Thank you for attending our workshop and for sharing your ideas with us

ST3G

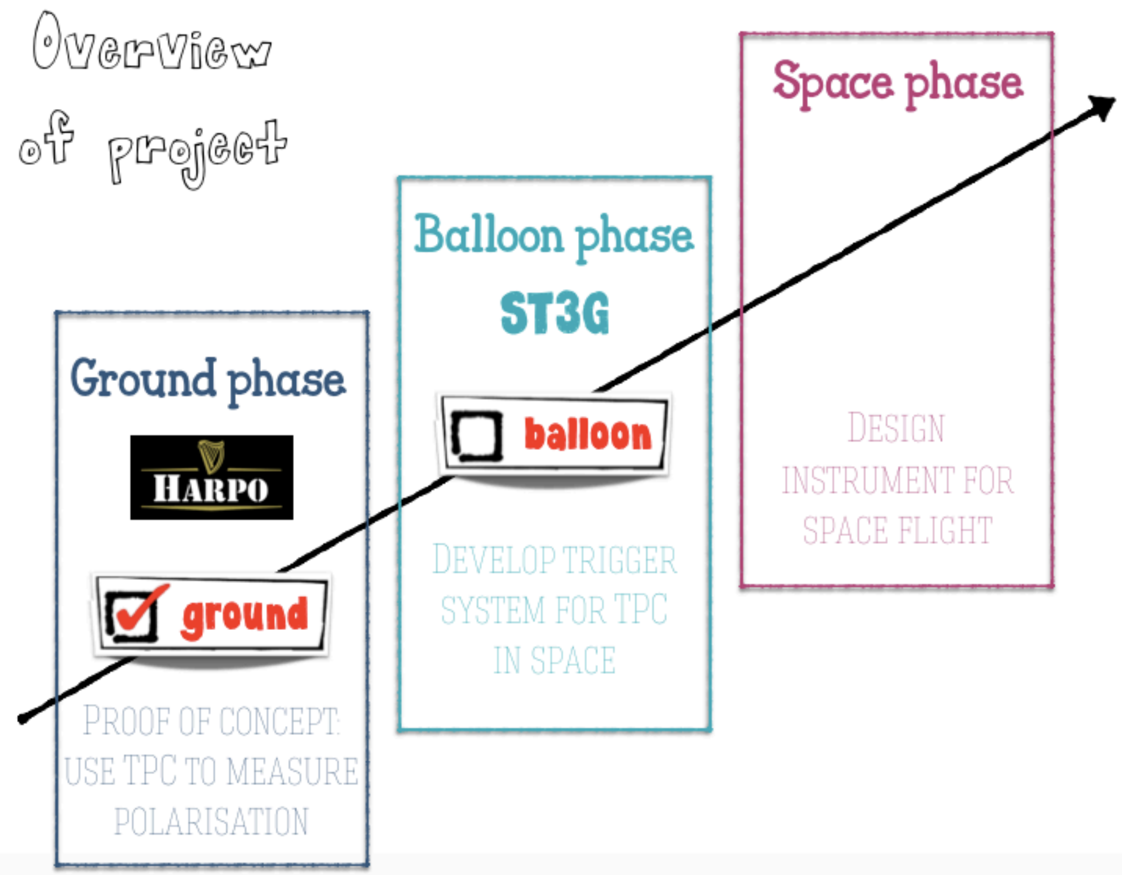
"stègue"

A PROTOYPE BALLOON DETECTOR

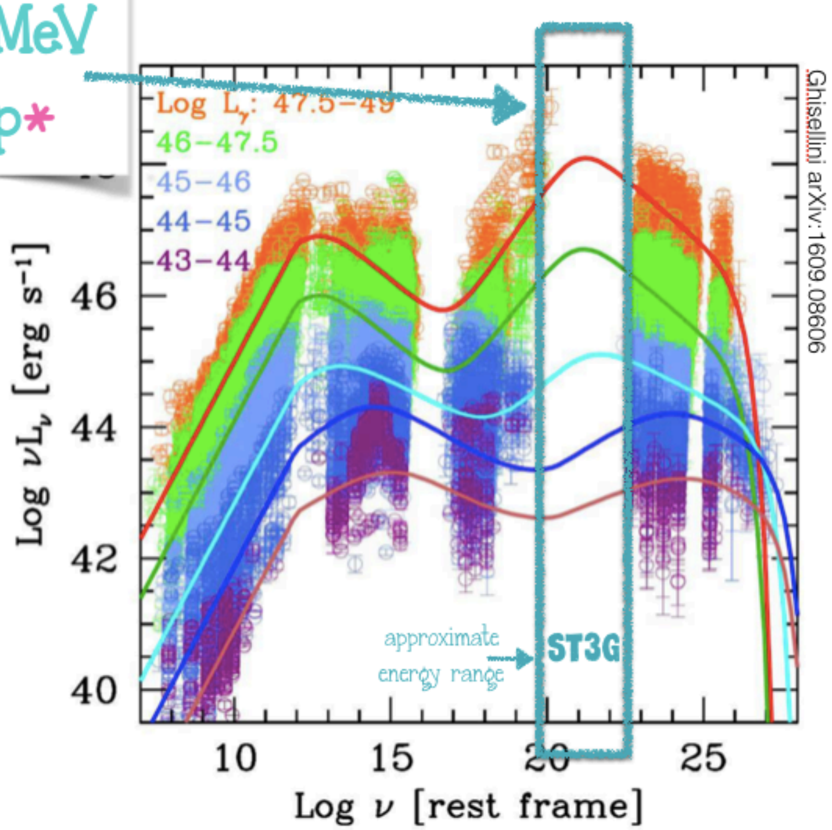
Self-triggering TPC telescope for gamma-rays

Deirdre HORAN, TPC MeV Workshop, 12.04.2017

Overview of project

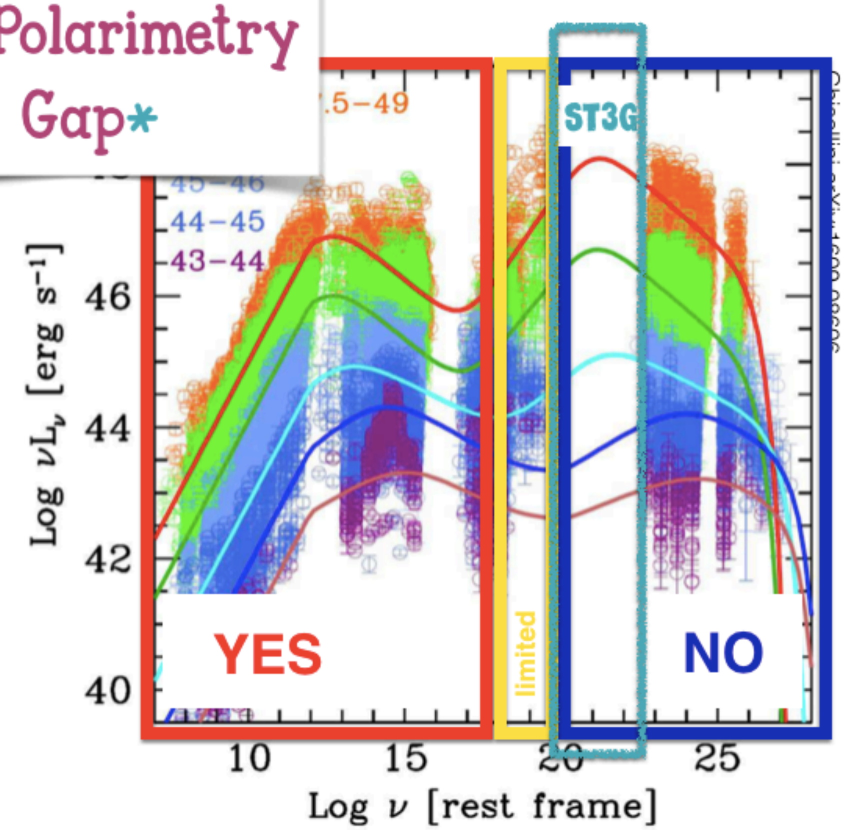


The MeV Gap*



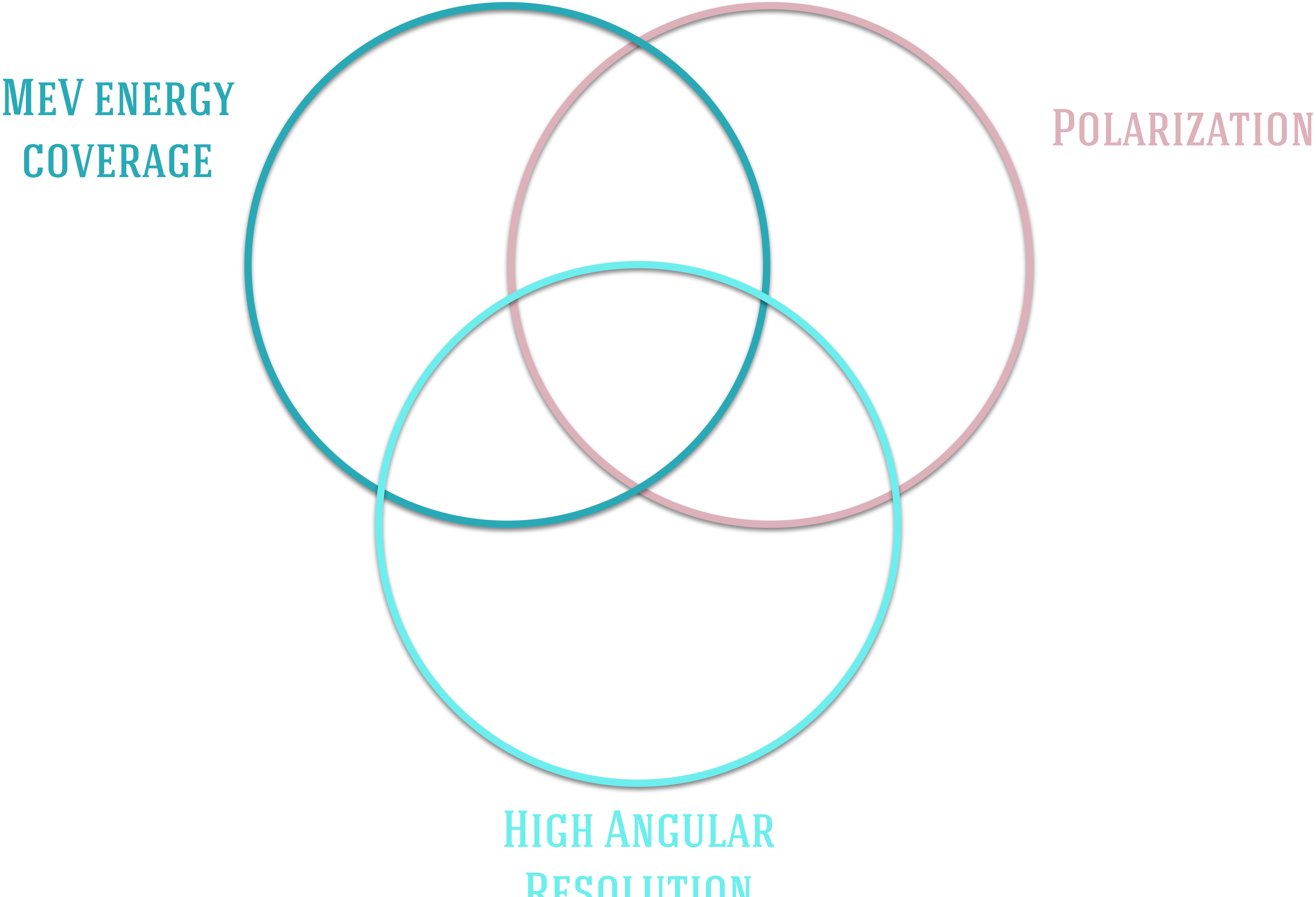
* using blazars to illustrate the gap since these are broadband emitters from radio all the way up to gamma rays

The Polarimetry Gap*



* using blazars to illustrate the gap since these are broadband emitters from radio all the way up to gamma rays

