SPACE TECHNOLOGIES CONSULTING SERVICES (STConsulting)

Training Modules

March 2022

Introduction

TURKSAT STConsulting offers the following training modules about space systems, spacecraft design and satellite communication:

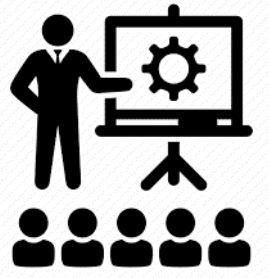
- **Introduction to Space Systems and Spacecraft Design (2 weeks course)**
- **Introduction to Satellite Communications (1 week course)**

✓ Both courses can be done via online or on-site in Turksat premises

✓ Course content can be modified according to your requests and preferences.

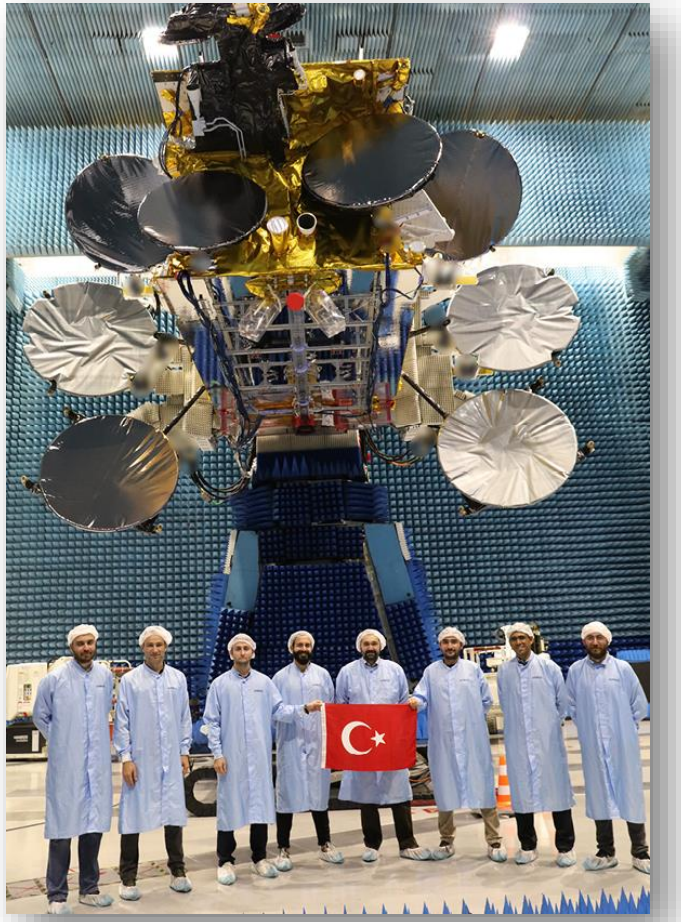
✓ Limitation for number of trainees for online modules is 12. For on-site modules number of trainees is limited up to 8.

✓ Also , customized training modules such as In orbit testing can be organized upon request.



Instructors Profiles

- ✓ Courses are given in English (or Turkish if requested) by TURKSAT AS instructors.
- ✓ These instructors have been involved in many satellite projects as follows;
  - Türksat 3A, Türksat 4A/4B, Türksat 5A/5B, Türksat 3USAT and Türksat 6A
  - The establishment of the Space Systems Integration Test (USET) center for GÖKTÜRK-1 Project
- ✓ They have history of working with leading international spacecraft manufacturer companies such as Thales Alenia Space, Mitsubishi Electric, and Airbus Defense and Space.
- ✓ Also, participated launch activities with ILS Launch, SpaceX, and Ariane.



Price of training modules

- **Introduction to Space Systems and Spacecraft Design (2 week course)**
  - Online or on-site* (in Turkey) Training

- **Introduction to Satellite Communications (1 week course)**
  - Online or on-site* (in Turkey) Training

* On-site in Turkey module does not consist of any travel or accommodation expense of trainees. If requested this can be organized separately.

Syllabus of Training Modules

Title	Day
❖ Overview	1
❖ Space Missions and Systems	1
❖ Satellite Design	5
❖ Development & Validation	2
❖ Trends & Future Missions	0.5
❖ AIT Visit (if done in Turkey)	0.5

Introduction to Space Systems and Spacecraft Design

Introduction to Satellite Communication

Title	Day
❖ Introduction	0,5
❖ Satellite Communications Market And Systems	0,5
❖ Introduction to Digital Communication	0,5
❖ Link Budget	0,5
❖ RF Architecture	1,5
❖ Antennas	0,5
❖ Validation, IOT	0,5
❖ Question & Answer Session*, Quiz	0,5

*Visit to Turksat premises can be arranged separately

Demo Presentations

Module:

Introduction to Space Systems and Spacecraft Design

Section:

Satellite Design

Subsection:

Thermal Control Systems

Presented by:

