



**LEAFSPACE**

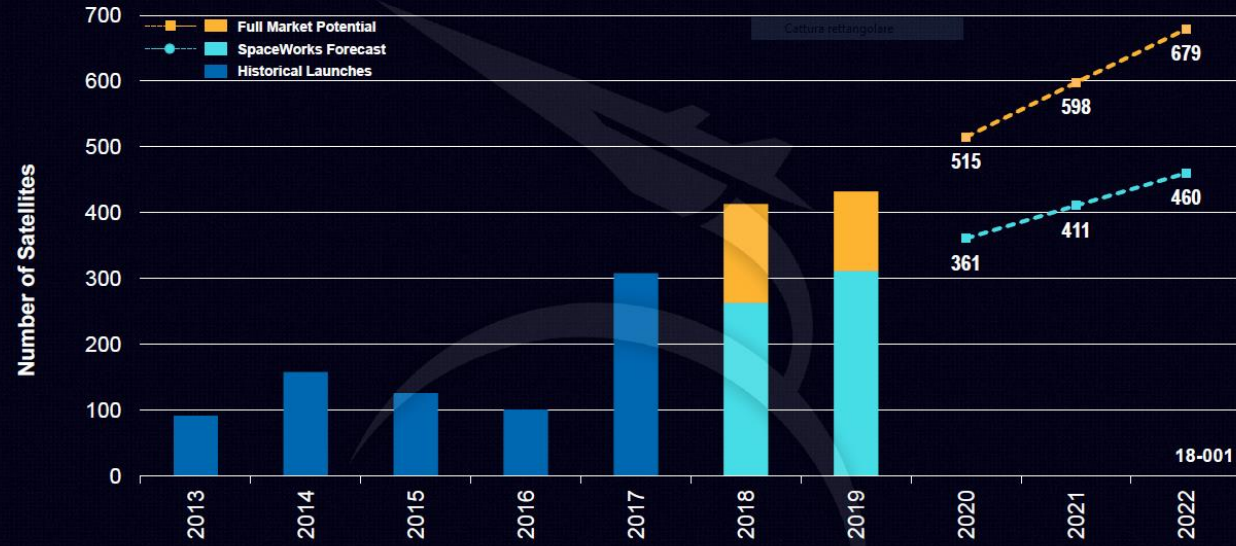
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**DUAL S/X-BAND GROUND STATION SYSTEM FOR SMALL-SATELLITE APPLICATIONS**

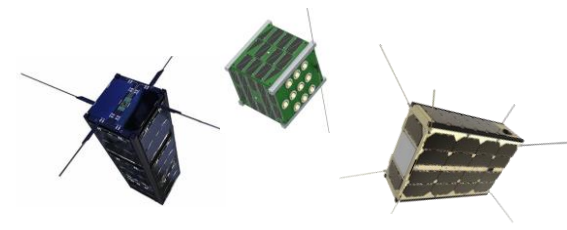
*Giovanni Pandolfi Bortoletto - CTO*

*Cubesat Developers Workshop*

## 2018 Nano/Microsatellite Launch History & Market Forecast (1 - 50 kg)



SpaceWorks' estimates up to 2,600 nano/microsatellites will require launch over the next 5 years



Space segment



Data bottleneck



Ground segment



- Multi-Mission
- Completely Automated
- Cloud-Based
- Rapid Scalability
- High Flexibility

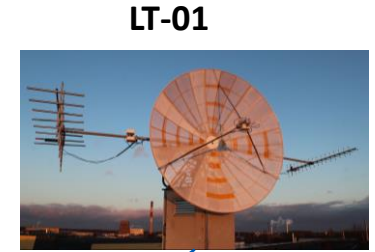
LEAF LINE - GROUND SEGMENT AS-A-SERVICE

**Leaf Line** is a unique multi-mission Ground Segment as a Service solution, completely owned and operated by Leaf Space

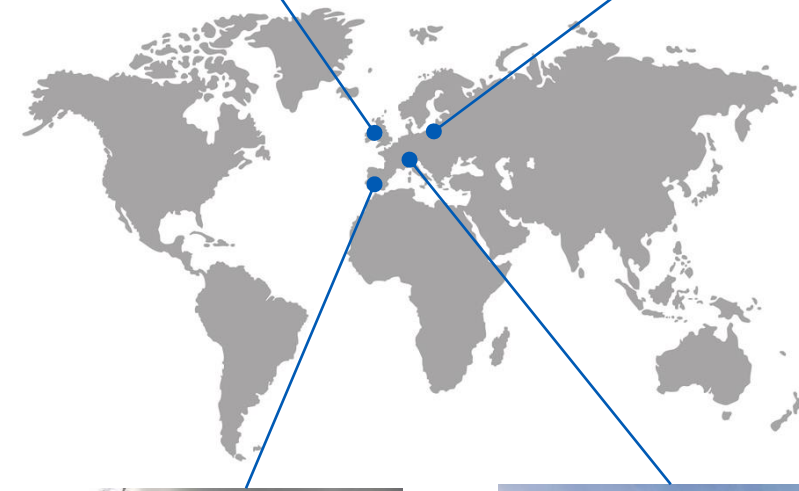
NETWORK EXPANSION		
	Incremental GSs	Cumulative GSs
2019	+ 3	8
2020	+ 4	12



