Workshop OCEVU/Astro
2015 January 20th

Optical follow-up of GRB alerts

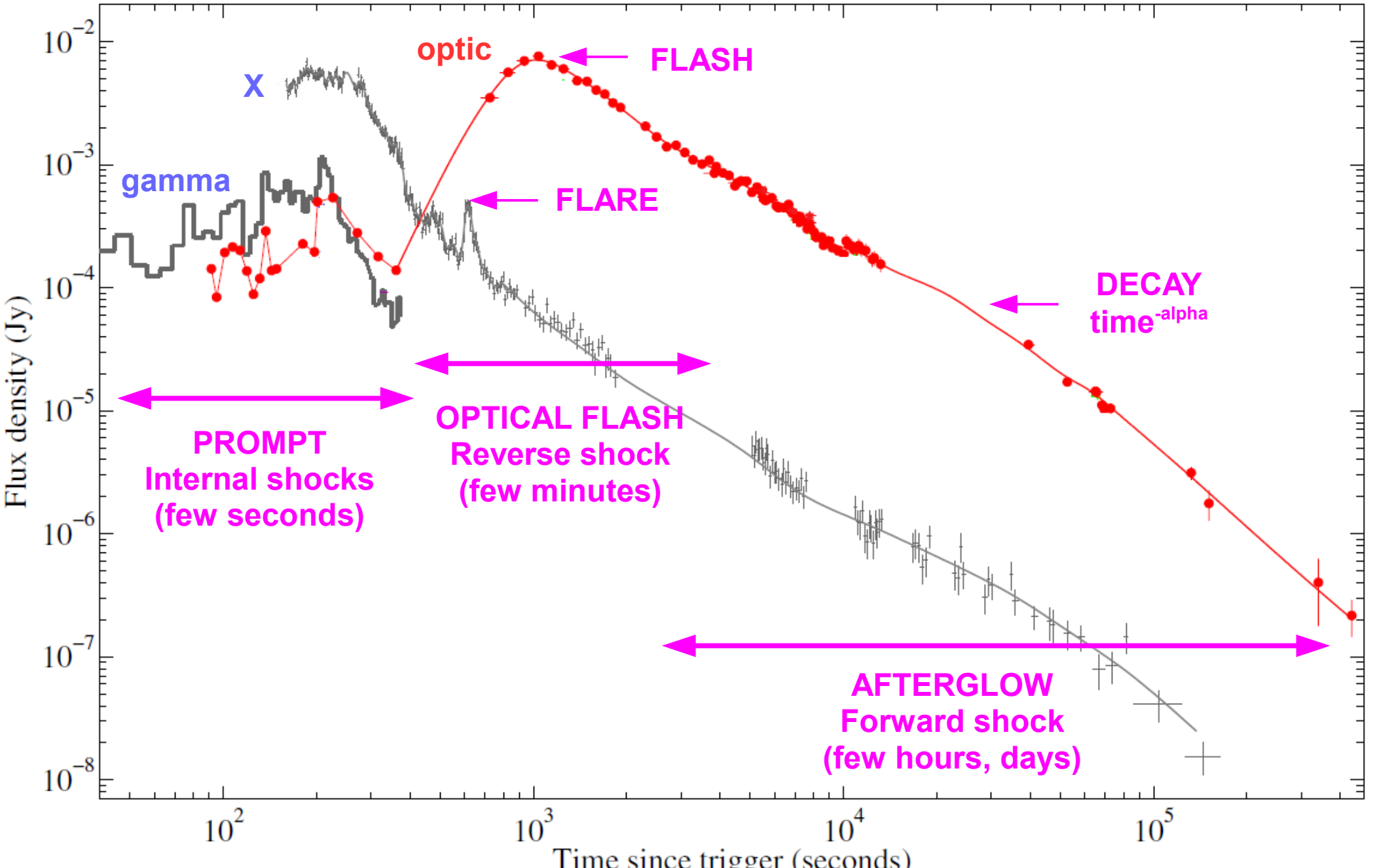
In the Swift area and beyond

Présented by Alain KLOTZ (IRAP)

OCEVU laboratoies involved in this talk:

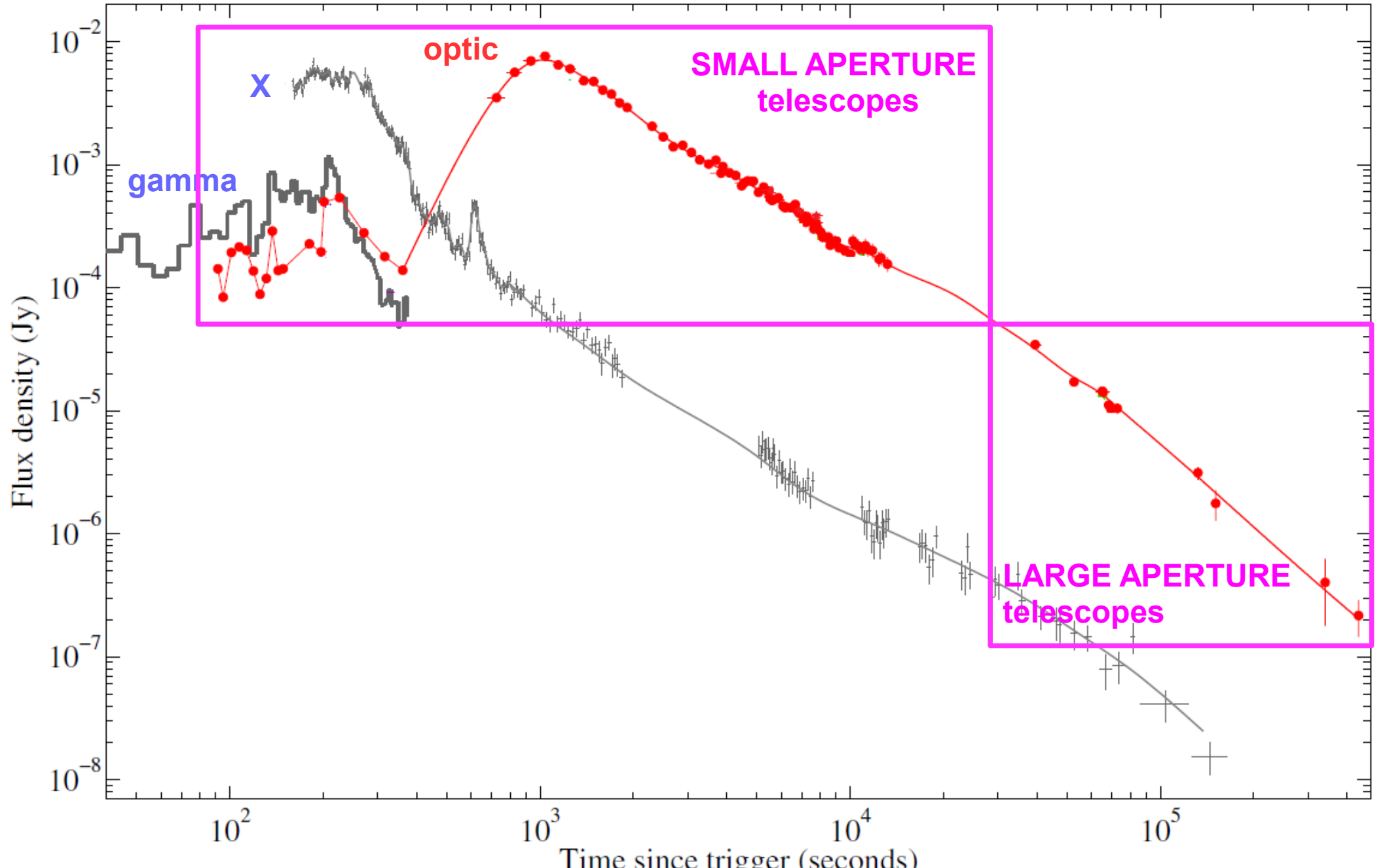
Context of astronomical GRB alerts

Gamma Ray Burts multi wavelength phenomenology



Context of astronomical GRB alerts

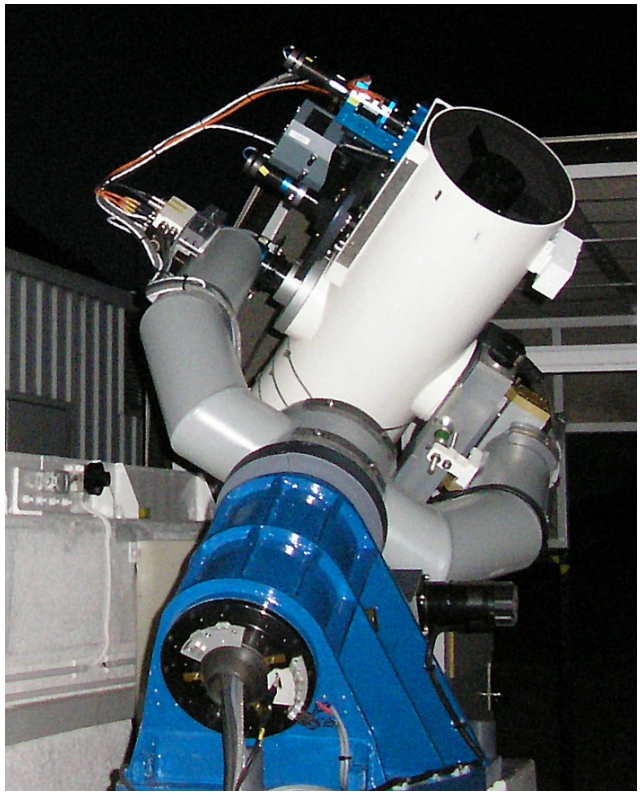
Optical telescopes



Context of astronomical GRB alerts

TAROT telescopes

Telescopes are **25cm** aperture F/D=3.3 (= small aperture)
Caméras are Andor: Field of view **2°x2°** sampling 3.3 arcsec/pixel



Chili 2006 (62 alerts)

SATELLITE
gamma

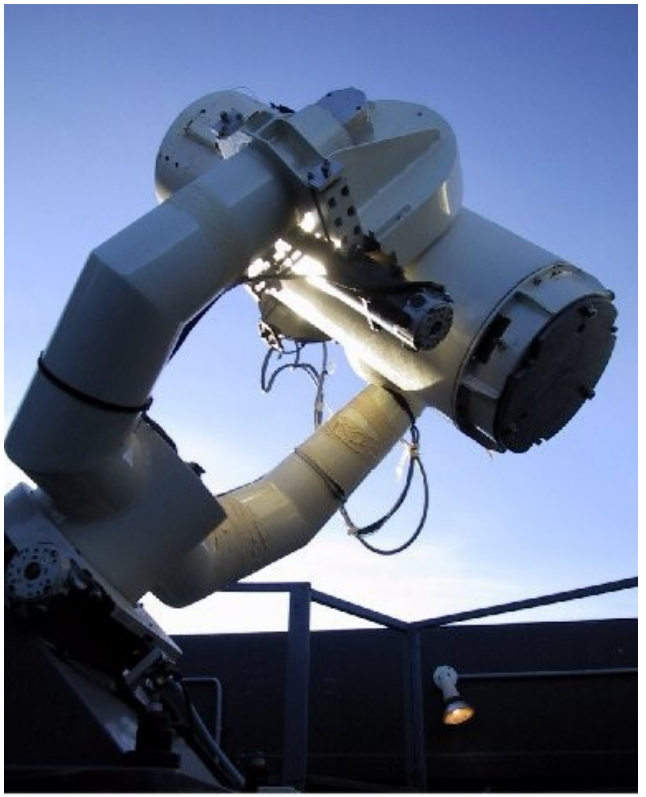
↕ ~15 sec

GCN

↕ 1 sec

Tel. Robotics
optics

↔ ~10 sec ~10 sec ↔



Calern 1998 (108 alerts)

16 papers in refeered journals
173 GCN circulars

Context of astronomical GRB alerts

TAROT telescopes and their competitors

List of observatories with telescopes D < 1 meter
that published more than 100 GCN circulars

Name	nb GCNC	Diam(cm)	nb telescopes (PI country)
MASTER	262	40.0	5 telescopes (Russia)
MITSuME	229	50.0	3 telescopes (Japan)
ROTSE	224	45.0	4 telescopes (USA)
TAROT	173	25.0	2 telescopes (France)
PROMPT	115	41.0	4 telescopes (USA)
TNT	109	80.0	1 telescope (China)
REM	101	60.0	1 telescope (Italy)

All are **small aperture**, **fast pointing, autonomous, robotic** telescopes

Fast pointing means first image taken less than 1 min after the trigger

Small aperture limits the detectivity hence only photometry during the night of the trigger.