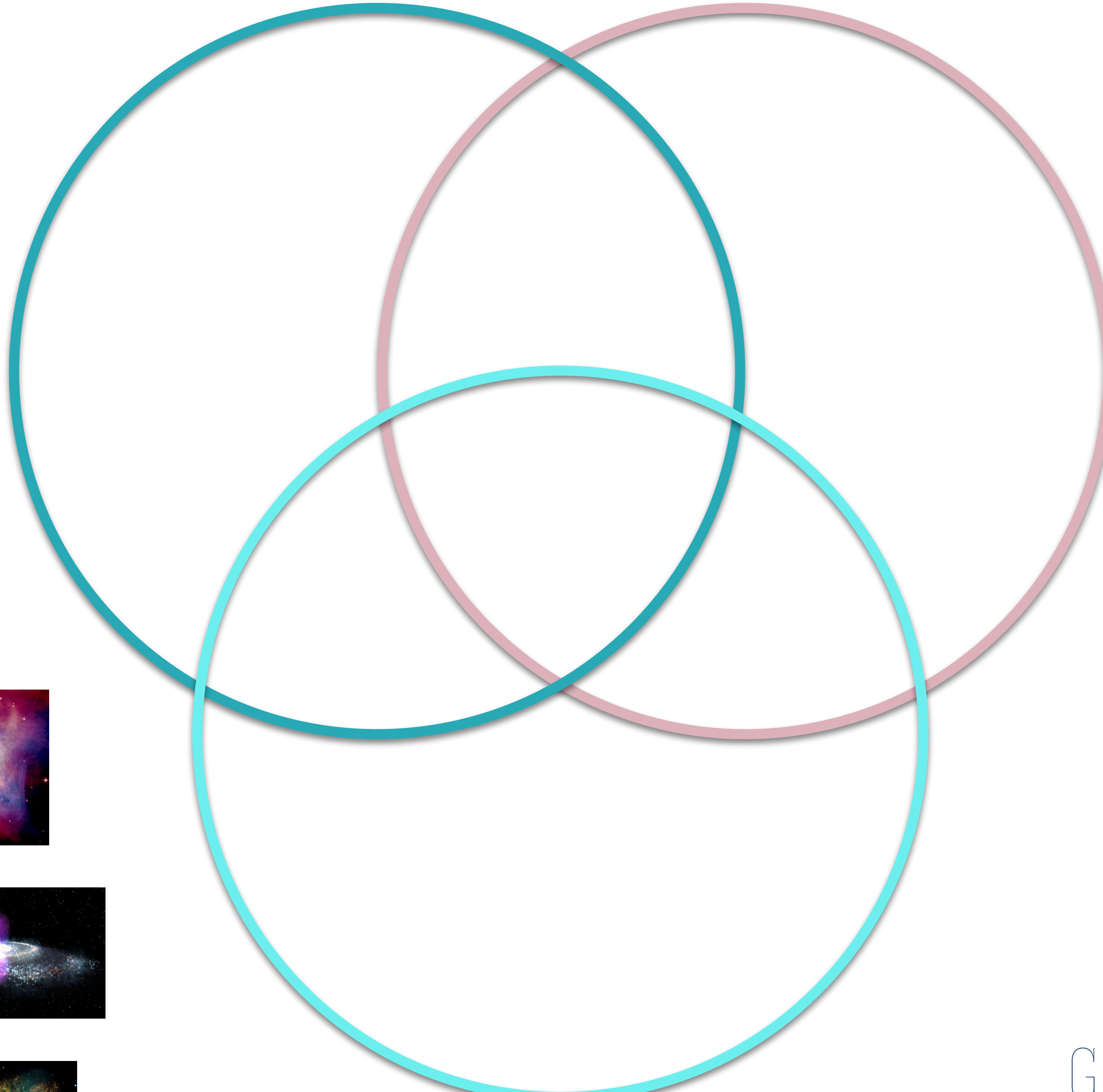
Gamma-ray Astrophysics at MeV energies



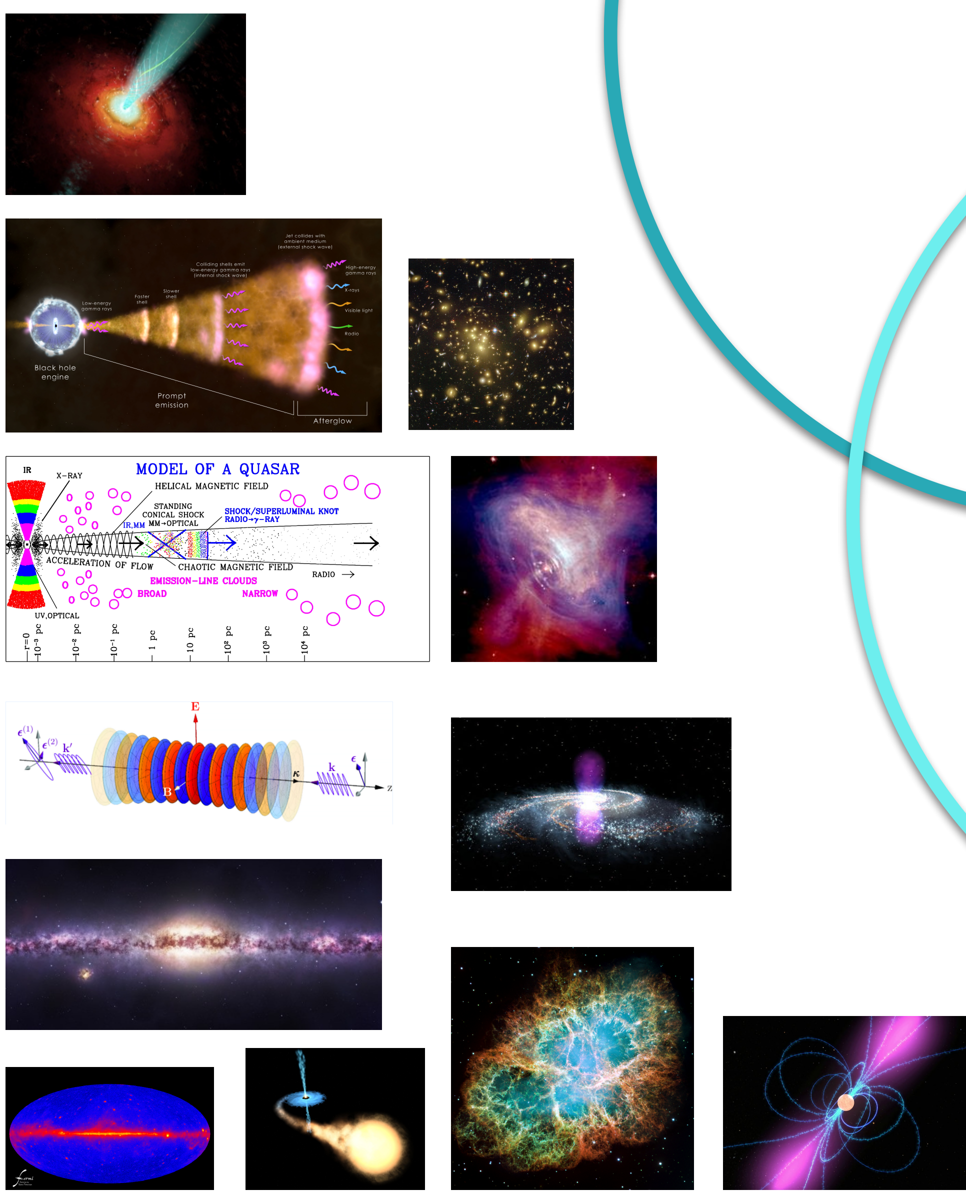
Gamma-ray Astrophysics at MeV energies

MeV energy coverage

Polarization

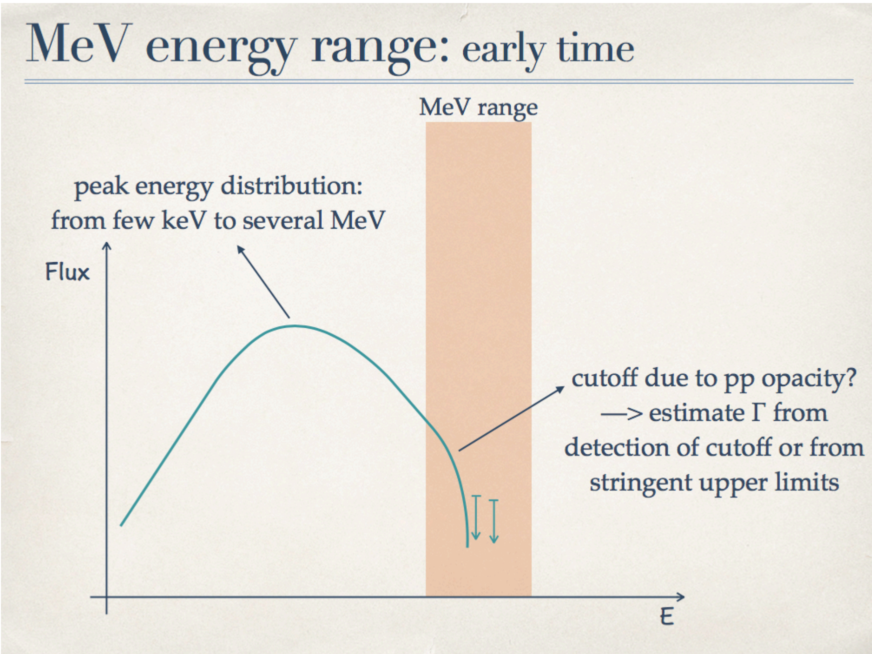


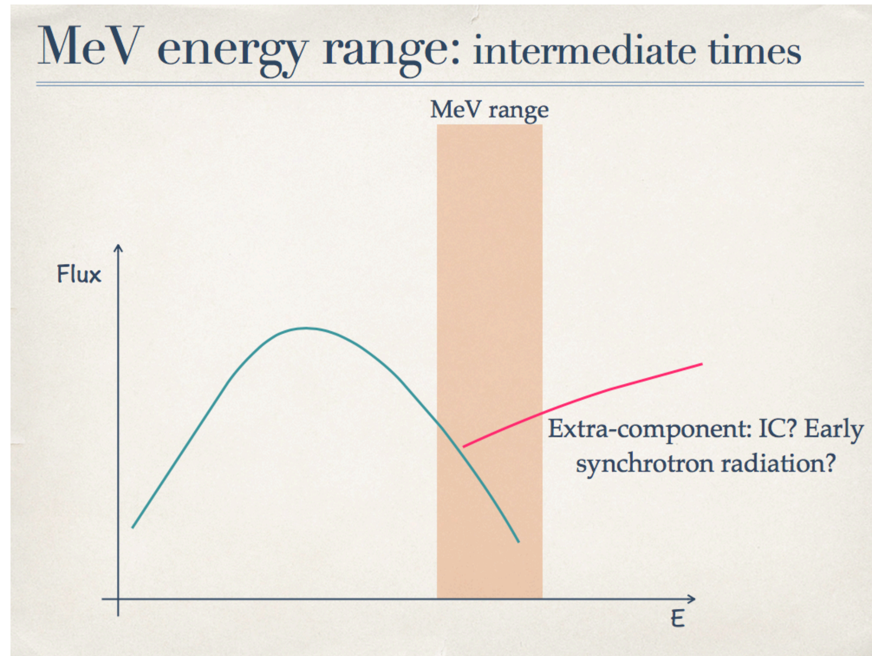
High Angular Resolution

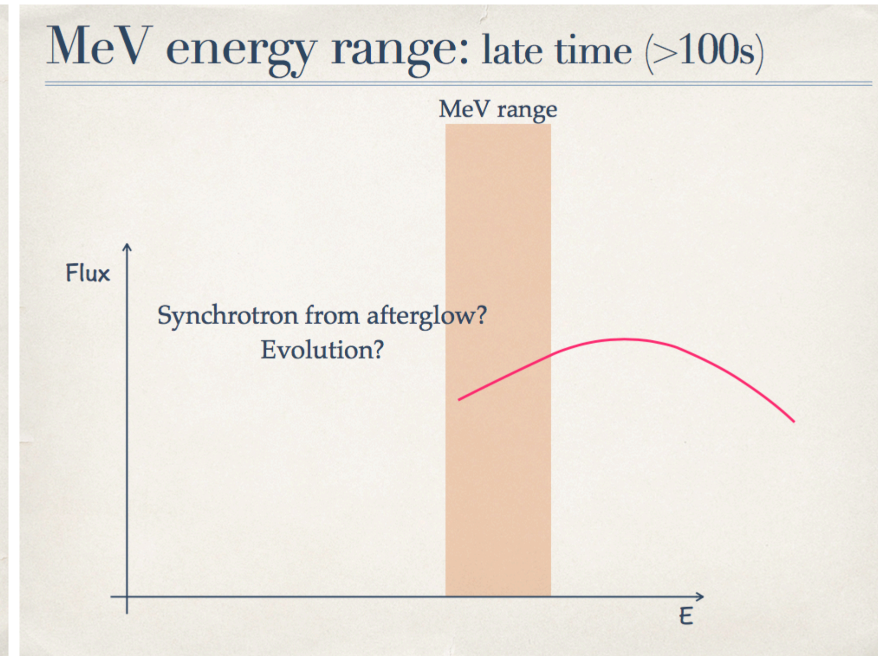


Blazars
Pulsars
Binaries
Cosmic rays
Dark matter
Fermi bubbles
MeV background
Gamma-ray bursts
Lorentz invariance
Supernova remnants

