



Istituto sull'Inquinamento Atmosferico
Consiglio Nazionale delle Ricerche

LA MISSIONE SBUDNIC: UNA DIMOSTRAZIONE DELLA ACCESSIBILITÀ DELLO SPAZIO

Lorenzo Bigagli¹ e lo SBUDNIC Team²

1 - National Research Council of Italy – Institute of
Atmospheric Pollution Research (CNR-IIA)

2 - Brown University School of Engineering

Anthony Bishop-Gyls, David Chen, Julien Cormary, Duncan
Crane, Marco Cross, Theodore Fernandez, Rick Fleeter, Haley
Rose Flores, Audrey Gallagher, Kazen Gallman, Dheraj
Ganjikunta, Cameron Goodreau, Laura Jankowski, Selia Jindal,
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Pellinger, Vikas Rana, Dan Rapoport, Mia Rollins, Sejal Shah,
Gabby Shieh, Maddie Simon, Miku Suga, Ethan Zucker

Workshop “L’impegno italiano nel settore dei
CubeSat: tecnologie e missioni future” – 2° ed.
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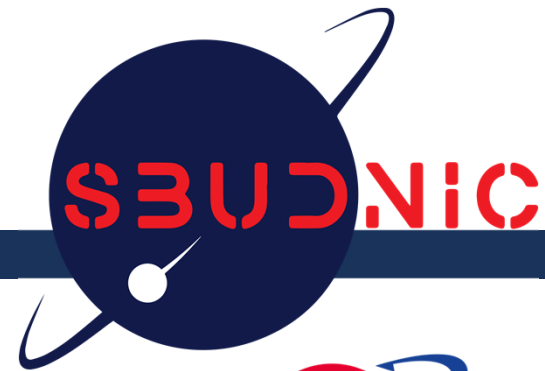


Outline



- Introduction to the SBUDNIC project
- Timeline
- Mission design
- Notable issue: registration
- Notable outcomes
 - ▣ Orbital decay
- Conclusions

