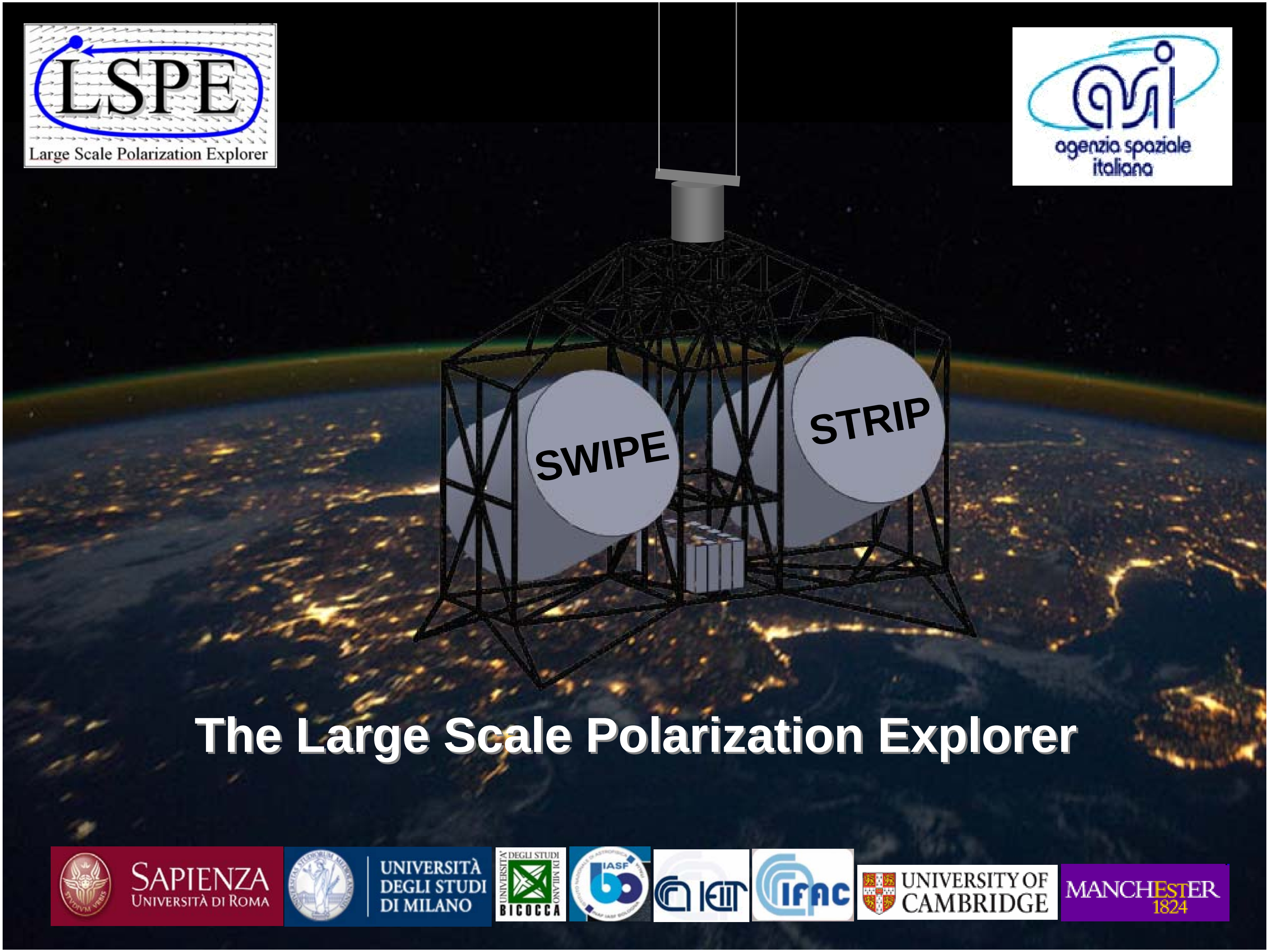

SPIDER Forecast
N_ℓ 94 GHz
N_ℓ 150 GHz
N_ℓ 240 GHz
94GHz (samp. + stat.)
150GHz (samp. + stat.)
$r = 0.2$
$r = 0.03$
lensing
$\ell(\ell+1)C_\ell^{BB}/2\pi\ [\mu K^2]$
10^{-1}
10^{-2}
10^{-3}
10^{-4}
1
10
100
Multipole ℓ

CLASS will deploy a 40 GHz and a 90 GHz channel this year.

The telescope scans 70% of the sky and is designed to explore the re-ionization peak.





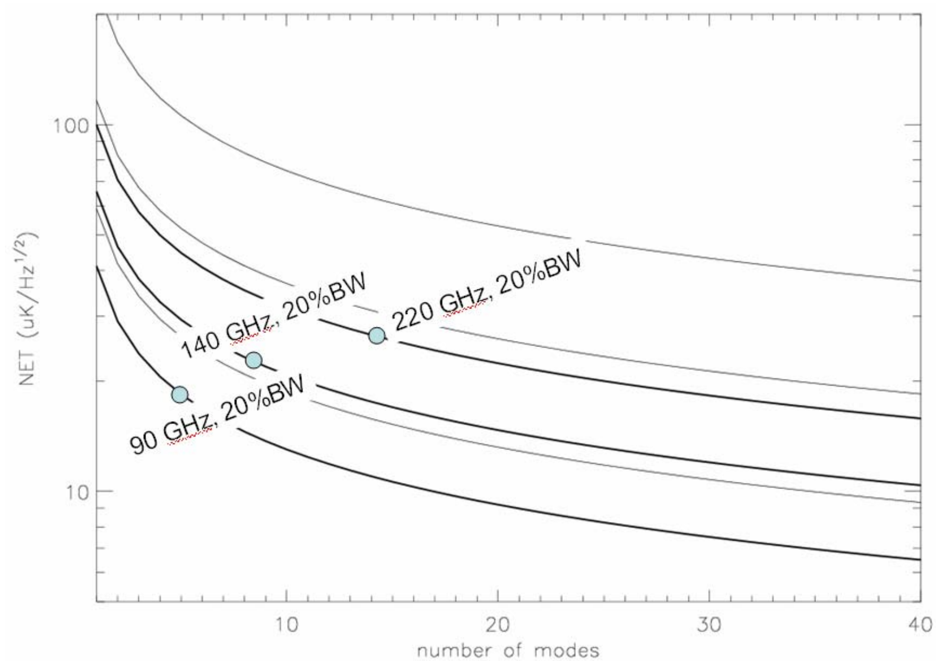

LSPE
Large Scale Polarization Explorer
agenzia spaziale italiana
SWIPE
STRIP
The Large Scale Polarization Explorer
SAPIENZA UNIVERSITÀ DI ROMA
UNIVERSITÀ DEGLI STUDI DI MILANO
UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA
IASF
IFAC
UNIVERSITY OF CAMBRIDGE
MANCHESTER 1824

LSPE in a nutshell

- The Large-Scale Polarization Explorer is
  - a spinning stratospheric balloon payload
  - flying long-duration, in the polar night
  - aiming at CMB polarization at large angular scales
  - using polarization modulators to achieve high stability
- Frequency coverage: 40 – 250 GHz (5 channels)
- Angular resolution: 1.5 – 2.3 deg FWHM
- Sky coverage: 20-25% of the sky per flight – target both reionization bump and horizon bump.
- Combined sensitivity: 10 μK *arcmin* per flight

SWIPE

- The **S**hort **W**avelength **I**nstrument for the **P**olarization **E**xplorer
- Uses overmoded bolometers, trading angular resolution for sensitivity
- Sensitivity of photon-noise limited bolometers vs # of modes:



Number of modes actually coupling to the bolometer absorber

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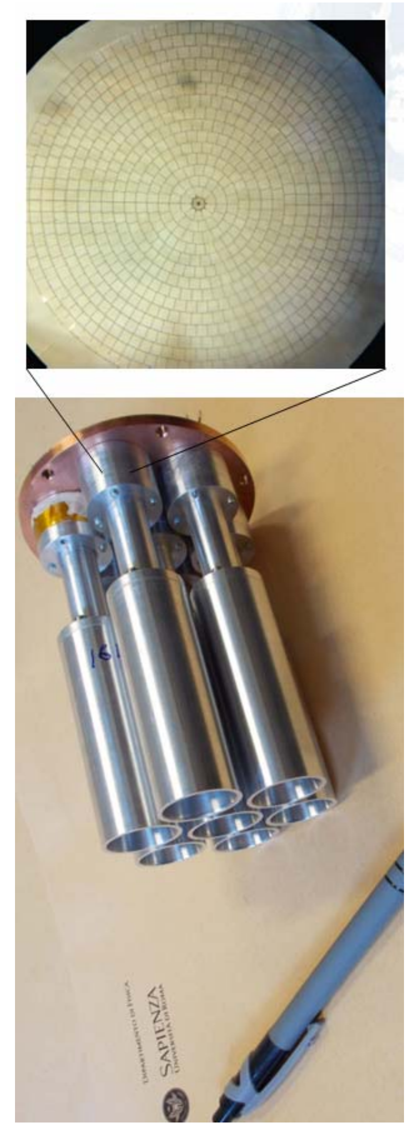
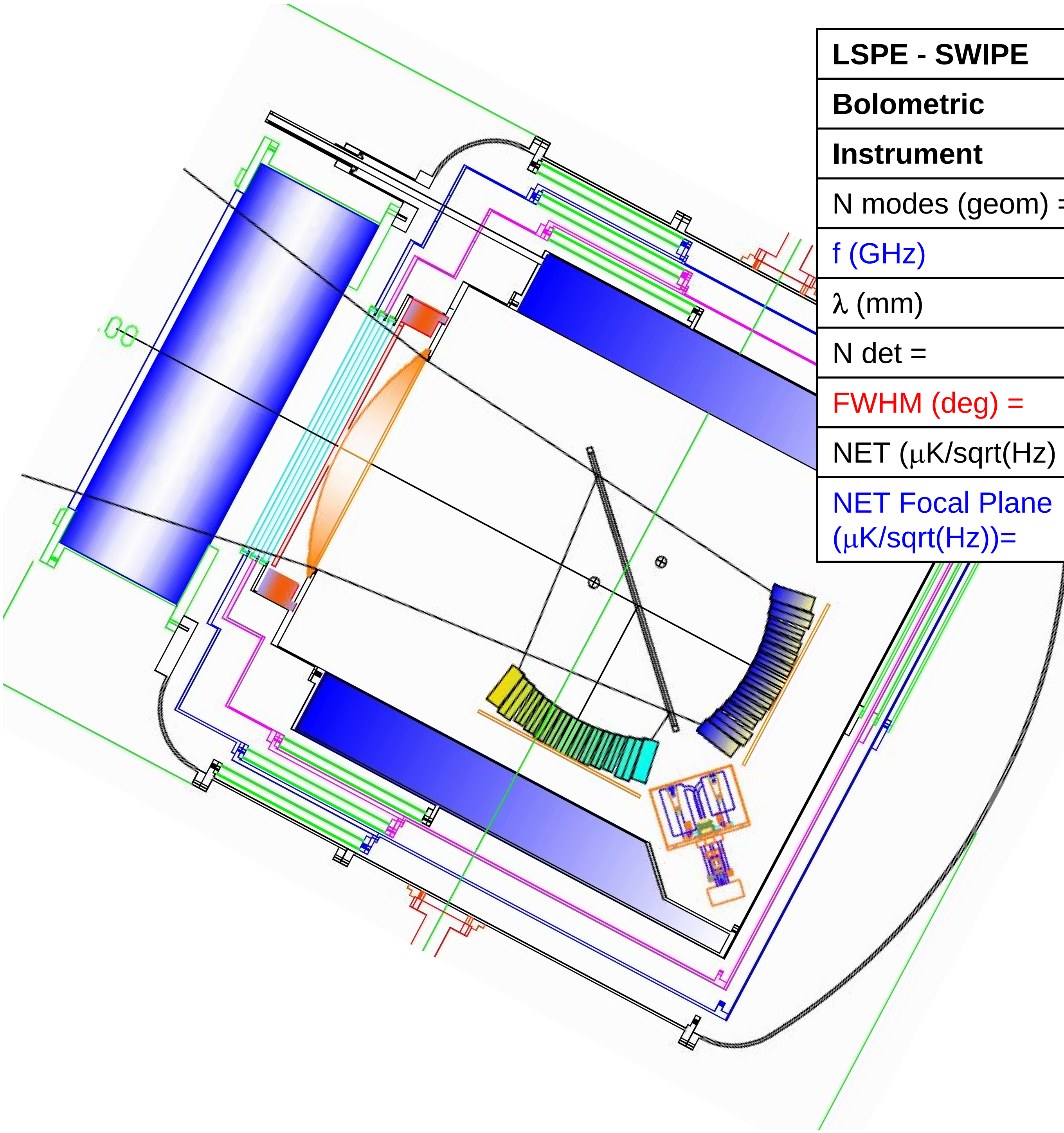




