Leonardo Developments on Space Components

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LEONARDO
AIRBORNE & SPACE SYSTEMS

Outline

Leonardo development areas:

- **GaN Technology**
- **Vacuum Tubes Technology**

GaN Technology for Space

- GaN technology providing at the same time:
  - ✓ High power density
  - ✓ High efficiency
  - ✓ Low noise performance combined with robustness to high RF signals
  - ✓ Wideband operation capability
- For these reasons actually GaN MMICs represents the best solution for the development of very compact and efficient Transmit Receive (TR) Module as required for future Radar Systems for Defense and Space Application
- Industrial & Academic teams of synergic competencies, supported by the Italian Space Agency (ASI), are promoting specific actions to strengthen an Independent National Capability on GaN technology

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ThalesAlenia Space
mecsa
Università di Roma Tor Vergata
Università degli Studi di Padova
Università degli Studi di Modena e Reggio Emilia
LFoundry
IMT Ingegneria Marketing Tecnologia
IFN Istituto di Fotonica e Nanotecnologie

GaN Technology Status

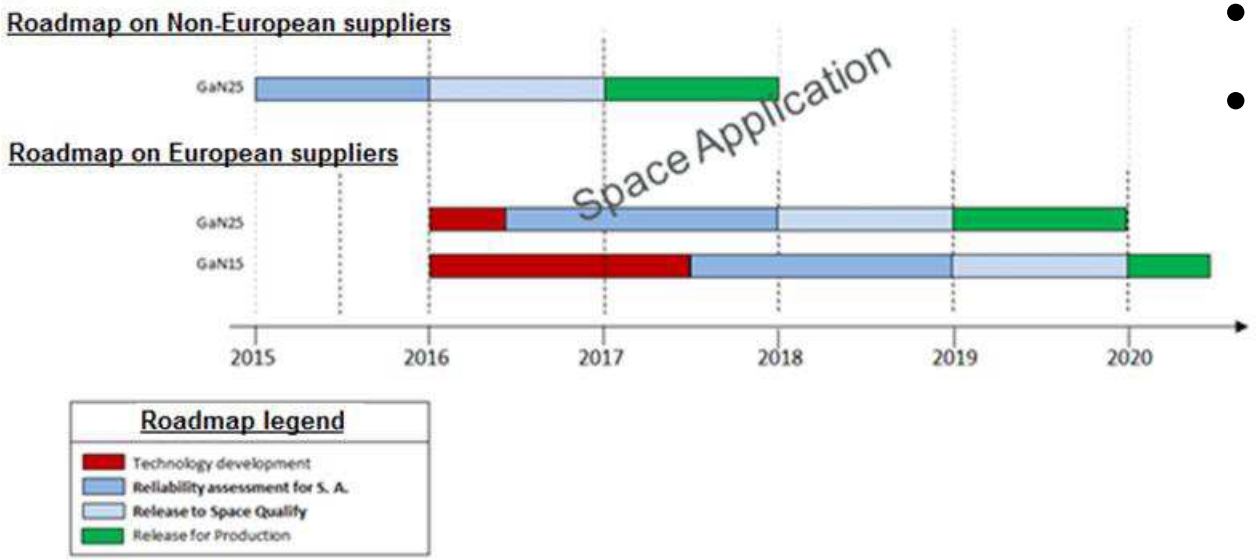
- Half-micron technology has been developed for high performance and reliable power applications up to C-Band
- 0.5 µm technology is actually applied for MMICs prototype production

g_{mMAX} mS/mm	I_{DSS} mA/mm	V_{BGD} V	F_t (25V) GHz	F_{max} (25V) GHz	Gmax (10 GHz) dB	P_{OUT} (25V) W/mm	η_D @ 25V %
> 250	> 600	> 100	> 16	> 40	12	4.5	> 65%

- On the basis of this experience quarter-micron process has been developed for power applications up to Ku-Band frequency.
- This process technology represents the best solution to develop MMICs operating in X and 2-18 GHz WB

g_{mMAX} mS/mm	I_{DSS} mA/mm	V_{BGD} V	F_t (25V) GHz	F_{max} (25V) GHz	Gmax (10 GHz) dB	P_{OUT} (25V) W/mm	η_D @ 25V %
> 250	> 700	> 100	> 25	> 50	16	> 4	> 55%

GaN Technology Roadmap 1/2



The development plan is based on Leonardo internal funding and external ones.