> 100 GCN circulars means great technical reliability of these observatories

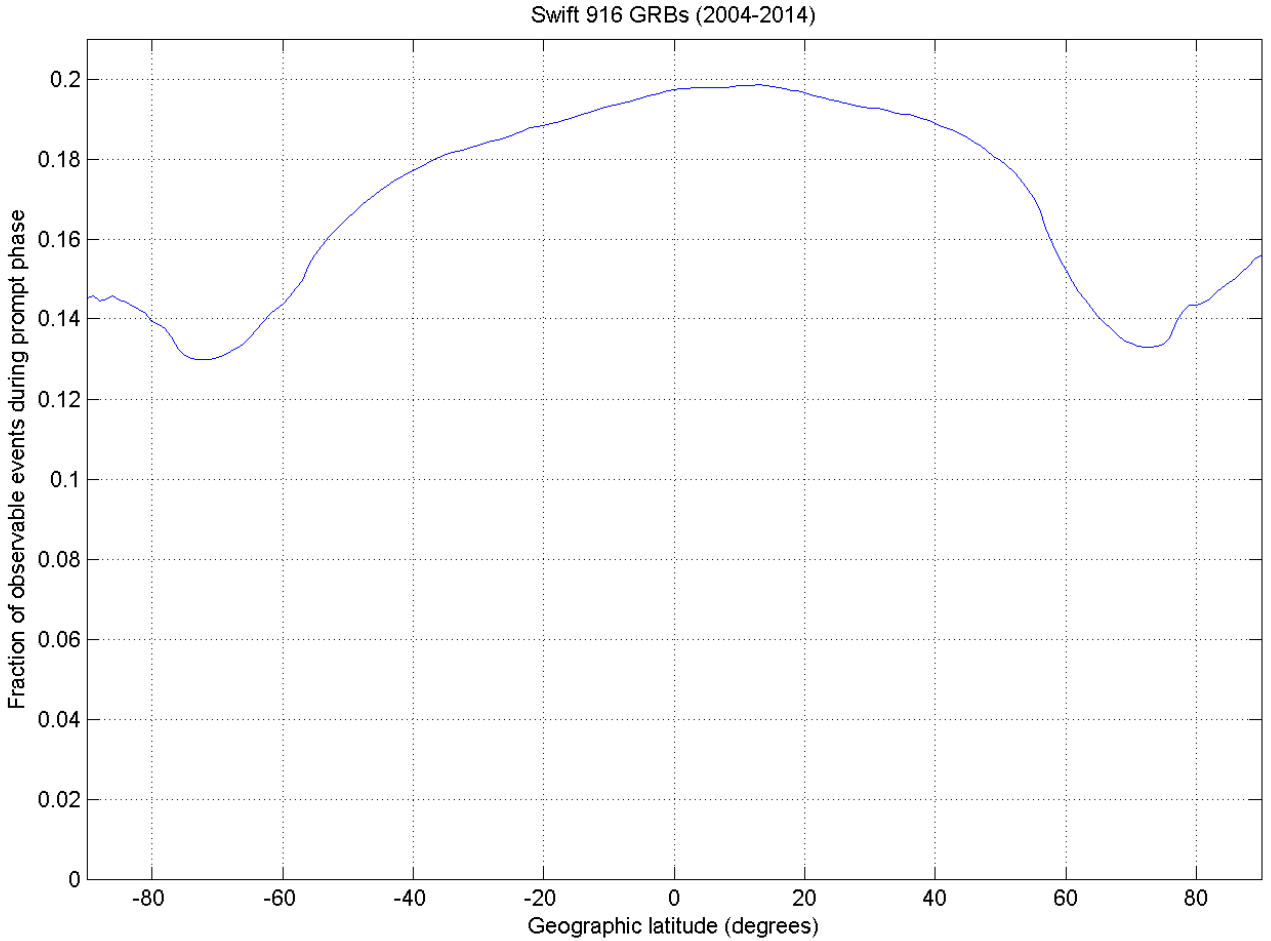
Context of astronomical GRB alerts

Efficiency of early observation for one optical telescope

Theoretically :

The GRB is upper than an elevation of 10° : 1/2*(1-sin(elevation)) = 0.41
The sun is lower than an elevation of -10° : 1/2*(1+sin(elevation)) = 0.41
The total efficiency is 0.41*0.41 = 0.17 = 17% (visible GRBs during prompt)

Real : Swift and the geographic latitude dependancy



916 Swift GRBs

2 TAROTs
99 early observations
Efficiency ~ 6 % / telescope

(instead of ~18%)

Tech problems
Moon
Clouds

Context of astronomical GRB alerts

Statistics from optical telescopes

TAROT (25 cm, <1 minute)

149 GRBs observed
32% optical emissions seen.
21% GRB observed during prompt emission,
7% optical transient seen during prompt emission.

Zadko (100 cm, >2 minutes)

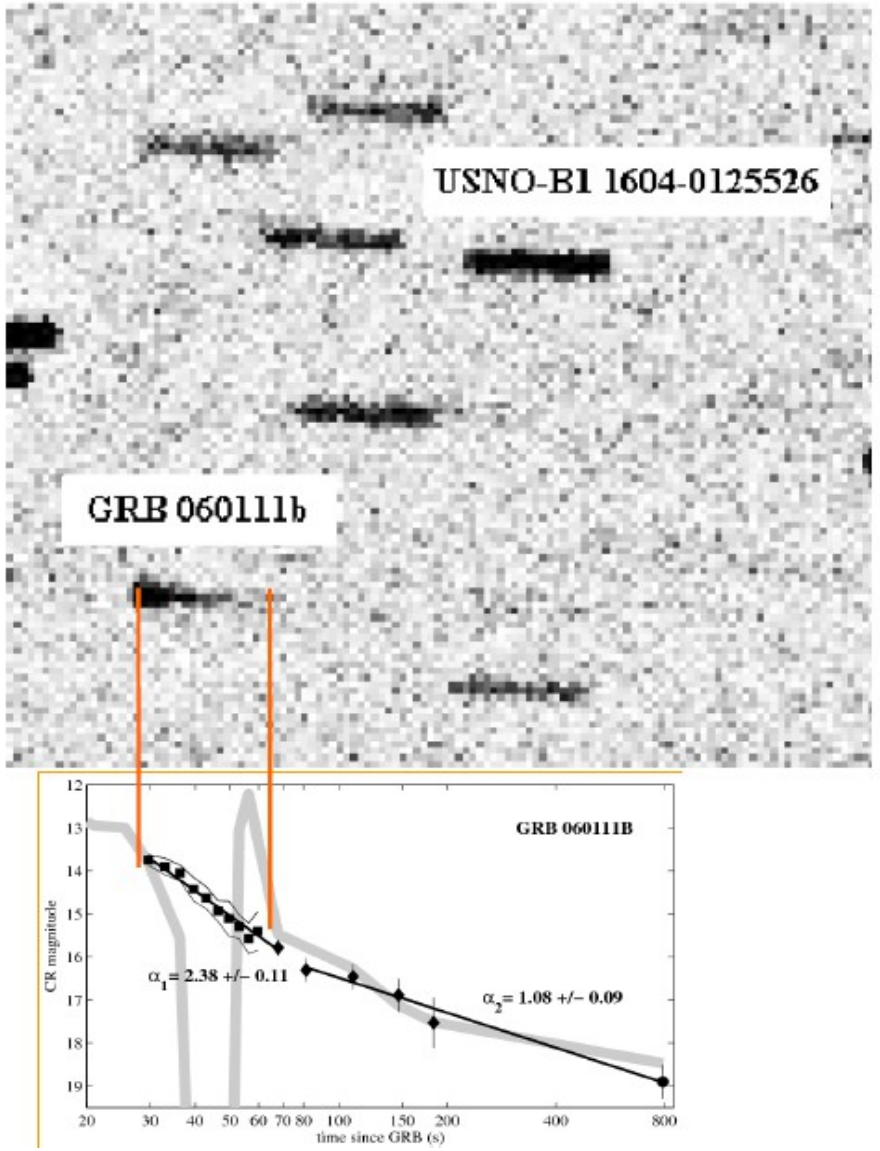
31 GRBs observed
39% optical emissions seen.
0% GRB observed during prompt emission,
0% optical transient seen during prompt emission.

Context of astronomical GRB alerts

Main results of TAROT telescopes

Prompt trail technique (7 GRBs)

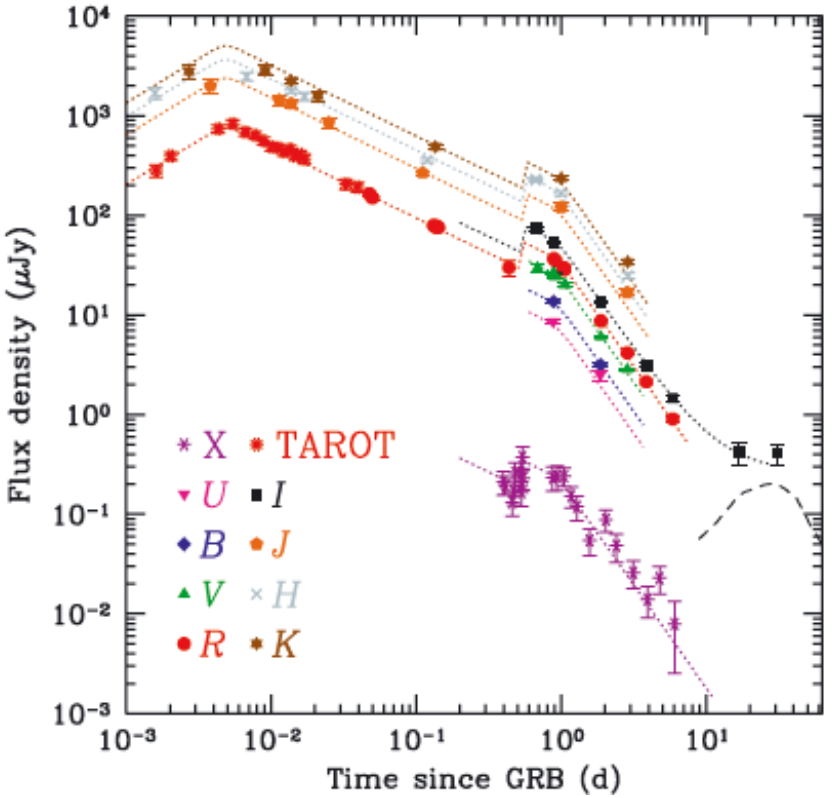
060111B, 080903A 110205A, 111209A, 120119A, 120909A, 121024A