SBUDNIC project



BROWN

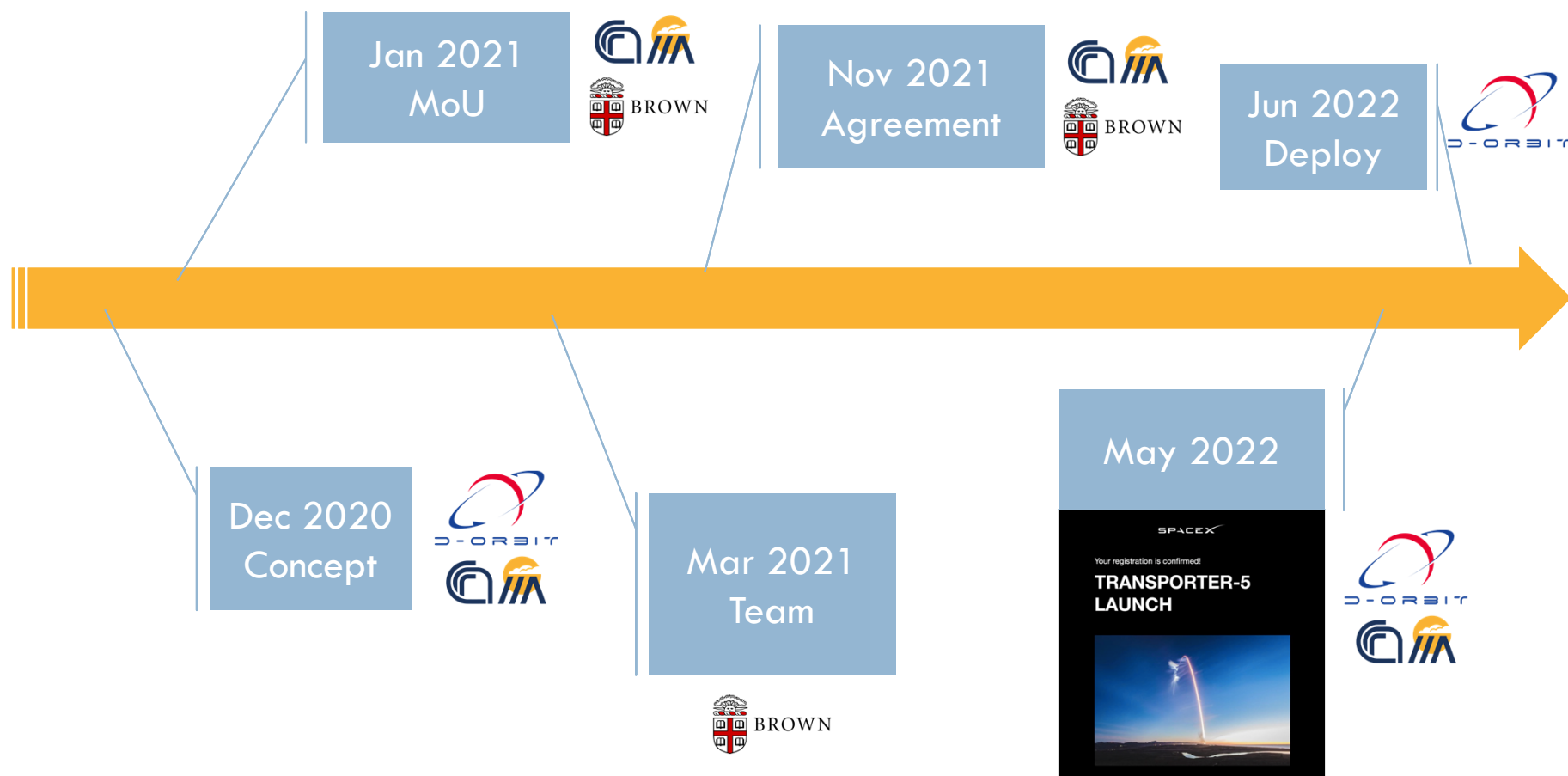


School of
Engineering



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Timeline



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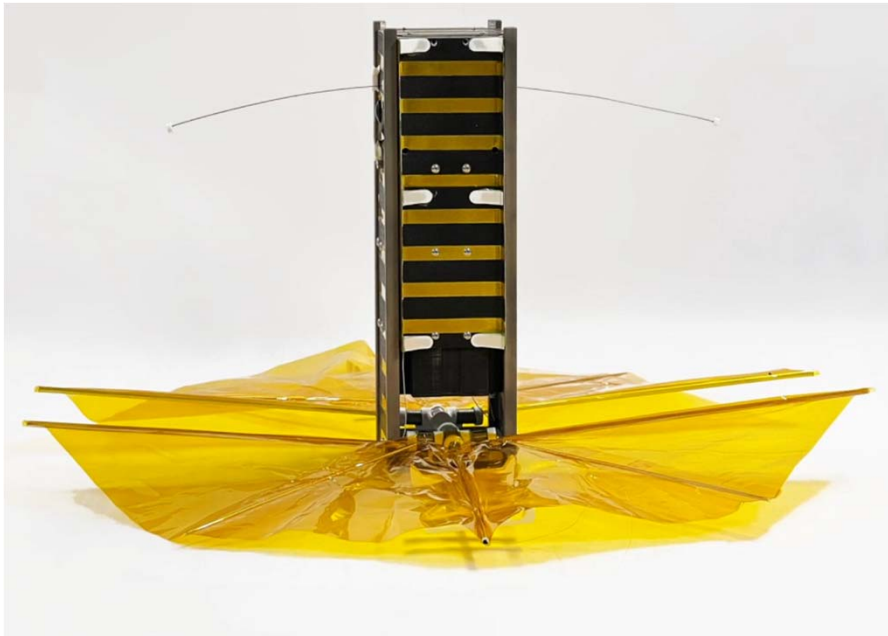
Mission design

- Educational application
 - ▣ Download of low resolution images in the amateur radio band
- Agile design
 - ▣ Risk mitigation vs. avoidance
 - ▣ «Good enough» vs. ECSS
- COTS components
 - ▣ AA Energizer batteries
 - ▣ Arduino
- Consumer-grade 3D printing