IE-01



LT-01



ES-01



IT-01





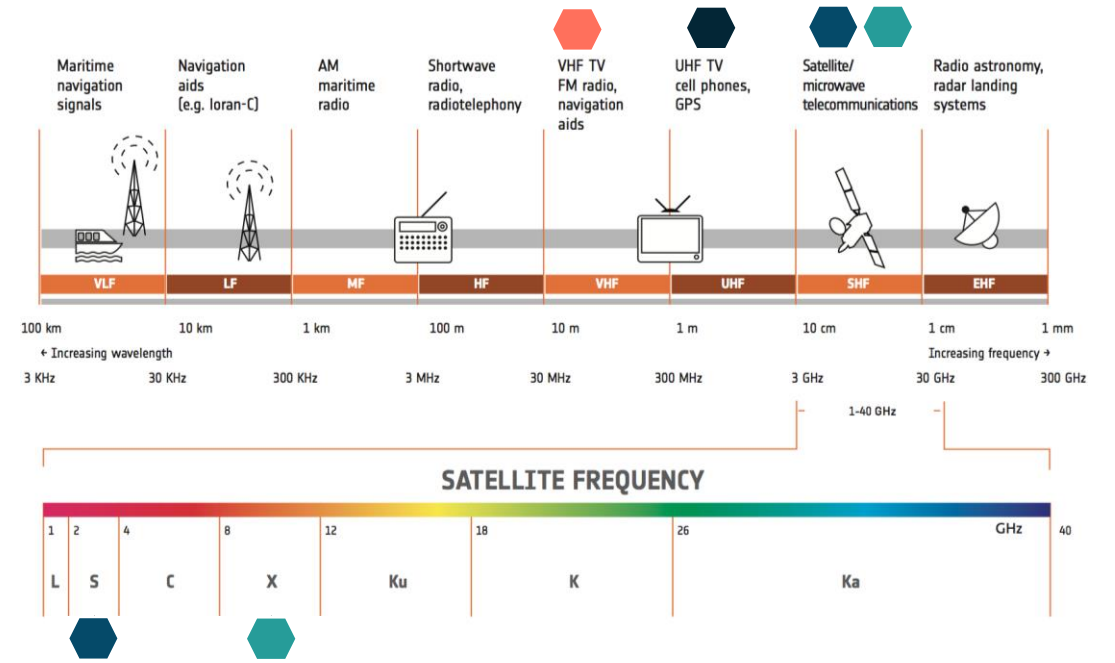
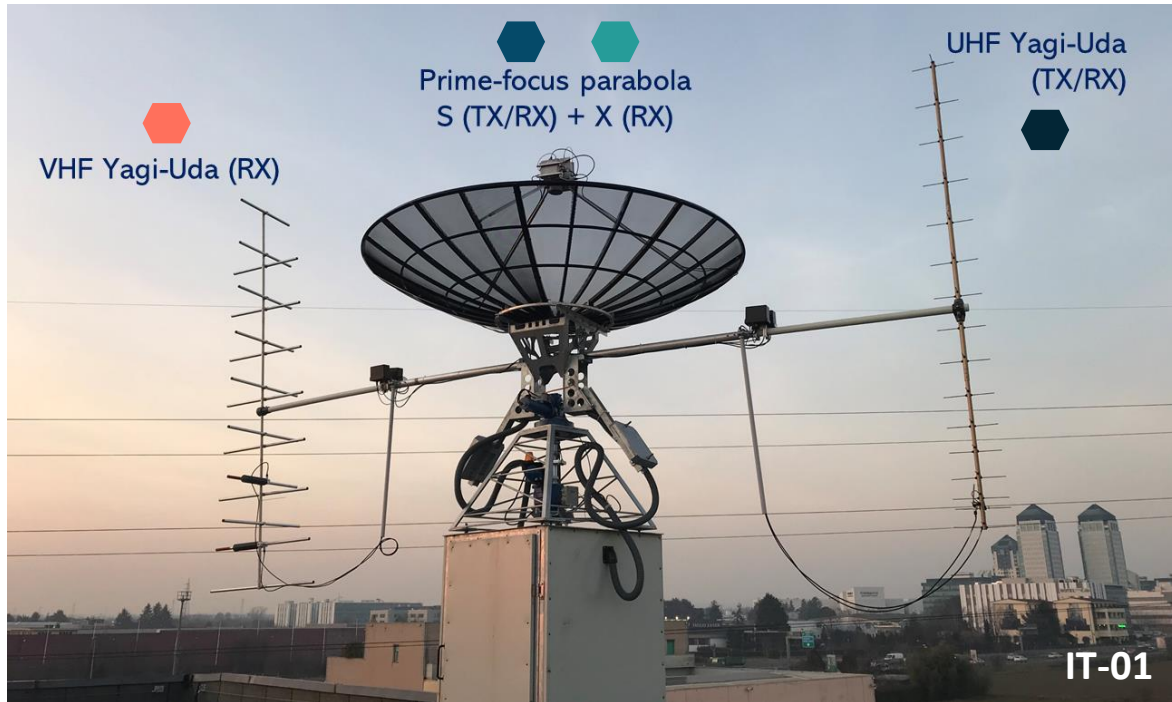
LEAF LINE - GROUND SEGMENT AS-A-SERVICE