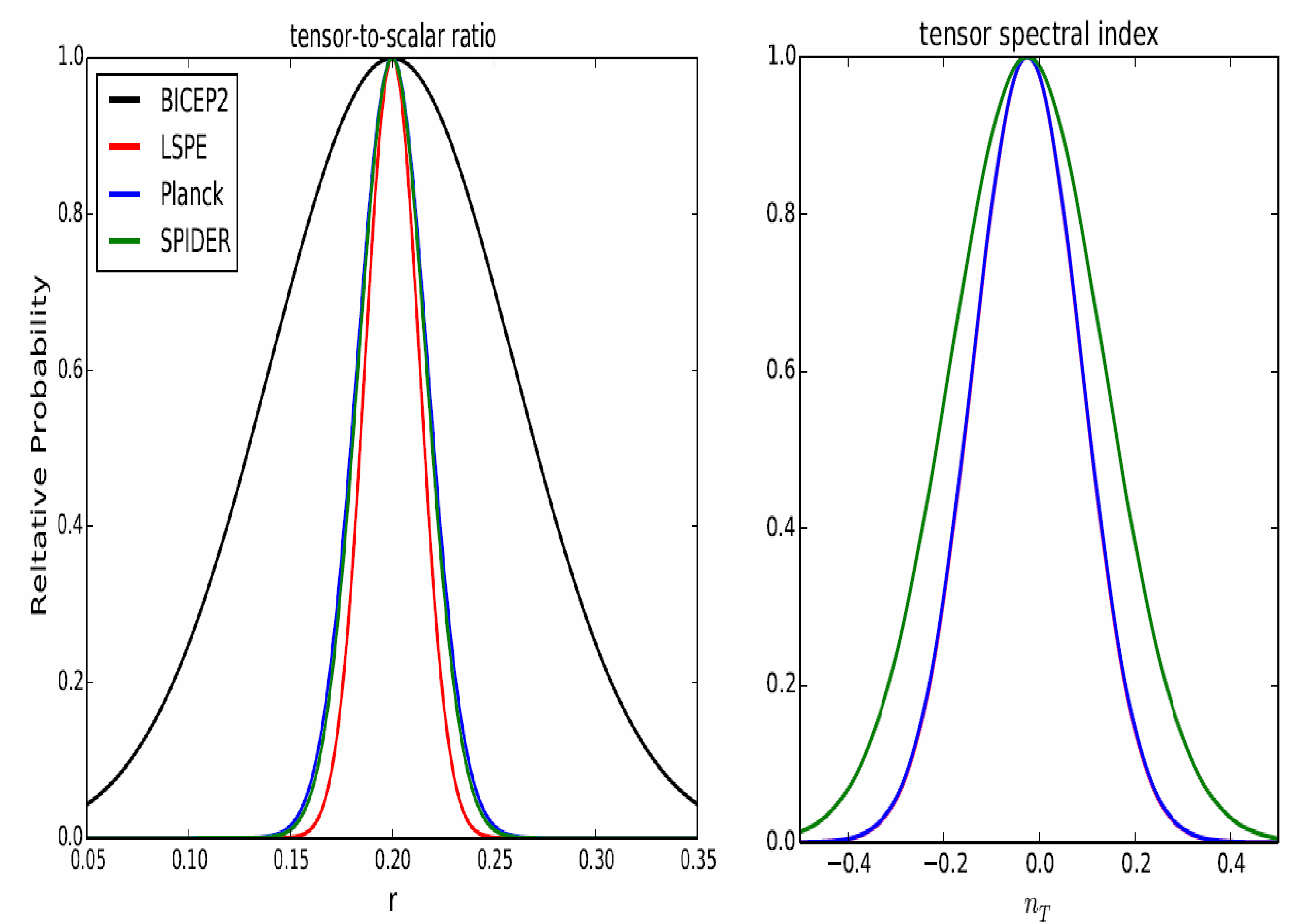
LSPE - SWIPE	eff =	0.25	
Bolometric	D lens =	0.4	m
Instrument	F =	0.8	m
N modes (geom) =	15	25	40
f (GHz)	90	145	220
λ (mm)	3.3	2.1	1.4
N det =	37	58	83
FWHM (deg) =	2.4	1.9	1.6
NET (μK/sqrt(Hz)) =	15	25	30
NET Focal Plane (μK/sqrt(Hz))=	**2.5**	**3.3**	**3.2**

Target : r = 0.01
in a single long-duration flight in the polar night
Covering large angular scales

Very much complementary to SPIDER, EBEX

Flight in 2016

Winter flights recently demonstrated from Longyearbyen (78N)



Simulazioni: Luca Pagano

Nessun effetto sistematico

Advantages of LSPE

- … in terms of systematic effects:
  - Designed as a polarimeter from the very beginning - Polarization modulation obtained with a rotating HWP
  - Wide frequency coverage (all foregrounds monitored)
  - Wide sky coverage (winter flights, northern hemisphere)
  - Clean beam patterns (multimoded horns)

Detector technology for LSPE

- Low frequecy channels: coherent integrated radiometers from JPL (44, 90 GHz)

- High frequency channels (90, 140, 220 GHz) : multimode detectors, possibly made in Italy
  - TES (ASI - mm-wave technologies)
  - KIDs (INFN - CSN 5, RIC)

E tion Systems

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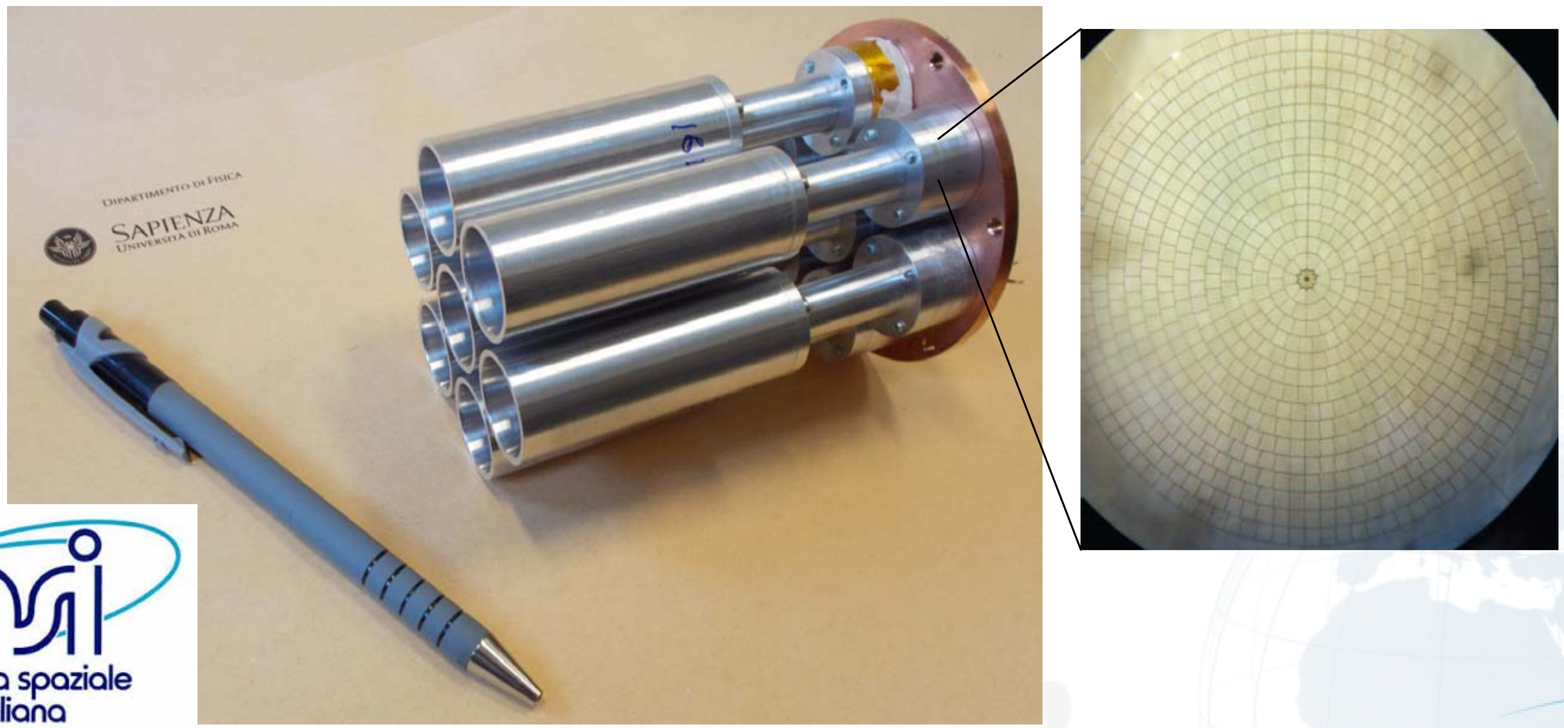
- **Introduction (PdB)**
- **Detector Array Design & Mfg 231-2AD – UniRoma1 (PdB)**
- **FE Electr. Design & Mfg 232-2AD – TAS-I (Massimilano Pecora)**
- **Detector Chips Design & Mfg 233-2BA – UniGe (Flavio Gatti)**
- **Test – UniRoma1 – 234-2BA (PdB)**



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Design & Mfg 231-2AD

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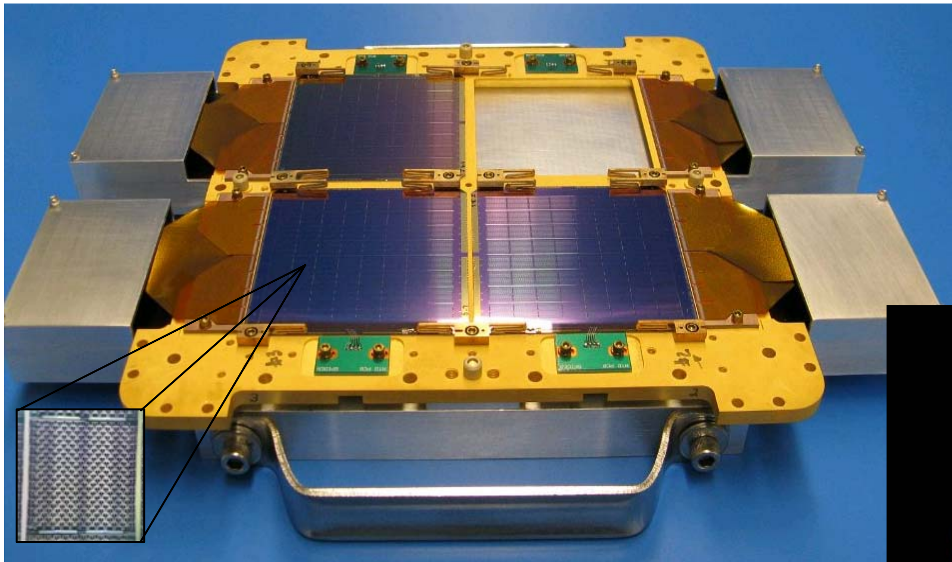
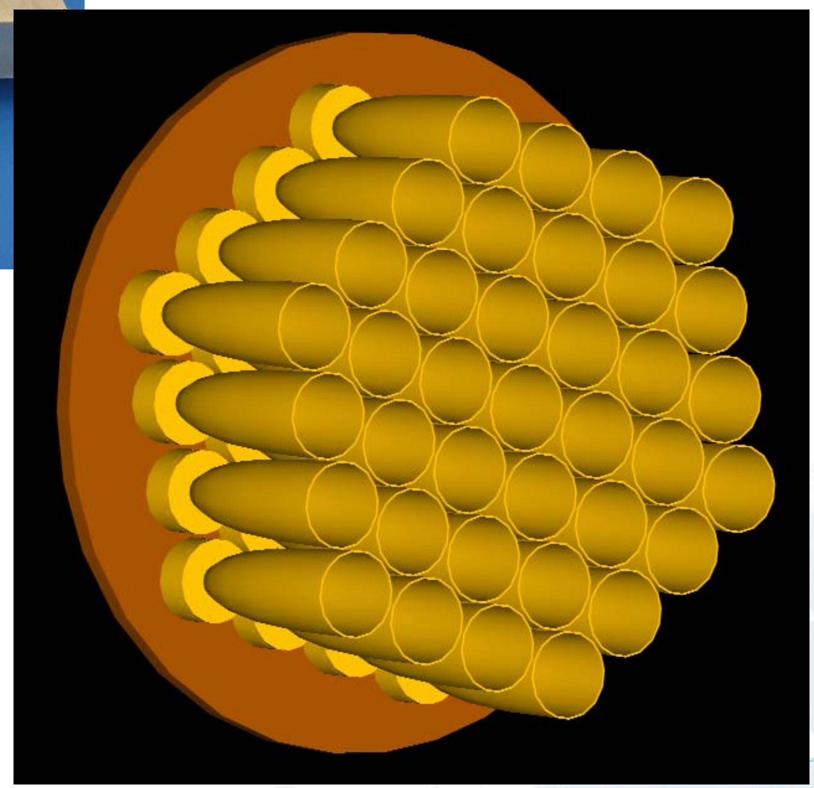


SPIDER focal plane.
2048 pixels, diffraction limited
Several M$



LSPE focal plane (1/2).
37 pixels, multimoded
Low-cost

agenzia spaziale italiana

ThalesAlenia Space
A Thales / Finmeccanica Company

Design & Mfg 231-2AD

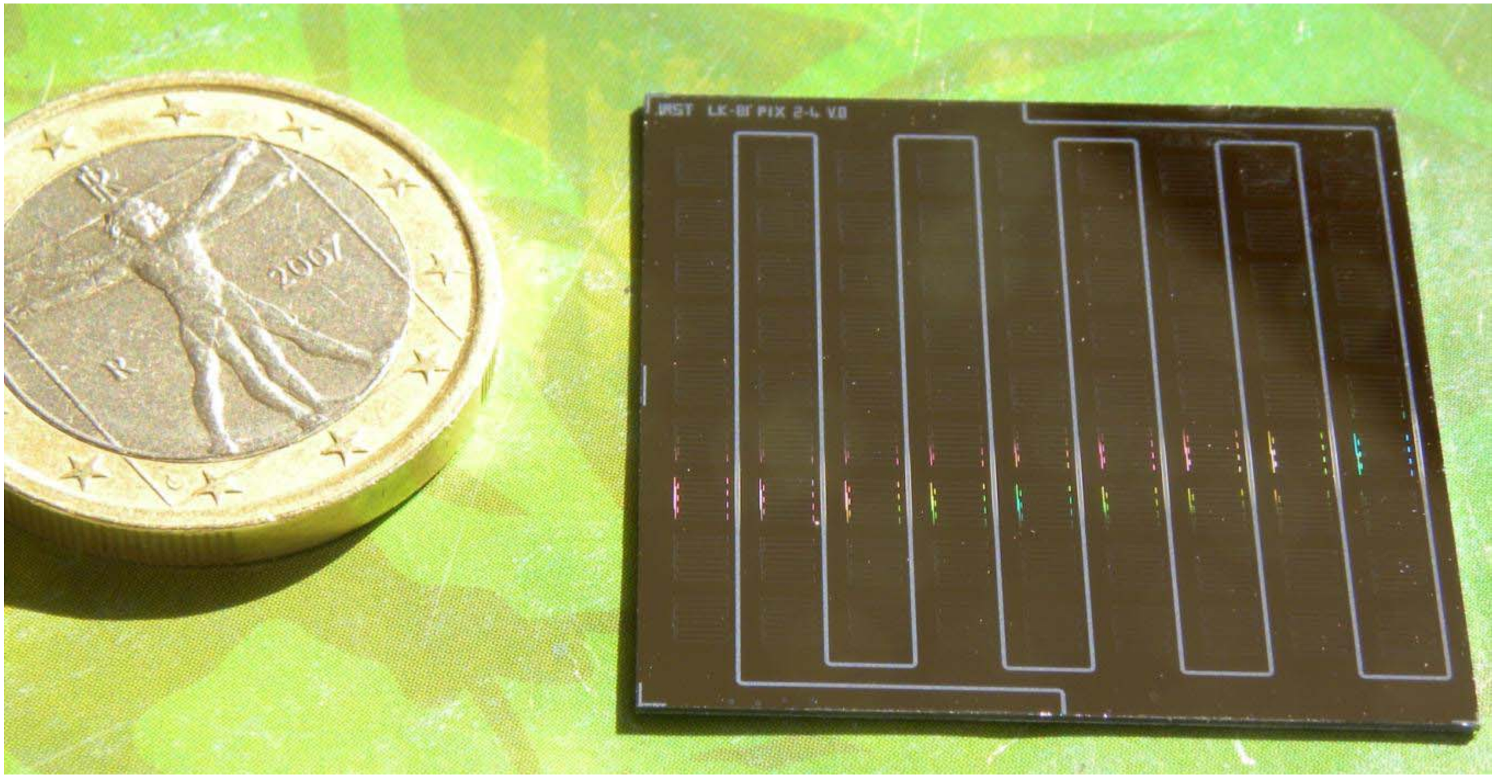
SPIDER focal plane.
2048 pixels, diffraction limited
Several M$

