Guide preparation for **Power of air**

Duration: approx. 45 mins **Age group**: suitable for all age groups

Introduction area	Experimental area

Suggested structure & timings

Time	Task	Equipment
10 mins	**Introduction to workshop**: Introduce yourself + general info + goal + CMS video + air pad demo + briefing about trolleys	PowerPoint. 1 air pad + balloon.
Checkpoint 1: No later than 7mins into workshop: go into experimental area.		
Setup of Phase 1: Students take out the 1st tray of student trolley. Guide hands 1 balloon per person and a set of 4 short neck pads per table.		
10 - 15 mins	**Experimental Phase 1 (friction):** Students to explore air pad on different surfaces.	Balloons Short neck pads 1st tray
Setup of Phase 2: Students put 1st tray back in the trolley, then take out the 2nd tray. The balloons and air pads stay out. Guide hands a set of 4 long neck pads per table.		
10 – 15 mins	**Experimental Phase 2 (weight challenge):** Students to balance as much Duplos as possible on air pad.	Balloons Short + long neck pads 2nd tray
OPTIONAL - Setup of Phase 3: *Students put 2nd tray back in trolley, then take out the 3rd tray. The balloons and air pads stay out. Guide takes out tinkering material from teacher trolley.*		
10 mins	***OPTIONAL - Experimental Phase 3 (tinkering):*** *Students to design CMS transport system.*	*Balloons* *Short + long neck pads* *Tinkering materials* *3rd tray*
Tidying up: All air pads go in the "used" tray in the teacher trolley. Students put their balloon in their pocket. All other equipment in the correct tray and back in trolley.		
Checkpoint 2: No later than 35mins into workshop: students should stop & tidy up.		
5 mins	**Guide explanation:** Debrief. What we did today. Link to CERN. Any questions?	PowerPoint.
5 mins	**Large hovercraft demo**	Large hovercraft

Setup of workshop

When you arrive in the labs, the equipment should already have been set up as follows:

1 teacher trolley near the smartboard, containing:

- 1st tray: six sets of 4 short neck pads,
- 2nd tray: six sets of 4 long neck pads,
- 3rd tray: balloons
- 4th tray: "used", where you will put all air pads at the end of the workshop,
- 5th tray: tinkering material (scissors, string, tape).

6 student trolleys (one per table), each containing:

- 1st tray: friction trays, ramp, balloon pump,
- 2nd tray: duplos (about 12),
- 3rd tray: CMS models, other air pads and building equipment.

Suggested Script

Everything written in " " is a suggestion of the type of explanations that can be given, feel free to adapt as required.

Introduction area

<u>Introduction to workshop (no more than 5mins)</u>

➔Introduction of guide(s):
"Welcome to the Science Gateway Labs at CERN! My name is …, I work at CERN …" If possible, either a) explain why you think that science is fun, b) tell something cool about what you do at work, or c) share a story from early high school that motivated you to get a scientific work (ideally from when you were around 12, 13, 14 years old, so that the students can relate to your passion for science).

➔**General info**: "In case of an alarm, you will leave your belongings here and follow us down the stairs, as you may have practiced at school. We will take you outside to the nearest assembly point. We ask you not to eat or drink in the experimental area - the area with the tables over there. Feel free to take pictures if you want."

➔ **Goal of the workshop**: “During this workshop we will try to exploit the power of air to move heavy things. That is very similar to what the scientists at CERN are doing. They are using pressurised air to open and close their detectors.”

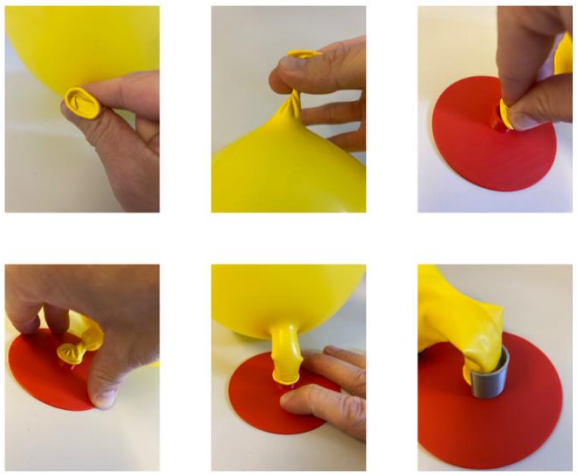
➔**Video**: *Theatrical/Mysterious* “We have huge detectors at CERN. We move them using nothing but air despite them being very heavy. How heavy do you think 1 slice is?… Up to 1500 tonnes, which weighs the same as 500 elephants!” You show them the video – stop&go depending on whether you want to talk throughout or not.