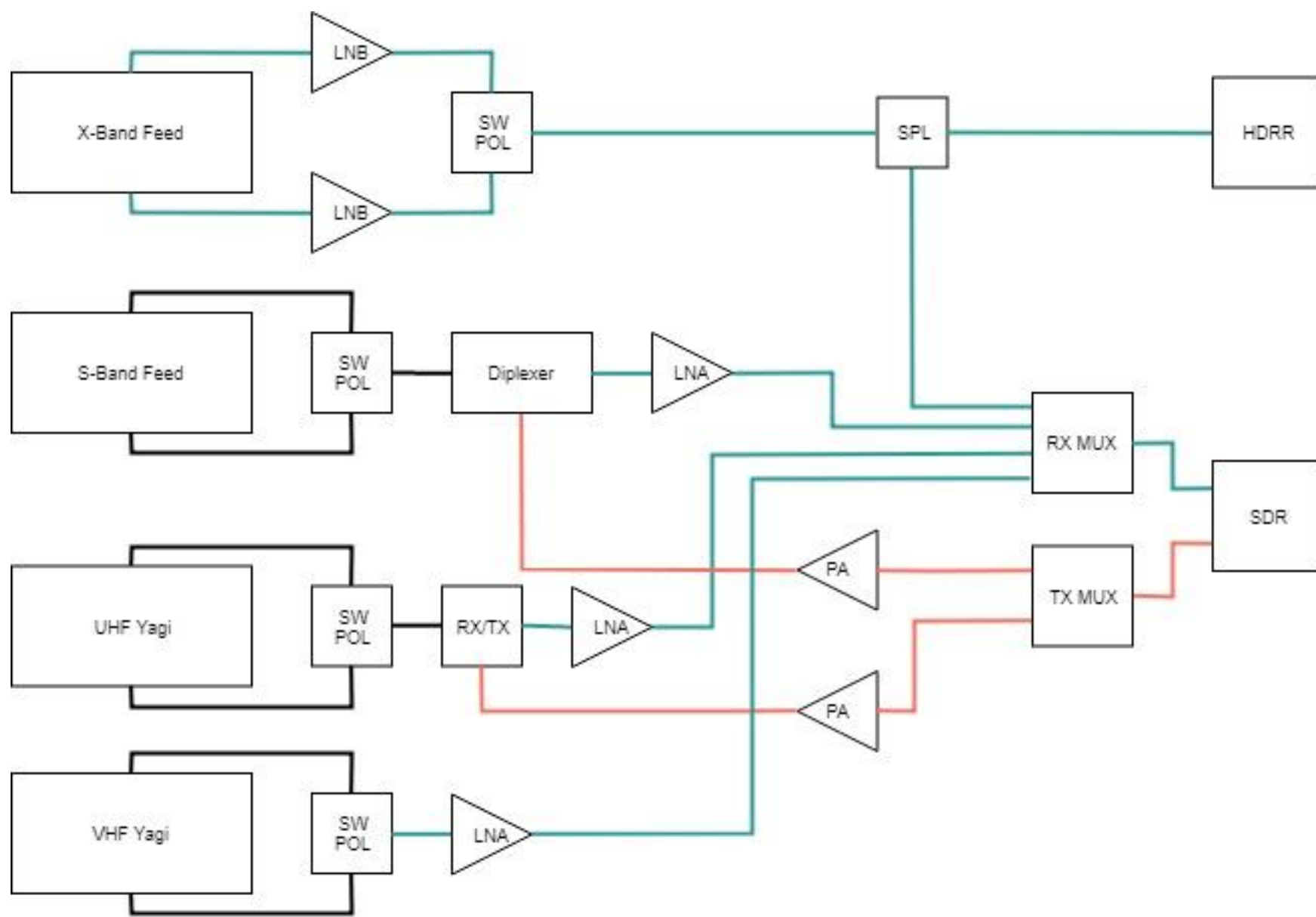
LEAF LINE GROUND STATION





	VHF	UHF	S-Band	X-Band
RX Frequency	137-144	399-402	2200-2400	8025-8400
TX Frequency	-	401-403	2025-2120	-
Polarization	RHCP-LHCP	RHCP-LHCP	RHCP-LHCP	RHCP-LHCP
Antenna Type	Yagi 16 el.	Yagi 32 el.	3m dish	3m dish
Antenna Gain [dBi]	14	14.8	33	44
G/T [dB/K] @ 10°	-14.6	-11.6	10.6	24
EIRP [dBW]	-	34	43	-
Modulation	Configurable			
Protocol	Configurable			





- Main goals for prime-focus S/X dual band solution:

- **S-band**

- RX & TX, manageable in half or full duplex
- Switchable polarization (RHCP/LHCP)
- Cross-pol discrimination (XPD) > 15 dB
- Power handling capability > 10 dBW

- **X-band**

- RX only
- Switchable polarization (RHCP/LHCP)
- Cross-pol discrimination (XPD) > 20 dB

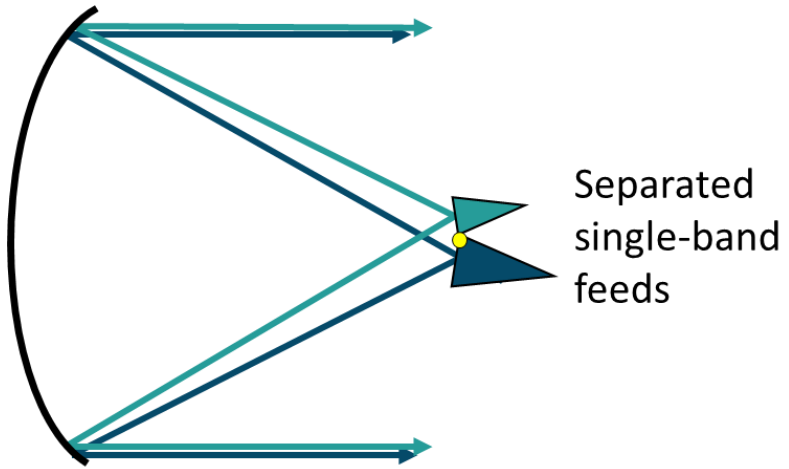
+ **Reduced costs** for series production