Structrural and Thermal Subsystem

Agenda

Introduction

Thermal Environment

Requirement and Design Constraints

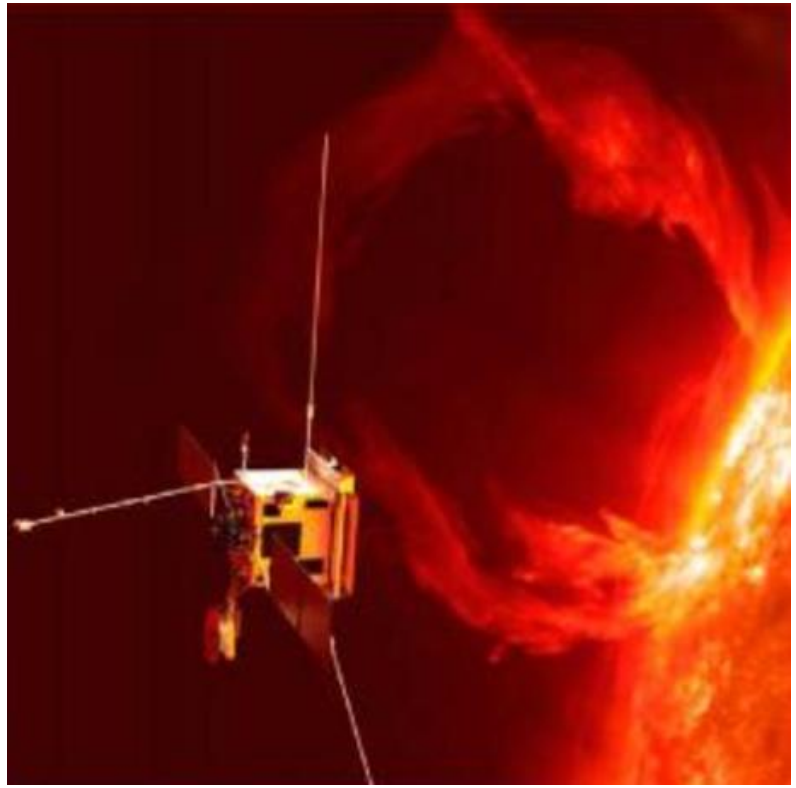
Basic Principles

Thermal Control System Design

Thermal Development Plan

Thermal Analysis and Model

Thermal Vacuum Test



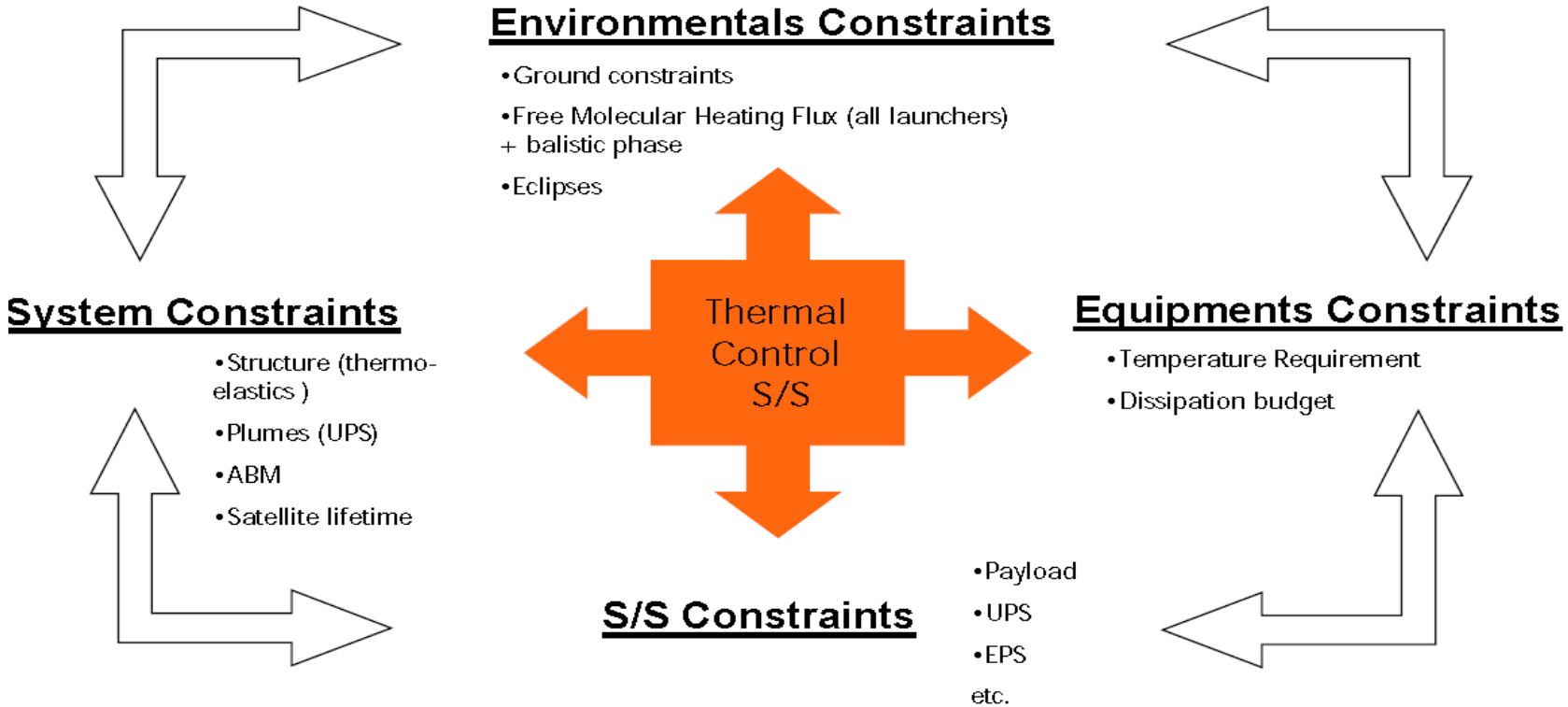
Introduction

The purpose of a Thermal Control System (TCS) is to maintain all spacecraft's components within the allowable temperature limit for all modes of the spacecraft in all thermal environments.