Notable issue: registration

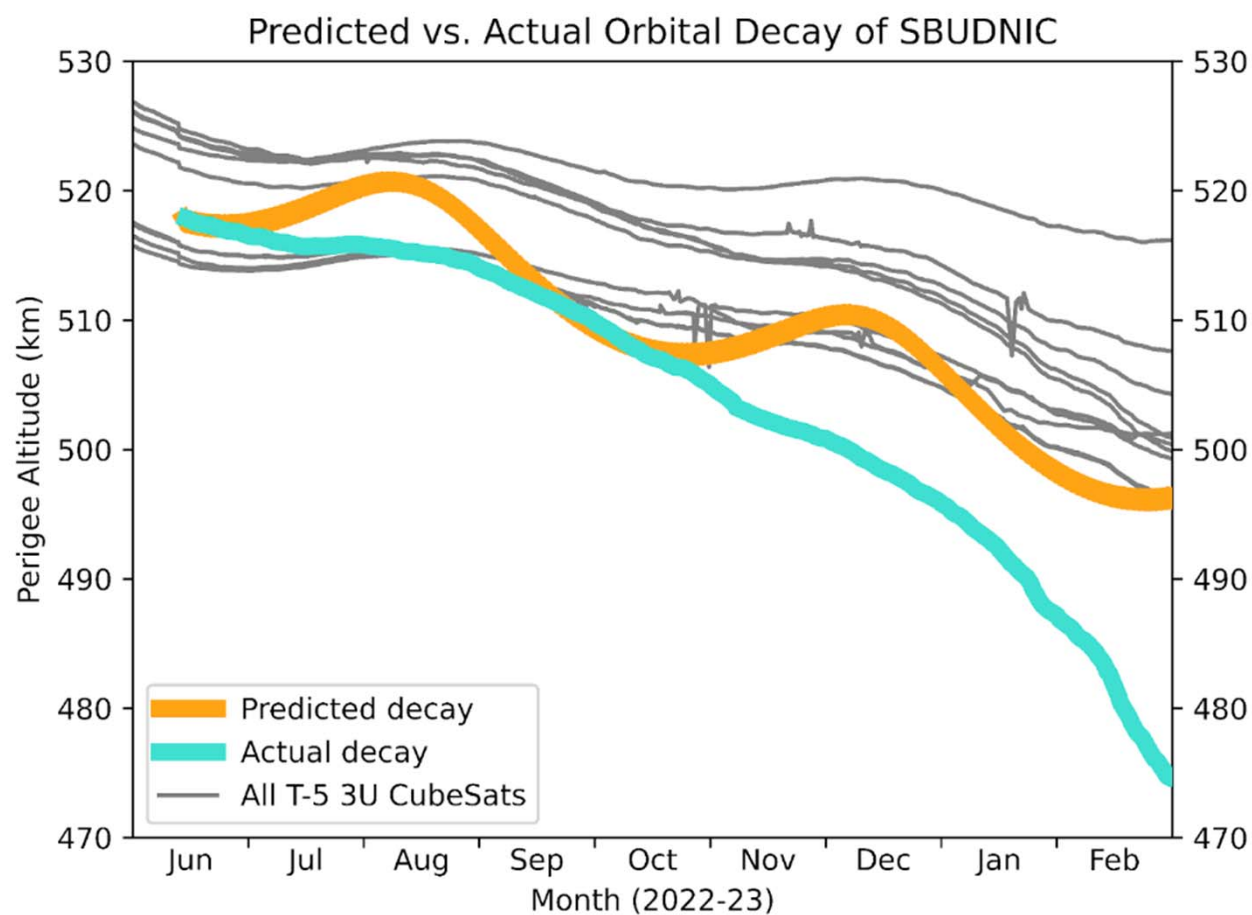
- US bus, operated by Italy
- UNOOSA Convention on Registration of Objects Launched into Outer Space (1975)
- Concerns «launching State», meaning:
 - i. A State which launches or procures the launching of a space object
 - ii. A State from whose territory or facility a space object is launched