+ **Light-weight** to avoid deflection on supporting structure

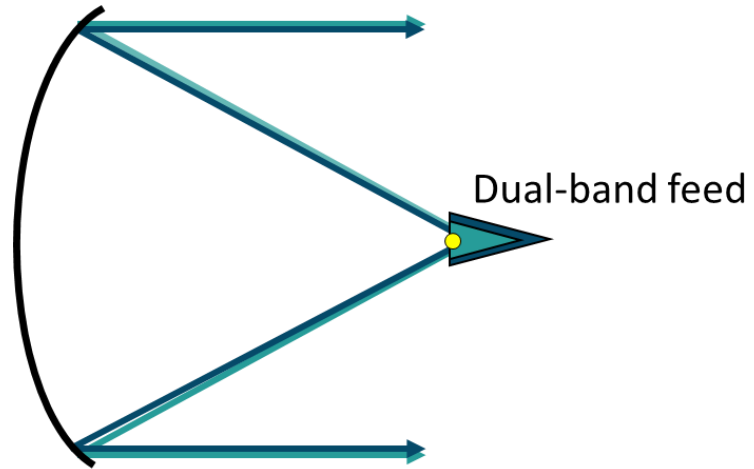
+ **Compact** enough to ease installation and minimize blockage on parabola



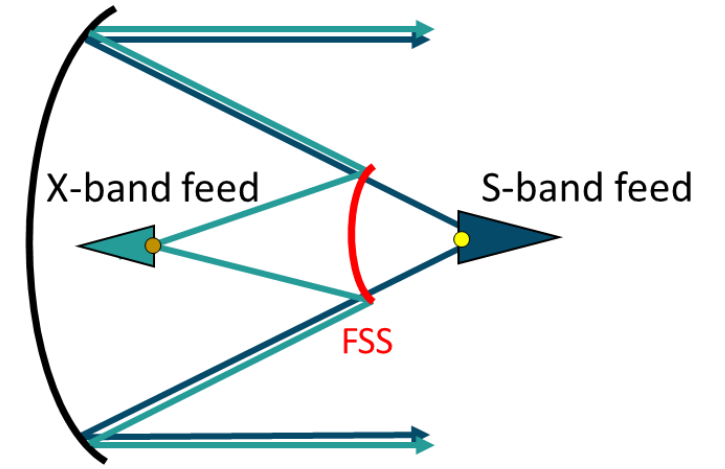
**Solution #1**



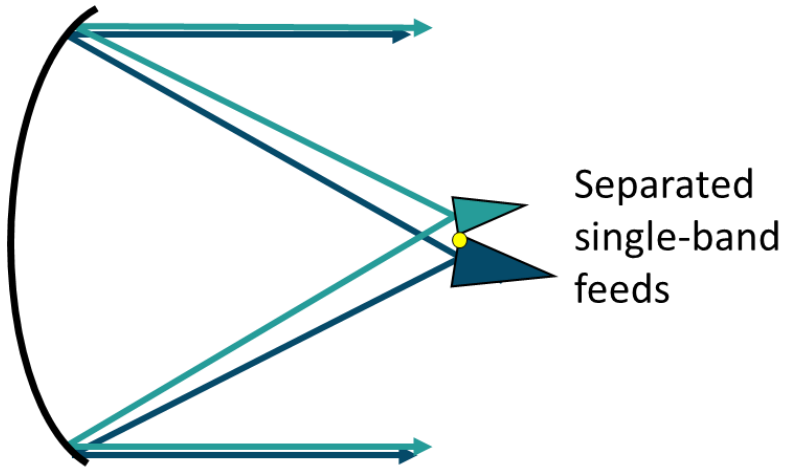
**Solution #2**



**Solution #3**

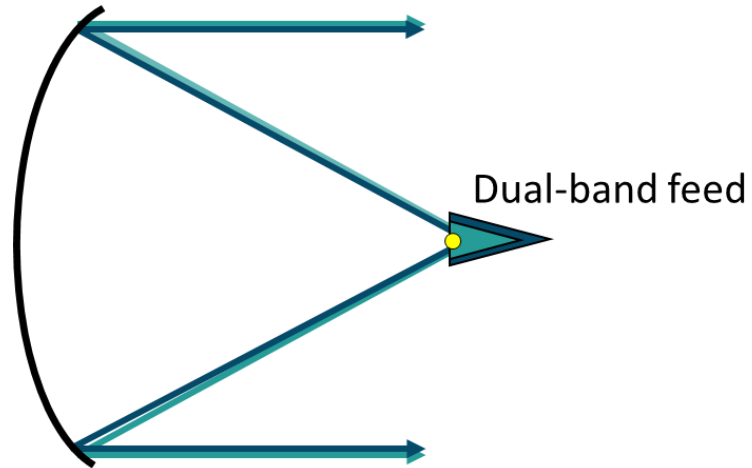


### Solution #1



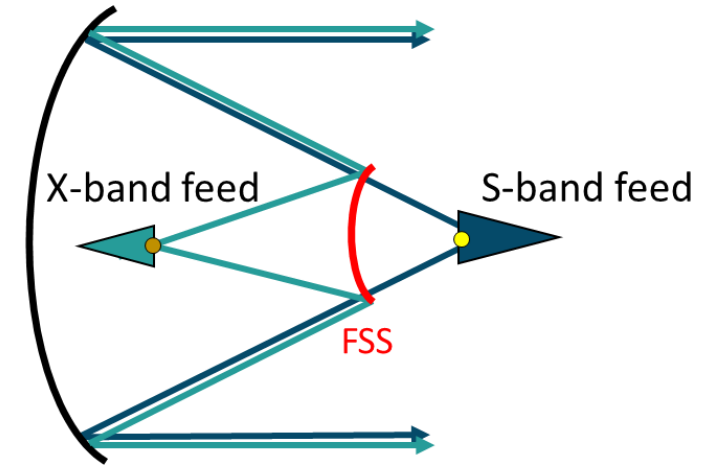
- ✓ Low-cost
- ✓ Off-the-shelf availability
- ✓ Fast & modular approach
- ✗ Poor RF performance
- ✗ De-pointing of main beam