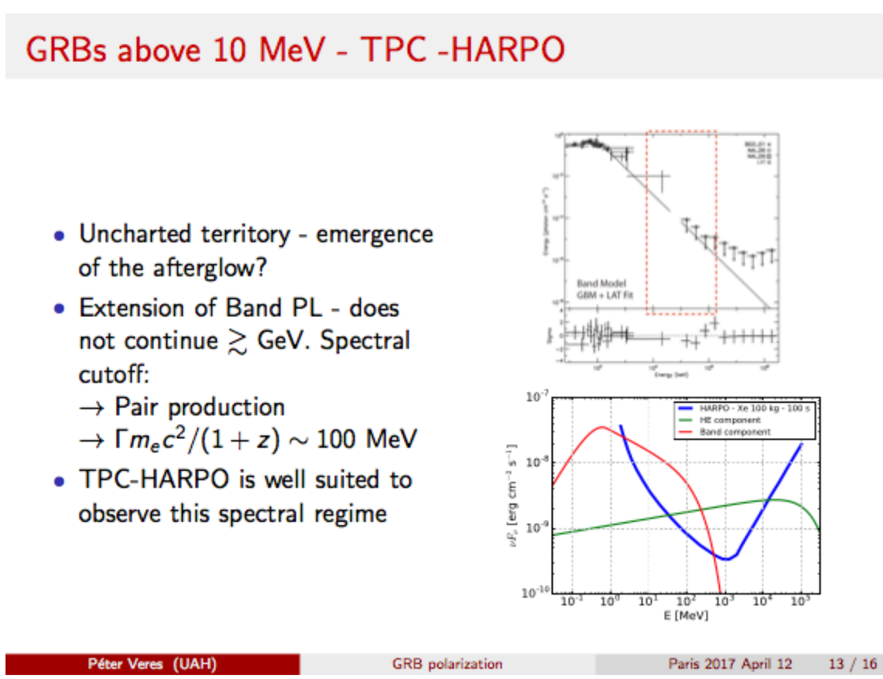
GRBs - Lara Nava

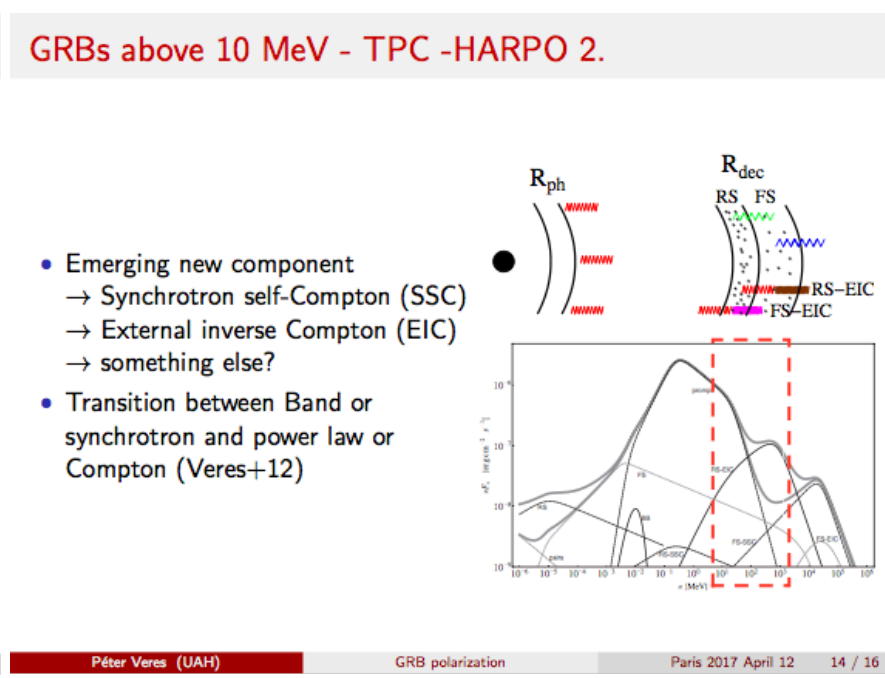


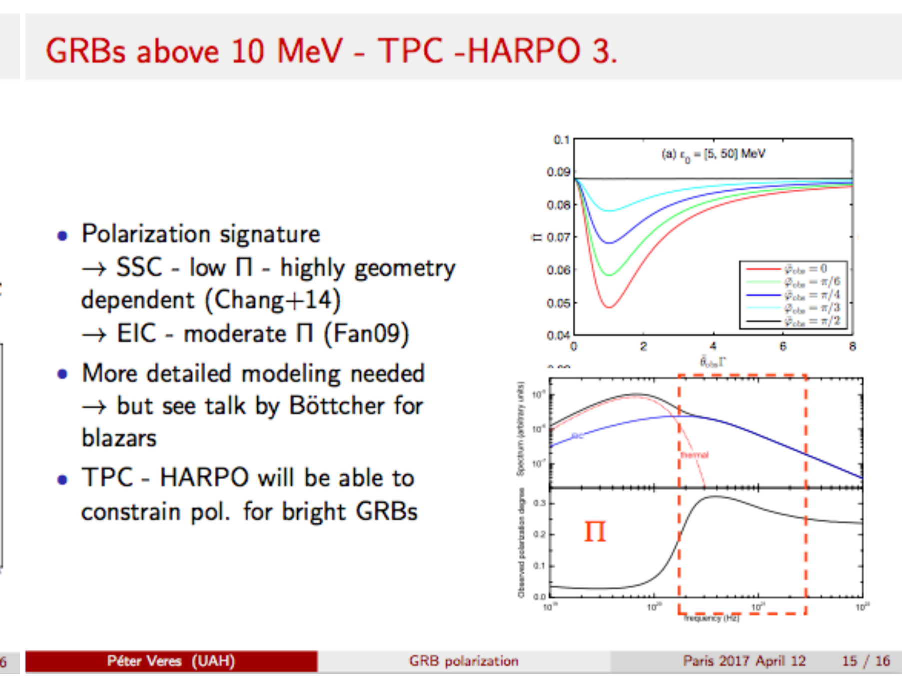




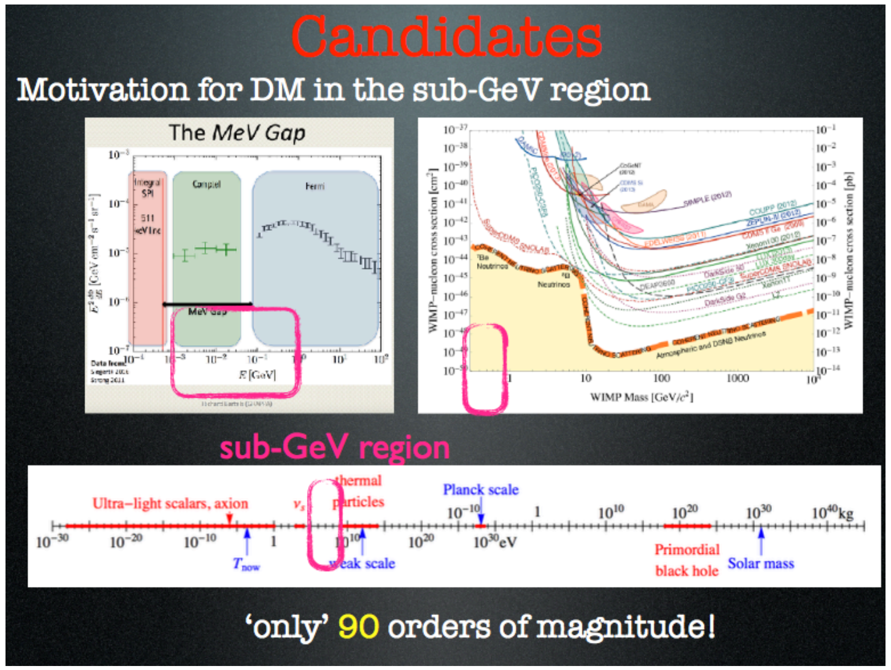
GRBs - Péter Veres

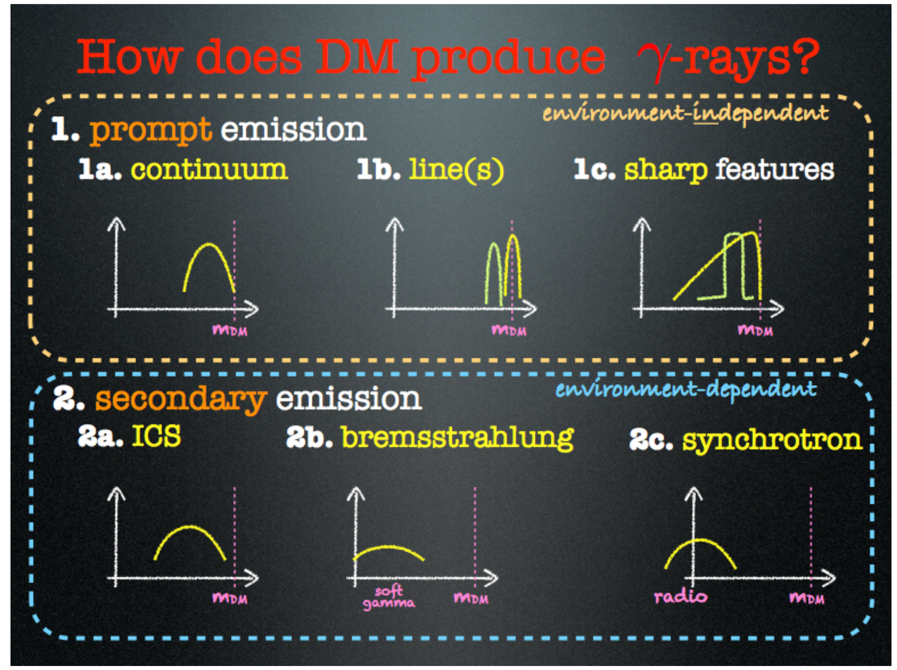


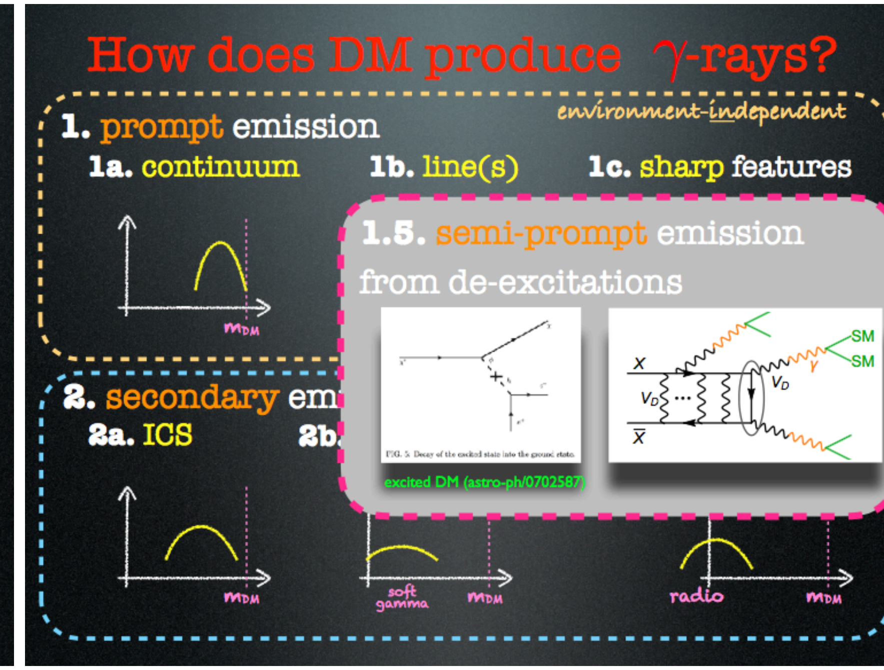




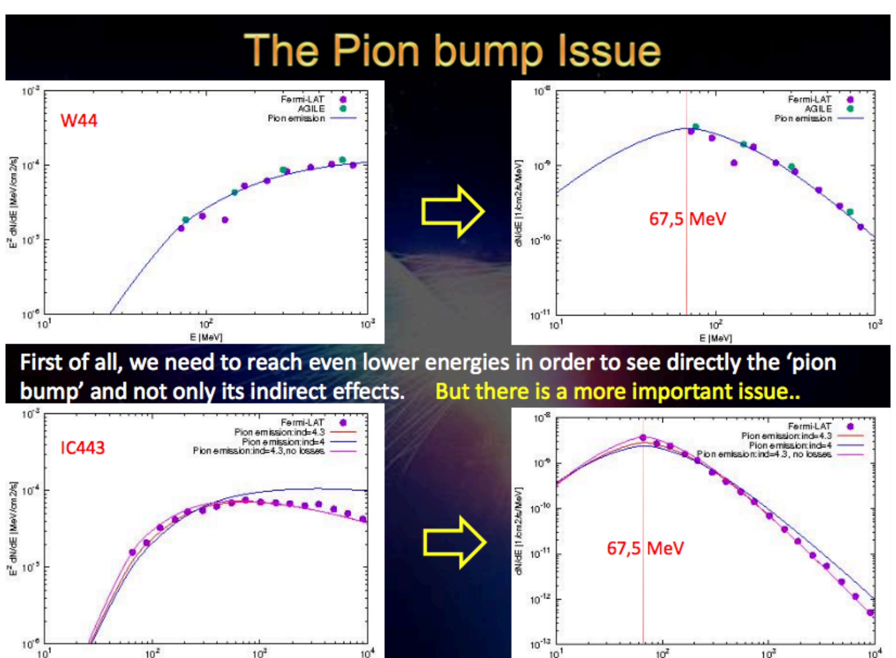
MeV Dark Matter - Marco Cirelli