Main objectives of the thermal control system are:

- To maintain equipment temperature in specified ranges (usually room temperature) in order to guarantee their performances during all mission life.
- To guarantee optimum performances when equipment is operating.
- To avoid damage when equipment is not operating.
- To keep the specified temperature stability for delicate electronics, or stable optical components.

Requirements and Design Constraints



These requirements are achieved with passive and active thermal control hardware

Thermal Control System Design

- Heat Pipes

- OSR

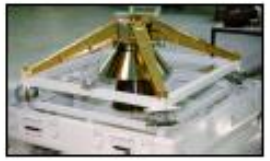
- Heaters : ground commanded

- Thermistors & thermostats

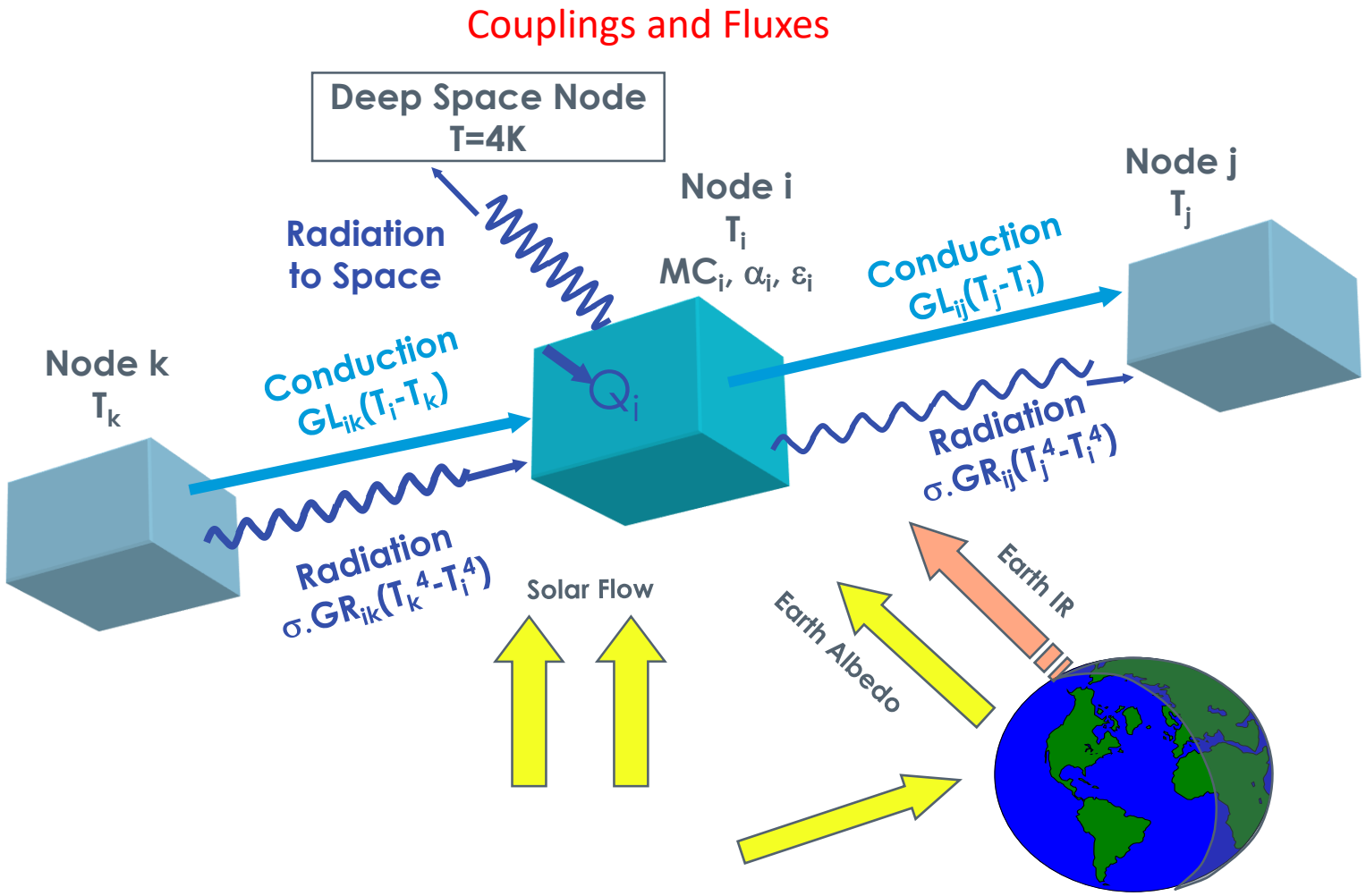
- MLI

- Surfaces finishes (Paint, Al, scotch)

- Heat shields



Thermal Analysis and Model



Module:

Introduction to Satellite Communications

Section:

Antennas

Presented by:

Payload Subsystem and TCR Group

Agenda

General Points

Fundamental Concepts

Design Constraints

Reflector Antennas

Active Antennas

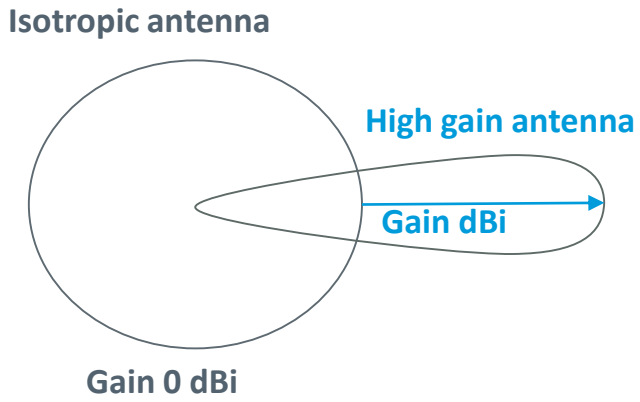
Feed Horns

Antenna RF Design Tools

Radomes-Sunshields

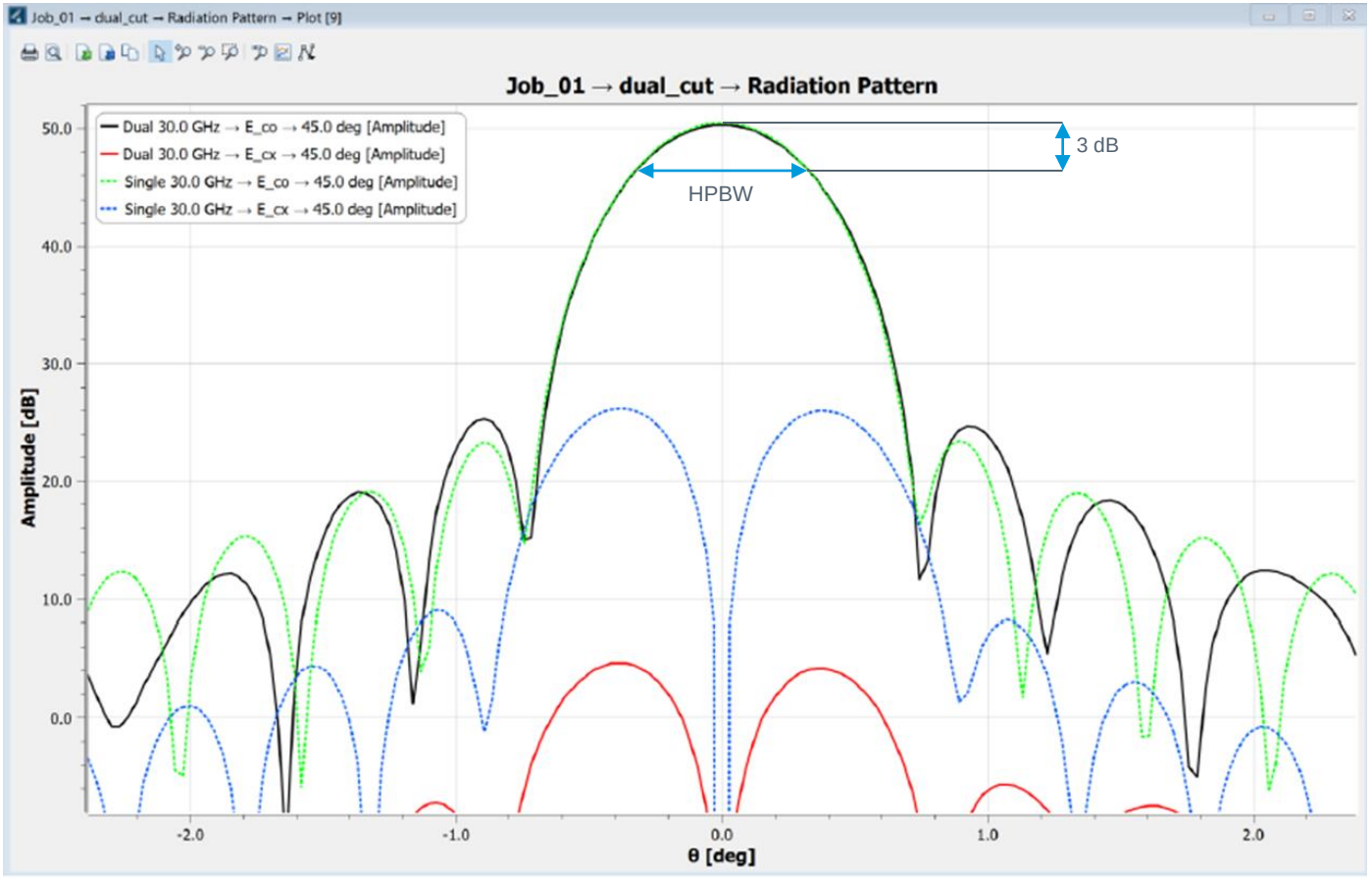
Gain and Directivity

The **gain (G)** of an antenna in a given direction is the ratio of the radiation intensity to the average radiation intensity over the radiation sphere if all accepted power is radiated isotropically.