SAME SURVEY SENSITIVITY

LSPE focal plane (1/2).
37 pixels, multimoded
Low-cost

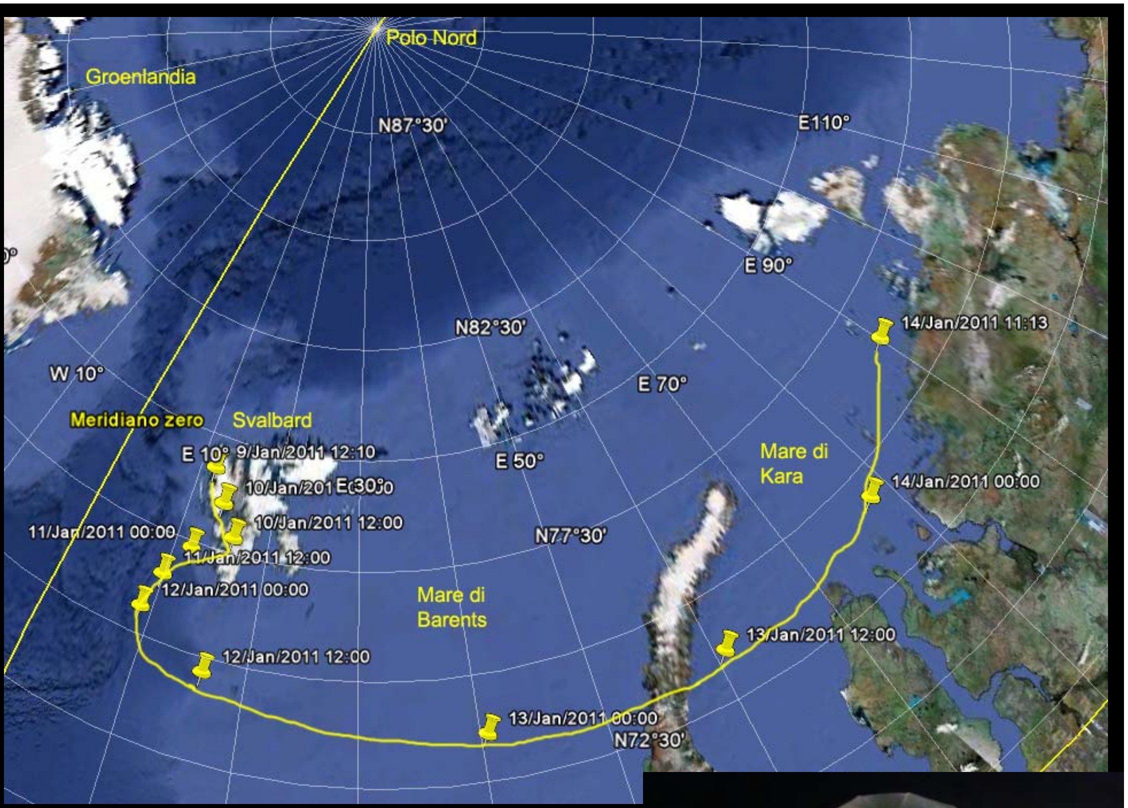
KIDs

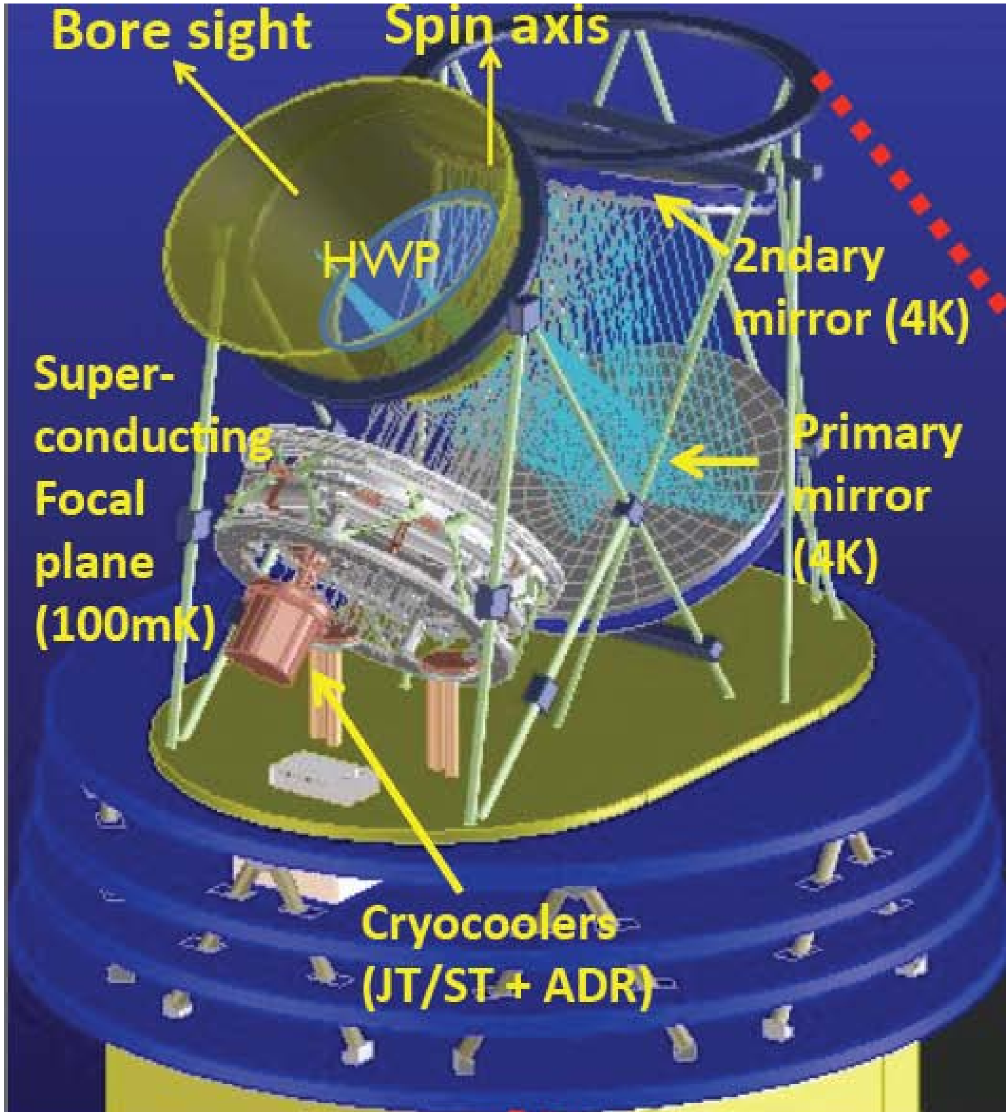
- INFN CSN5 activity RIC (2007-2009):
  - Kinetic inductance detectors
  - made in Italy (fabrication @FBK, design and test @Sapienza G31)
  - Process well developed, good final performance (Calvo et al. 2010)
- Further developments in sinergy with CALDER
  - fabrication @IFN-CNR, design and test @Sapienza G31)
- Needs optimization for large scale and space use
- Needs dedicated funds



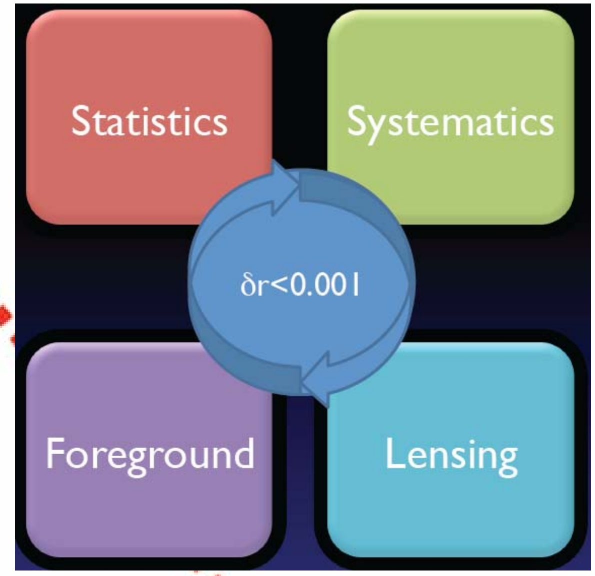
LSPE

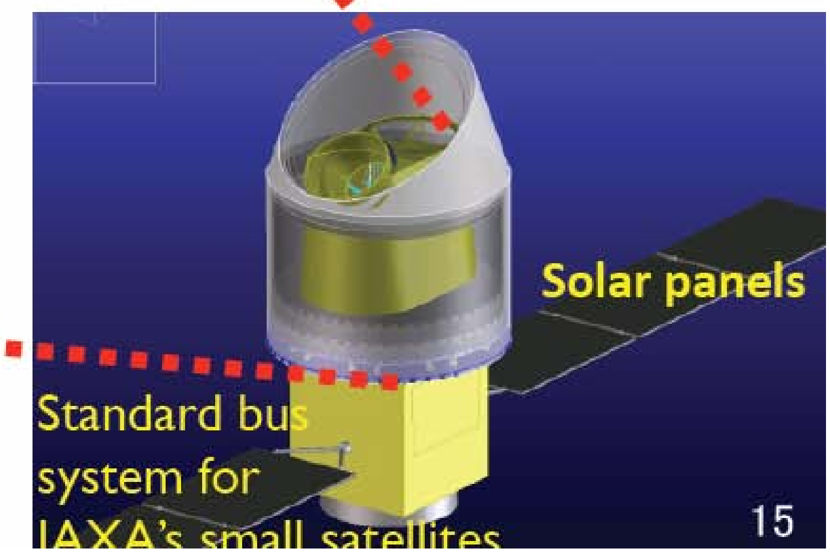
- Design of cryostat, gondola and ACS completed
- Cryostat fabrication started
- SWIPE detectors to be finalized very soon
- Flight in 2016 from Longyearbyen (Svalbard)




Bore sight
Spin axis
HWP
2ndary mirror (4K)
Super-conducting Focal plane (100mK)
Primary mirror (4K)
Cryocoolers (JT/ST + ADR)