### Solution #2



- ✓ Reduced blockage
- ✓ Compact device
- ✗ Critical defocusing effects
- ✗ No off-the-shelf solution

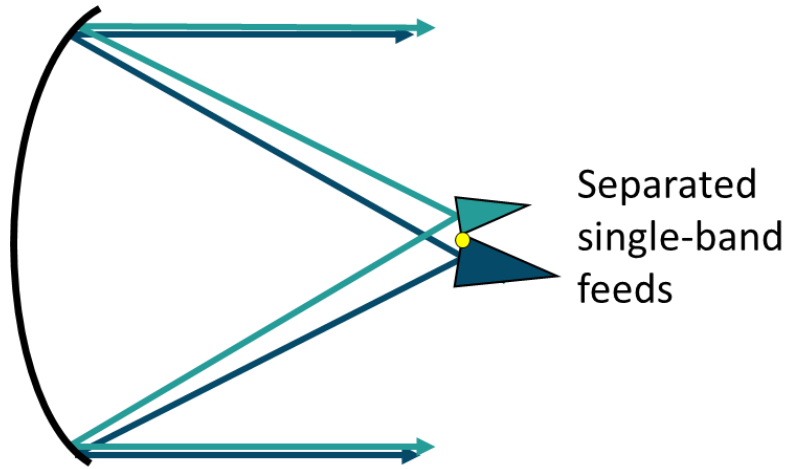
### Solution #3



- ✓ Off-the-shelf availability
- ✓ Reduced defocusing criticalities
- ✓ Reduced antenna noise temperature (ground) at X-band
- ✗ Complex structural layout
- ✗ No off-the-shelf solution for FSS

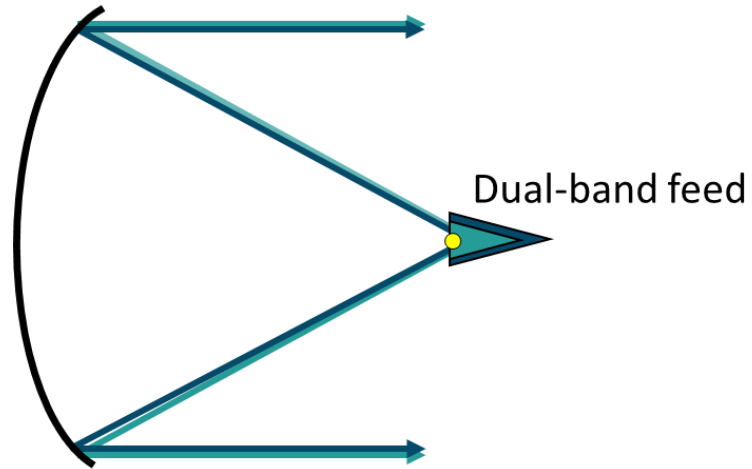


**Solution #1**



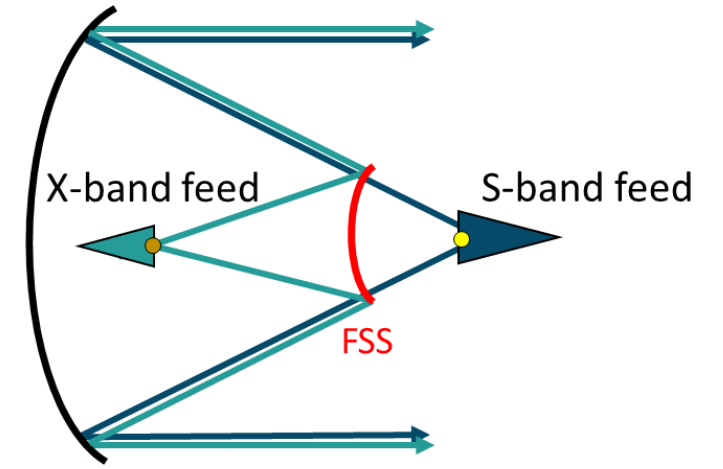
Not viable

**Solution #2**



Viable, in-house solution needed

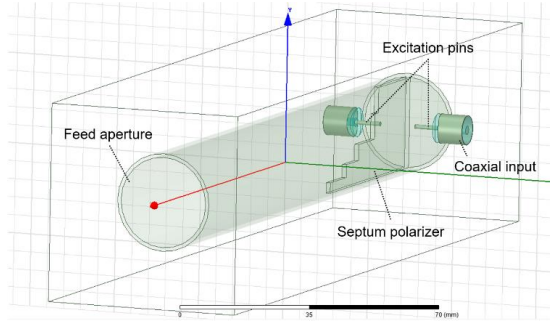
**Solution #3**



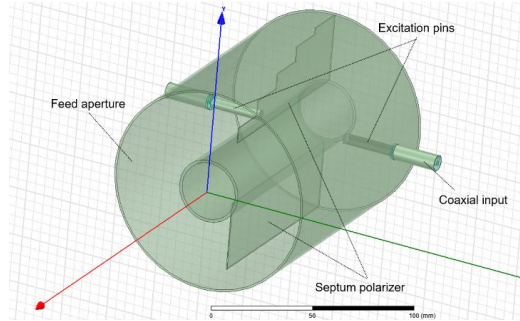
Viable, but rather complex manufacturing and testing