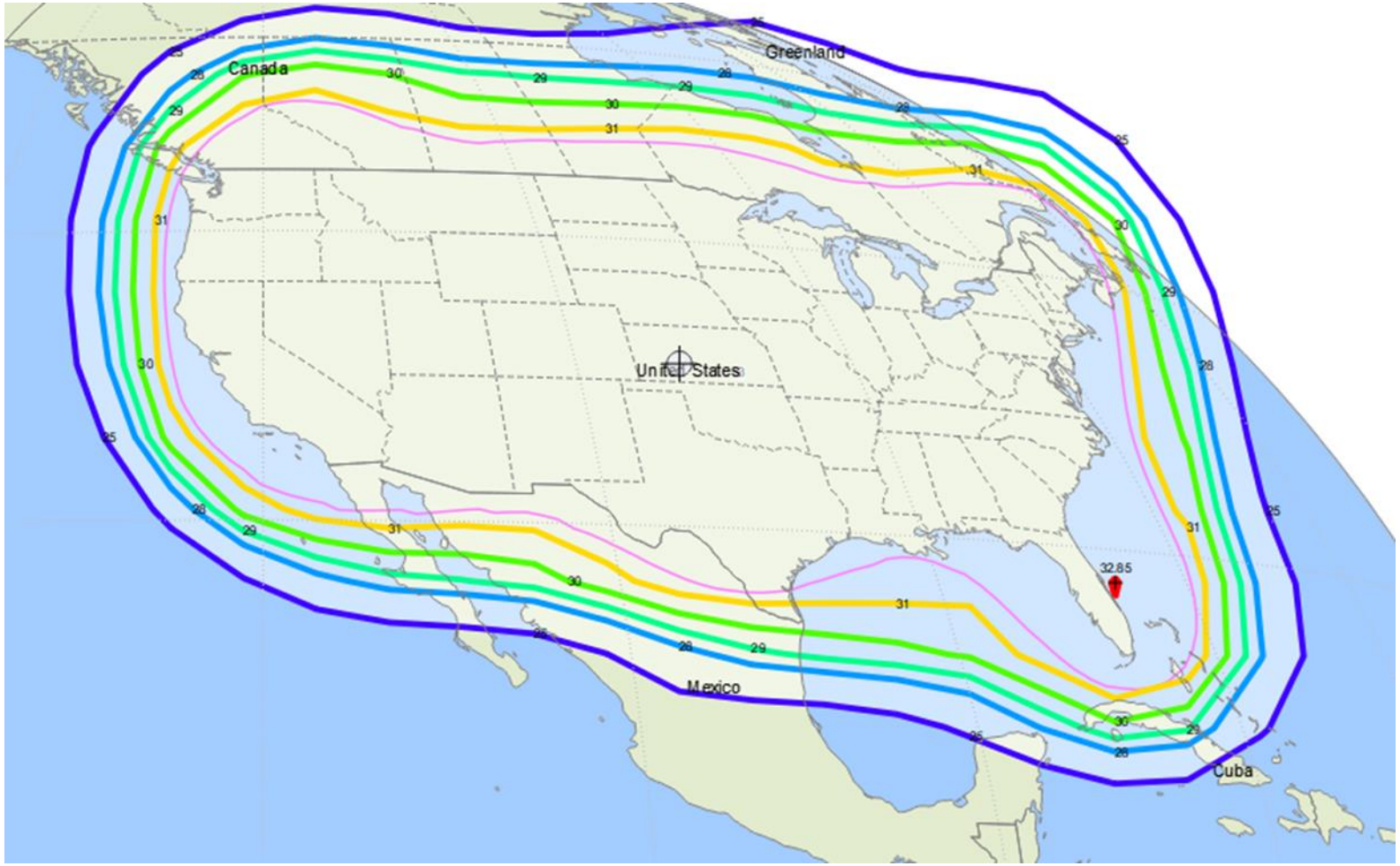


Basically gain of a practical antenna is the ratio of radiated power per unit solid angle in the direction called «u» to the power radiated per unit solid angle by an isotropic antenna powered with the same power.