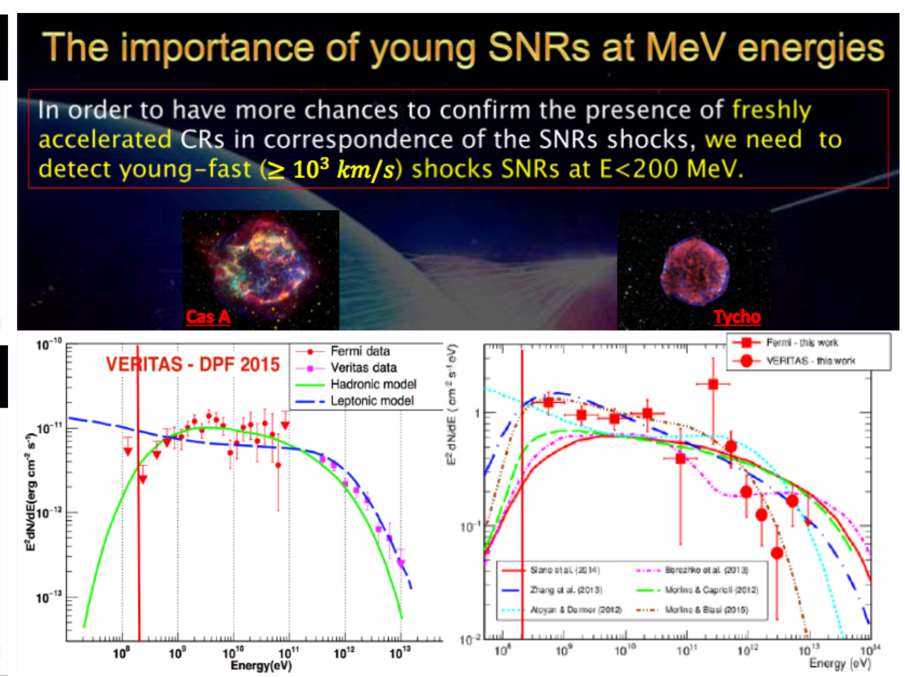


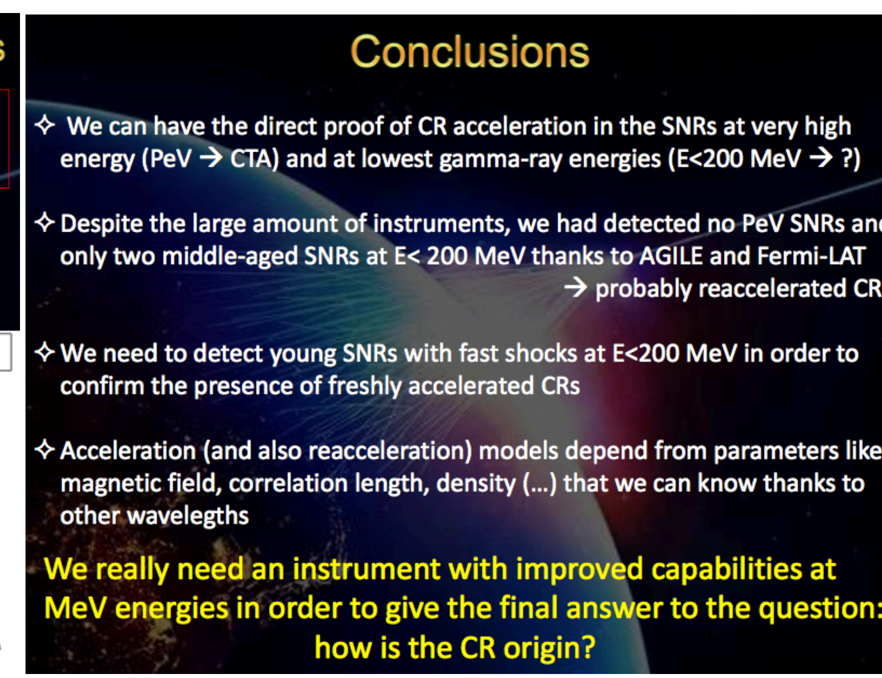




SNRs - Martina Cardillo

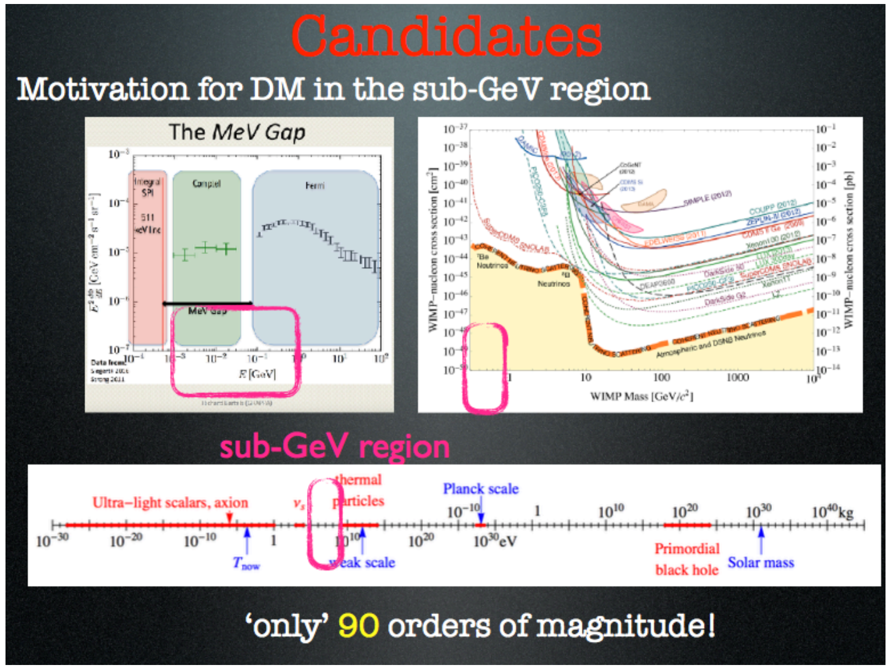


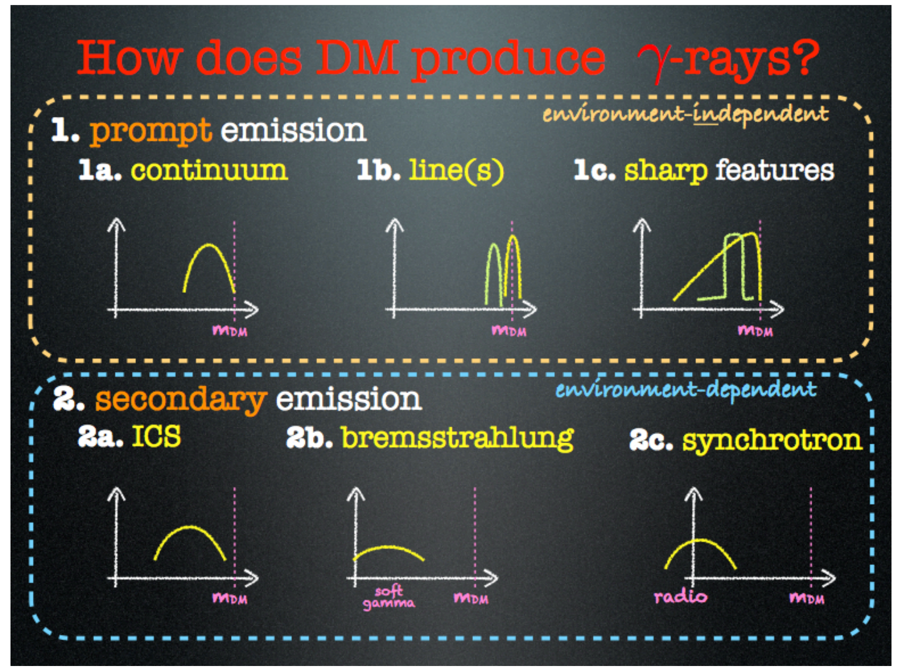


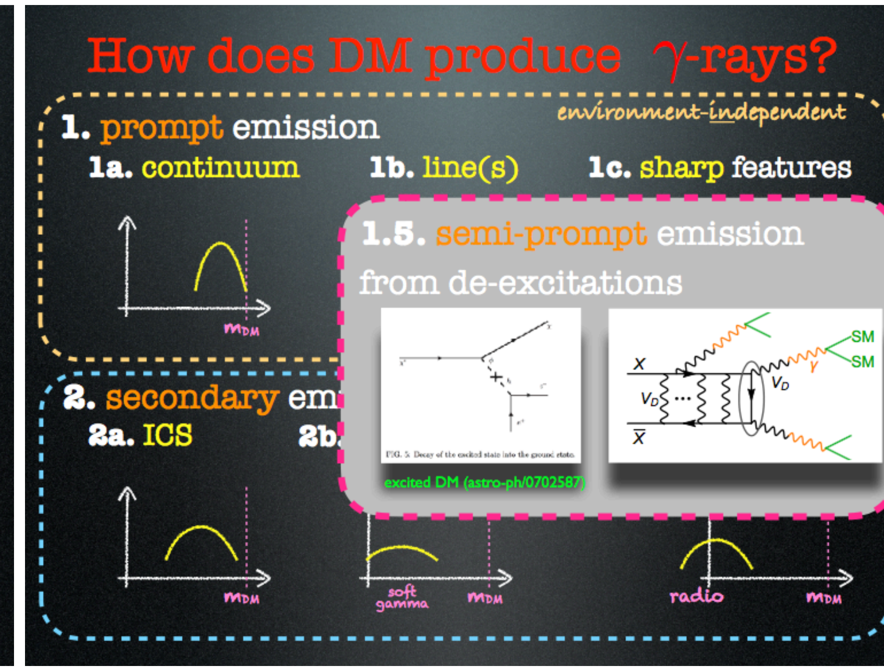


MeV Dark Matter - Marco Cirelli

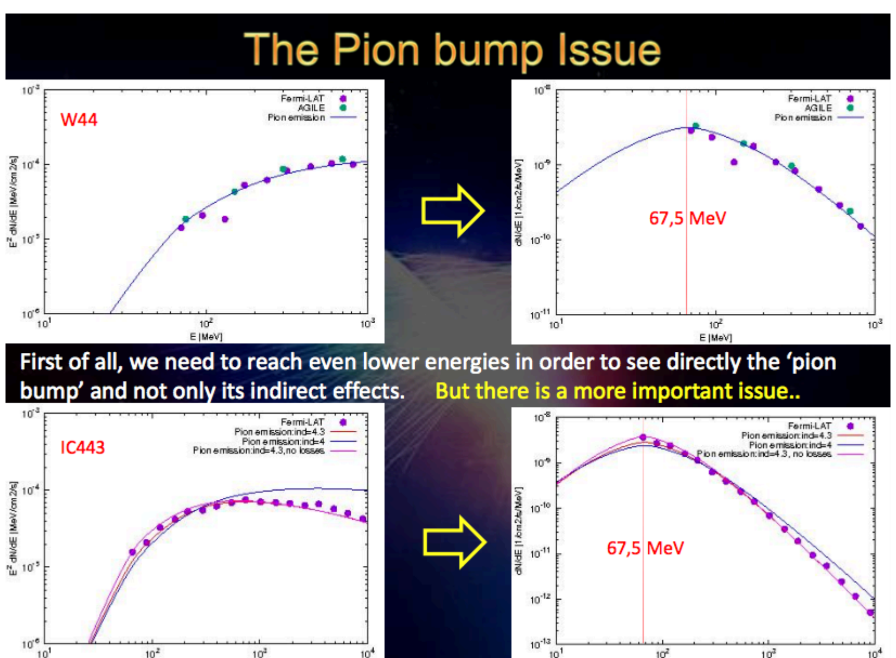
detected! Jean-Marc!