LiteBIRD

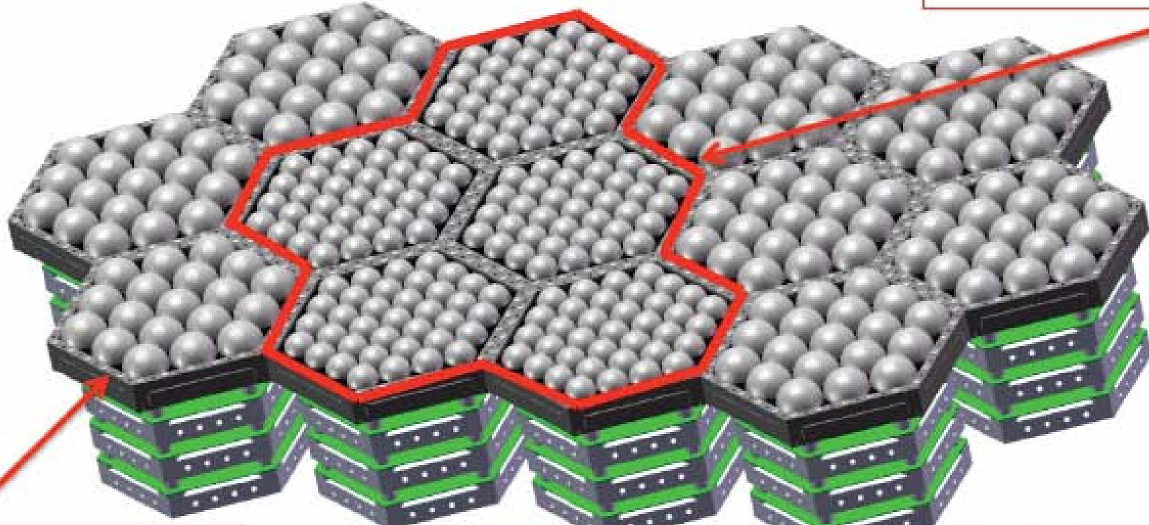

Statistics
Systematics
δr<0.001
Foreground
Lensing


Solar panels
Standard bus system for JAXA's small satellites

LiteBIRD focal plane design

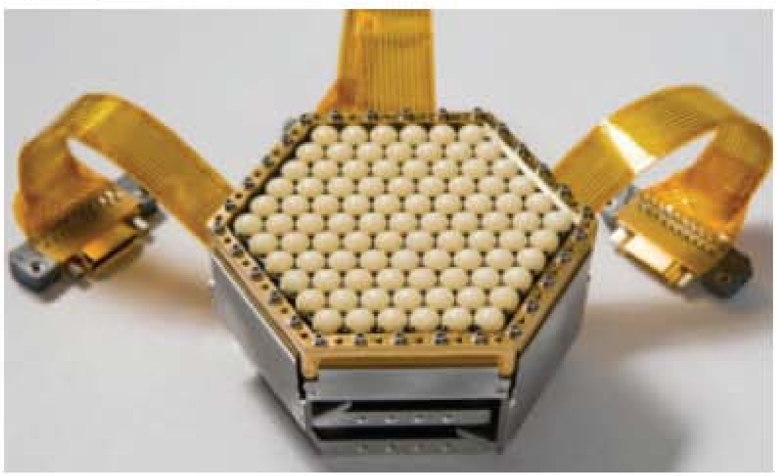
UC Berkeley TES option

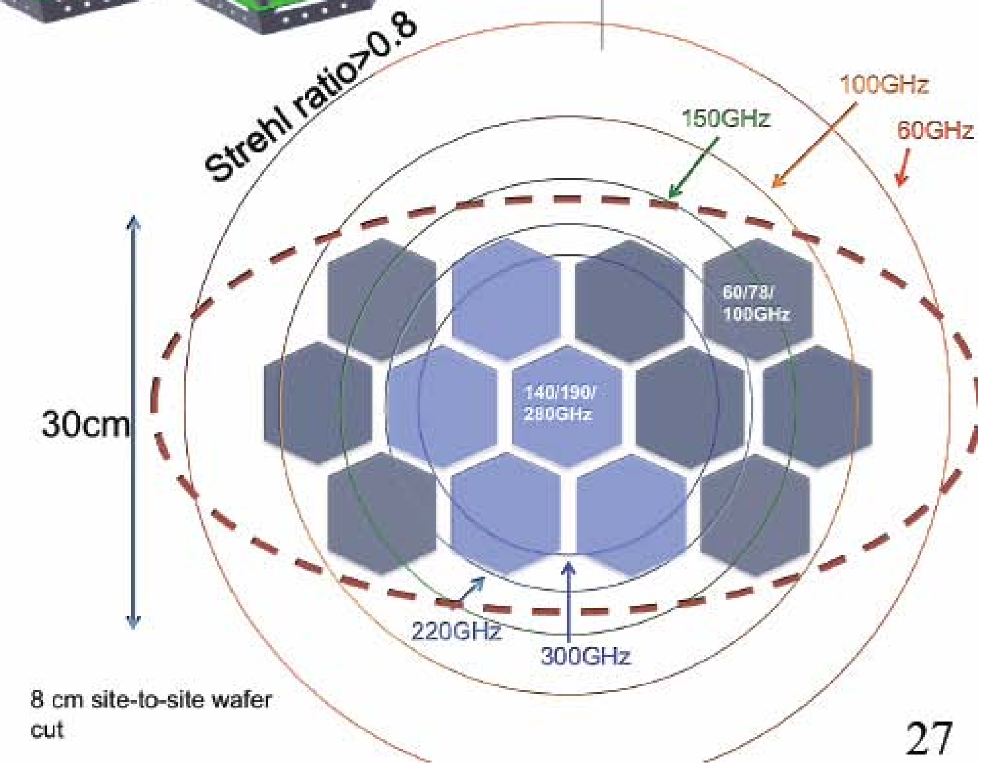
tri-chroic（140/190/280GHz）

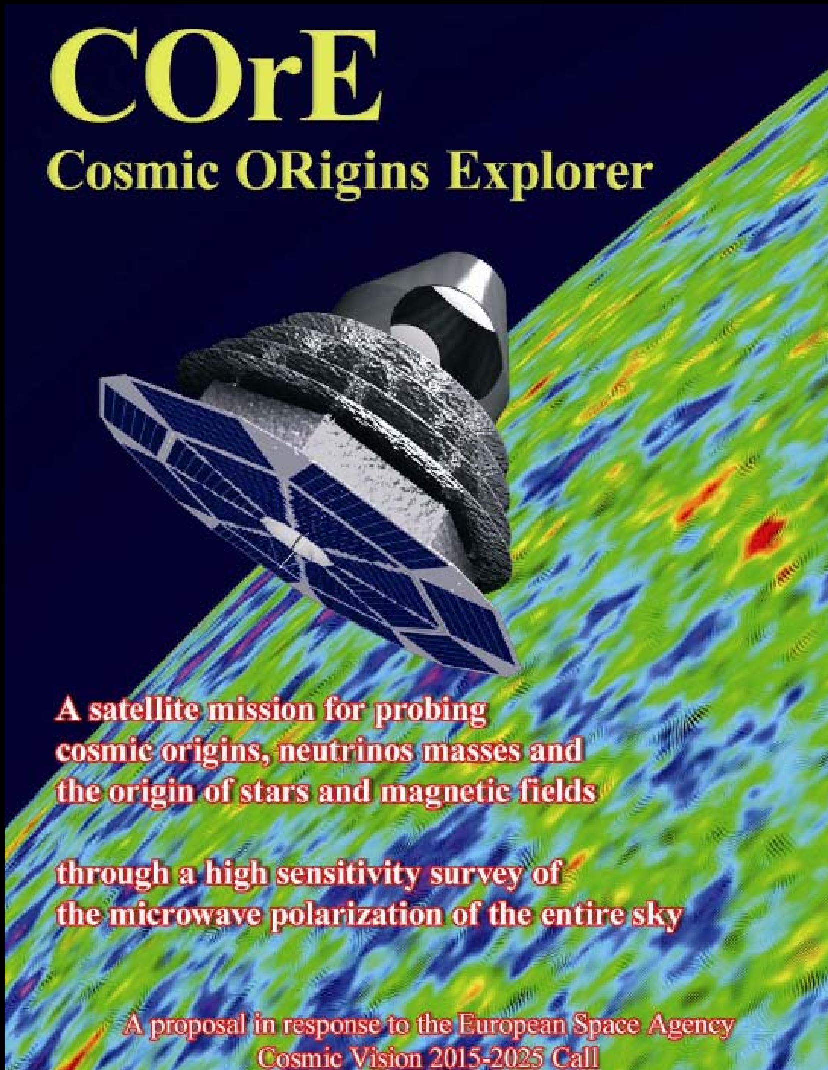


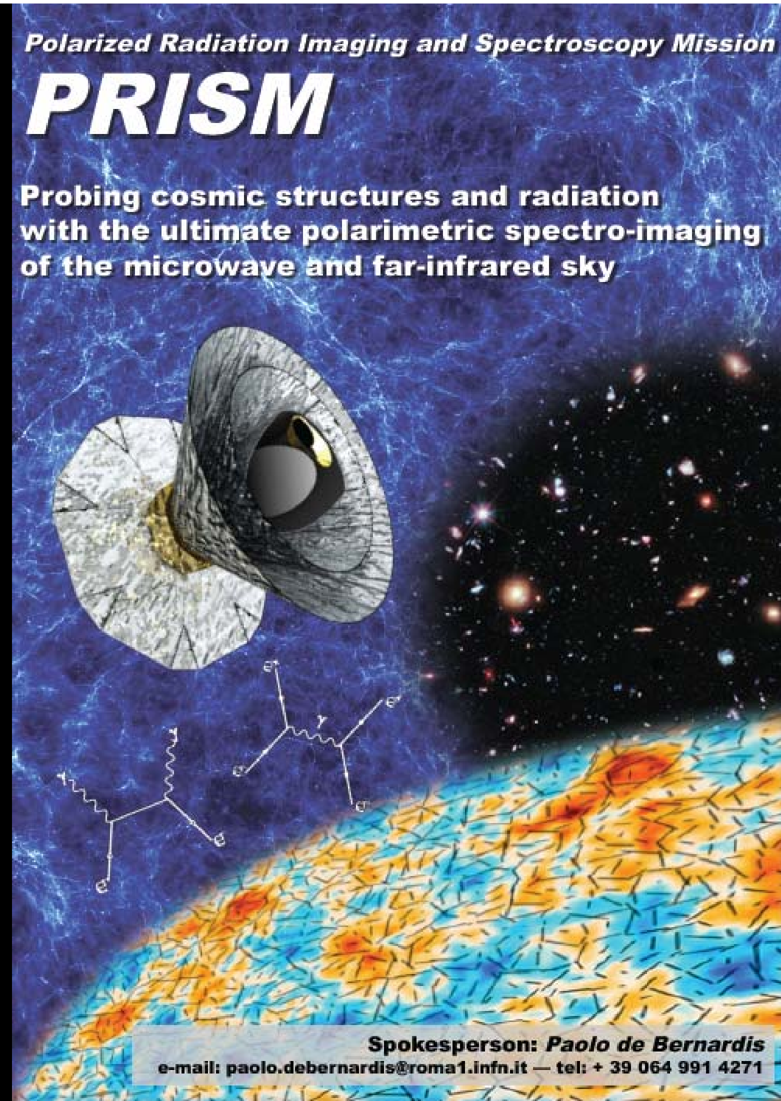
tri-chroic（60/78/100GHz）

$T_{bath} = 100mK$





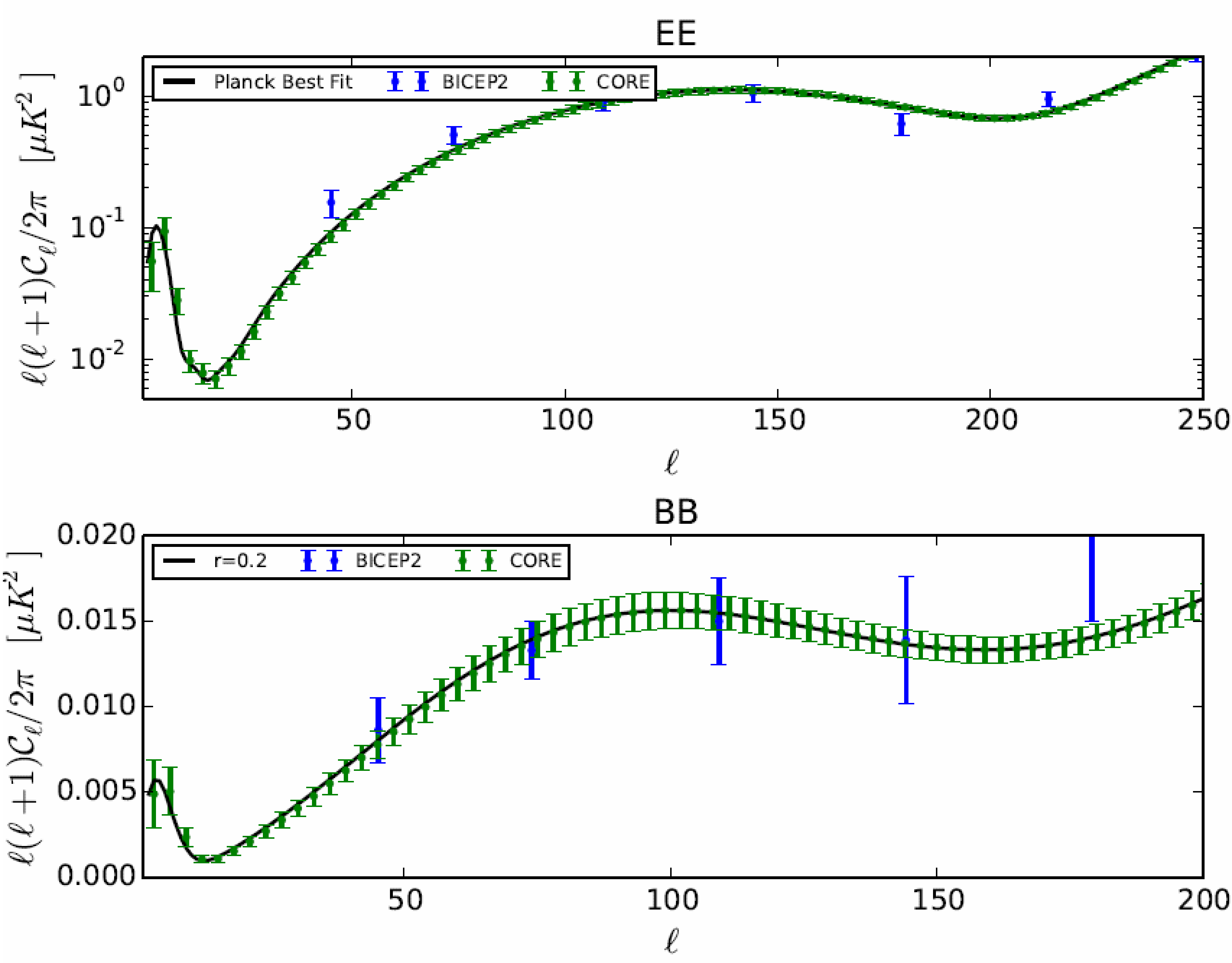




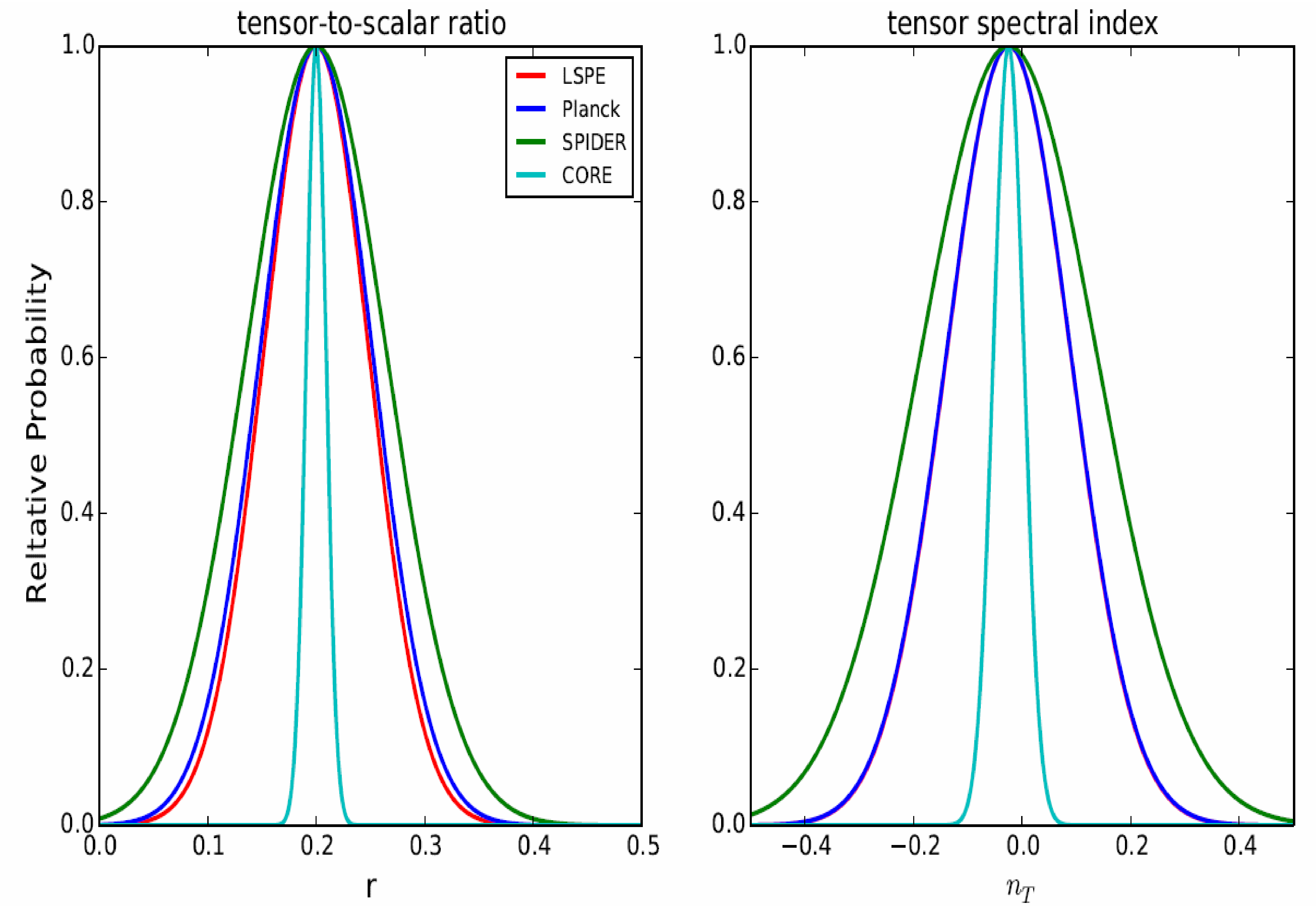
Call for medium missions – 2010-dec-03

Call for science themes for Large Missions 2013-may-24

forthcoming ESA call: M4 medium mission – sometimes in 2014

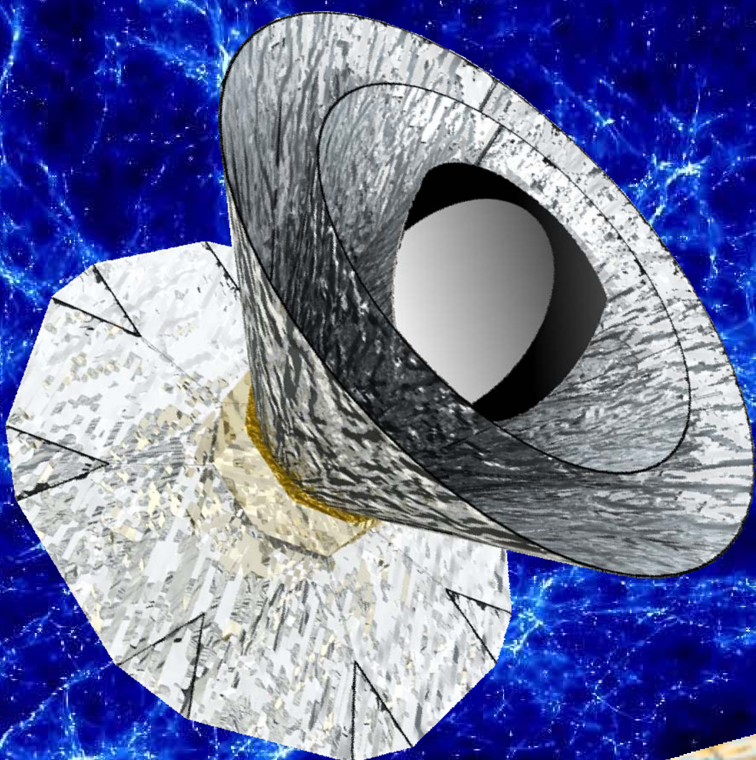


Simulazioni: Luca Pagano



Simulazioni: Luca Pagano

Microwave and Far-IR polarimetric spectroimaging of the full sky

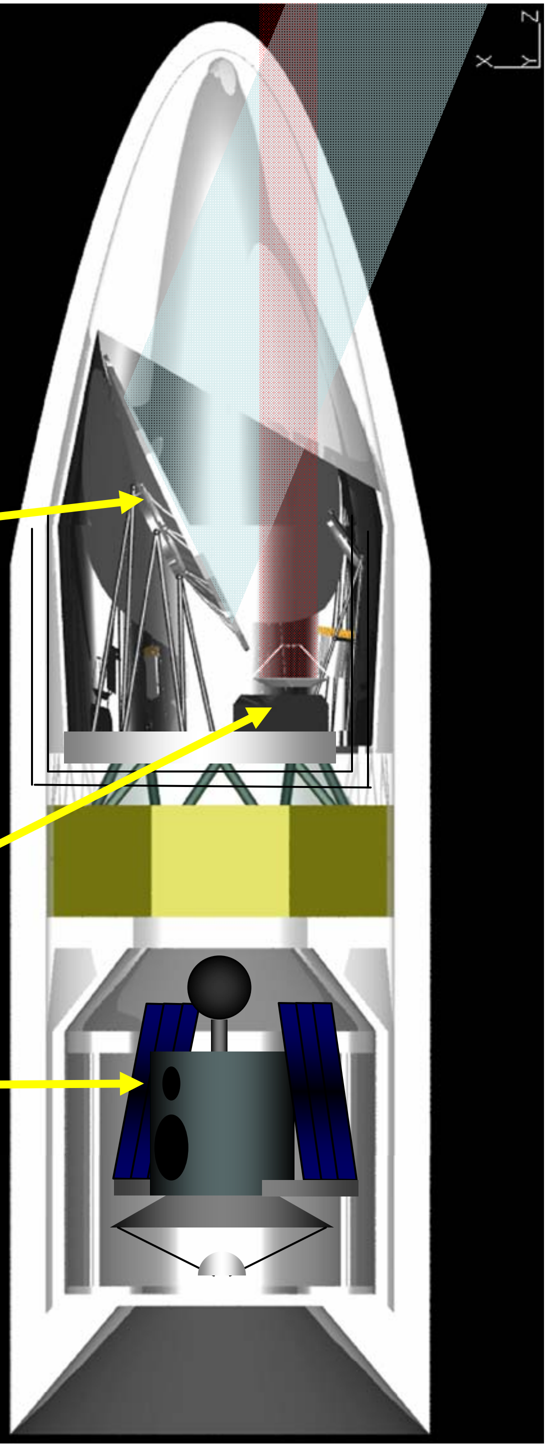


Paolo de Bernardis
Sapienza University of Rome
for the PRISM collaboration
(see www.prism-mission.org)

Science Themes for the L2 and L3 missions
Presentation meeting
3-4 September 2013
Institut Océanographique de Paris

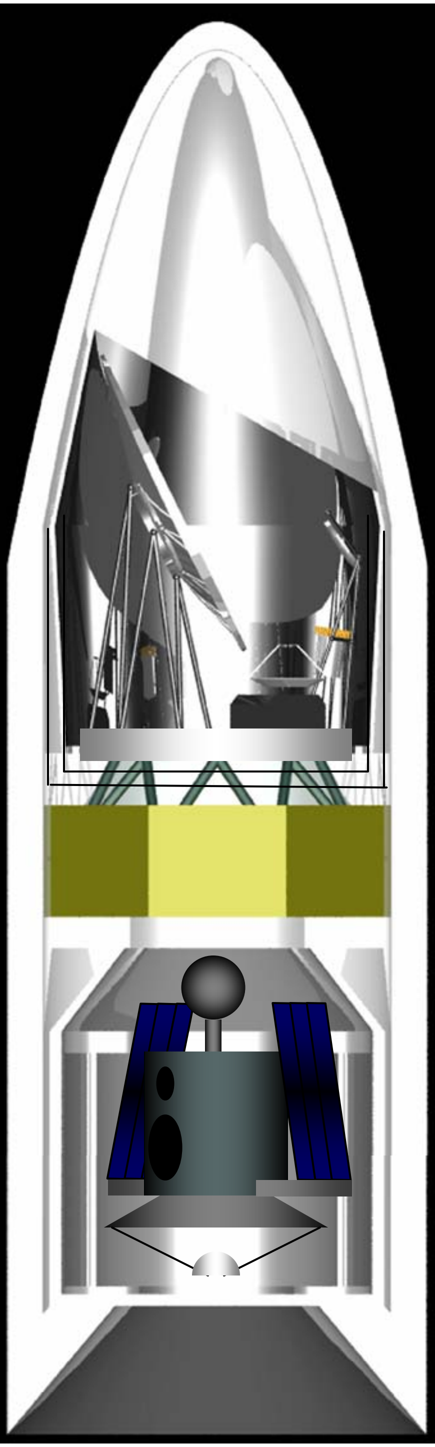
- Proposed implementation
  (www.prism-mission.org)

  - Ariane 5 , orbit around Sun-Earth L2 point
  - Main satellite : two cryogenic instruments:
    - Wide-field polarimetric imager (3.5m telescope @ 10K, 7000+ bolometers @ 0.1K)