Half Power Beam width



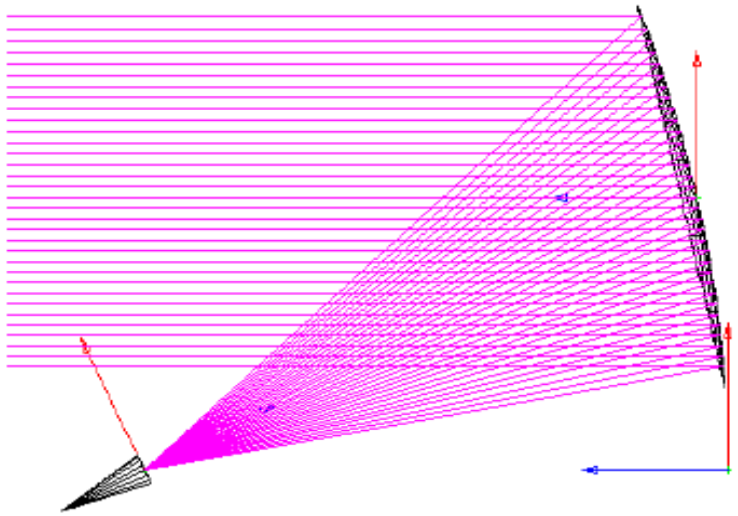
Radiation Pattern



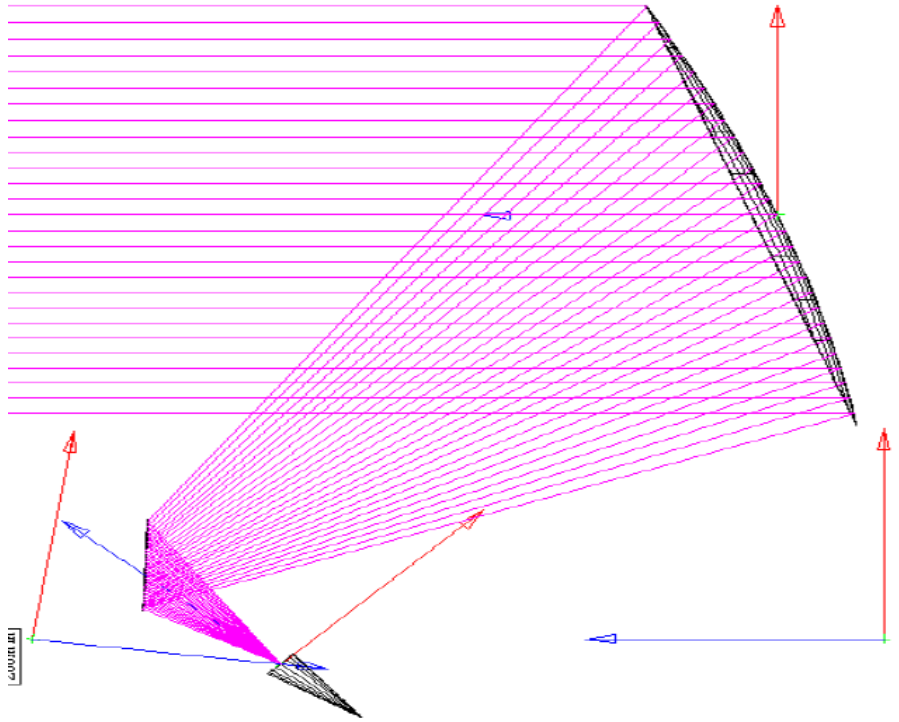
Iso level contour radiation pattern

Reflector Antennas

The role of a 'reflector' is to reflect the wave coming from the feed(transmit antenna or from space for a receive antenna) and modifying the structure of this wave:



a parabolic reflector transforms the spherical wave coming from the feed into a planar wave front in proximity to the reflector (inverse operation in reception).



a hyperbolic/ellipsoid reflector transforms the spherical wave coming from one of its foci into a spherical wave appearing to emerge from the second focus (Cassegrain/Gregorian antenna).

For more detailed info, please contact us:

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ANNEX-1

Detailed Syllabus of Training Modules

1. Introduction to Space Systems and Spacecraft Design (1/3)

Title	Day
❖ **Overview**	**1**
▪ Introduction	
▪ Historical Perspective	
▪ Space Industry Overview	
▪ Space Missions and Orbits	
❖ **Space Missions and Systems**	**1**
▪ The different types of missions and systems	
▪ Orbits	
▪ Systems	
▪ Space Environment, Radiation Analysis	
❖ **Satellite Design**	**5**
▪ Spacecraft System Design, Reliability/Redundancy	
▪ Structure and Material & Mechanism	
▪ Thermal Control System	

1. Introduction to Space Systems and Spacecraft Design (2/3)

Title	Day
▪ Propulsion System	
▪ Launcher and Interface with Satellite	
▪ Attitude Orbit and Control System	
▪ Electrical Power System	
▪ Electromagnetic interference/compatibility	
▪ Satellite Management, On Board Data Handling, FDIR	
▪ RAMS (System Dependability)	
▪ Payload Missions and Types	
▪ Payload Design and Components	
▪ Telemetry/Telecommand/Ranging (TCR)	
▪ CMC, SLCC, museum visit	
❖ **Development & Validation**	**1**
▪ Project & Development Phases	
▪ AIV/AIT	
▪ Quality Assurance & Product Assurance	
▪ Requirement Management & Configuration Management	

1. Introduction to Space Systems and Spacecraft Design (3/3)

Title	Day
❖ **Trends & Future Missions**	**1**
▪ Examples of Spacecraft Design	
▪ Trends for the Future (Satellites and Missions, Subsystems)	
❖ **AIT Visit**	1

2. Introduction to Satellite Communications (1/5)

Title	Day
❖ **Introduction**	**0,5**
▪ Satellite Types	
○ Mission	
○ Orbit Etc.	
▪ Geostationary Satellites	
▪ LEO Satellites	
▪ Ground Stations	
▪ Payload Types	
○ Bent-pipe Payload	
○ Digital Payload	
○ Flexible Payload	
▪ New Generation Satellites	
▪ Fundamentals Components Of Satellite Communication	

2. Introduction to Satellite Communications (2/5)

Title	Day
❖ **Satellite Communications Market And System Factors**	**0,5**
▪ Applications Of Satellite Communication	
○ Data Communication	
○ Broadcasting	
○ VSAT	
▪ Frequency Bands	
▪ Payload Types	
▪ ITU Regulation	
▪ Terminal Types	
▪ Flexible Payload	
▪ Earth Station Design	

2. Introduction to Satellite Communications (3/5)

Title	Day
❖ **Introduction to Digital Communication**	**0,5**
▪ Introduction	
▪ Source/Channel Coding	
▪ Modulation/Demodulation	
▪ Digital Filtering	
▪ DVB Standards	
▪ Link Parameters	
○ Bit Rate	
○ BER	
○ Bandwidth	
○ SNR	

2. Introduction to Satellite Communications (4/5)

Title	Day
❖ **Link Budget**	**0,5**
❖ **RF Architecture**	**1,5**
▪ System concept	
▪ Earth Station/User Terminal	
▪ Satellite Payload	
○ General Payload Architecture	
○ Input Section	
○ Amplificaiton	
○ Output Section	
○ Subconnectors	
○ OBP	