(Klotz et al. 2006 A&A 451, L39)

First hours photometric follow-up (22 GRBs)

050525A, 050904,
060904A,
070420, 071010A,
080210, 080430, 081126A
090102,
110205A, 111209A,
120119A; 120326A, 120327A, 120909A, 120913B, 121024A
130610A, 131117A
141109A, 141221A, 141225A



Covino et al. MNRAS. 388, 347–356 (2008)

Multi wavelength analysis of GRBs

Gamma Ray Burts & fireball theory

Optical + X ray + gamma
light curves & spectra

Optical spectrum

X-ray spectrum

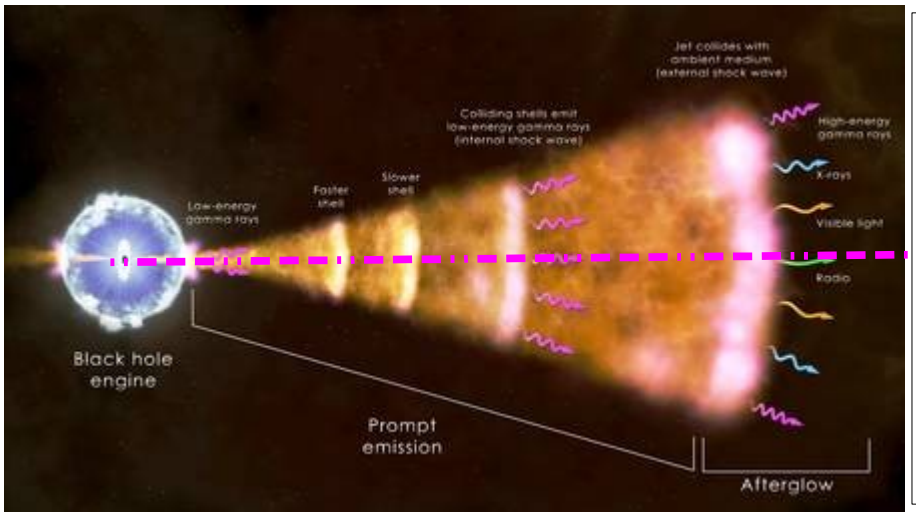
Optical spectrum

E_{iso}, η
ε_B
ε_e
p

nH

Av, NH, Z

z



host galaxy

inter galactic medium

Stellar evolution - Physics

Cosmology

Multi wavelength analysis of GRBs

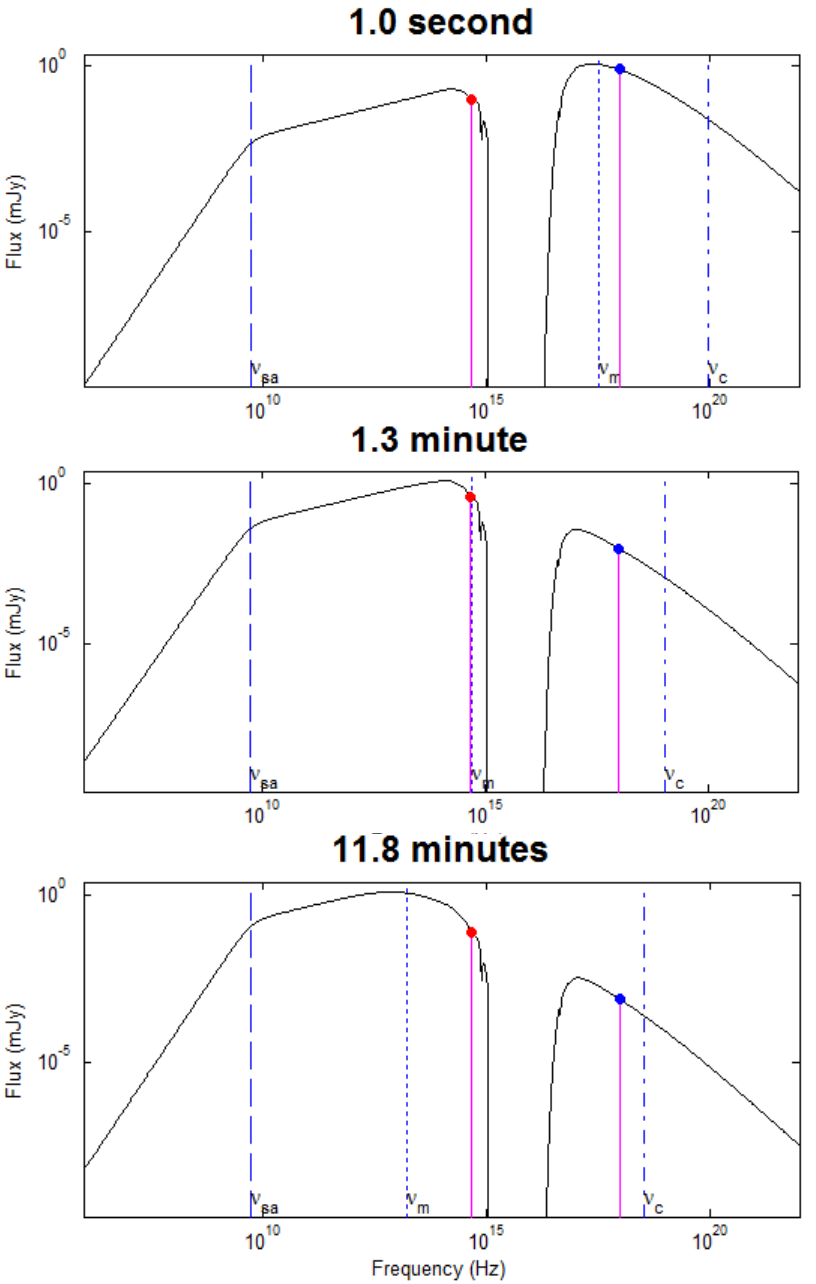
Gamma Ray Burts – Importance of the early observations

Optical + X ray + gamma
light curves & spectra

E_{iso}, η
ε_B
ε_e
p

nH

Determination of the parameters
is done unambigously
only with
continuous data acquired
during **the ten first minutes**