## Step #1 - EM design & 3D printing prototyping

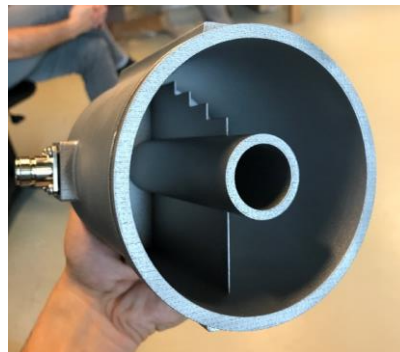
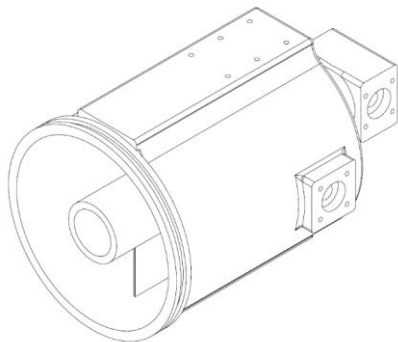
Study of a coaxial feed horn and manufacturing



Inner: X-band horn



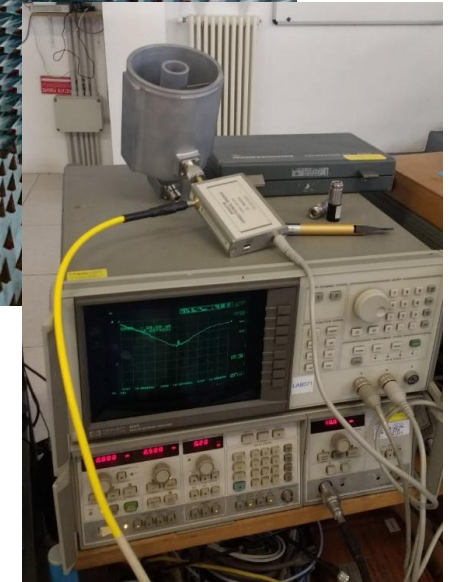
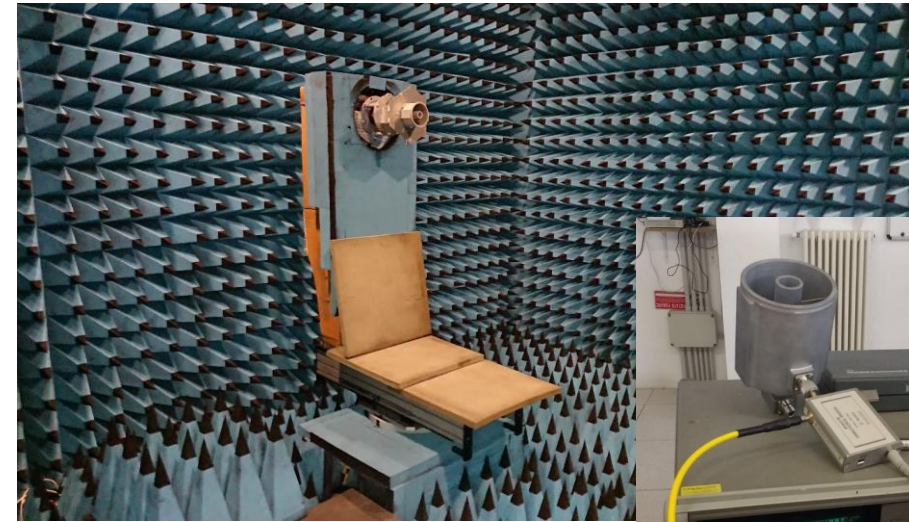
Outer: S-band horn



4 ports:

- 2 x RHCP (S + X bands)
- 2 x LHCP (S + X bands)