Main External funding:

- Italian MoD (EDA-PNRM)
- ASI-ESA (GSTP-TRP)

GaN Technology Roadmap 2/2

- ✓ Leonardo Finmeccanica GaN HEMT technology, represents a National and European asset to increase the competitiveness of all the Italian and European industries
- ✓ Release on EPPL of 0.25 µm GaAs Technology for 2016
- ✓ Reliability assessment of 0.25 µm GaN Micro-Strip technology for Space application expected for the end of 2016
- ✓ Development of 0.15 µm GaN Micro-Strip technology for Space application expected for 2017
- ✓ On the basis of this technological capability, the Italian Space Agency (ASI) is supporting the creation of an Italian National team of competencies in order to promote a European GaN technology for the next European Space missions where the Leonardo Finmeccanica production line represents a strategic asset

Vacuum Tubes for Space

Leonardo Vacuum tubes capabilities are being successfully exploited in the Space field and several new development are foreseen.

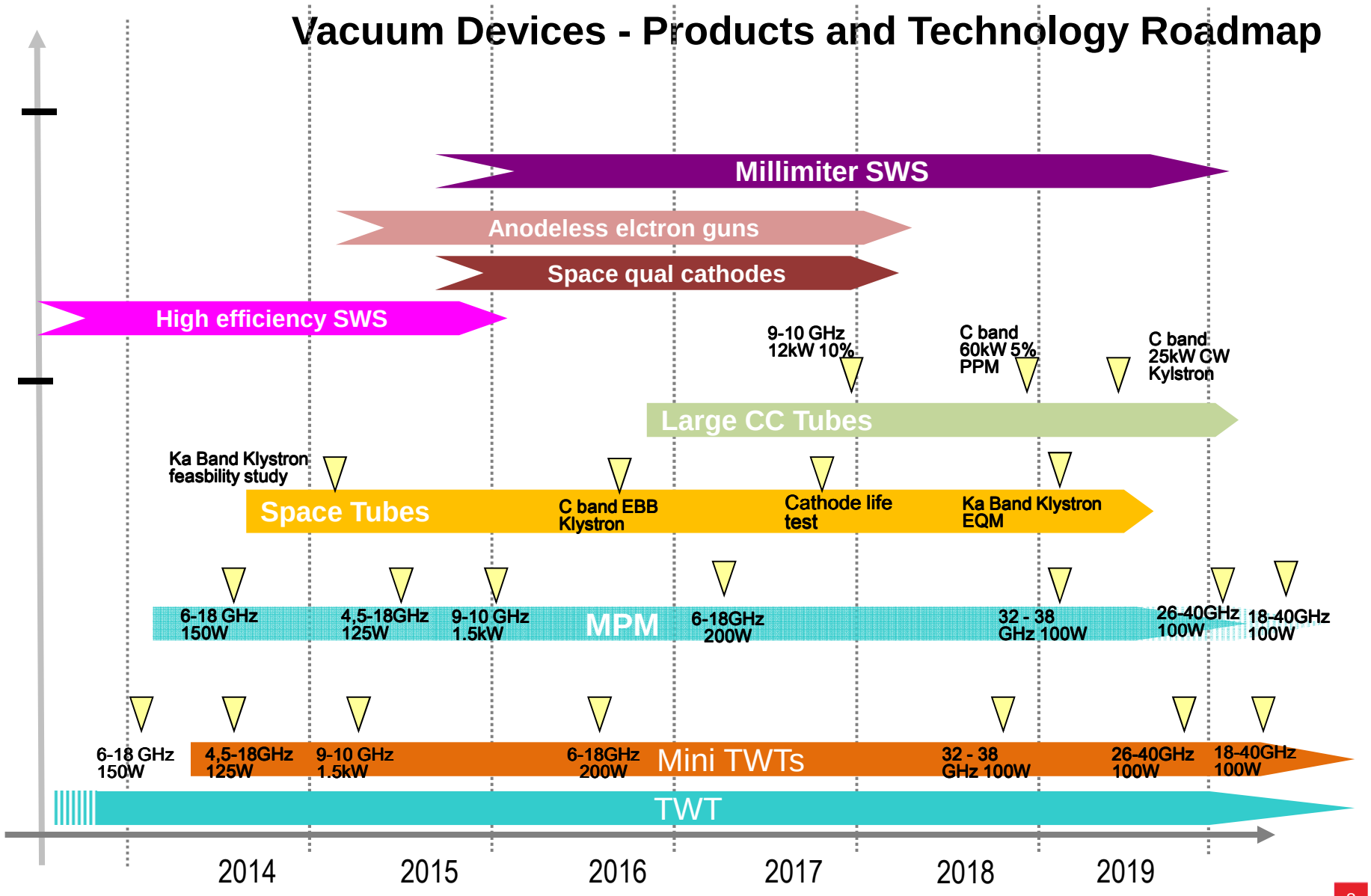
- The Cathode life test is running in order to demonstrate 7.5 years operating life
- Development of pulsed Ka-band Klystron for SAR instruments that ESA is going to implement in the near term.
- Cathodes for neutralizers (for Electric propulsion) for ESA programs and other partners.