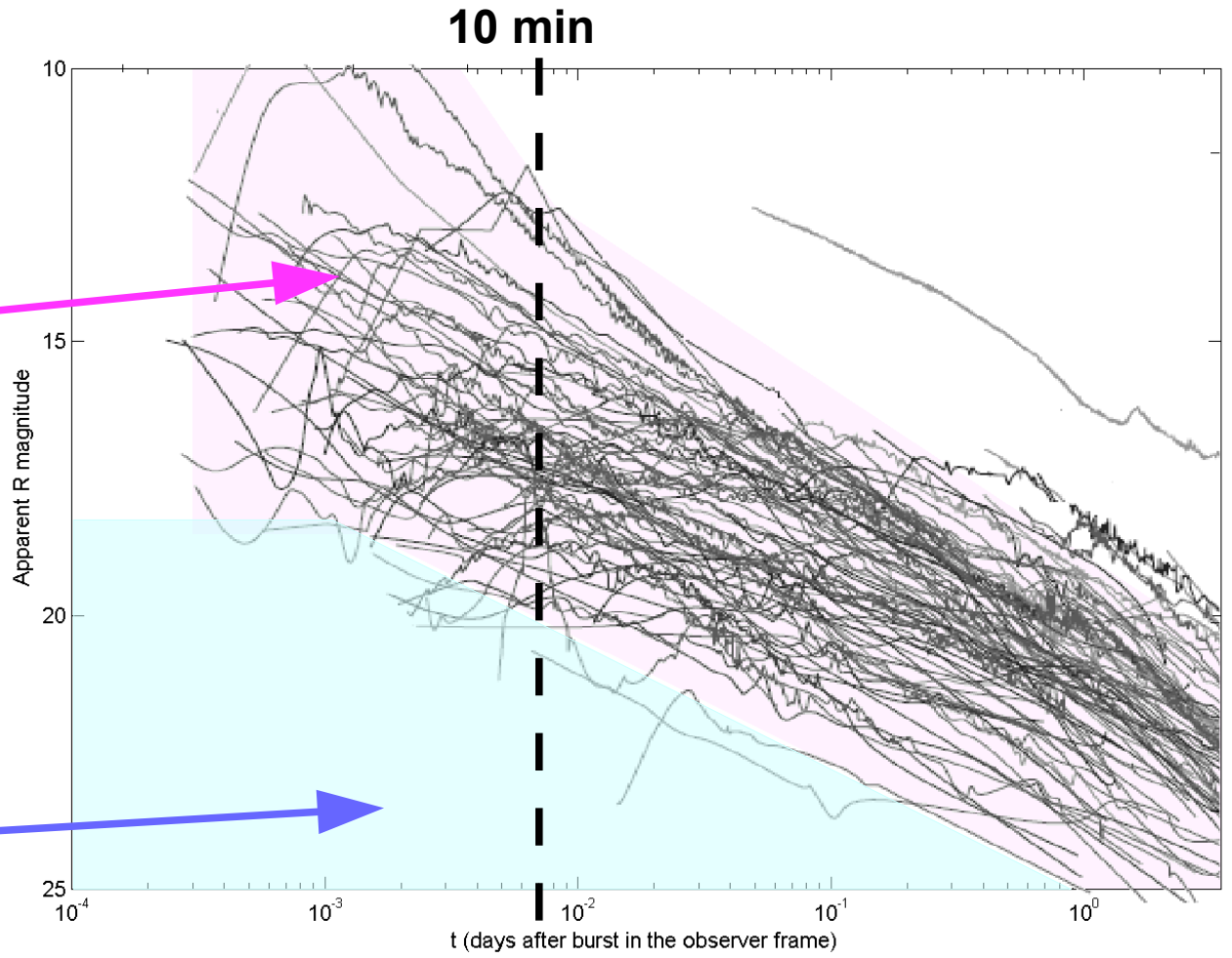
Optical light curves – 2000-2010 apparent light curves

Adapted from Kann et al. (2010) ApJ 720, 1513

Only 40%
of Swift afterglows
are detected
in optical
In this area

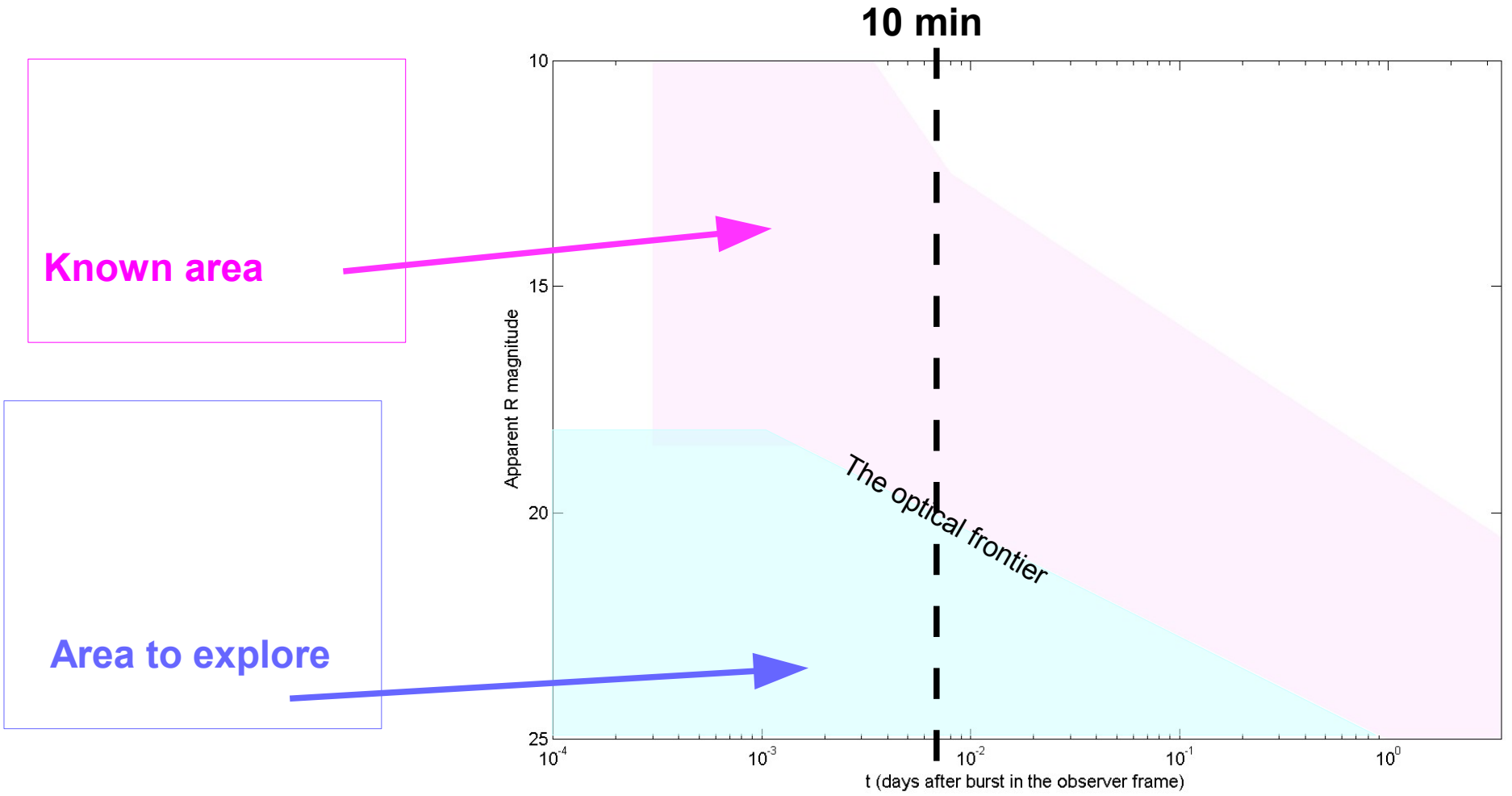
60%
of Swift afterglows
are NOT detected
in optical.