Notable outcomes



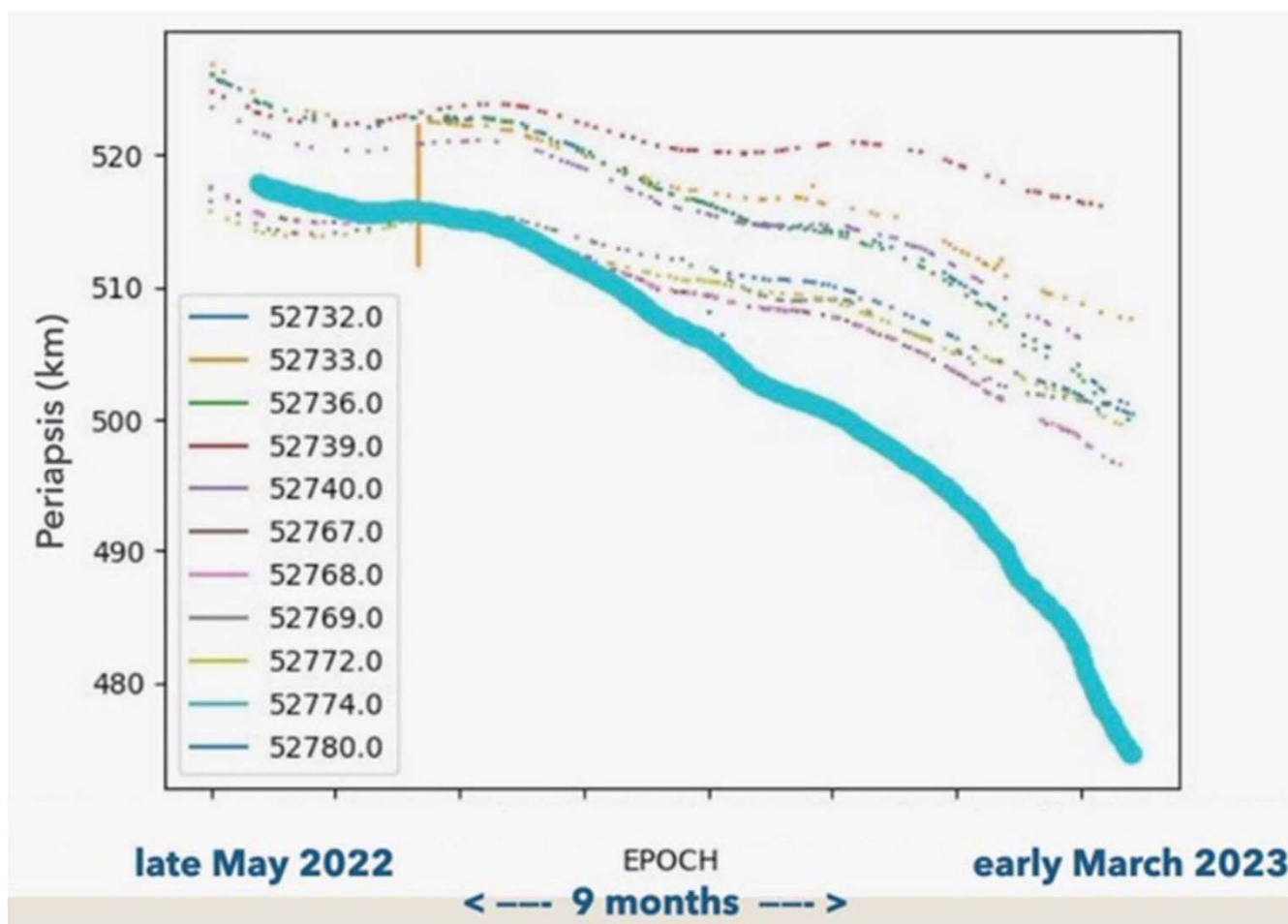
- Open Architecture
- From concept to orbit < 1,5 yr
- Initial budget 25k\$ + 175k\$ in-kind
- Total spent 16k\$ + 18k\$ post-launch
- Cost to reproduce 6.210\$
- Thermal control system 225\$
- Dragging device <\$200, <175 gr