    - Absolute spectrometer (FTS @ 2.7K, 0.5-15 GHz resolution)
  - Ancillary satellite for
    - precision instruments calibration
    - High-datarate TM relay



Strawman mission

- PRISM will cover the 30 GHz – 6 THz frequency range with two instruments:
  - A thousands-pixels **polarimetric imager** with 30 broad *diffraction limited* bands ($\Delta\nu/\nu \approx 0.25$), plus Galactic lines monitors (either narrow bands or spectrometers on chip with $\delta\nu/\nu \approx 0.025$). Its sensitivity will be limited by intrinsic photon noise, minimized by cooling the 3.5m telescope to <10K. Its optical axis is offset from the spin axis by 30°.
  - An **absolute spectrometer** cooled to 2.7K, with an angular resolution of 1.4°, and both a high and a low spectral resolution observing mode ($\Delta\nu \approx 0.5$ GHz and 15 GHz respectively). Its optical axis is aligned to the spin axis.
- The platform will orbit around the **L2** Sun-Earth Lagrange point.
- A **companion satellite** will provide c**alibrators** for in-flight beam and polarization mapping, and a high-gain pointing antenna for high data-rate telemetry.



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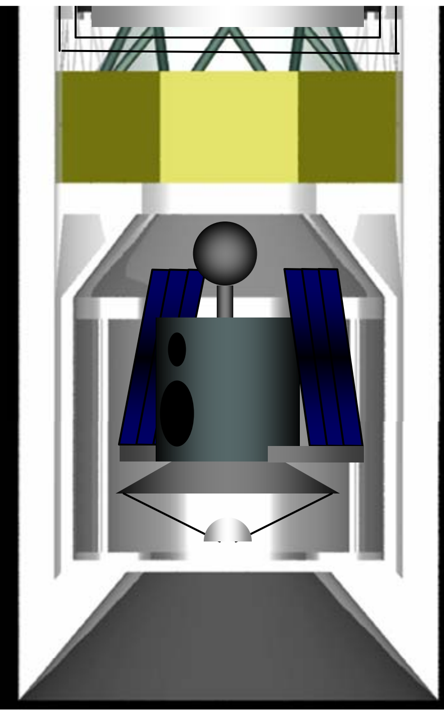
Imagine a super Herschel-SPIRE, with
- full sky coverage
- colder telescope (100x sensitivity)
- many more bands
- polarimetric capability