They are somewhere
here



Optical light curves – The optical frontier

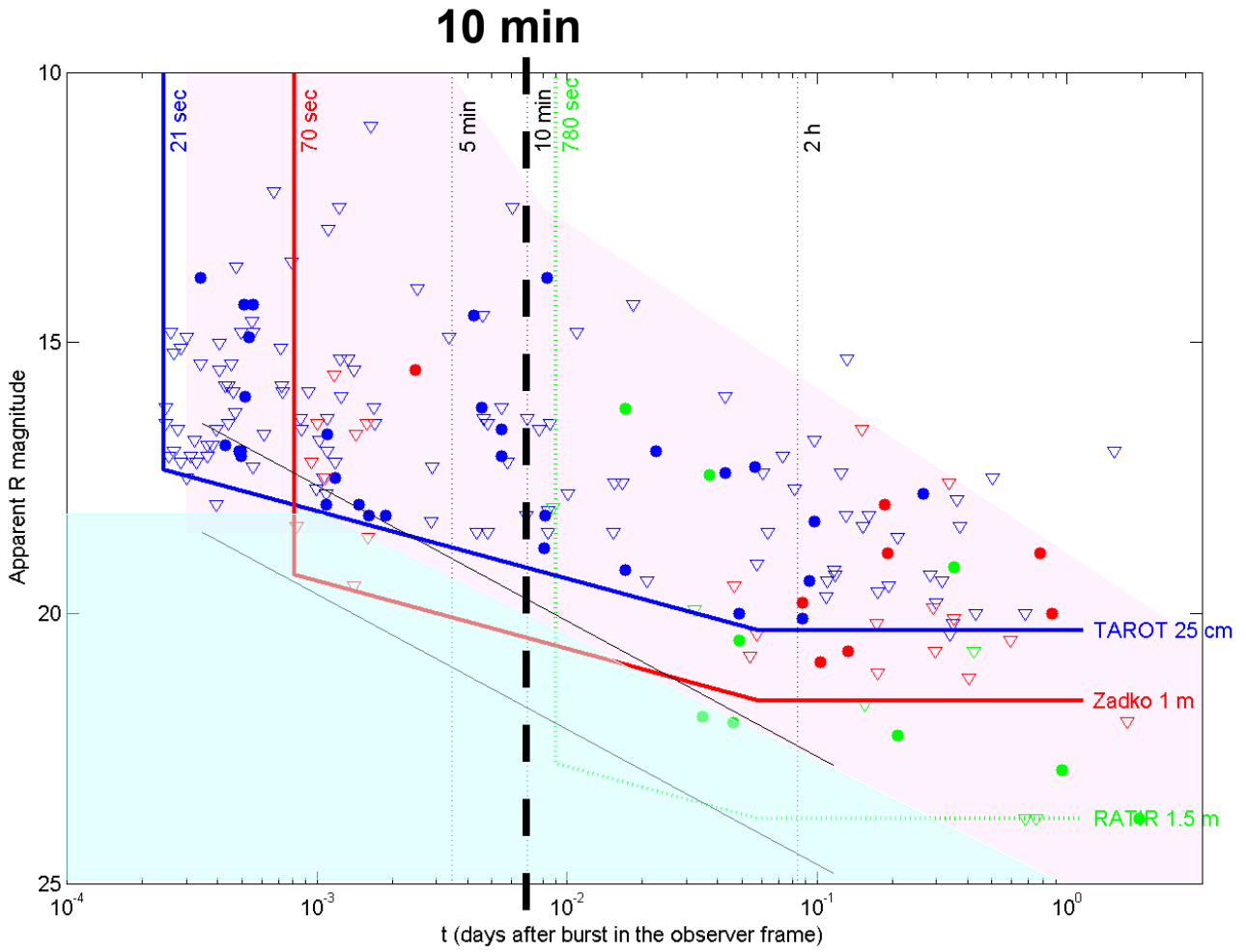
Analogy with the American frontier in the XIXth century