➔**Air pads demo:** “In a minute, everybody is going to receive 1 balloon each. You will only get 1 balloon each. If you decide to break it, you might not be able to continue doing all the activities in the workshop, so be careful with this.”

Secret Rule: There is not really a per person limit, but watch out for students that break many (more than 2 balloons damaged is not really ok / suggests they are not following instructions). When a balloon breaks, make sure to tell the person that the next balloon will be the last one they get, otherwise they have to collaborate in another way for the rest of the session. We suggest you carry extra balloons in your pocket to just hand out on an individual basis.

Show them operating instructions only once: “You need to pay attention now, as I will train you on how to operate these lab air pads exactly once!”

1. Blow up balloon
2. While in mouth, close off with fingers, then TWIST to prevent air from escaping
3. Slide over the air pad lip, while holding air pad down with a few fingers.
4. Place on table – “only when you are ready for an experiment, let go”
5. Show how to be careful when removing balloon so as not to tear the balloon.
6. OPTIONAL : add grey/silver ‘neck support’ to balloon, available in 2 sizes.



➔**Briefing about trolleys:** “Next to each table, there is a trolley in which you will find all the equipment you need. For each phase of the workshop, we will ask you to take out a specific

tray and to put it on the table. At the end of the task, you will need to put it back before moving on."

Experimental area

Set up of Phase 1 (You can give the instructions while still in the intro area)

Students will take out the 1st tray of student trolley. Guide will give 1 balloon per person and a set of 4 short neck pads per table.

"First task will be to investigate whether there are differences between the air pads and which surface the different air pads slide on best! You can then try on the surfaces with and without the balloon and use these ramps if you like."

"Any questions? Otherwise, team up and get started."

Experimental phase 1 (friction)

Your main role as guide is to go around and check whether students are able to:

- Blow up & attach balloons as instructed
- Help with set-up & experimentation
- Go around and discuss with students:
  "Did you notice any differences between air pads?" "How does this affect the ability to glide?" (Hint: lasts longer, able to go over rougher surfaces, more stable…)
- Keep time and launch Phase 2 after 10mins.

For your reference – for 1 deep breath average inflated balloon and no load on air pad:

Air pad hole diameter (mm)	Approximate deflation time
1 •	2-5mins
2 ●	1min
3 ●	20-30s
10 ●	5-10s

Set up of Phase 2

Options: you can either ask for everyone attention or give your instructions to each table separately.
Students must get all equipment (except for balloons and air pads) back in 1st tray and put it back in the trolley, then take out the 2nd tray. The guide hands a set of 4 long neck pads per table.

"Second task will be a weight challenge. Your job will be to carry as much weight as possible with the air pad (in the form of DUPLO bricks) and make it go 1m across the table without falling off."

Experimental phase 2 (weight challenge)

Let the students try and load as many duplos as they can on the air pads. You can suggest them to try air pads with different sizes of holes and necks, or to team up to craft a multi-hovercrafts system…