Also super-Planck
- 100x more detectors
- 3-5x resolution
- many more bands



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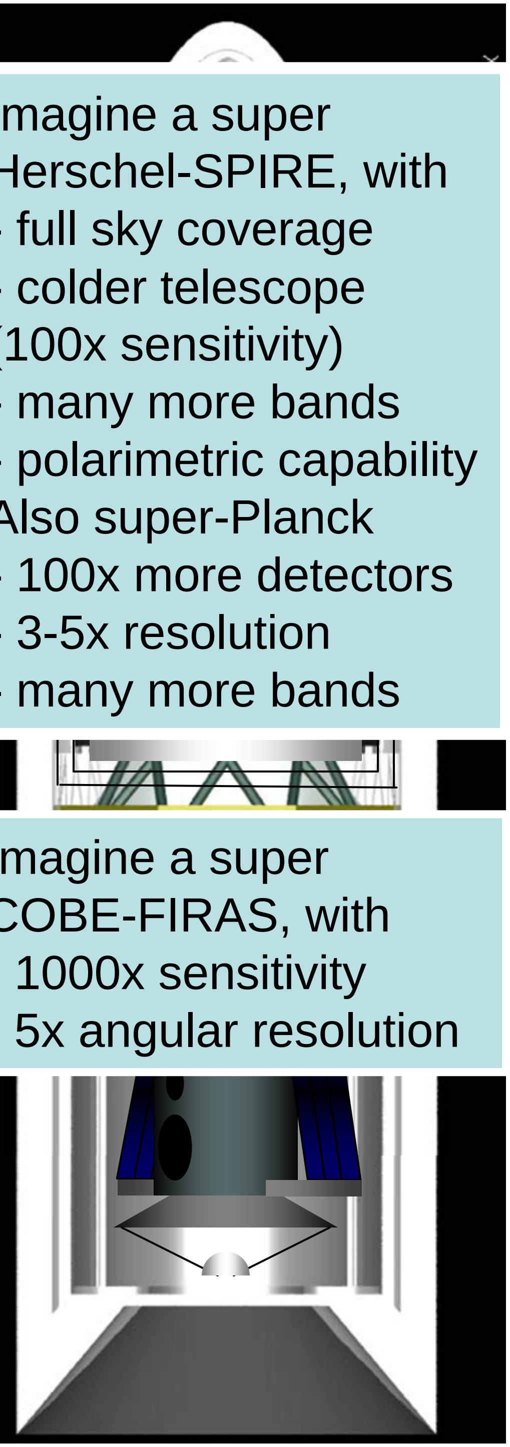
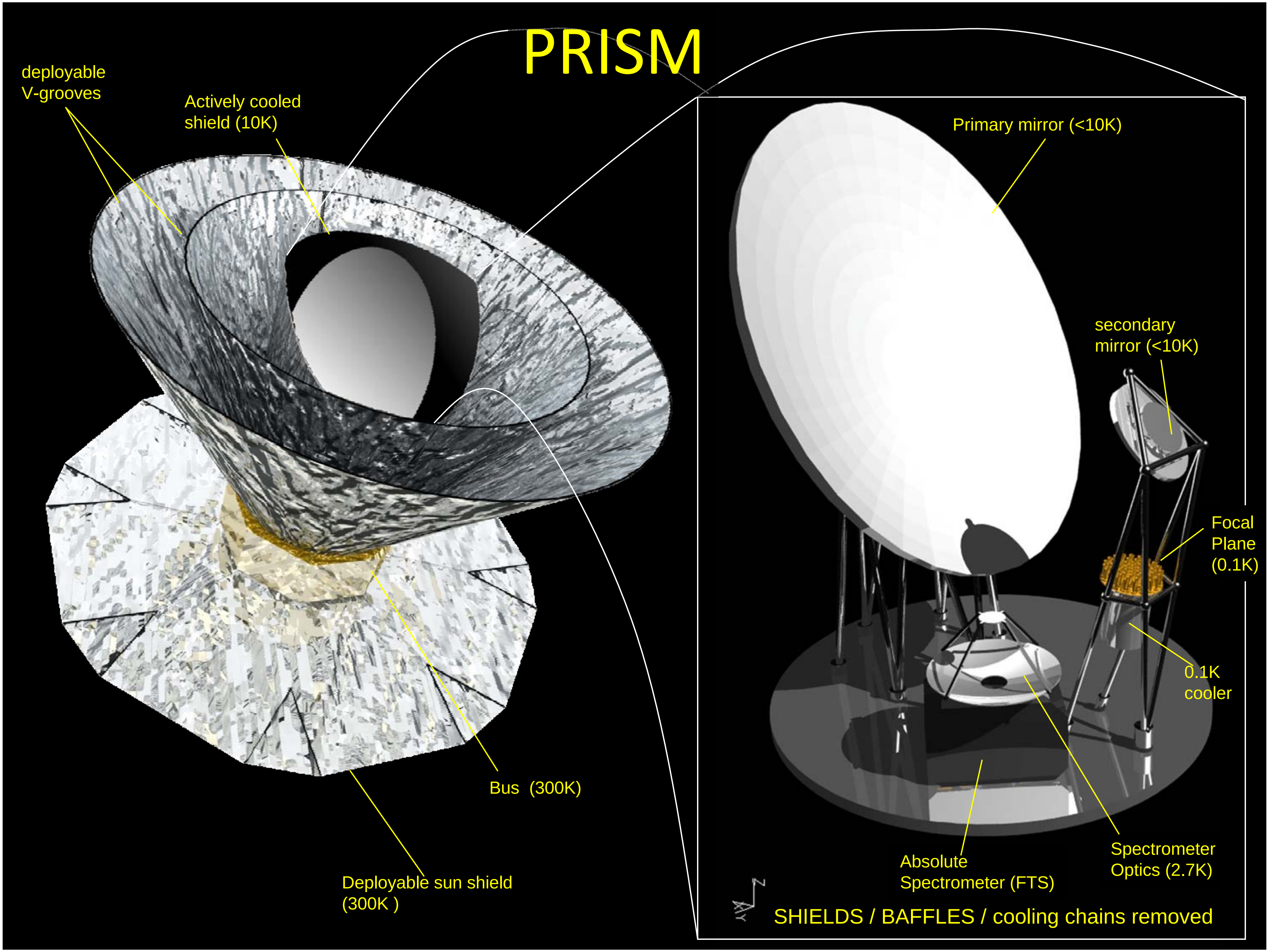
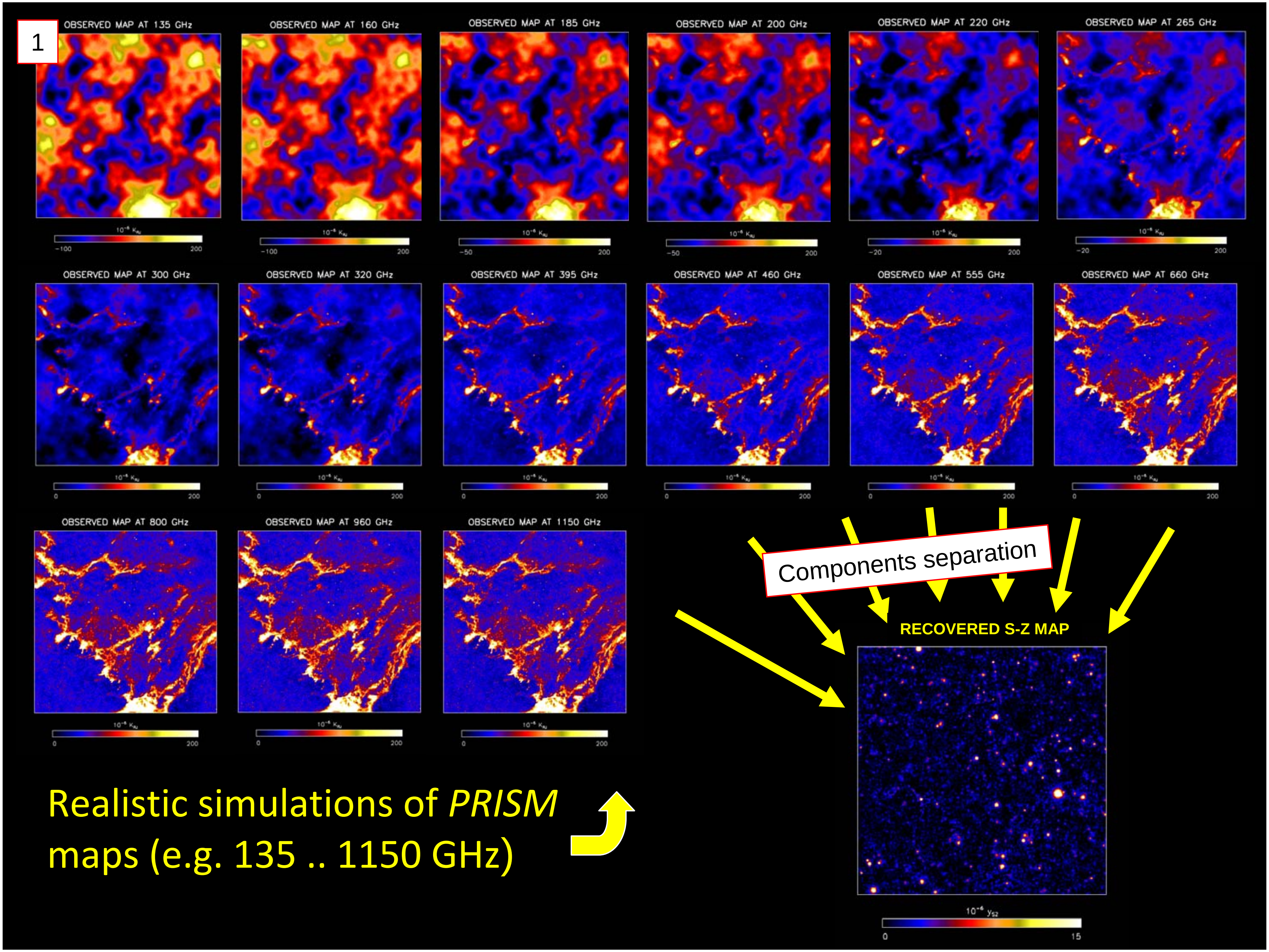


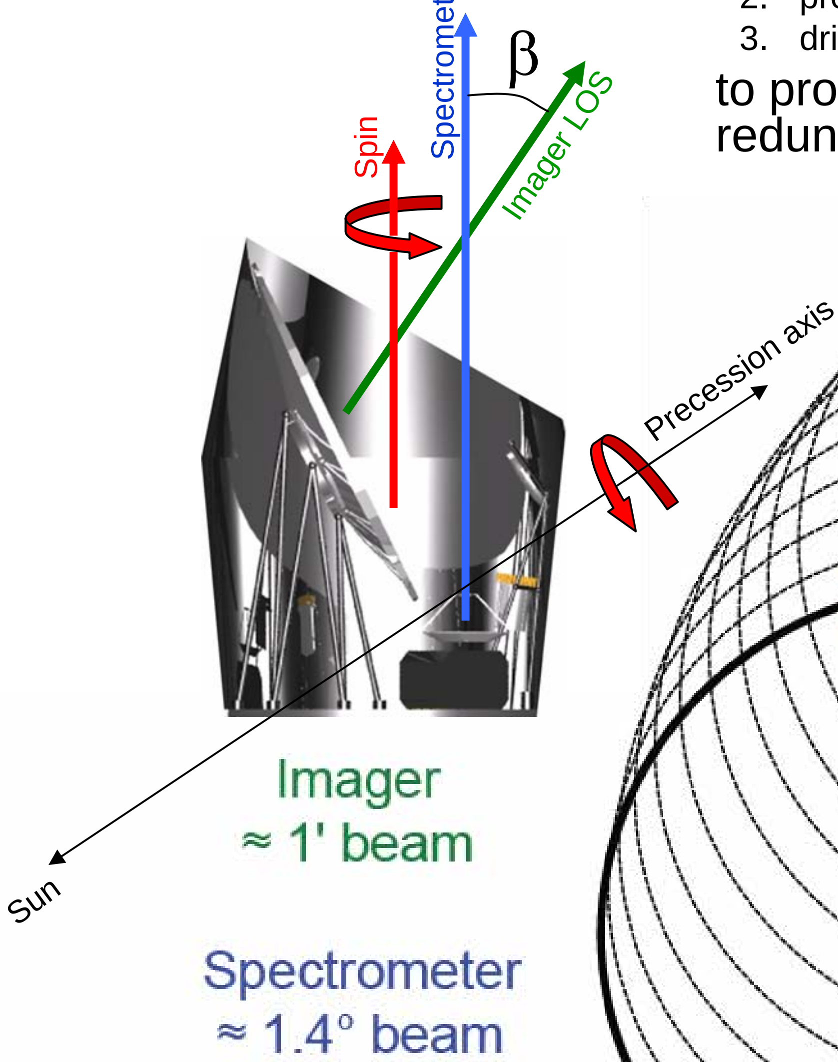
Imagine a super Herschel-SPIRE, with
- full sky coverage
- colder telescope (100x sensitivity)
- many more bands
- polarimetric capability
Also super-Planck
- 100x more detectors
- 3-5x resolution
- many more bands

Imagine a super COBE-FIRAS, with
- 1000x sensitivity
- 5x angular resolution


PRISM
deployable
V-grooves
Actively cooled
shield (10K)
Bus (300K)
Deployable sun shield
(300K)
Primary mirror (<10K)
secondary
mirror (<10K)
Focal
Plane
(0.1K)
0.1K
cooler
Absolute
Spectrometer (FTS)
Spectrometer
Optics (2.7K)
SHIELDS / BAFFLES / cooling chains removed

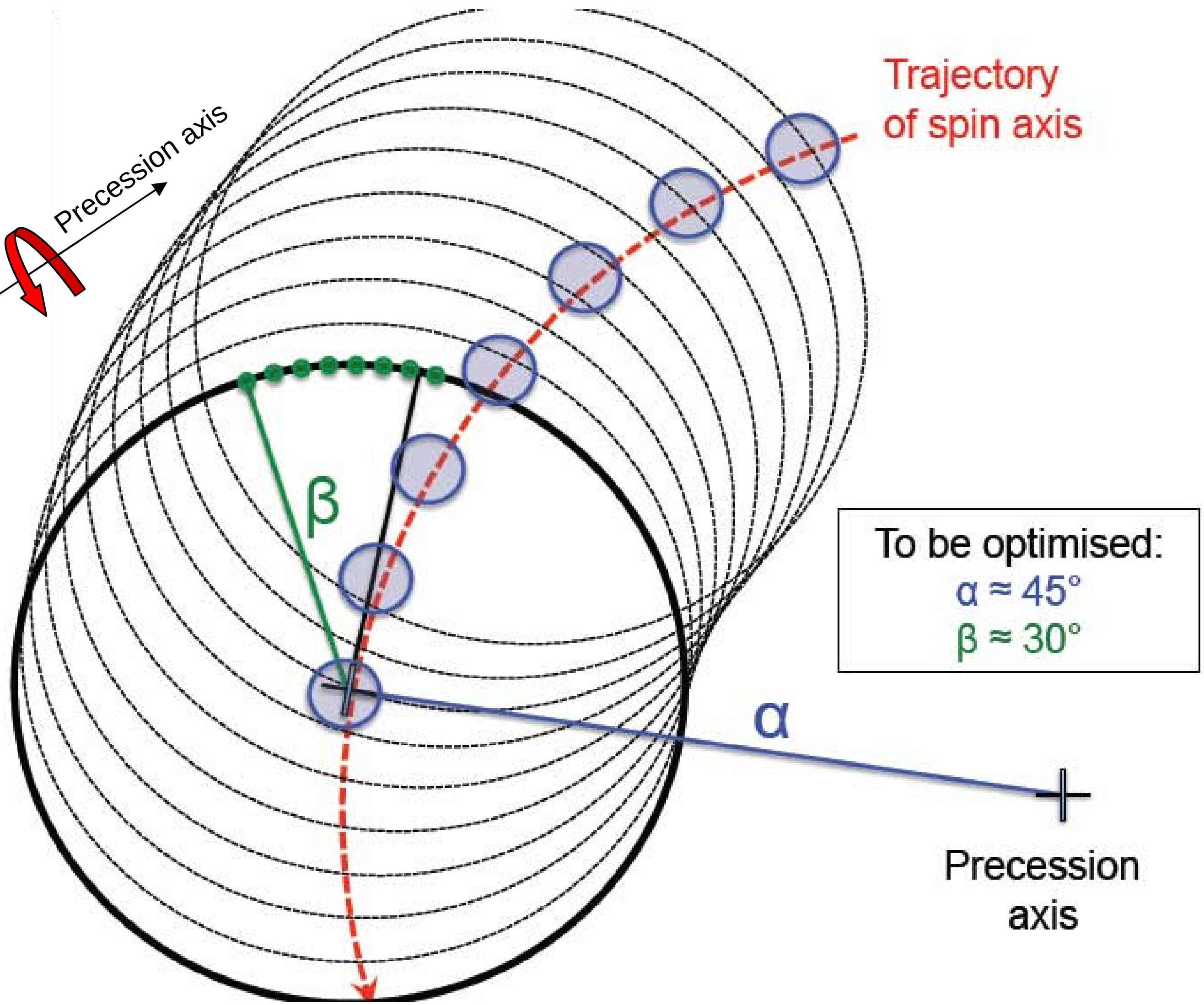

1
OBSERVED MAP AT 135 GHz
OBSERVED MAP AT 160 GHz
OBSERVED MAP AT 185 GHz
OBSERVED MAP AT 200 GHz
OBSERVED MAP AT 220 GHz
OBSERVED MAP AT 265 GHz
OBSERVED MAP AT 300 GHz
OBSERVED MAP AT 320 GHz
OBSERVED MAP AT 395 GHz
OBSERVED MAP AT 460 GHz
OBSERVED MAP AT 555 GHz
OBSERVED MAP AT 660 GHz
OBSERVED MAP AT 800 GHz
OBSERVED MAP AT 960 GHz
OBSERVED MAP AT 1150 GHz
Components separation
RECOVERED S-Z MAP
Realistic simulations of *PRISM* maps (e.g. 135 .. 1150 GHz)