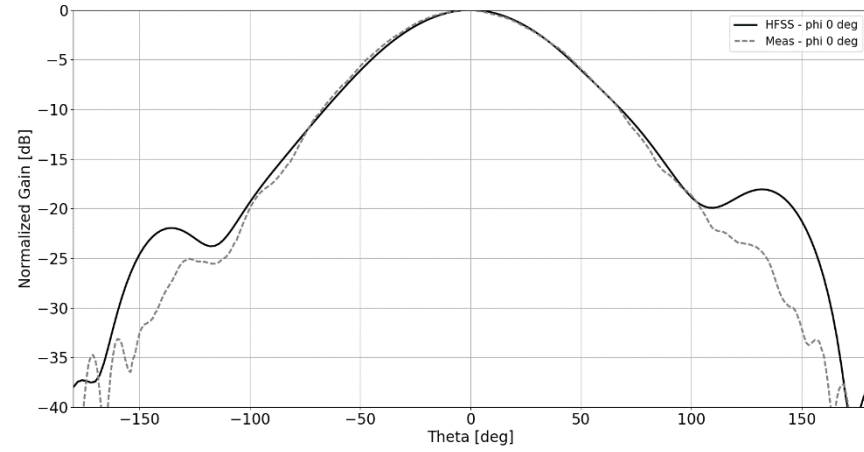
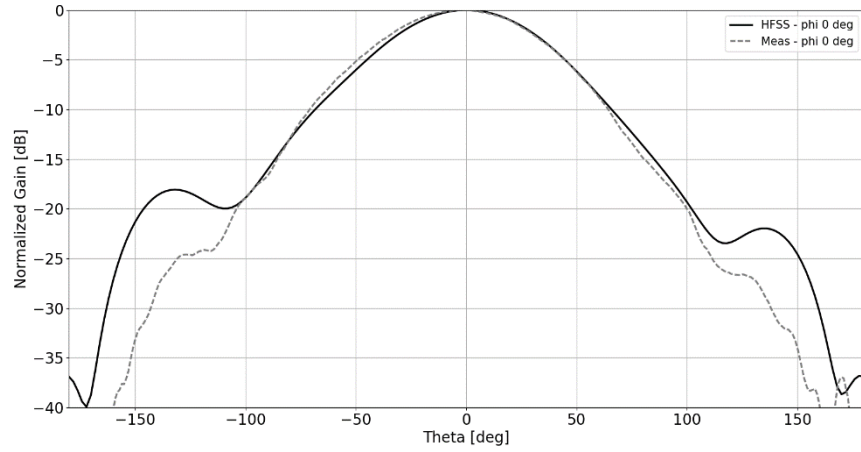
## Step #2 - VNA measurements + Anechoic chamber tests



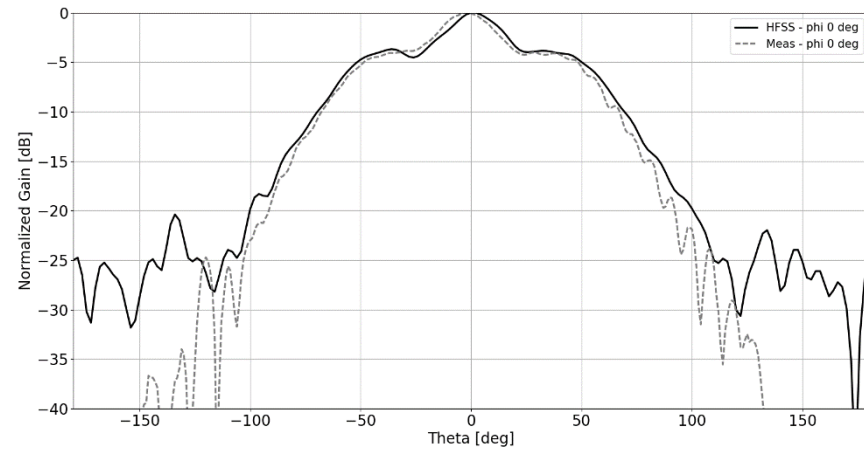
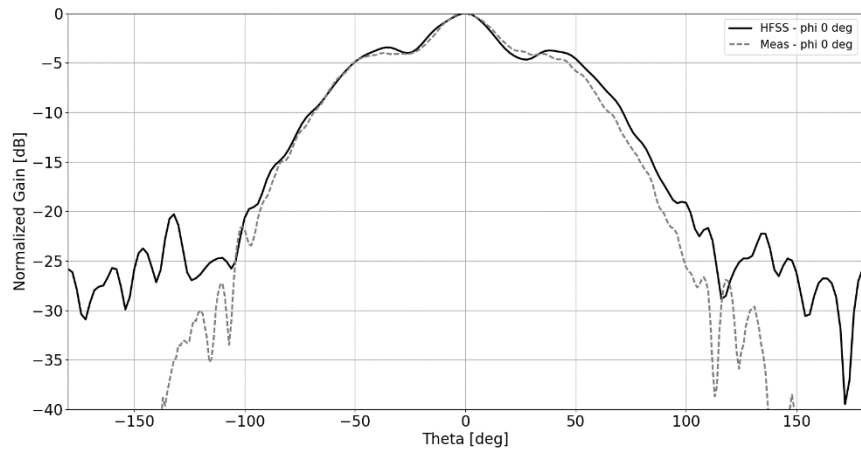
# LHCP