OPTIONAL - Set up of Phase 3

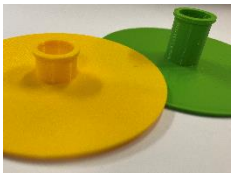
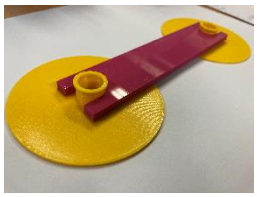
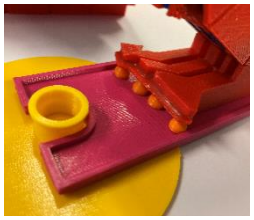
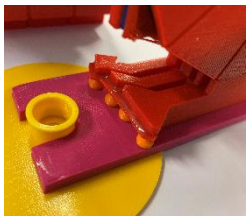
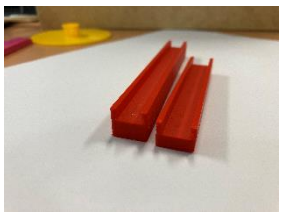
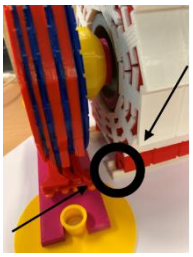
Students put duplos back in the 2nd tray, and back in the trolley, then take out the 3rd tray. The balloons and air pads stay out. Guide takes out tinkering material. Present 3D printed detectors, ***mention they are fragile****.*

"Third task will be to try and design a system that will lift the CMS model so that you can close it. You can use all the equipment from the third tray, as well as the air pads that you already have." You can show them the slide with the picture of a CMS model closing system to inspire them. Tell students not to waste excessive material (i.e. only use a small amount of tape, only cut as much wire/rope/line as you need).

OPTIONAL - Experimental phase 3 (tinkering)

Let them tinker and find their own solutions to move the CMS. Students should try and figure most things out themselves and be creative, so try to refrain from guiding them too much and do not try to solve their problems for them.

Quick overview of available materials & hints for guides

Challenges	Hints & pointers	Photos
Choice of neck size	Longer necks are easier	
Assembly of platform	Longest connector pieces are best. Simple designs work well.	 
Alignment challenge 1	2 main options to place connectors. The left option shown leaves CMS more stable.	 
Alignment challenge 2	CMS needs to be raised using these pieces to align. Pieces exist in different heights & lengths.	 
Attachment challenge	Attaching string to air pads directly is easier than to CMS model, which is more fiddly.	

Tidying up:

Approx. 10 minutes before the end of the time, ask everyone to tidy up their spot.

- All pads go in the "used" tray in the teacher trolley.
- Students put their balloon in their pocket – they can take it home.
- All other equipment goes back in the correct tray and back in student trolley.

Then everyone moves on to the discussion area.

Introduction area

Guide explanation

Main points to point out and for them to understand:

"Engineers and Physicists come up with beautiful solutions to all sorts of problems. It is a team effort. When a system is designed well, it just works. It requires some creativity and sometimes thinking outside of the box, but great innovations can be as simple as using the power of air to move really heavy things."

"Friction happens because surfaces are not completed smooth. Even if they look smooth to our eyes, if we look closely, we will see tiny bumps and roughness. When two surfaces rub against each other, these little bumps get stuck together and make it harder to move."

"The air cushion below slightly lifts the air pad and reduces friction. This is why it is then so easy to move heavy things with just a small amount of force."

Large hovercraft demo

"There is a limit to how much air pads can carry, and it depends on the flow rate or pressure of air: The pressure of the balloon is not enough to lift a person, but the pressure from a leaf blower is. We have got one last surprise for you – your teacher will get the chance to experience our DIY air pad."

We recommend you don't let a student go on the hovercraft – the other ones will think it is unfair. You can ask the teacher if they want to try, else one of the guides can do the demo. The other guide then gently pushes the hovercraft around. Make sure that the following rules are applied:

- 1 person at a time on air pad.
- The person on the air pad must be seated.

"This air pad is not enough to move the detectors, but it works on the same principle!"

A few tips and suggestions:

1) Make sure everyone can see the demos – tell students to come closer if needed.

2) Insist on the importance of tidying up correctly between each phase. Since workshops might be scheduled back-to-back, the trolleys need to stay as organized as possible.

3) During the hands-on part: if you feel that the table-to-table interaction takes too much time, you can ask for everyone's attention and give instructions to the entire group instead.

4) If students don't listen to your instructions because they are too busy playing with the balloons and air pads: "Everyone put their balloon on the table and their hands behind their back (or on their head)!".

5) If some students seem to lose interest or struggle to focus, you can try and give them specific responsibilities: "Go check which team managed to get the most duplos on an air pad and come back to tell me", "You are in charge of getting the tinkering material for your team", "I need your help to go and hand four of these air pads to each table, in the right color", etc.