Sky scan

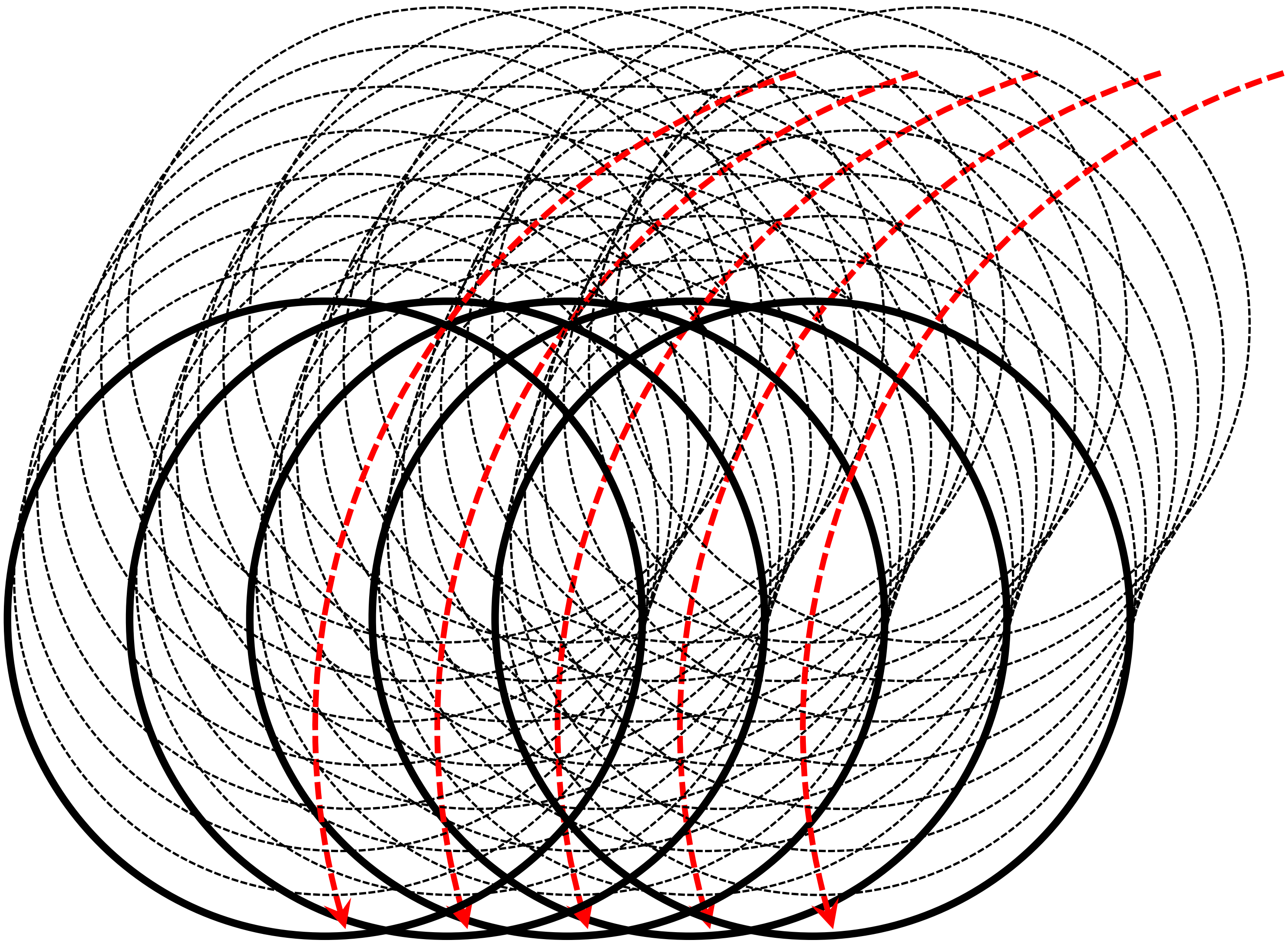


- The sky scan will be obtained with a combination of:
  1. spinning with a 10s period;
  2. precession of the spin axis on a 45° cone;
  3. drift of the precession axis (1°/day antisolar)

  to provide optimally cross-linked full-sky coverage and redundant polarization sampling without a modulator.



- As the precession axis is being moved, each pixel is visited by each detector of the imager in every possible orientation.

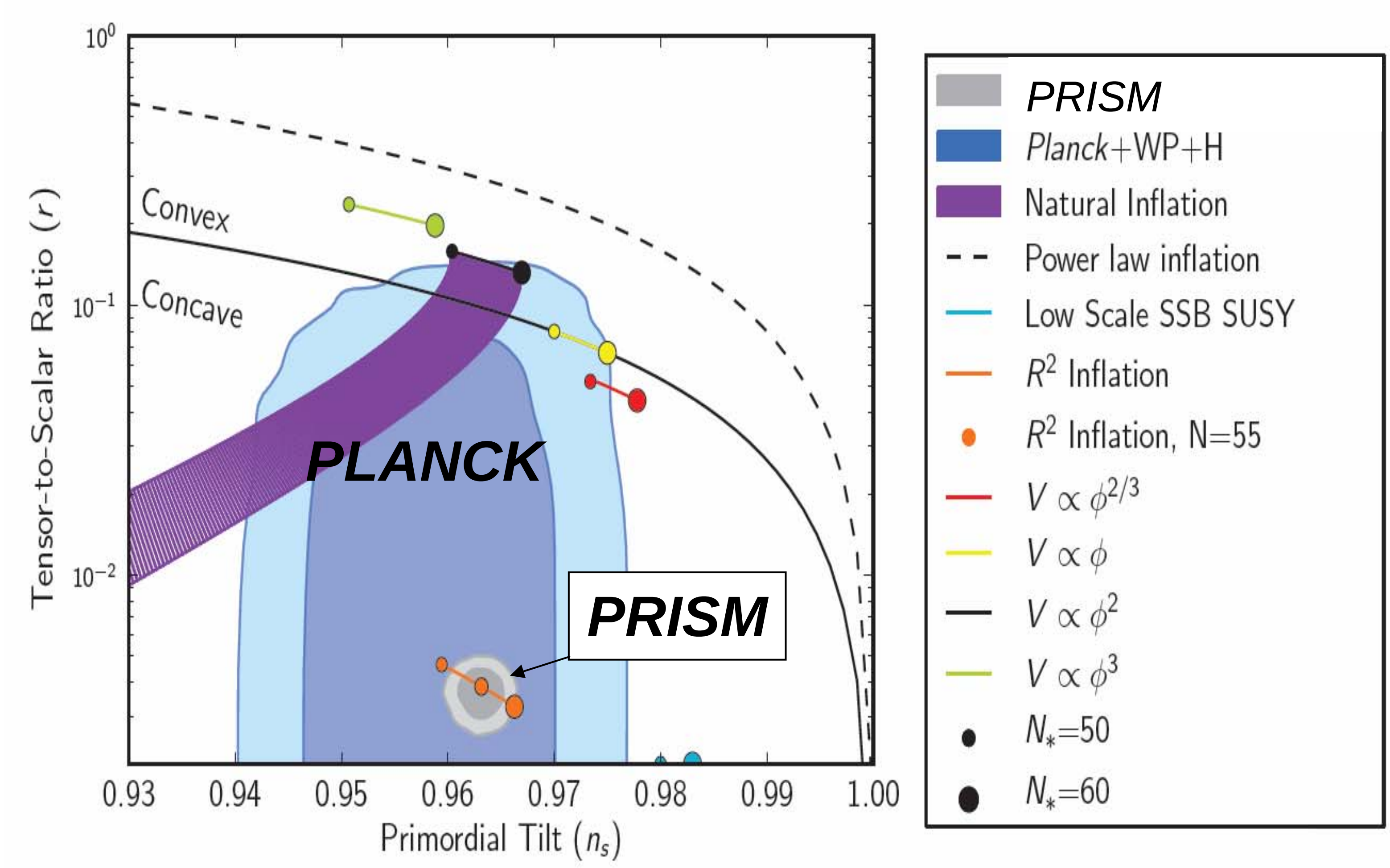


Accurate polarimetry without polarization modulators

- Our imager beams are small (1’@1mm)
- Even with beam ellipticity at the edges of the focal plane of the order of 1%, we can average many independent beams to get a synthetic beam with 0.01% ellipticity, still having enough resolution for the scales of interest for B-modes.
- The spin + precess scan strategy allows for a wide and even coverage of polarization angles in all pixels.

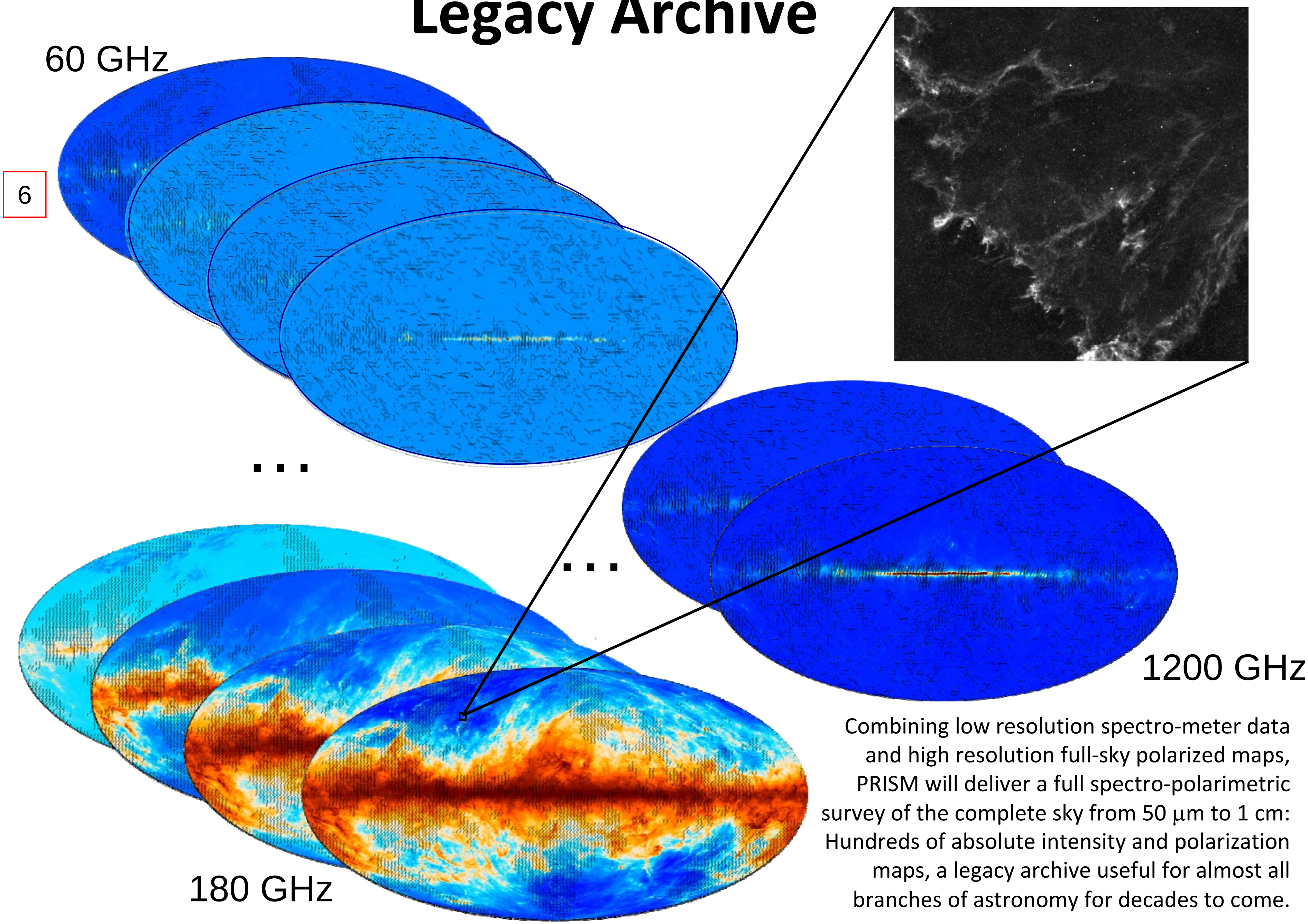
Comparing Planck vs PRISM constraints on inflation

5



- The Planck mission has excluded a large number of inflationary models but many others remain. Prism will be able to reduce the parameter space r-n_s by orders of magnitude (grey-region)

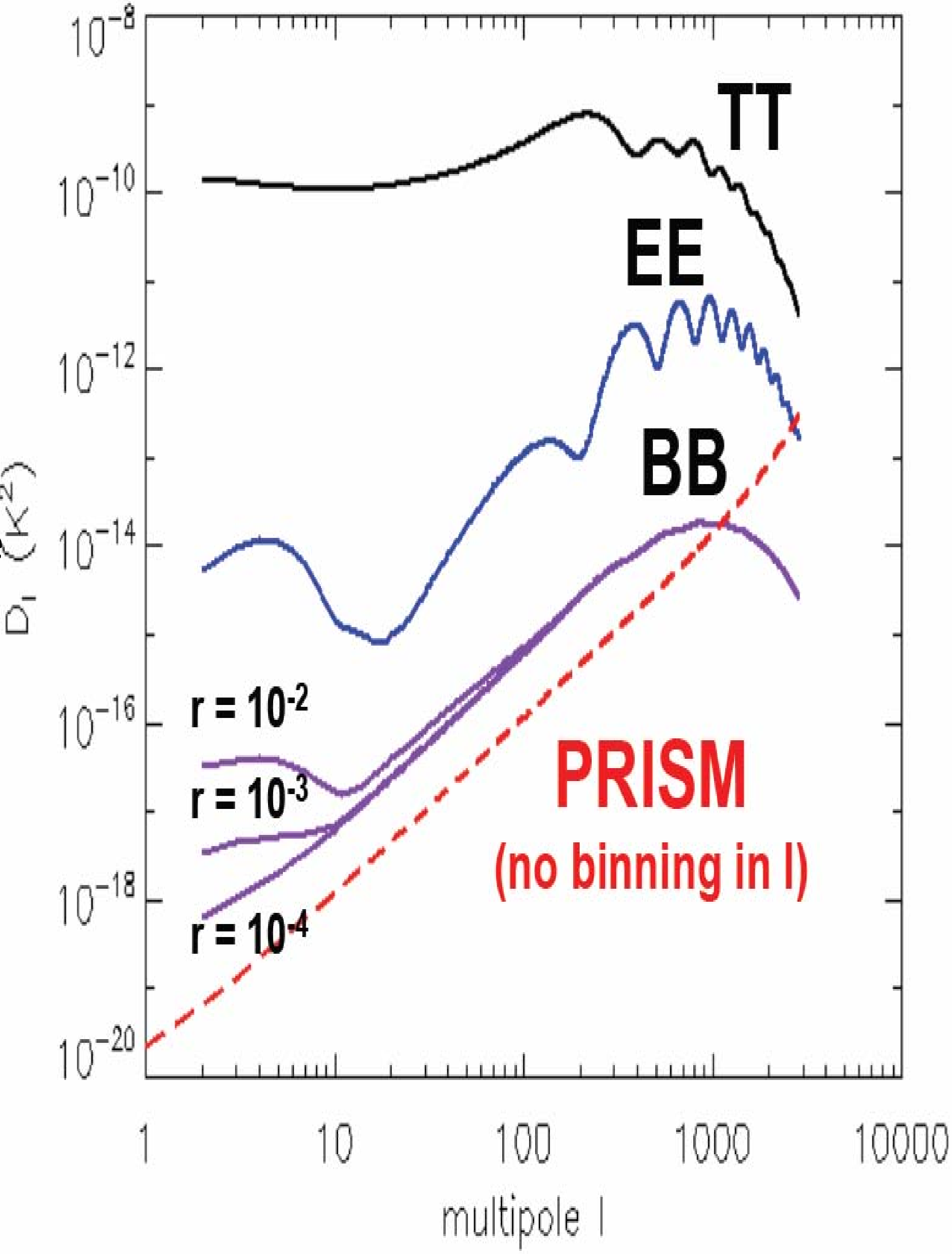
Legacy Archive



Combining low resolution spectro-meter data and high resolution full-sky polarized maps, PRISM will deliver a full spectro-polarimetric survey of the complete sky from 50 μm to 1 cm: Hundreds of absolute intensity and polarization maps, a legacy archive useful for almost all branches of astronomy for decades to come.