Optical light curves – Check the telescope detectivity

Small aperture telescopes

Large aperture telescopes



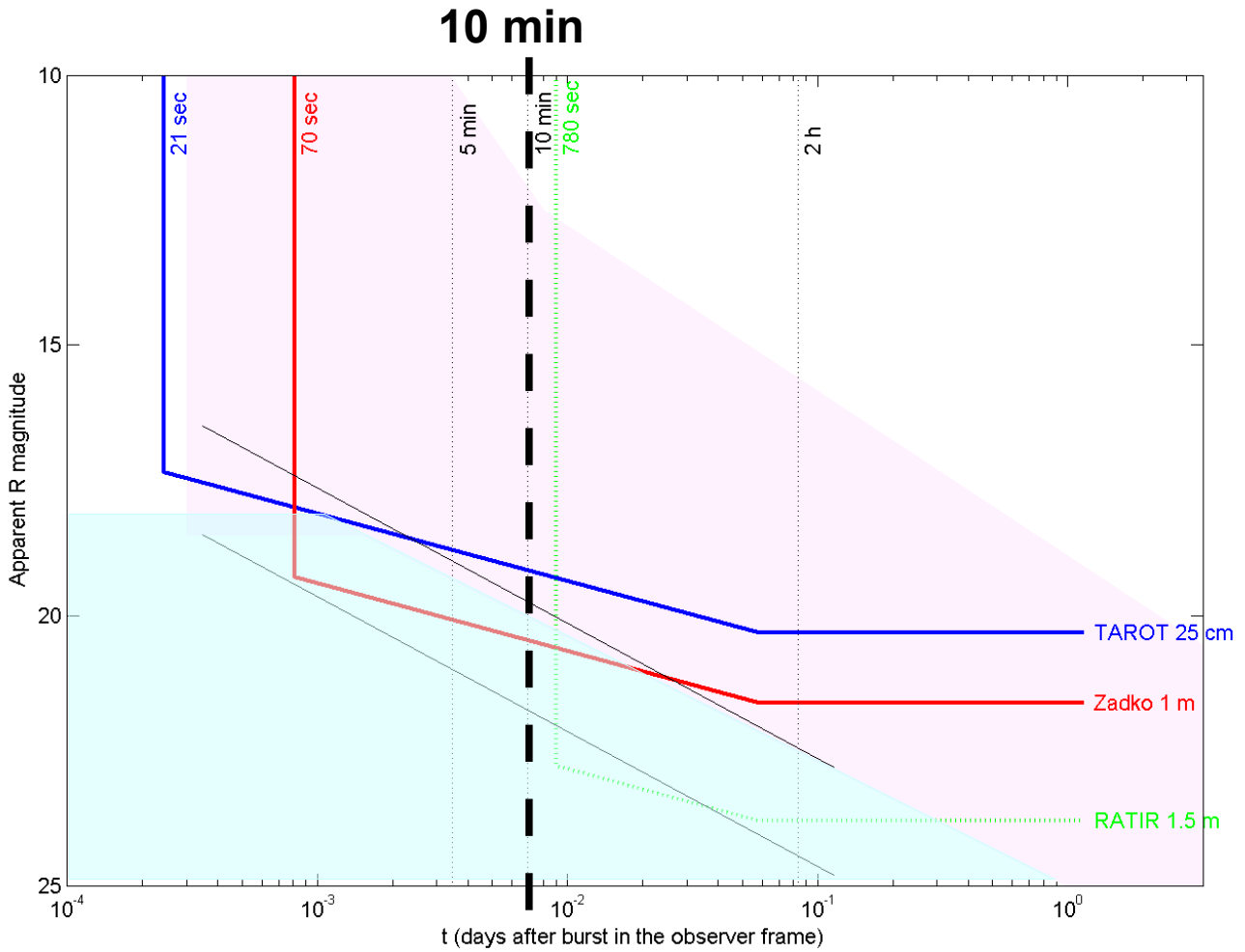
fast pointing telescopes

slow pointing telescopes

Optical light curves – Check the telescope detectivity

Small aperture telescopes

Large aperture telescopes



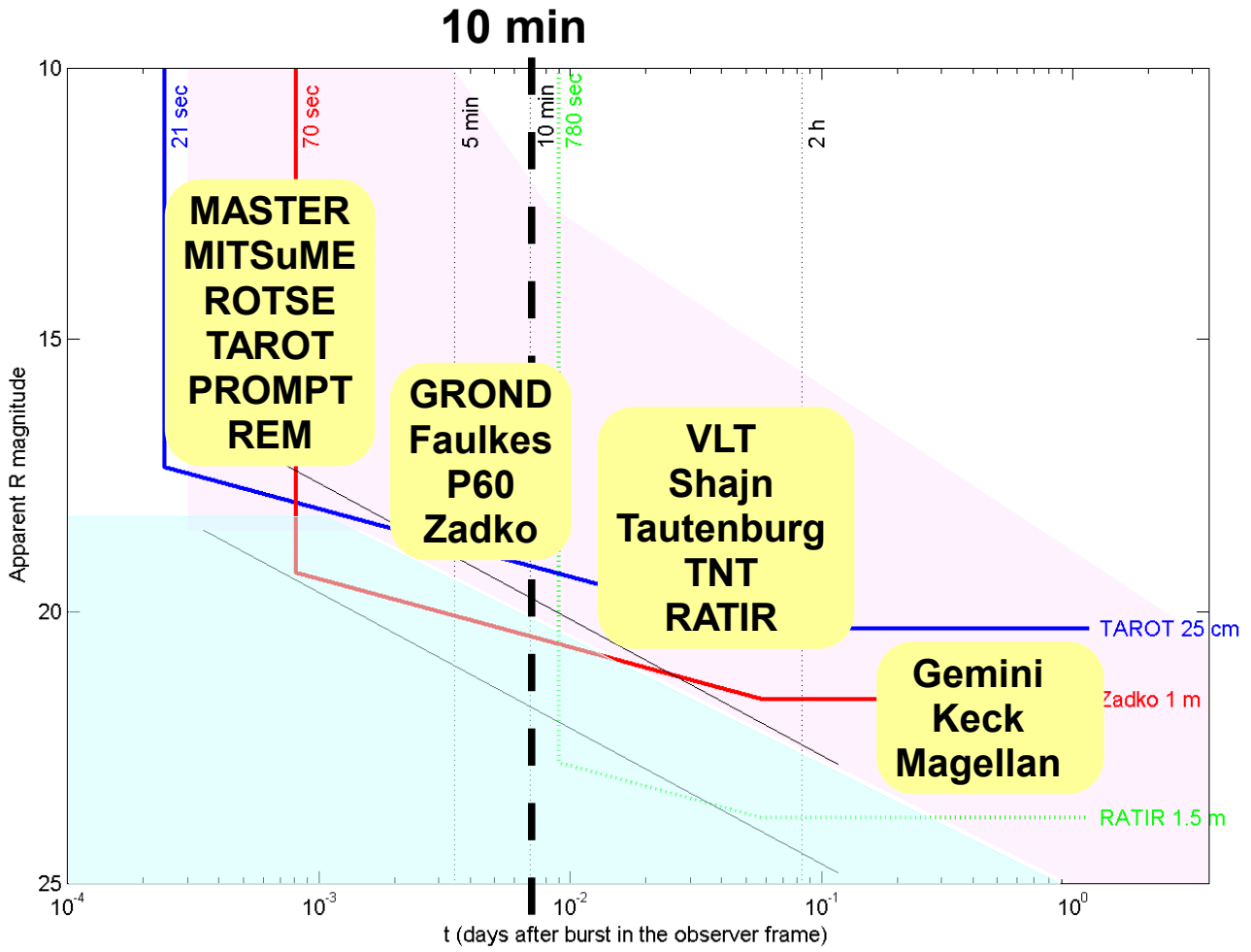
fast pointing telescopes

slow pointing telescopes

Optical light curves – Active observatories

Small aperture telescopes

Large aperture telescopes



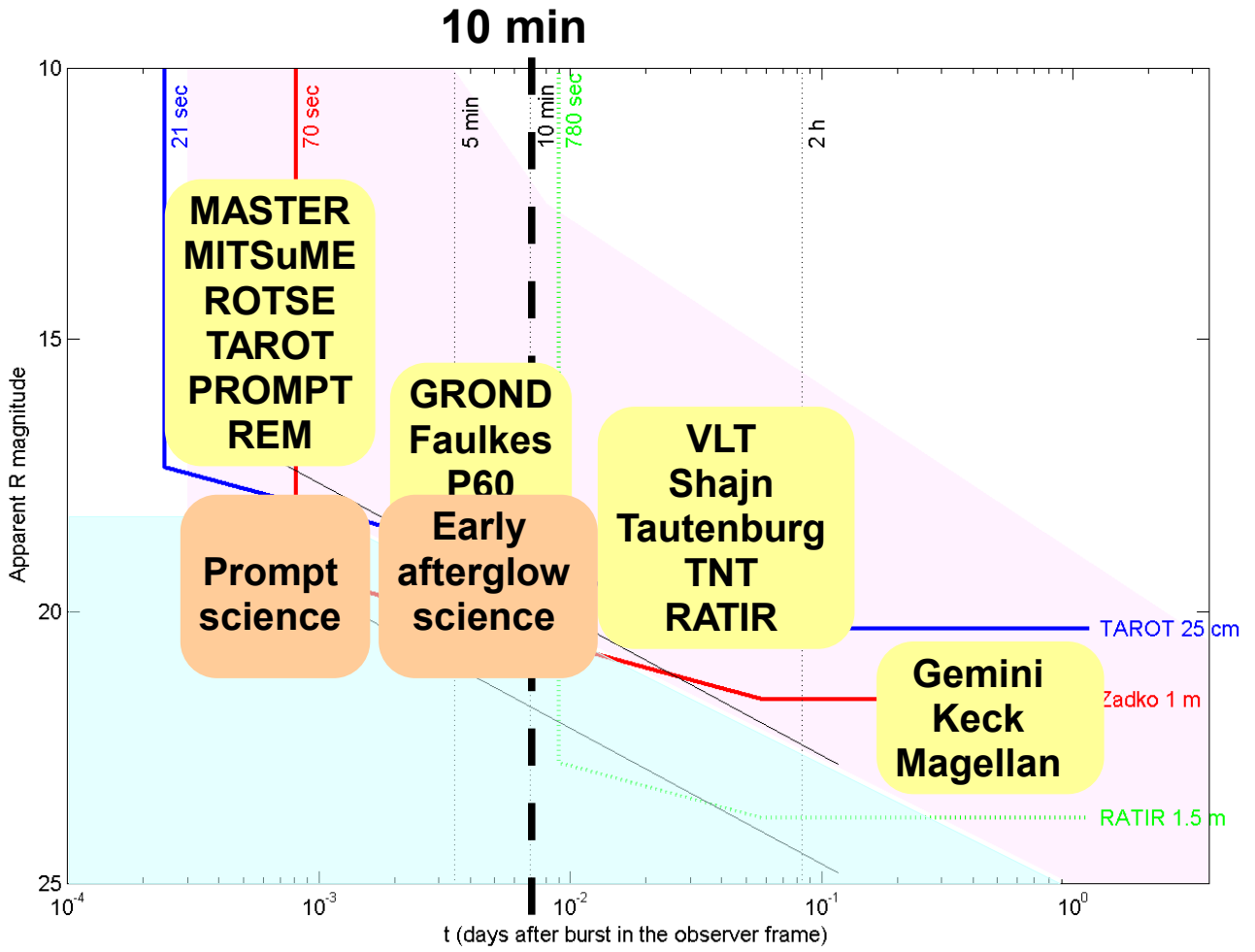
fast pointing telescopes

slow pointing telescopes

Optical light curves – Science to explore

Small aperture telescopes

Large aperture telescopes



fast pointing telescopes

slow pointing telescopes

Optical light curves – SVOM Follow-up projects

OCEVU Flash Telescope

One large aperture telescope: 1m20
Efficiency 30% due to SVOM orbit
Fast response ~30s after the trigger
Fast pointing (<30 s)
Covering the Field of View of SVOM
1 visible camera
1 near infrared camera