Predicted vs. actual decay



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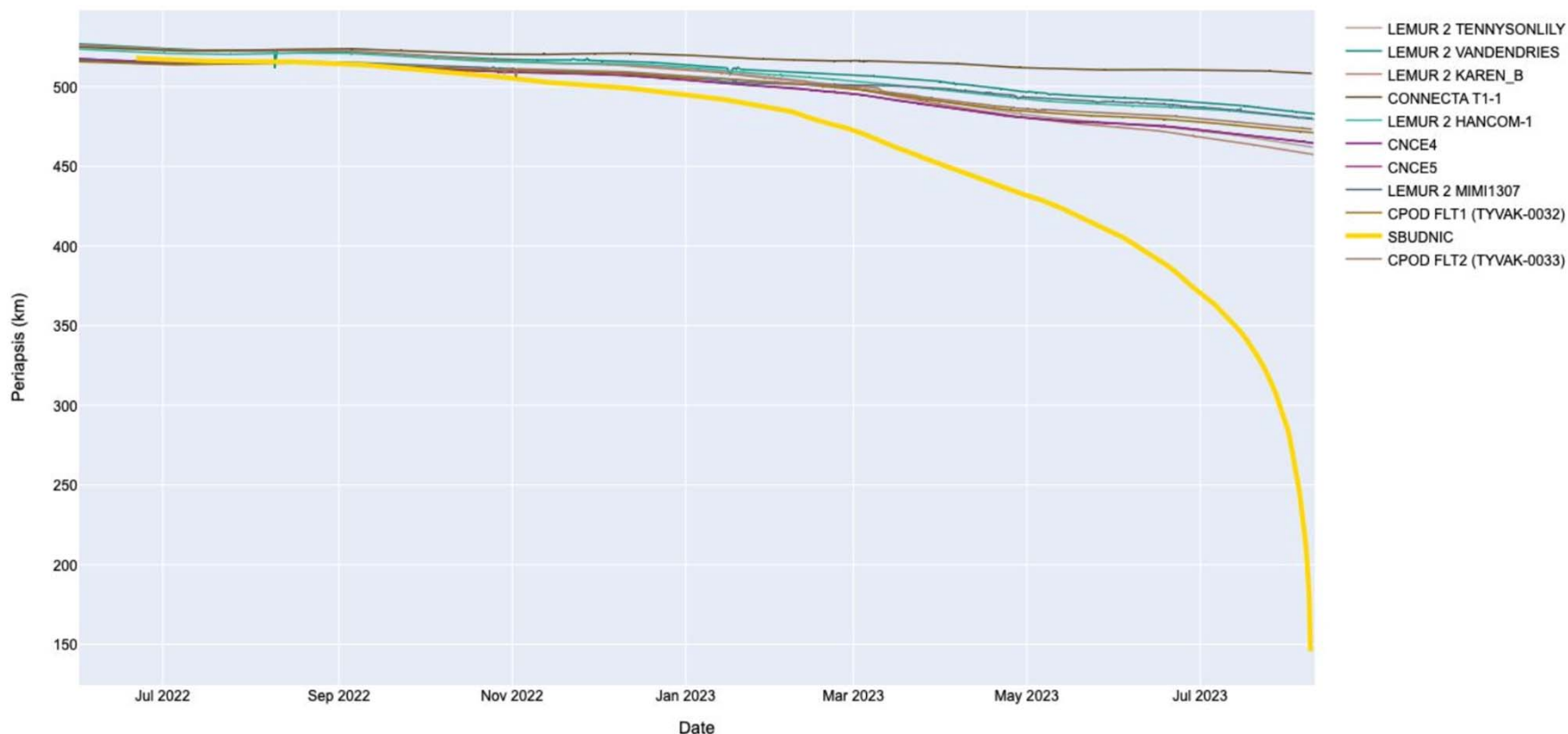
Accelerated decay



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Complete orbital decay dataset

Transporter 5 3U Satellite Periapsis vs. Time



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Conclusions

- A New Space experiment
- Provided useful insights on several organizational, technological and regulatory aspects
- Demonstrated technologies that can facilitate low-cost, short-timeline satellite programs for many applications
- Offered scientific value for Space Weather studies
- Confirmed the increasingly affordable accessibility of Space to the scientific and academic community
- Underscored the potential of LEO satellites in understanding geospace dynamics

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Extra slides

Notable issues

- Launch licensing
- Custom clearance
- Operations
 - ▣ Frequency clearance
- Registration

Launch licensing

- By SpaceX from US soil
- Acceptance test
 - ▣ vibrations, emissions, etc.
- Insurance subrogation waiver
- Payload or dummy integration

Custom clearance

- US Export Controls
 - ▣ ITAR and/or EAR
 - ▣ Concern ownership/shipments/transfers out of the US and transfers to foreign nationals within the US
 - ▣ Educational Information and Fundamental Research Exclusion

Operations

- Satellite operator license
 - ▣ i.e. frequency clearance
- NOAA license for remote sensing systems, either:
 - ▣ operated in the US
 - ▣ anywhere by US persons
- Ground infrastructure
 - ▣ Volunteer federations available
 - tinyGS, SatNOGS
 - May require IARU approval

Frequency clearance

- ❑ National jurisdiction
- ❑ Requires ITU publication (40+ days) and coordination (ongoing)
- ❑ Possible fee incurred
- ❑ Easier for short-term missions
- ❑ Easier in ham radio bands
- ❑ IARU requires relevance for ham radio community
- ❑ US FCC reluctant about educational projects in ham radio bands

Registration

- UNOOSA COPUOS (1961)
- UNOOSA Convention on Registration of Objects Launched into Outer Space (1975)
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