# RHCP

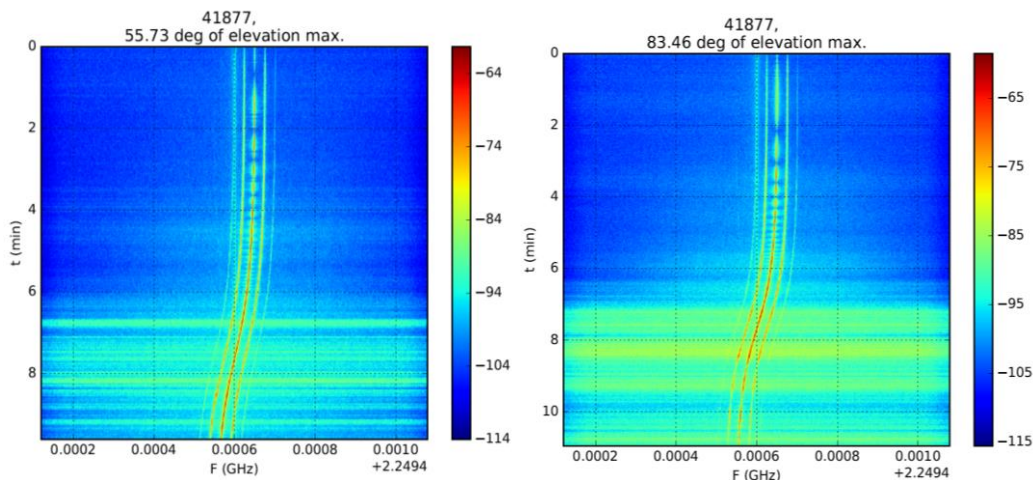
S-band



X-band



### Step #3 - Full GS system testing

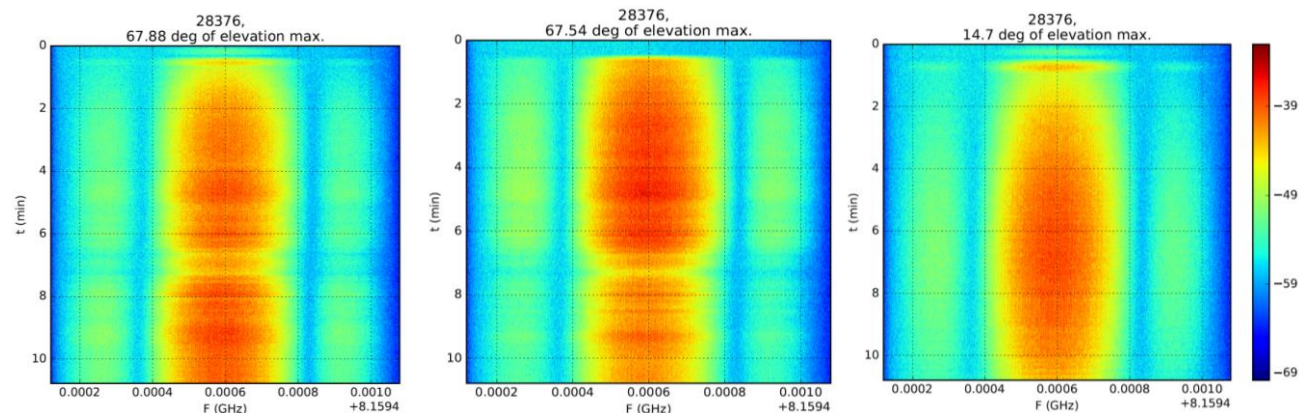


IT-01

ES-01

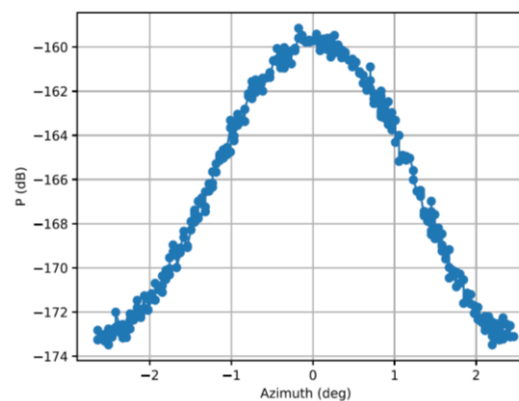
#### Simultaneous acquisition test

RESOURCESAT-2 satellite (S-band)  
from two GSs (Italy and Spain)



#### Different elevation/weather acquisition test

AURA satellite (X-band) from IT-01



#### Solar noise signal acquisition test

Azimuth span on the Sun and noise  
power recording at X-band



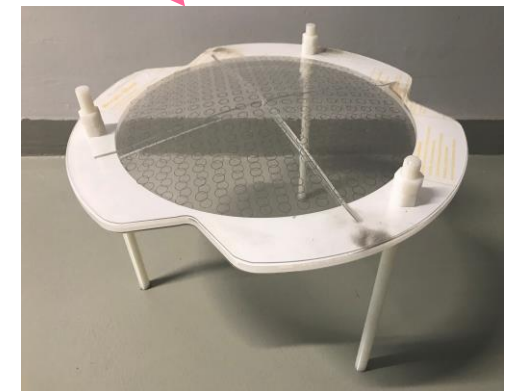
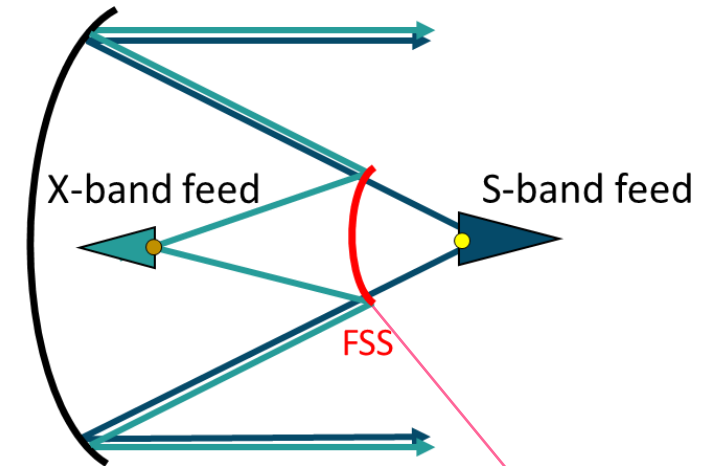


PRODUCTION ITEM



LEAFSPACE

- G/T improvement techniques
  - Higher antenna efficiency and/or larger antenna aperture
  - Lower Noise Figure on RF chain
  - Higher frequency bands exploitation (Ku, Ka) → **critical!**
- Alternative parabola configurations (Cassegrain)
  - FSS already prototyped (2018)
  - Encouraging preliminary tests (Lab.)
  - Outdoor testing planned for 2019
    - Pointing assessment at X-band at all elevation angles
    - Resistance to rain, hail, snow + humidity & temperature gradients
    - Power handling capability evaluation
    - Mechanical stiffness evaluation





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THANK YOU!

Visit our Booth

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