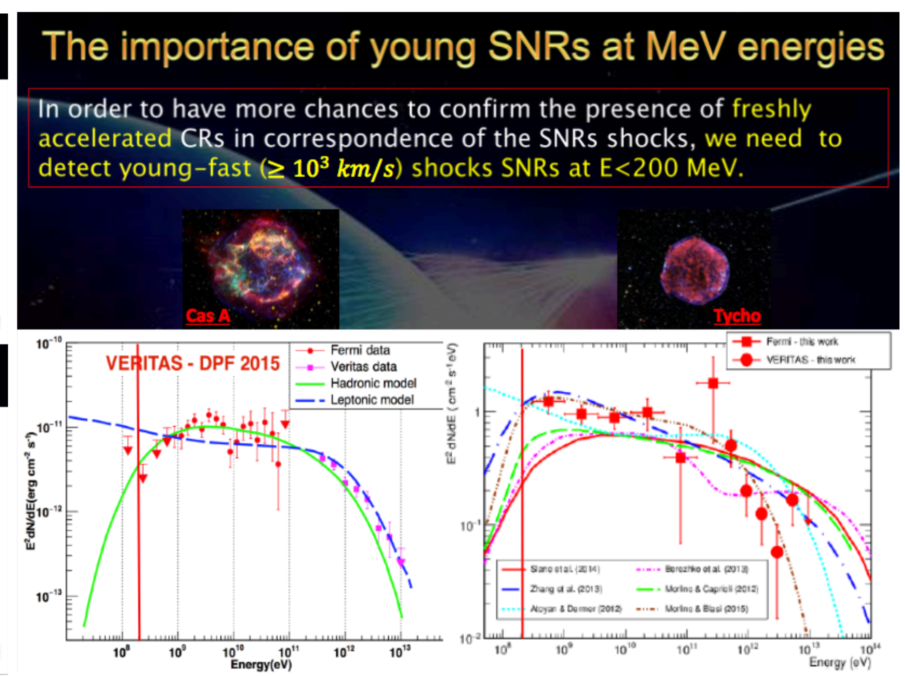


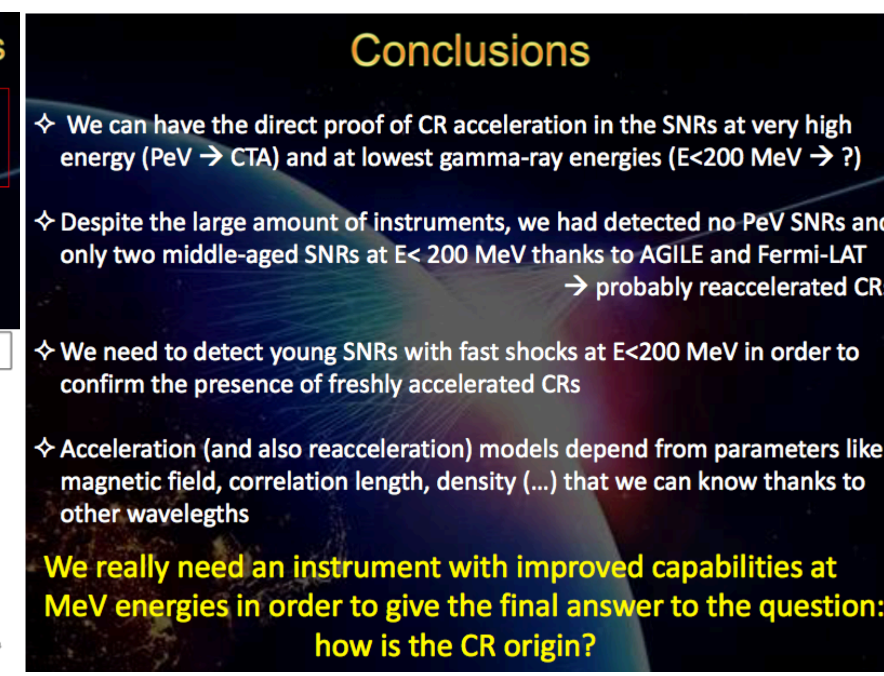




SNRs - Martina Cardillo



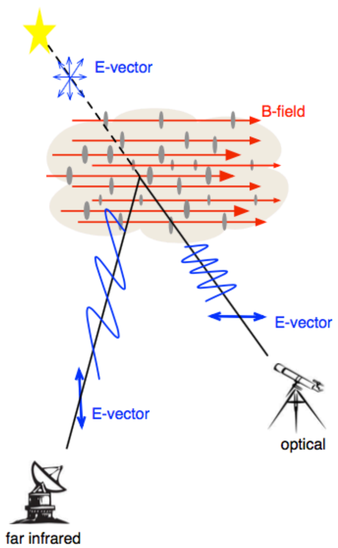




but Bremsstrahlung!!

PASIPHAE - Kostas Tassis

Optopolarimetry of Starlight



Dust absorption – induced polarization of starlight:

Common origin with polarized dust emission

Unique handle on 3-d structure of foreground dust & B-field

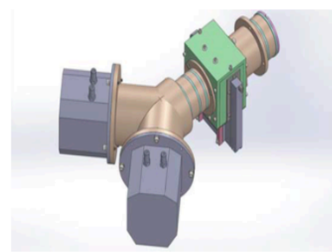
20

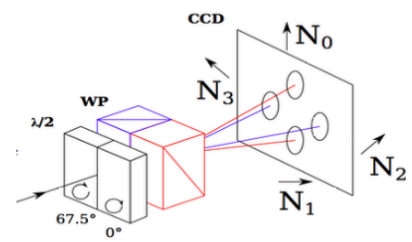
PASIPHAE's WALOPs: Innovative Design

For each point source:

- Split light in 4 linear polarization states differing by 22.5° .
- Project each state in a different CCD
- Combine to obtain Stokes Parameters

- Technology successfully tested with RoboPol, expanded to wide FoV





$$q = \frac{N_0 - N_1}{N_0 + N_1} \qquad u = \frac{N_2 - N_3}{N_2 + N_3}$$

26

Survey Mode

PASIPHAE will identify high optical polarization point sources

- Previously Unknown High Energy Systems
- Candidate Optical Counterparts For *Fermi* Unidentified Sources

29

High-energy Polarisation - Nachi Chakraborty

Chakraborty, Pavlidou & Fields, ApJ (2015), 798, 15

The Astrophysical Journal, 798:16 (12pp), 2015 January 1 Chakraborty, Pavlidou, & Fields

Table 2
Input Parameters for 3C 279 are Detailed in Section 5.4.2

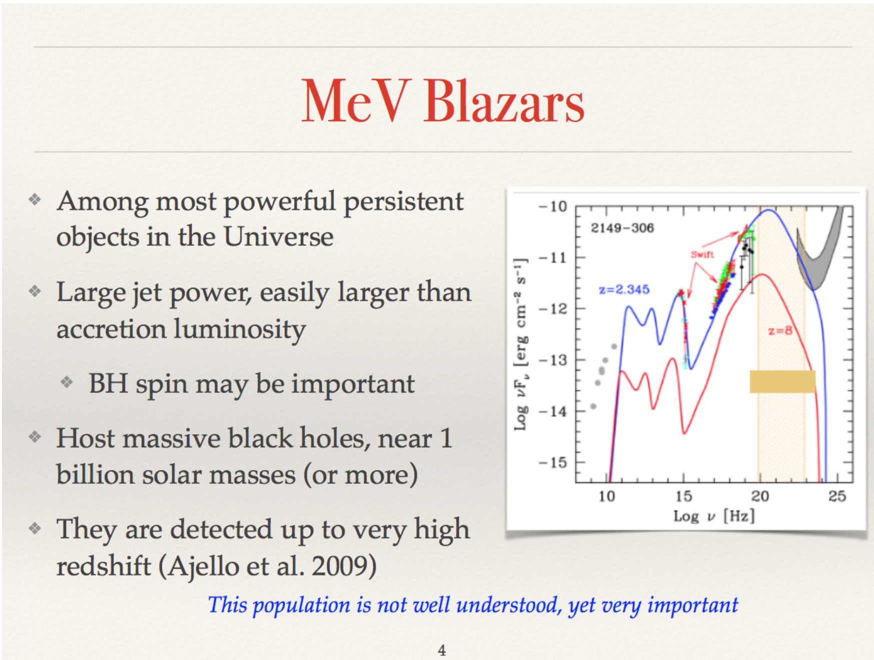
Polarimeter ID j	Polarimeter Energy Range $\Delta E_{pol}(j)$ (keV)	Energy Range of Observed Flux $\Delta E_{obs}(j)$ (keV)	Observed Energy Flux of Blazar $F_{E,\Delta E_{obs},blazar}(j)$ ($\times 10^{-12}$ erg cm^{-2} s^{-1})	Scaled Energy Flux of Blazar $F_{E,\Delta E_{pol},blazar}(j)$ ($\times 10^{-12}$ erg cm^{-2} s^{-1})	Photon Index of Blazar $\Gamma_{blazar}(j)$	Electron Index of Blazar $p(j)$	Seed Polariz. Degree Π_{init} (%)
1,2	25–80	17–60	12.40	13.07	1.6	2.2	20.0
3,4	2–10	2–10	10.00	10.00	1.56	2.12	20.0
5,6	50–195	14–195	34.3	22.7	1.49	1.98	20.0

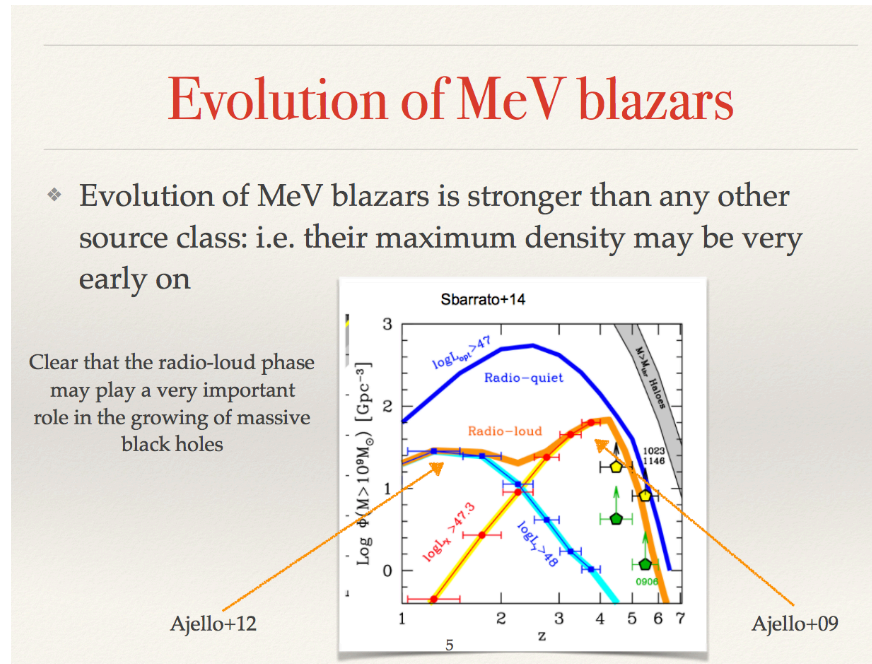
Notes. We list the energy fluxes in the observed energy ranges and the scaled energy fluxes appropriate for the polarimeter energy range, $\Delta E_{pol}(j) = E_{pol,min}(j) - E_{pol,max}(j)$, using the spectral index, Γ, of 3C 279 in the observed energy range, $E_{obs,min}(j) - E_{obs,max}(j)$. In the final column, we also list the seed polarization degree value (temporal average). For ASTRO-H and GAP, we scale fluxes to a BAT energy range of 50–195.