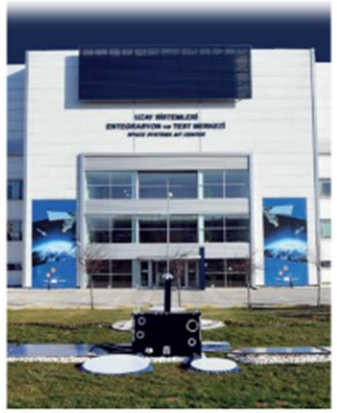
2. Introduction to Satellite Communications (5/5)

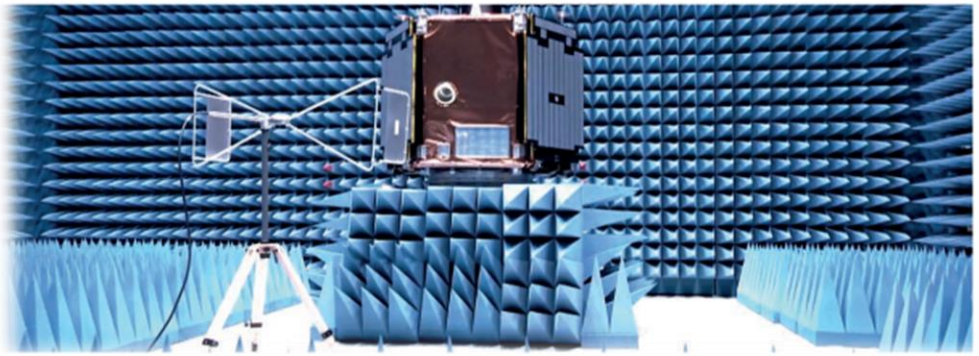
Title	Day
❖ **Antennas**	**0,5**
▪ General Points	
▪ Fundamental Concepts	
▪ Design Constraints	
▪ Reflector Antennas	
▪ Active Antennas	
▪ Feed Horns	
▪ Antenna RF Design Tools	
▪ Radomes&Sunshields	
▪ Technology for reflector and structure	
❖ **Validation**	**0,5**
▪ Ground tests	
▪ Compact antenna tests	
▪ In Orbit Tests	
❖ **Question and answer session, Quiz**	**0,5**