Other opportunities might include the "***spacelization***" of existing Helix TWTs for:

- L / C / X band SAR Earth Observation systems for LEO satellites;
- Ku / Ka / W band for Radar Earth Observation satellites;

to be intended for different applications by several Countries in Europe and Asia.

Vacuum Devices - Products and Technology Roadmap



C Band Klystron – EBB Model

- Elegant BreadBoard fully representative of the klystron design (RF and thermal design)
- Demonstration of the electrical performances at full duty cycle and over qualification temperature range

SYMB	PARAMETER	LIMIT VALUES		UNITS	MEASURES
		MIN	MAX		
F	Operating Frequency	5354	5356	MHz	5355
DC	Duty Cicle	3,68%	3,68%		3,68%
P_o	Peak Output Power	2,2	2,8	kW	2,51
ΔP_o	Output Power Variation over frequency range	---	0,2	dB	< 0,19
	Harmonics (up to 5th)				
	2nd Harmonics				-57
	3rd Harmonics				-48
	4th Harmonics				-75
H OR	5th Harmonics	---	-20	dBc	-70
S	Spurious	---	-50	dBc	
PW	Pulse lenght	1,15	1,15	msec	1,15
PRF	Pulse repetition Frequency	32	32	Hz	32
P_{in}	RF input power	28	34	dBm	33,8
VSWR	Source and Load VSWR	---	1.25:1		1.15:1
η_e	Electronic efficiency	30%	---		32,50%
η_{tot}	Tube efficiency	40%	---		37%

Cathode Life Test – June 2016 achievement

Since November 2015, seven cathode LTV Life Test Vehicles are being aged in the following conditions:

- # 3 LTVs at nominal cathode temperature, T ° C (LTV_{Tnom});
- # 2 LTVs at 40° C more than the nominal temperature, (LTV_{T+40});
- # 2 LTVs at 80° C more than the nominal temperature, (LTV_{T+80});

Each month the Roll Off curve, cathode current vs heater voltage, is measured in order to predict periodically the EOL – end of life. Each estimation is more accurate of the previous one.

At the time being more than 48,300 (5.5 yrs eq.) cumulated hours - failure free – have been achieved.

Predicted EOL at the last “measurement point” (June 2016) are summarized as follow:

- Average predicted EOL for LTV_{Tnom} is more than 157kHours (nearly 18yrs eq.);
- Average predicted EOL for LTV_{T+40} is more than 145kHours (>16yrs eq.);
- Average predicted EOL for LTV_{T+80} is nearly 50kHours (>5,5 yrs eq.);

In December 2016 a further more accurate prediction shall be available.
The life cathode test shall be completed by Q3’ 2017.

THANK **YOU** FOR YOUR ATTENTION

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