Measuring B-modes

- Measuring B-modes to Δr=0.001 will require **exquisite control of polarized foregrounds**.
- Current extrapolations with the simplest allowed foreground models predict that the galactic foreground will outshine the Δr=0.001 primordial by about x100 in all frequency channels, and emission properties are likely to be more complicated than many of the optimistic foreground forecasts suggest
- While forthcoming experiments could find (or have already found) hints of cosmological B modes, **only a large mission with wide frequency coverage, high angular resolution, and exquisite polarization puruty can provide a reliable and precise measurement.**



Non-Gaussianity

- All inflationary models predict a small amount of non-Gaussianity. One of the key PLANCK results was to rule out all the models with large non-Gaussianity proposed by theorists to explain the WMAP hint of f_{NL}~87.
- At present nothing more involved than a simple single scalar field model is needed to satisfy Planck constraints.
- **PRISM will provide the ultimate CMB constraints on primordial non-Gaussianity** thanks to its full-sky coverage and exquisite angular resolution. (Other probes have to rely on uncertain modeling.)

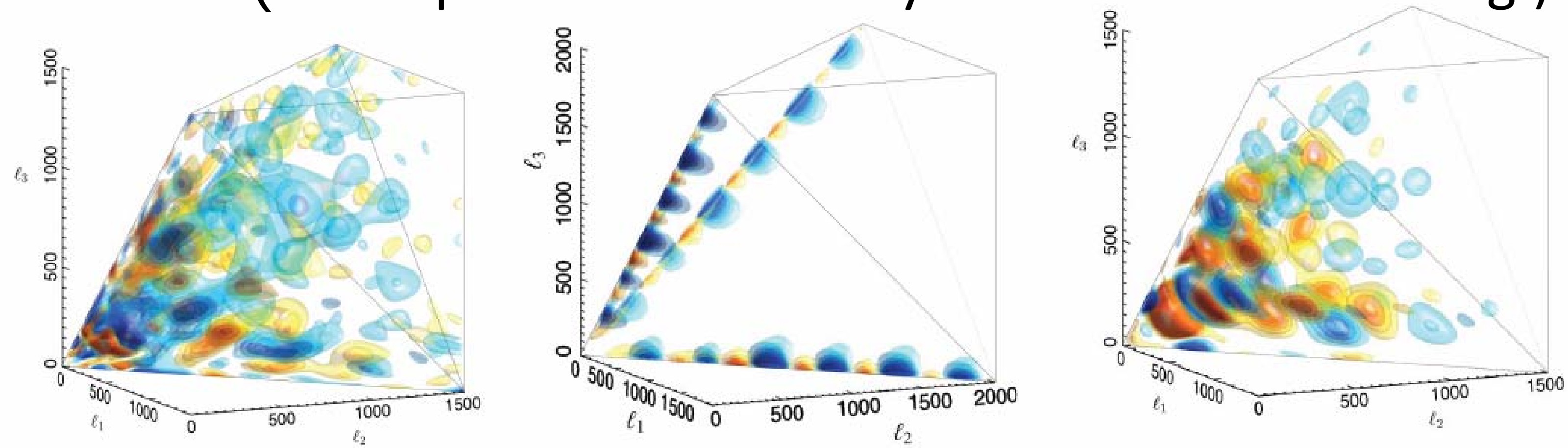
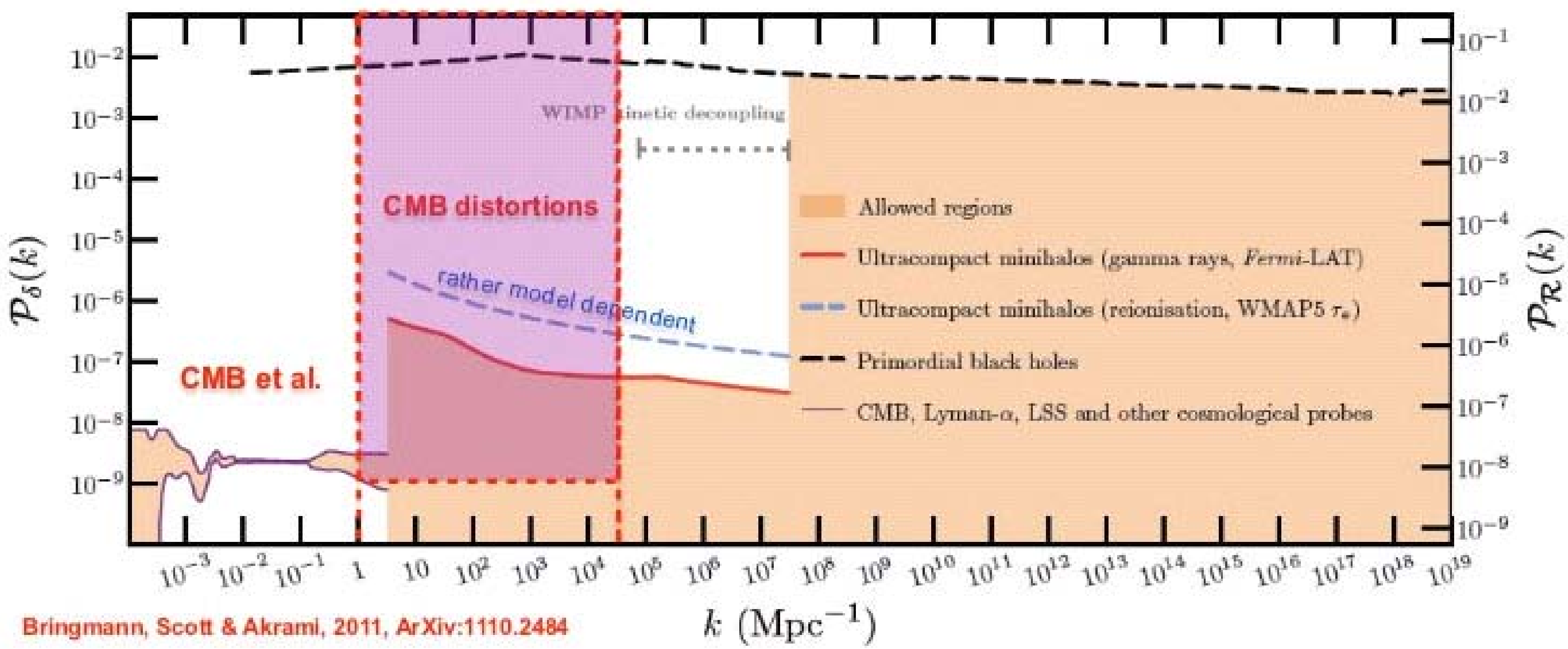
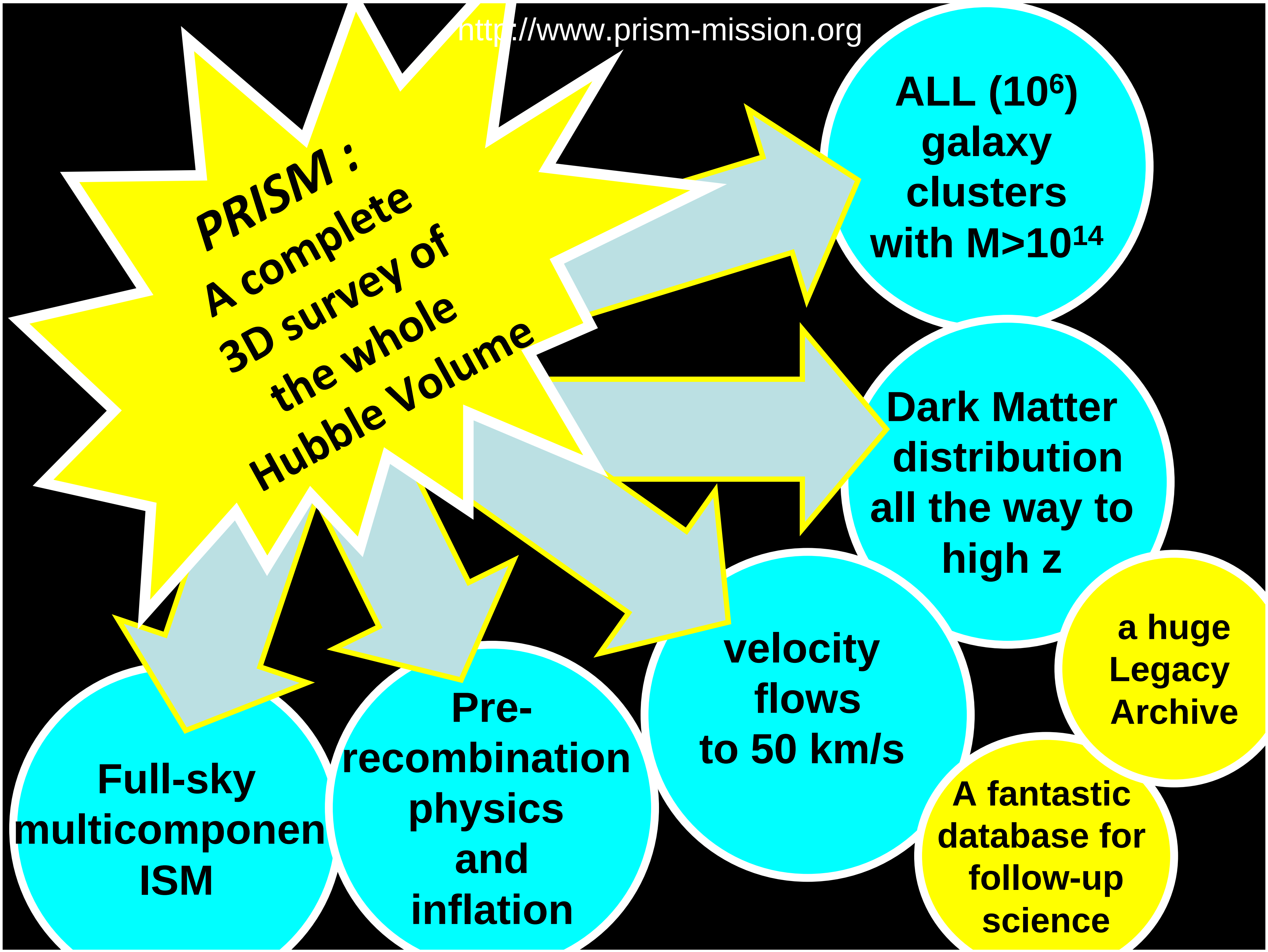


Figure 5: *Planck* CMB temperature bispectrum [84] (left) and primordial (right) and late-time (middle) non-Gaussian shapes [84, 83]. Note the periodic CMB ISW-lensing signal (middle) in the squeezed limit along the edges, which is seen at the 2.5 σ level in the *Planck* bispectrum on the left. Scale-invariant signals predicted by many inflationary models are strongly constrained by the *Planck* bispectrum, although 'oscillatory' and 'flattened' features hint at new physics. A example of an inflationary 'feature' model is shown on the right. PRISM will probe these hints with an order of magnitude more resolved triangle configurations.

Probing primordial power spectrum on very small scales using spectral distortion

- Current constraints on the power spectrum (and the spectral index n_s) are limited by the size of current horizon (CMB quadrupole) on large scales, and by nonlinearity and Silk damping on small scales.
- Little improvement can be expected from galaxy surveys and SKA because of these fundamental limitation.
- The small scale primordial power dissipated by Silk damping does not disappear completely, but leaves its imprint in **spectral distortions** from the perfect CMB blackbody spectrum. **Important target for the PRISM spectrometer.**




http://www.prism-mission.org
PRISM :
A complete
3D survey of
the whole
Hubble Volume
ALL (10^6)
galaxy
clusters
with $M>10^{14}$
Dark Matter
distribution
all the way to
high z
velocity
flows
to 50 km/s
Full-sky
multicomponen
ISM
Pre-
recombination
physics
and
inflation
a huge
Legacy
Archive
A fantastic
database for
follow-up
science

Search for B-modes in the CMB

- Impressive technology & methods development :
- Large bolometer arrays, polarization modulators, long duration balloon experiments, optimal polarization extraction techniques, de-lensing, correlations …
- CMB polarization space-mission studies. COrE, PRISM not selected. Forthcoming opportunity : M4 (difficult, when spoiled with PRISM, but boosted by BICEP2 claim)
- See http://www.core-mission.org/
- Italian contribution & know-how important, despite of lack of resources. Opportunities to boost our share and discovery potential are there, and should be taken.