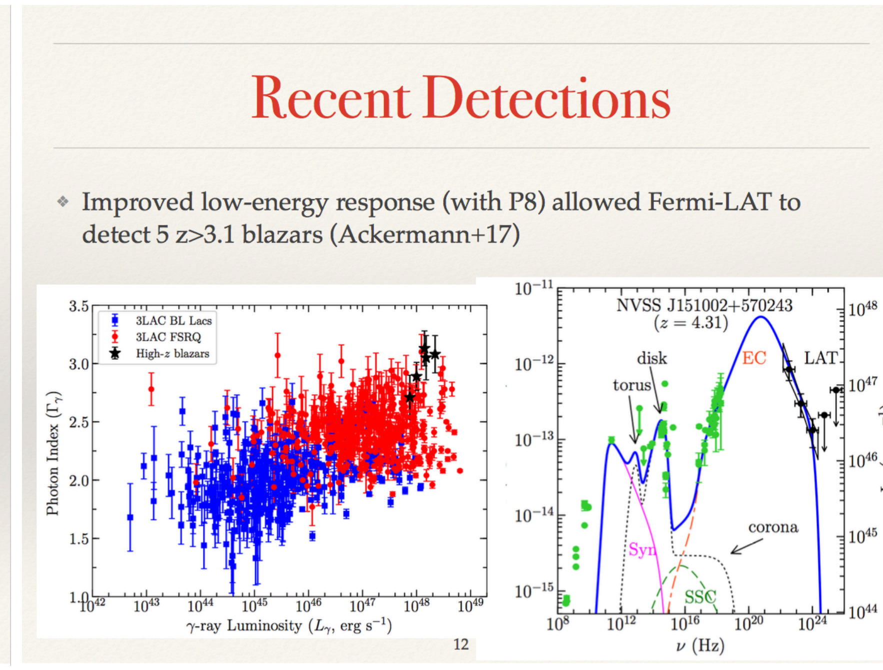
Table 3
Input Parameters for PKS 1510-089 are Detailed in Section 5.4.2, as in Table 2 for 3C 279

Polarimeter ID j	Polarimeter Energy Range $\Delta E_{pol}(j)$ (keV)	Energy Range of Observed Flux $\Delta E_{obs}(j)$ (keV)	Observed Energy Flux of Blazar $F_{E,\Delta E_{obs},blazar}(j)$ ($\times 10^{-12}$ erg cm^{-2} s^{-1})	Scaled Energy Flux of Blazar $F_{E,\Delta E_{pol},blazar}(j)$ ($\times 10^{-12}$ erg cm^{-2} s^{-1})	Photon Index of Blazar $\Gamma_{blazar}(j)$	Electron Index of Blazar $p(j)$	Seed Polariz. Degree Π_{init} (%)
1,2	25–80	10–50	38.2	45.7	1.23	1.46	15.0
3,4	2–10	2–10	6.09	6.09	1.38	1.76	15.0
5,6	50–195	14–195	70.0	36.4	1.38	1.76	15.0