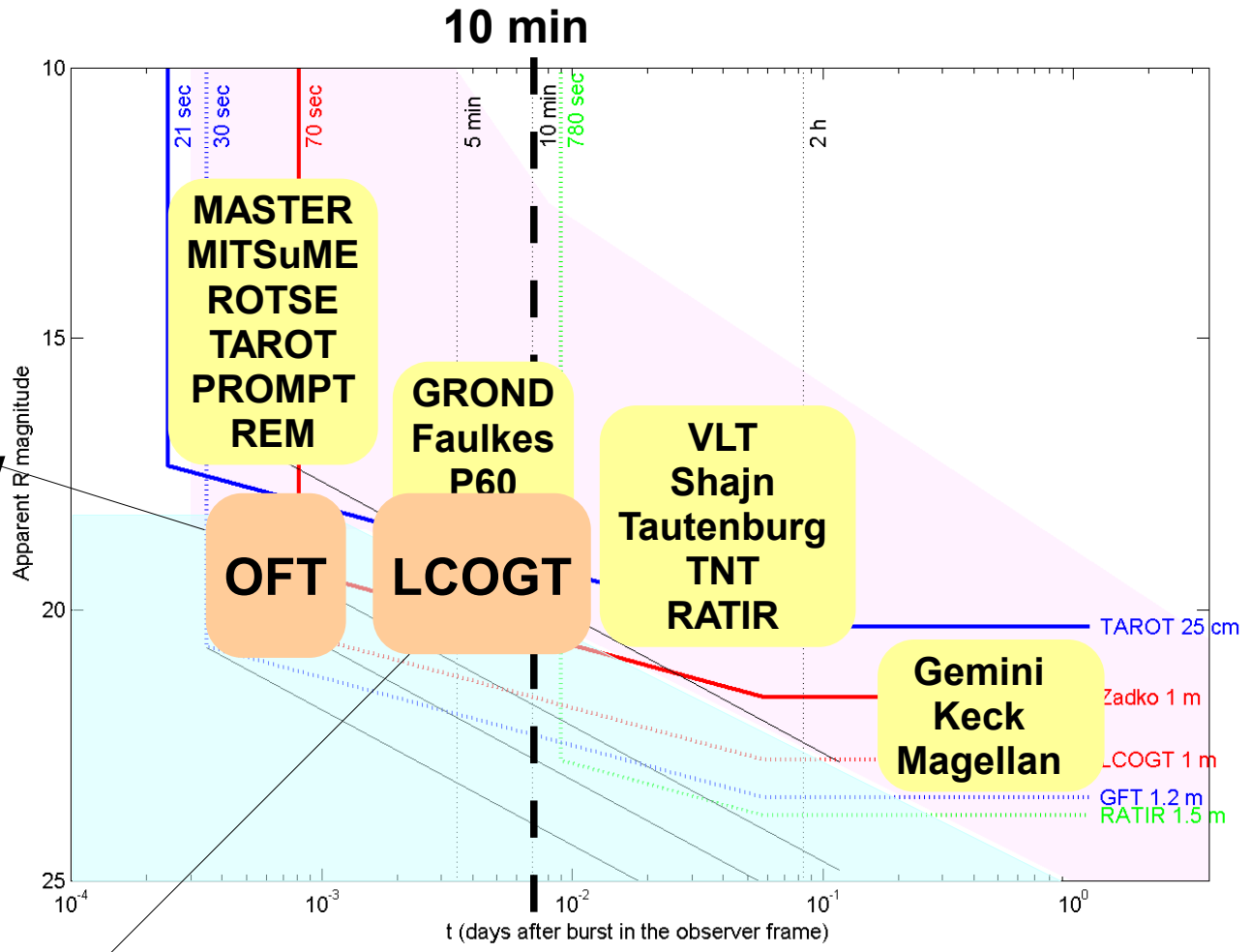
Detection of near infrared emission
Cosmology (7 < z < 10)
Faint prompt optical emissions
Dark afterglows and SGRBs
Transition prompt->afterglow
High energy physics

LCOGT Telescope network

5 to 7 medium aperture telescope: 1m
Efficiency >90% due to the network
Fast response ~30s after the trigger
Slow pointing (~60 s)
Covering the Field of View of SVOM
1 visible camera
1 near infrared camera

Identification of all afterglows
Allowing redshift for all GRBs
First day photometry
Afterglow detailed light curves

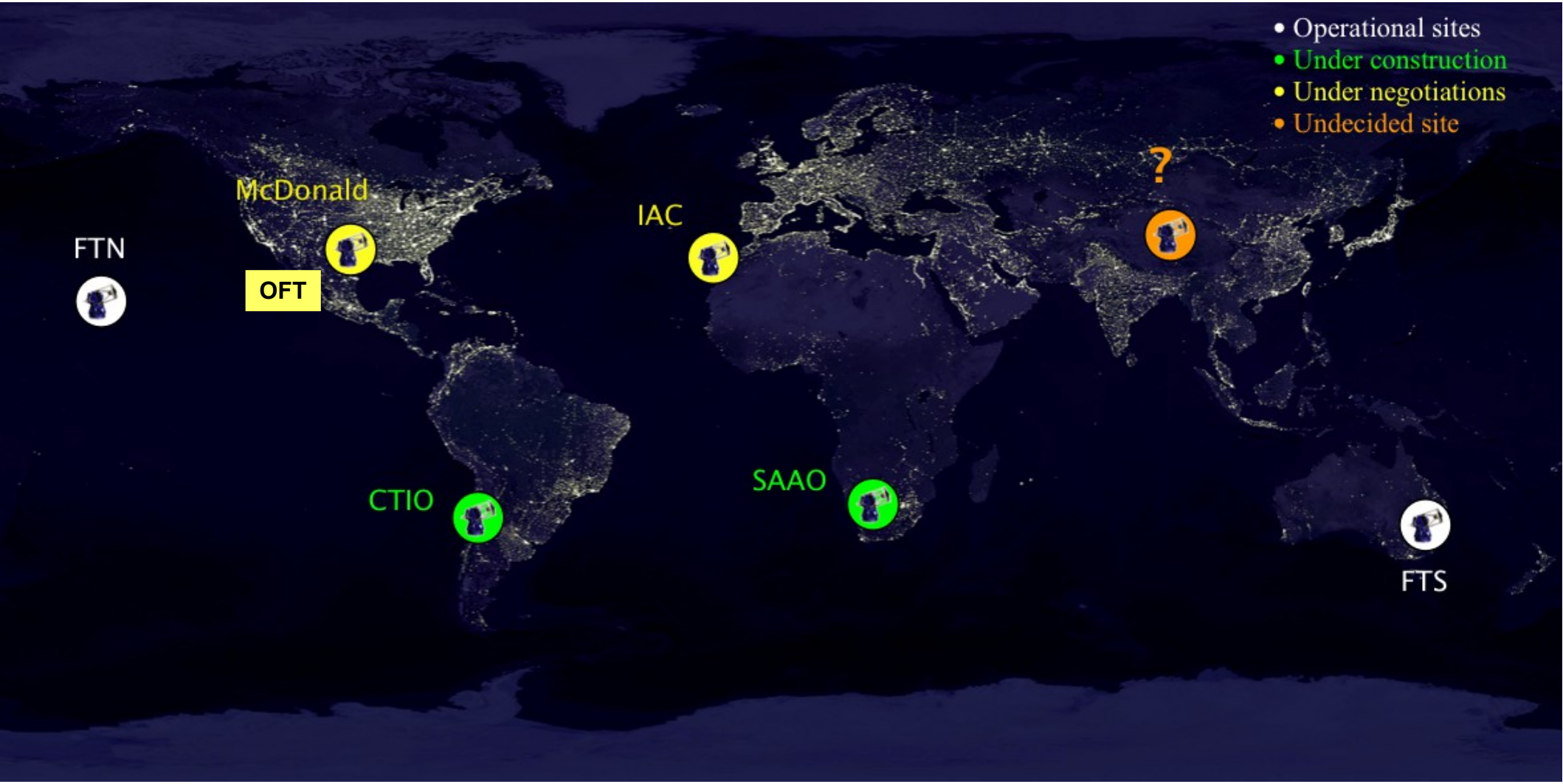
Exploring down the frontier



SVOM will be launched in 2021

Possibiliy to observe GW and neutrino alerts

Optical light curves – SVOM Follow-up projects



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cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

instituto de astronomía
unam

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