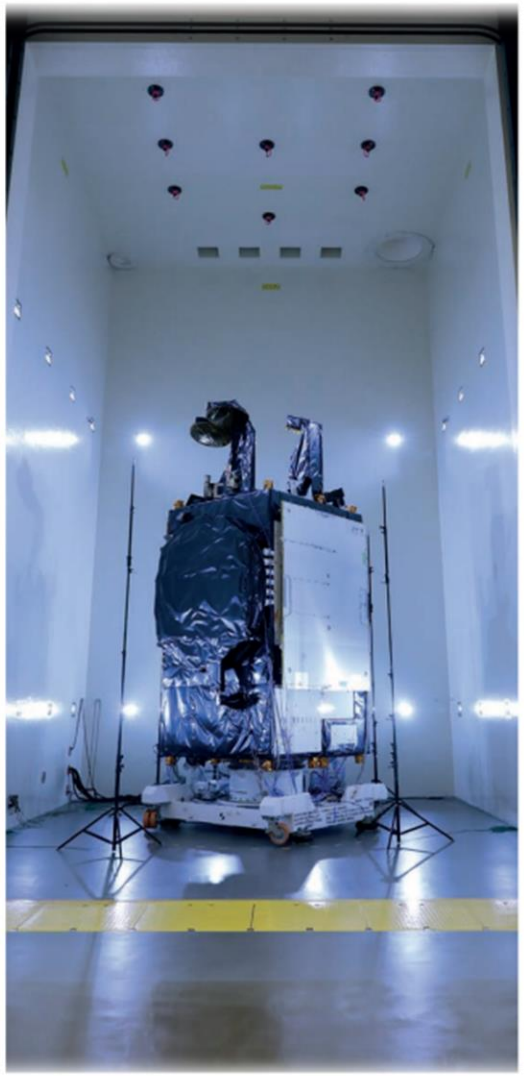
ANNEX-2

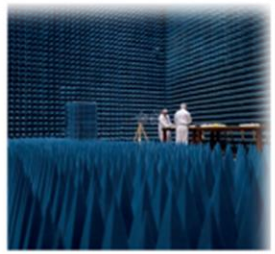
AIT Center and Türksat Museum

AIT Center









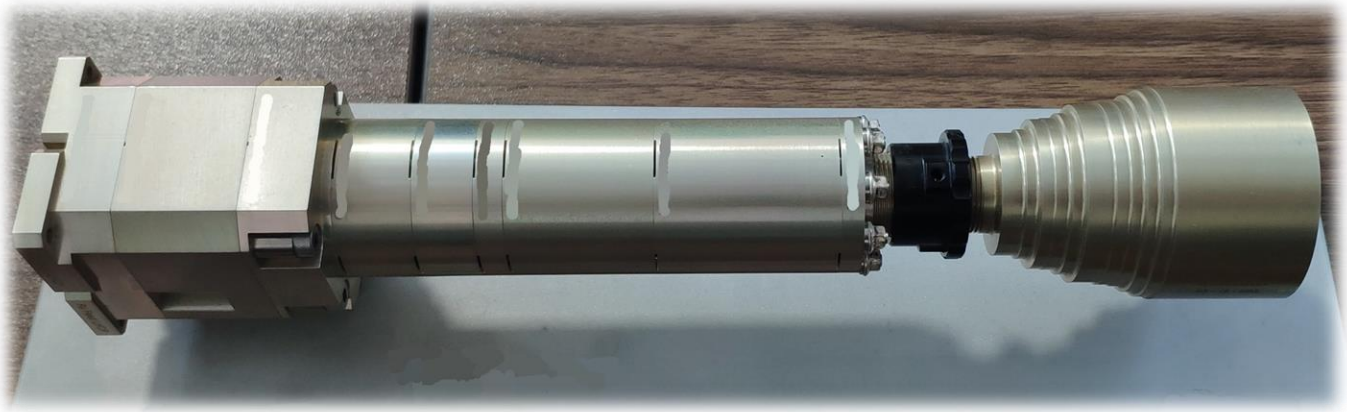
Türksat Museum

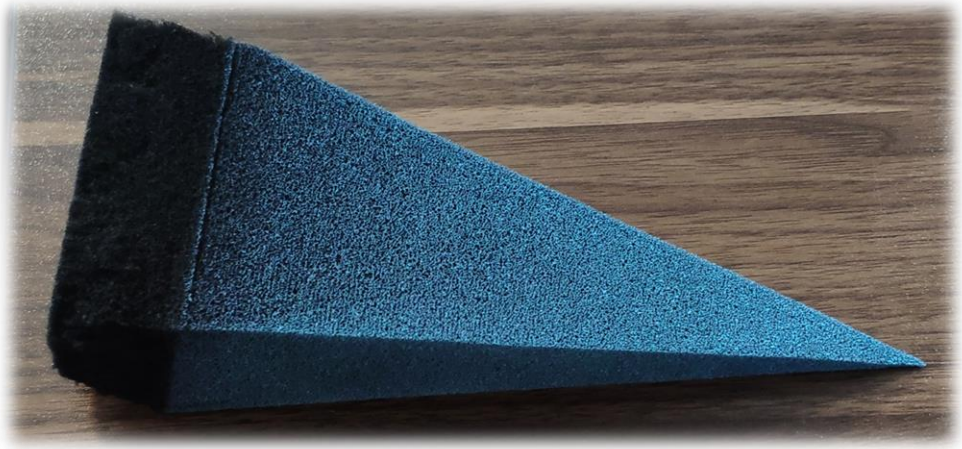
Turksat Museum

ANNEX-3

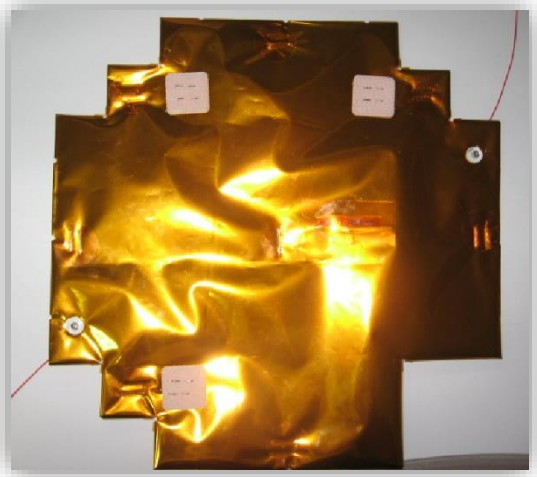
Auxiliary Materials for Training Modules

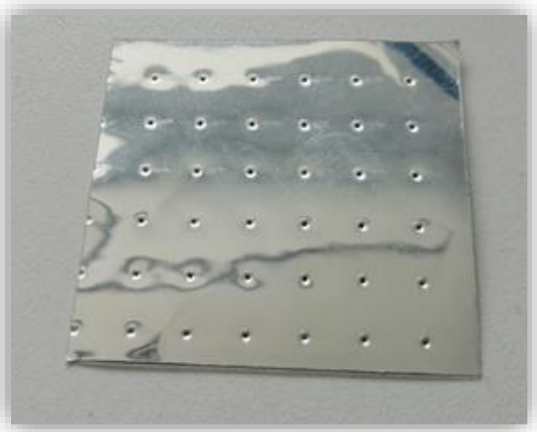
Some components and models for visualization

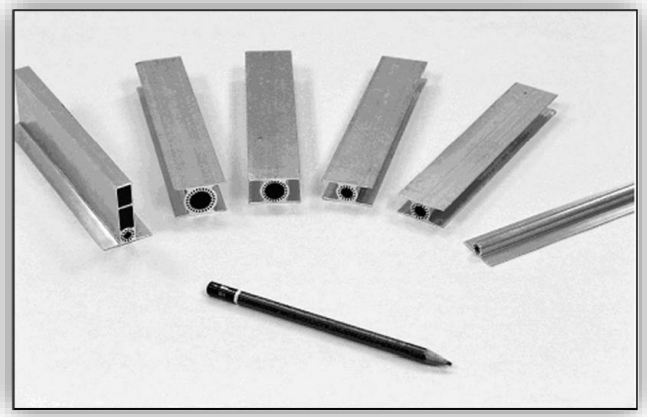




Some components and models for visualization







Some components and models for visualization

Some components and models for visualization