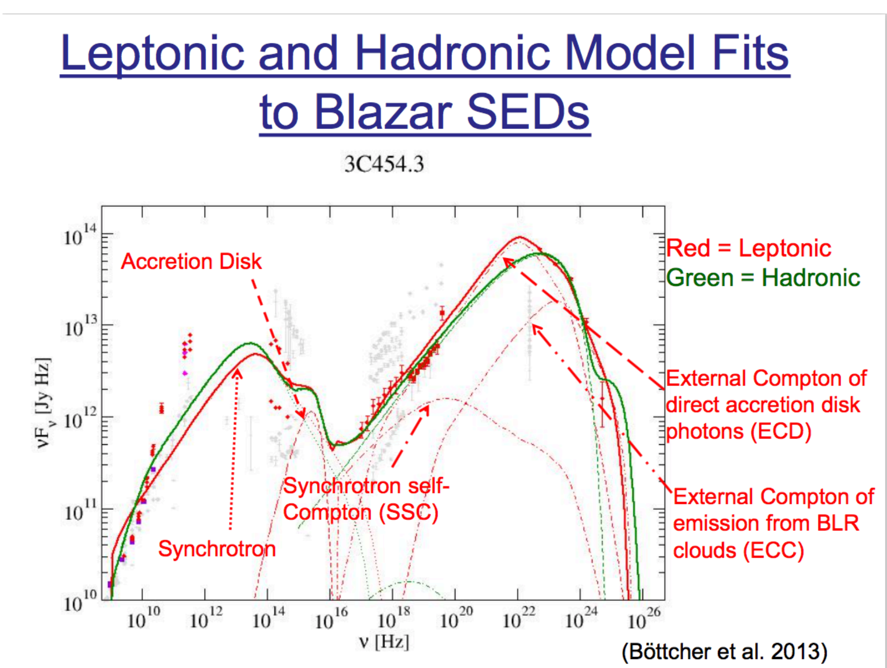
MeV Blazars - Marco Ajello

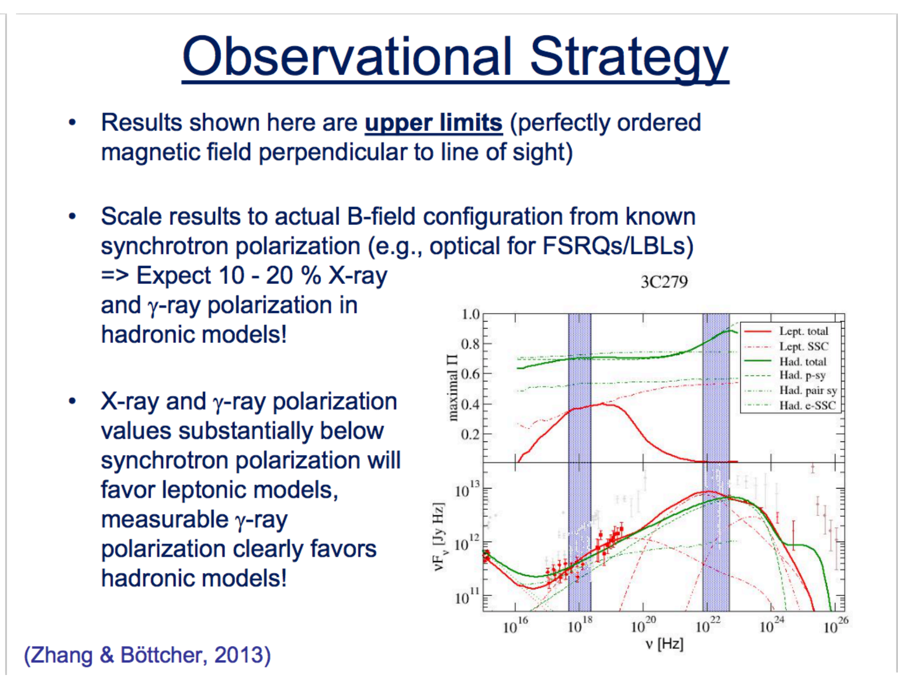


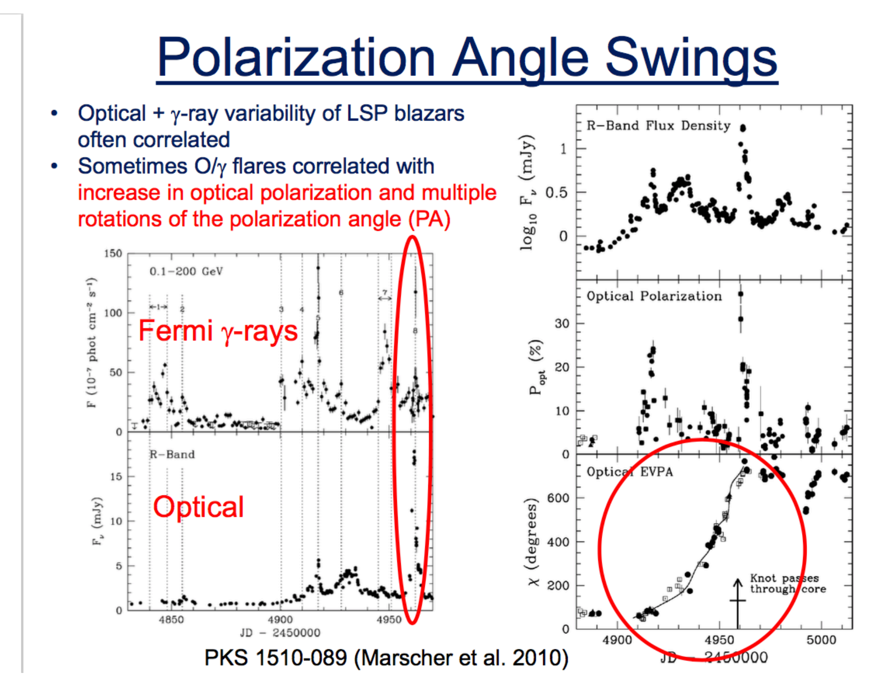




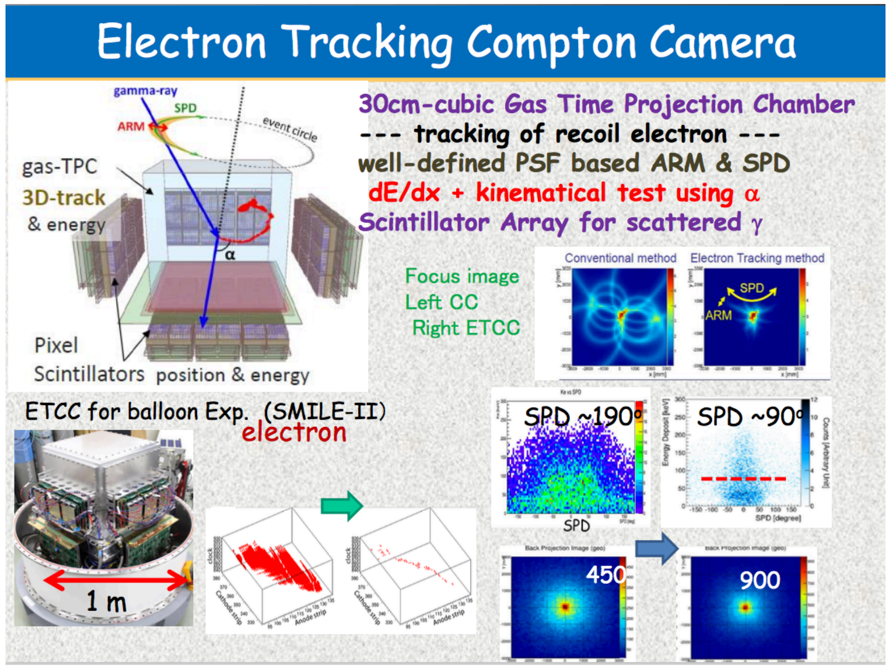
Blazars - Markus Böttcher

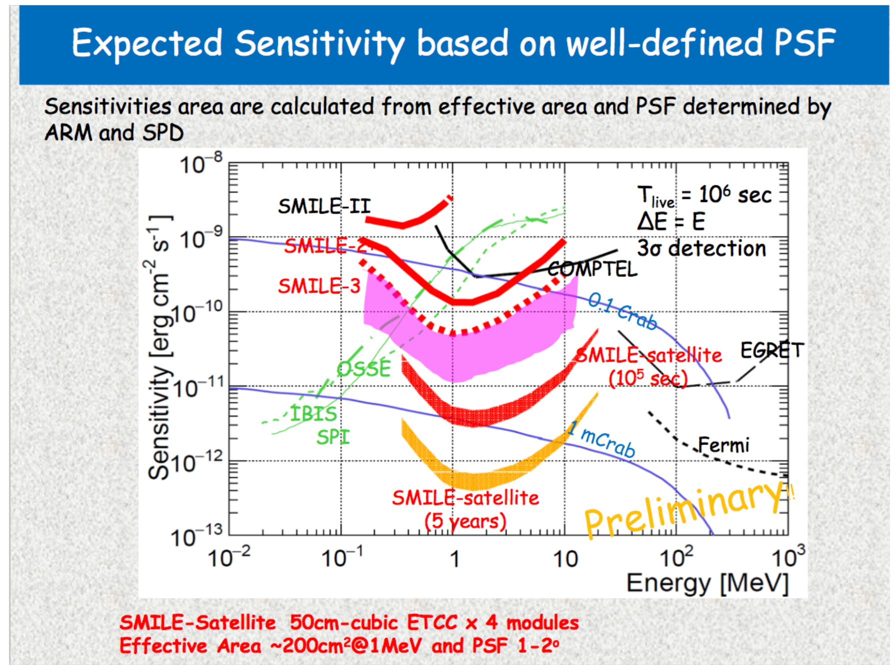


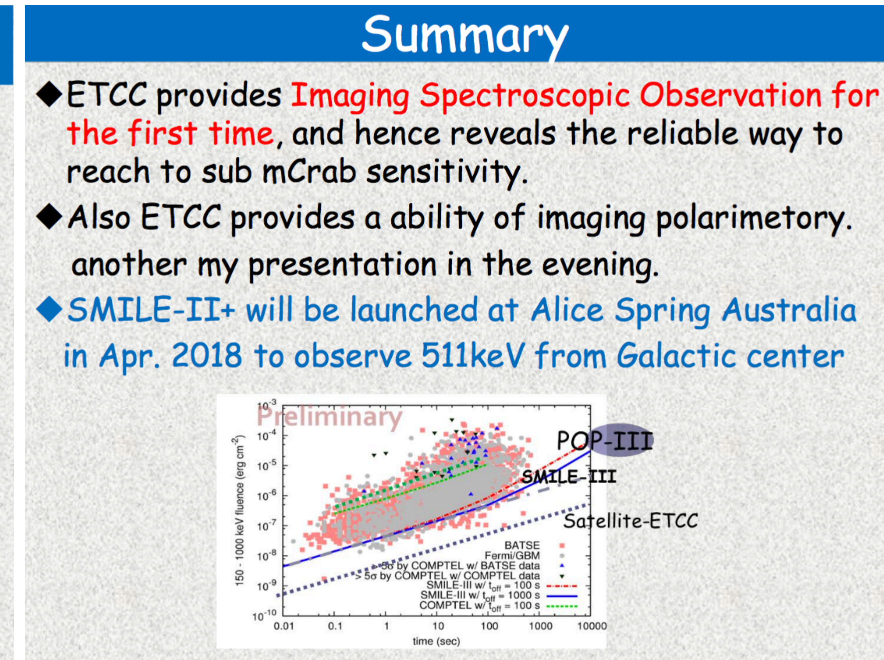




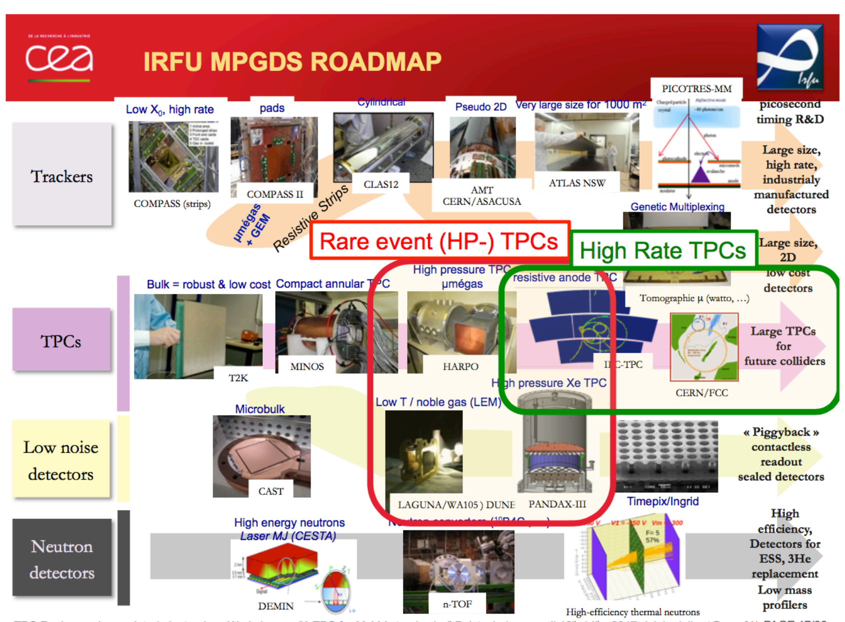
Electron Tracking Camera - Toru Tanimori

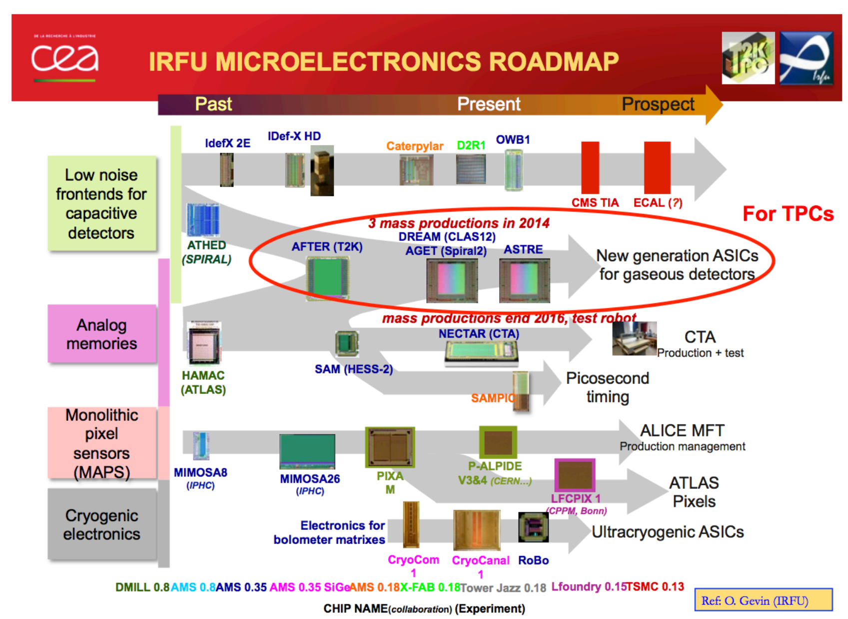


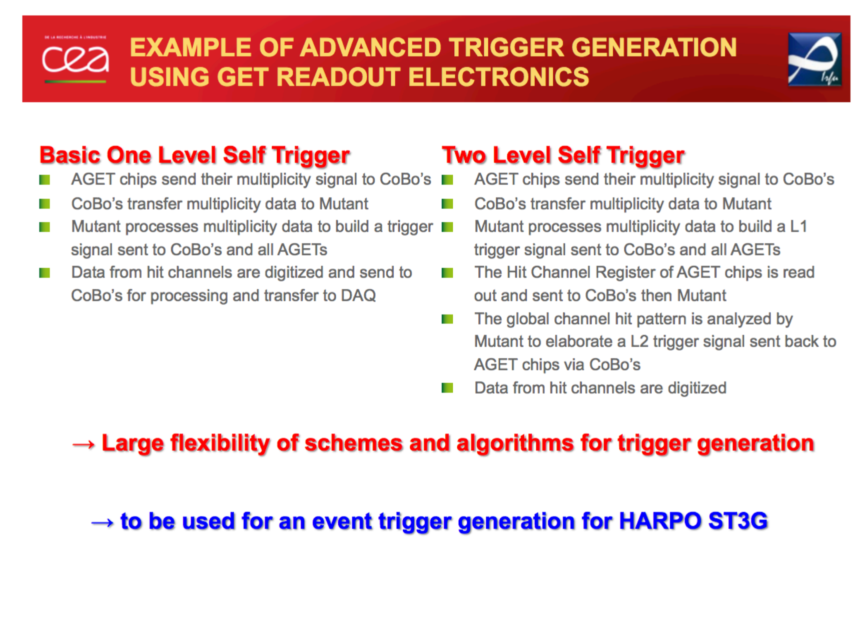




TPCs - Alain Delbart



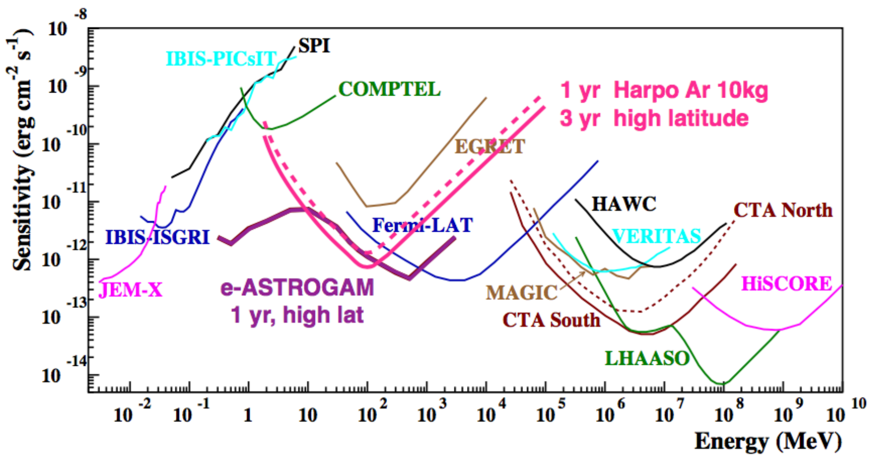




Pulsars
Isabelle Grenier (+ Alice Harding)

prospects for MeV pulsars in a nutshell

- uncover the population of energetic MeV pulsars
- shed light on acceleration & pair cascades near the polar caps
- diagnostics of
  - the radiation processes at MeV & GeV energies
  - the pulsed radiation pattern (caustic crossing)
  - magnetic reconnection in the wind



Pulsar Timing - David Smith

Conclusions

- Recording accurate event times and instrument positions isn't as easy as you may think.
- Many major missions goofed.
- Studying gamma polarization as a function of pulsar rotational phase requires forethought and testing.

2

Binaries - Benoît Cerutti

Conclusions

- Gamma-ray binaries are **bright** and **variable** **MeV sources**.
- MeV emission probes the **high-end** of the particle energy spectrum. Constraints on extreme particle acceleration mechanism?
- Origin of the **MeV flux** is still not understood.
- **Connection** between MeV and >100 MeV is not clear. Two **different components** are needed.
- Great opportunity to **probe pulsar and pulsar wind physics.**

B. Cerutti *TPC-MeV workshop, April 12-14, 2017*

Galactic Diffuse- Jean-Marc Casandjian

Conclusions

Lot's of astrophysics can be done at low energy gamma-ray

We did learn a lot about ISM and CRs with Fermi.

MeV will give us access to the electrons and positions density in the local and outer Galaxy and clouds.

It should be possible to model the diffuse emission for point-source extraction.

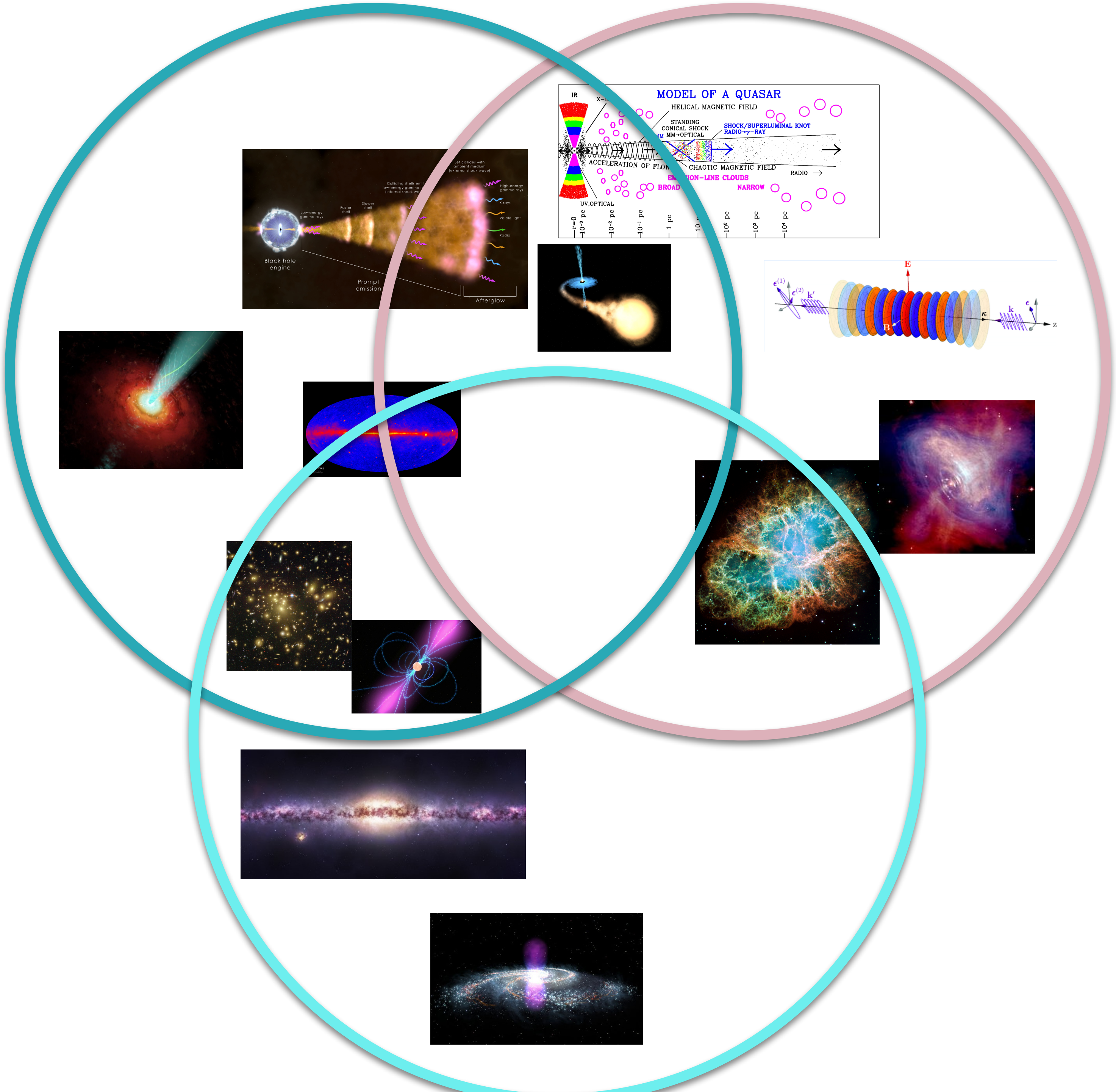
IC has a smooth spatial structure, it is difficult to model, it should be ok for point sources but a problematic background for extended sources.

From Fermi we know a good PSF helps a lot to study the interstellar emission.

Gamma-ray Astrophysics at MeV energies

MeV energy coverage

Polarization



High Angular Resolution

ST3G - what next?

CNES Appel d'offre 2017: deadline - 21 April

- We will submit a proposal to construct demonstrator of ST3G
- We will not request a balloon flight at this point

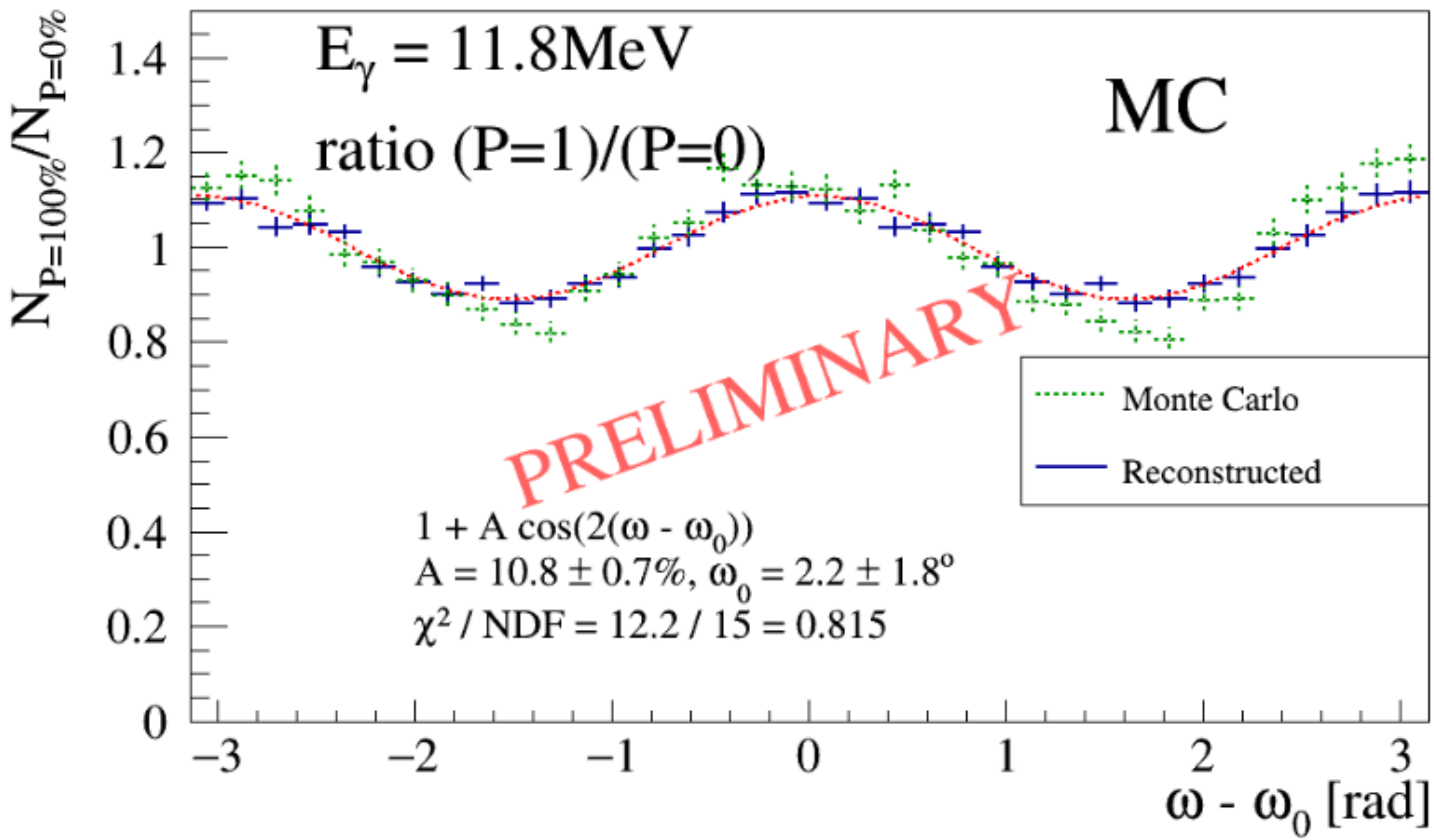
P2IO Post-doc call: deadline - 18 April

i.e. next Tuesday!

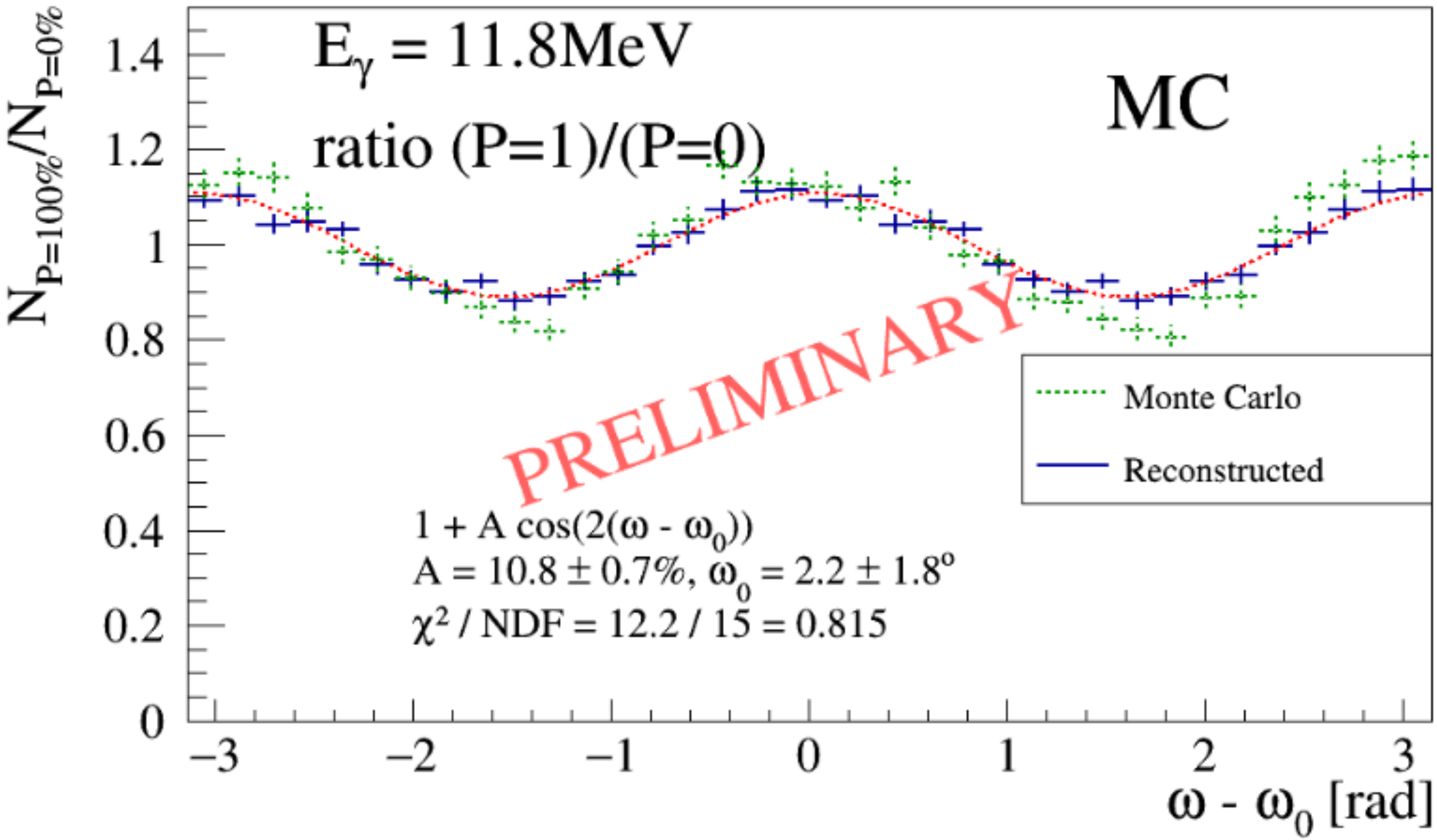
- Joint post-doc with another P2IO lab - 2 years

en suite ...

- ANR?
- ERC?
- ???



E_γ = 11.8MeV
ratio (P=1)/(P=0)
MC
PRELIMINARY
Monte Carlo
Reconstructed
1 + A cos(2(ω - ω0))
A = 10.8 ± 0.7%, ω0 = 2.2 ± 1.8°
χ² / NDF = 12.2 / 15 = 0.815
N P=100% / N P=0%
ω - ω0 [rad]



$N_{P=100\%}/N_{P=0\%}$
$E_\gamma = 11.8$MeV
ratio (P=1)/(P=0)
MC
PRELIMINARY
Monte Carlo
Reconstructed
$1 + A\cos(2(\omega - \omega_0))$
$A = 10.8 \pm 0.7\%$, $\omega_0 = 2.2 \pm 1.8^o$
χ^2 / NDF = 12.2 / 15 = 0.815
$\omega - \omega_0$ [rad]
1.4
1.2
1
0.8
0.6
0.4
0.2
0
−3
−2
−1
0
1
2
3

HARPO Tour